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Northeastern Area State and Private Forestry

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Christmas Tree Pest Manual

Second Edition

MICHIGAN STATE UNIVERISTY EXTENSION

Acknowledgments

First Edition: This manual was originally developed as part of a Forest Service technology transfer designed to get research findings off the shelf and into the hands of people who need them. A team of scientists and pest specialists worked with a writer/editor to summarize and compile more than 10 years of research on Christmas tree pests and their control. Much of this research was conducted at the North Central Forest Experiment Station, headquartered in St. Paul, Minnesota. The first edition of this manual was published in 1983.

Contributors to the first edition from the station were: Thomas H. Nicholls, Principal Plant Pathologist; Louis F. Wilson, Principal Insect Ecologist; Darroll D. Skilling, Principal Plant Pathologist; and Marguerita A. Palmer, Associate Plant Pathologist. Contributors from Northeastern Area State and Private Forestry were: M. Kathryn Robbins, Plant Pathologist; and Peter A. Rush, Entomologist. Advisors to the Working Group included: Roger W. Leonard, Assistant Director for Research Planning and Application, North Central Forest Experiment Station; Robert D. Wray, Leader, Information Services, North Central Forest Experiment Station; James B. Hanson, State and Private Forestry Field Representative, Forest Pest Management; and Harold G. Marx, Technology Application Specialist, Washington Office, State and Private Forestry. Janine M. Benyus edited the first edition.

The following people reviewed the first edition: Michael R. Carroll, Minnesota Department of Natural Resources; Gordon R. Cunningham, University of Wisconsin; Patricia E. Gowen, Missouri Department of Conservation; Melvin R. Koelling, Michigan State University; William Merrill, Jr., Pennsylvania State University; Daniel G. Mosher, Michigan Department of Natural Resources; David J. Shetlar, Pennsylvania State University; Gary A. Simmons, Michigan State University; and the following members of the Minnesota Christmas Tree Growers Association: Charles O. Bork, Roger W. Conklin, John W. Donelson, Kenneth E. Goserud, Brad L.R. Johnson, and Thomas Wolcyn.

Second Edition: In 1997 and 1998, the manual was intensively reviewed by entomologists and pathologists at Michigan State University, Northeastern Area State and Private Forestry, the Wisconsin Department of Natural Resources, and the North Central Forest Experiment Station. New information acquired from recent research was added. Minor changes in the format were made to make it easier for readers to use the manual. One important change is that pesticide products have not been included in the new edition. Product registrations vary among states and change frequently, and new products become available each year. Readers are encouraged to consult county Extension offices, regulatory agencies, and regional or state Extension publications for up-to-date pesticide information.

Contributors to the second edition are: Deborah McCullough, Michigan State University; Steven Katovich, Northeastern Area State and Private Forestry; Mike Ostry, North Central Forest Experiment Station; Jane Cummings-Carlson, Wisconsin Department of Natural Resources; Glenn Dudderar, Michigan State University; Paula Kleintjes, University of Wisconsin, Eau Claire; Mike Albers and Jana Albers, Minnesota Department of Natural Resources; and Frank Sapio, Michigan Department of Natural Resources. The assistance provided by Alice Kenady, Department of Entomology, Michigan State University, is gratefully acknowledged.

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How to Identify and Control Pests:

Needle Feeding

Shoot/Branch Injury

Common Name **Scientific Name**

Pests

Adana tip moth	*Rhyacionia adana* Heinrich
Allegheny mound ant	*Formica exsectoides* Forel
aphids (also see spotted pine aphid; white pine aphid)	*Cinara* spp.
Anomala beetle-see pine chafer	
Armillaria root rot	*Armillaria* spp.
bagworm	*Thyridopteryx ephemeraeformis* (Haworth)
balsam fir needle rust	*Uredinopsis* spp. and *Milesina* spp.
balsam gall midge	*Paradiplosis tumifex* Gagne
balsam twig aphid	*Mindarus abietinus* Koch
broom rust of fir	*Melampsorella caryophyllacearum* J. Schrot
brown spot needle blight	*Mycosphaerella dearnessii* M.E. Barr
cedar-apple rust	*Gymnosporangium juniperi-virginianae* Schwein
Cooley spruce gall adelgid	*Adelges cooleyi* (Gillette)
Cyclaneusma needlecast (=Naemacyclus)	*Cyclaneusma minus* (Butin) DiCosmo, Peredoand Minter
Cytospora canker (=Valsa canker) - see Leucostoma canker	
deer	*Odocoileus virginianus* Miller
Diplodia shoot blight and canker-see Sphaeropsis shoot blight	
Dothistroma needle blight	*Mycosphaerella pini* Rostr.
eastern gall rust	*Cronartium quercuum* (Berk.) Miyabe ex. Shirai,
eastern pine shoot borer	*Eucosma gloriola* Heinrich
eastern spruce gall adelgid	*Adelges abietis* L.
eriophyid mites	*Setoptus* spp.
European pine sawfly	*Neodiprion sertifer* (Geoffroy)
European pine shoot moth	*Rhyacionia buoliana* (Denis & Schiffermuller)
grasshoppers	*Melanoplus* spp.
green spruce needleminer	*Epinotia nanana* (Treitschke)
Gremmeniella canker-see Scleroderris canker	
gypsy moth	*Lymantria dispar* L.
hare, snowshoe	*Lepus americanus* Erxleben
introduced pine sawfly	*Diprion similis* (Hartig)
jack pine budworm	*Choristoneura pinus pinus* Freeman
jack pine tip beetle	*Conopthorus banksianae* McPherson
juniper webworm	*Dichomeris marginella* (Fabricius)
Leucostoma canker	*Leucostoma kunzei* (Fr.:Fr.) Munk
Lirula needlecast	*Lirula nervata* (Darker) Darker
	Lirula mirabilis (Darker) Darker
Lophodermium needlecast	*Lophodermium seditiosum* Minter, Staley and Millar
meadow vole (mouse)	*Microtus pennsylvanicus* (Ord)

Naemacyclus needlecast-see Cyclaneusma needlecast	*Rhyacionia frustrana* (Comstock)
Nantucket pine tip moth	*Pissodes approximatus* Hopkins
northern pine weevil	*Petrova albicapitana* (Busck)
northern pitch twig moth	*Hylobius pales* (Herbst)
Pales weevil	*Phytophthora cinnamomi* Rands; Phytophthora spp.
Phytophthora root rot	
pine bark adelgid	*Pineus strobi* (Hartig)
pine chafer (Anomala beetle)	*Anomala oblivia* Horn
pine false webworm	*Acantholyda erythrocephala* (L.)
pine grosbeak	*Pinicola emicleator lecura* (Müller)
pine needle midge	*Contarinia baeri* (Prell)
pine needle rust	*Coleosporium asterum* (Diet.) Syd and P. Syd
pine needle scale	*Chionaspis pinifoliae* (Fitch)
pine root collar weevil	*Hylobius radicis* (Buchanan)
pine root tip weevil	*Hylobius rhizophagus* Millers, Benjamin, & Wagner

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INDEX A —— Common and Scientific Names

Common Name	Scientific Name
pine shoot beetle	*Tomicus piniperda* L.
pine spittlebug	*Aphrophora parallela* (Say)
pine thrips	*Gnophothrips* spp.
pine tortoise scale	*Toumeyella parvicornis* (Cockerell)
pine tube moth	*Argyrotaenia pinatubana* (Kearfott)
pine tussock moth	*Dasychira pinicola* (Dyar)
pine vole	*Microtus pinetorum* (Le Conte)
pine webworm	*Tetralopha robustella* Zeller
pine wood nematode	*Bursaphelenchus xylophilus* (Steiner & Buhrer) Nickle
pitch nodule maker-see northern pitch twig moth	
pocket gopher	*Geomys bursarius* (Shaw)

porcupine	*Erithizon dorsatum* L.
rabbit, cottontail	*Sylvilagus floridanus* (J.A. Allen)
redheaded pine sawfly	*Neodiprion lecontei* (Fitch)
Rhabdocline needlecast	*Rhabdocline pseudotsugae* Syd.
Rhizosphaera needle blight of firs	*Rhizosphaera pini* (Corda) Maubl.
Rhizosphaera needlecast of spruce	*Rhizosphaera kalkhoffii* Bubak
Saratoga spittlebug	*Aphrophora saratogensis* (Fitch)
Scleroderris canker (=Gremmeniella canker)	*Gremmeniella abietina* (Lagerb.) M. Morelet
Sphaeropsis shoot blight and canker (=Diplodia)	*Sphaeropsis sapinea* (Fr.:Fr.) Dyko and B. Sutton
spotted pine aphid	*Eulachnus agilis* (Kaltenbach)
spruce bud scale	*Physokermes piceae* (Schrank)
spruce budworm	*Choristoneura fumiferana* (Clemens)
spruce needleminer	*Endothenia albolineana* (Kearfott)
spruce needle rusts	*Chrysomyxa* spp.
spruce spider mite	*Oligonychus ununguis* (Jacobi)
Swiss needlecast	*Phaeocryptopus gäumanni* (T. Rohde) Petr.
thirteen-lined ground squirrel	*Spermophilus tridecemlineatus* (Mitchell)
webworms-see juniper webworm, pine false webworm, and pine webworm	
western gall rust	*Endocronartium harknessii* (J.P. Moore) Y. Hiratsuka
white grubs	*Phyllophaga* spp.
white pine aphid	*Cinara strobi* (Fitch)
white pine blister rust	*Cronartium ribicola* J.C. Fisch.
white pine weevil	*Pissodes strobi* (Peck)
wood borers and bark beetles	*Monochamus* spp., etc.; Ips spp.
yellow-bellied sapsucker	*Sphrapicus varius* L
Zimmerman pine moth	*Dioryctria zimmermani* (Grote)
Trees	
Austrian pine	*Pinus nigra* Arnold
balsam fir	*Abies balsamea* (L.) Mill.
Black Hills spruce	*Picea glauca* (Moench) Voss
Colorado blue spruce	*Picea pungens* (Engelm.)
Douglas-fir	*Pseudotsuga menziesii* (Mirb.) Franco.
eastern red cedar	*Juniperus virginiana* (L.)
eastern white pine	*Pinus strobus* (L.)
Englemann spruce	*Picea engelmannii* Parry ex Engelm.
Fraser fir	*Abies fraseri* (Pursh) Poir.
Norway spruce	*Picea abies* (L.) Karst.
red pine	*Pinus resinosa* Ait.
Scotch pine	*Pinus sylvestris* L.
Sitka spruce	*Picea sitchensis* (Bong.) Carr.
white fir	*Abies concolor* (Gord. & Glend.) Lindl. ex Hildebr.

white spruce Picea glauca (Moench) Voss

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INDEX B — Major Insect Pests and Diseases by Tree Species

Tree Species	Pests
Douglas-fir	Allegheny mound ant, aphids, bagworm, bark beetles, Cooley spruce gall adelgid, eastern pine shoot borer, grasshoppers, gypsy moth, mites, Pales weevil, pine needle scale, spruce budworm, white pine weevil, wood borers Armillaria root rot, Rhabdocline needlecast, Swiss needlecast
Eastern red cedar	Allegheny mound ant, aphids, bagworm, bark beetles, grasshoppers, gypsy moth, juniper webworm, pine needle scale, spruce spider mites, white grubs, wood borers Armillaria root rot, cedar-apple rust
All Firs:	*balsam, Fraser, white (concolor)* Allegheny mound ant, aphids, bagworm, balsam gall midge, balsam twig aphid, grasshoppers, gypsy moth, Pales weevil, spider mites, spruce budworm, white grubs, wood borers Armillaria root rot, balsam fir needle rust, Lirula needlecast diseases, Rhizosphaera needle blight

All Pines: *Austrian, eastern white, red, and Scotch*

Allegheny mound ant, aphids, bark beetles, eastern pine shoot borer, eriophyid mites, grasshoppers, gypsy moth, introduced pine sawfly, mites, jack pine budworm, northern pine weevil, northern pitch twig moth, Pales weevil, pine chafer (Anomala beetle), pine needle scale, pine root collar weevil, pine shoot beetle, pine thrips, pine tortoise scale, pine webworm, redheaded pine sawfly, spider mites, webworms, white grubs, white pine weevil, wood borers, Zimmerman pine moth

Armillaria root rot, pine wood nematode, Scleroderris canker

Austrian

Adana tip moth, European pine sawfly, European pine shoot moth, Nantucket pine tip moth

Dothistroma needle blight, Sphaeropsis (=Diplodia) shoot blight and canker

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Eastern White

bagworm, pine bark adelgid, pine root tip weevil, pine tube moth

white pine blister rust

Red

Adana tip moth, European pine sawfly, European pine shoot moth, jack pine tip beetle, Nantucket pine tip moth, pine needle midge, pine root tip weevil

Lophodermium needlecast, pine needle rust, Sphaeropsis (=Diplodia) shoot blight and canker

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Scotch

Adana tip moth, European pine sawfly, jack pine tip beetle, Nantucket pine tip moth, pine needle midge, pine root tip weevil

brown spot needle blight, Cyclaneusma (=Naemacyclus) needlecast, Lophodermium needlecast, pine needle rust, Sphaeropsis (=Diplodia) shoot blight and canker, pine-oak gall rust, pine-pine gall rust

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All Spruce:	*Colorado blue, Englemann, Norway, Sitka, white, and Black Hills* Allegheny mound ants, aphids, bagworm, bark beetles, grasshoppers, gypsy moth, northern pine weevil, Pales weevil, pine needle scale, spruce bud scale, spruce budworm, spruce needle miners, spruce spider mites, white grubs, white pine weevil, wood borers Armillaria root rot, Leucostoma (=Cytospora) canker
Colorado blue	Cooley spruce gall adelgid Rhizosphaera needlecast, spruce needle rusts
Engelmann	Cooley spruce gall adelgid
Sitka	Cooley spruce gall adelgid
White and Black Hills	Eastern spruce gall adelgid, eastern pine shoot borer Rhizosphaera needlecast, spruce needle rusts

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CHRISTMAS TREE PEST MANUAL

It's updated, reprinted, and ***available now!***

Information on the biology and signs or symptoms of damage will help you determine which pest is affecting your trees.

Since 1983, this has been an important resource for anyone who manages conifer trees, including Christmas tree growers, landscapers, and foresters.

Suggestions are provided to help you monitor pest populations and then select an appropriate control method.

This 143 page manual includes over *250 color photos of damage* caused by insects, disease, mice and other animals, and abiotic damage such as injury from frost, salt or herbicides. More than 75 pests are covered, including several pests *new this edition*. The Christmas Tree Pest Manual has also been re-formated to be easier to use.

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Christmas Tree Pest Manual

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HOW TO USE THIS MANUAL/INTRODUCTION

How to Use This Manual

This manual can help you identify and control damaging Christmas tree pests in the North Central region of the United States. Most of the information also applies to the northeastern states and to the southern portions of the Canadian Provinces that border these states.

You do not have to be a pest specialist to use this information; we wrote the manual in everyday language so that anyone with an interest in Christmas trees can read and understand it. Because it is meant to be a tool and not a textbook, we included only what you need to know to solve pest problems in your nursery or plantation.

In addition to the illustrated pest profiles, you will find plenty of practical advice on
- how to look for and recognize potential pests
- how to select, plant, and care for trees so they are less likely to be damaged by pests
- how to keep pest numbers at harmless levels

These techniques work to discourage pests and prevent them from causing serious damage. We encourage you to read the opening sections of the manual and become familiar with potential pests before they have a chance to build up on your trees.

Carry the manual with you when you inspect your nursery or plantation. If you notice anything out of the ordinary, turn to the “How to Identify and Control Pests” section. This section can help you diagnose tree injury in much the same way that a doctor diagnoses an illness—by working backwards from the symptoms to the cause. All you need to know is the tree species injured and what the injury looks like. Then simply follow six steps:

1. Decide what kind of injury your tree has.


needle discoloration


needle feeding


shoot/branch injury


shoot/branch galls


dead tree and stem/ root injury

Turn to the appropriate section in the manual. Check your selection by comparing the injury with the description on the first page of the section.

2. Leaf through that section, checking for your species on the lower outside corners of the pages.
These pages contain photos and descriptions of the pests. The tree species affected by each pest are also listed.

3. Now, sort through the pests that attack your species and find the photos that most closely match the damage you see on your trees.
When you are pretty sure that you have found the culprit, double check it against the “**pests that cause similar symptoms**” list at the end of each pest description. If you have any doubts about identification, you can send samples of the pest and the injured tree parts to your local pest specialist (see “How to Submit Material for Identification”).

4. Finally, review the symptoms and signs listed under “Look For.”
You can identify most pests by the clues they leave or by the kind of injury they cause. These symptoms and signs are highlighted in italic type and grouped by the time of year they are most likely to be seen (timing may vary with geographic location). Features visible year around are listed first, without a calendar heading. Pests are also described in terms of their importance, biology, and other characteristics.

5. Decide whether control is needed.
The "Monitoring and Control" section for each pest can help you measure the amount of pest activity on your trees and help you decide how much control, if any, is needed. Before you begin any pest control

treatment, ask yourself whether the value of the benefits will exceed the cost of the treatment. In short, will it pay? You may want to contact a pest specialist to help you predict and estimate damage. (See "How to Submit Materials for Identification.")

6. Select control methods.
In the "Monitoring and Control" section for each pest, recommended management and control techniques are divided into a section that provides suggestions to help prevent or reduce pest problems on established seedlings and trees now growing in your nursery or plantation. "Next Crop" controls can help you guard against pest problems on trees the next time you plant.

What is a Pest?

A pest is something that gets in the way of what people want to do. In the Christmas tree business, the goal is to harvest healthy looking, high-quality trees. Insects, diseases, animals, birds, and environmental factors that destroy or damage those trees are therefore considered pests. In their natural settings, these "pests" may be relatively harmless or perhaps even beneficial. In intensively managed nurseries and plantations, however, they can be undesirable and may require prevention or control. The pests in this manual fall into four groups

- insects
- fungi and nematodes
- birds and mammals
- environmental factors.

The more you know about them, the better able you are to solve pest problems in your nursery or plantation. This section briefly describes how these pests grow, reproduce, and affect Christmas trees. For more information about the biology or characteristics of a given species, see the "How to Identify and Control Pests" section.

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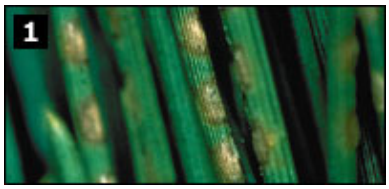
INTRODUCTION

Insects
Insects and their close relatives, mites, are the most common pests of Christmas trees. This manual lists the major ones, but there are many others that may cause minor injury to your trees.

When abundant, insects can cause costly injury at various times in a tree's growing cycle. Seedlings and young trees are particularly vulnerable because it takes only a few insects to injure or kill them.

However, older trees may also be injured when insects are numerous.



Insects damage Christmas trees in many ways. They can chew on or inside the needles or tunnel inside the shoots and trunk. Some insects suck sap from the needles, buds, or stems, weakening or killing the tree. Others cause swellings, or galls to form, and a few spread disease organisms directly or indirectly while feeding.

Insects are one of those unique groups of organisms that change form at least once during their lifetime. This is important to you as a Christmas tree grower because different insect forms cause different kinds of damage. For example, the larval form of one species may

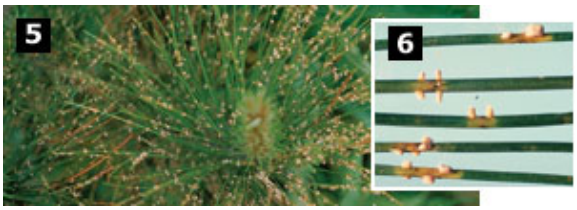
cause serious injury to a certain tree species while the adult form is perfectly harmless.

The simplest kind of change, or metamorphosis, starts when a nymph (a miniature copy of the adult) hatches from an egg and then sheds its skin, or molts, several times before maturing into an adult. Pests that have this simple metamorphosis include grasshoppers, thrips, spittlebugs, aphids and mites.

More complex, or complete, metamorphosis proceeds from the egg through larval, pupal, and adult stages. Like nymphs, larvae must molt several times before reaching the pupal stage. Each stage is greatly different in form from previous stages. Common insects with complete metamorphosis are beetles, weevils, moths, midges, and sawflies.

In both cases, the adults mate, produce eggs, and start the process over again. Most Christmas tree insect pests have one generation a year. Some insects and mites, however, may have two or more generations each year.

Four stages in the life of a sawfly: **1.** eggs, **2.** larva, **3.** pupa, and **4.** adult. **5 & 6:** Spore-filled fruitbodies erupt from needles infected with pine needle rust.



Fungi and Nematodes

Fungi and nematodes cause disease in trees. A diseased tree may develop abnormal swellings, galls, or deformed needles. Other evidence of disease includes discolored foliage, early needle drop, crooks, wilting, and cankers.

Fungi cause the majority of diseases of Christmas trees. A diseased tree infected with fungi may have a wide range of symptoms, such as abnormal swellings on the branches, discolored needles, needlecast or dropping of needles, pustules or blisters on the foliage, curling of the growing shoots, and cankers. Fungi are simple plants that can live on other living organisms; they do not have food-making chlorophyll of their own.

Fungi reproduce by means of spores — the fungal equivalent of seeds. Spores are produced in a wide variety of fungal “fruitbodies.” Some fungal spores are wind-blown and can spread quickly; other spores are carried in rain water and move only as far as raindrops are splashed or blown. Spores can also be transported on equipment, such as shearing knives, and on infected plant material.

Nematodes are members of a group of animals known as roundworms—long, worm-like animals tapered at both ends. Nematodes feed by puncturing tree cells with their hollow feeding tube and sucking out the cell contents. They hatch from eggs and pass through several larval stages when developing. Some nematodes that injure Christmas trees are carried from tree to tree by insects.

Birds and Mammals

Some birds and mammals will also injure Christmas trees. Pine grosbeaks eat buds and yellow-bellied sapsuckers peck holes in tree stems. Although birds usually cause only minor problems, they can sometimes cause enough injury to degrade trees.

Deer nip shoots and seedlings, occasionally causing important damage. Voles, rabbits, and gophers will chew the bark of stems or roots and can readily kill trees. Losses can sometimes be severe.

Environmental Factors

Some environmental factors that can injure Christmas trees either directly or indirectly are poor soil, extreme weather, and toxic chemicals, such as air pollutants, pesticides, salt, and excessive amounts of fertilizer. Disorders caused by these factors cannot spread from one tree to another like diseases.

1. Yellow-bellied sapsucker
2. White-tailed deer
3. Pine Voles
4. Tree girdled by voles
5. Thirteen-lined ground squirrel

Right: Air pollutants can discolor needles and lower the value of Christmas trees.

A Pest Management Primer


Before replanting, destroy unsalable trees and old stumps that may harbor pests.

Pest prevention begins before you plant your first tree and extends through harvest time. In fact, everything you do to your plantation, from selecting a species and preparing the site to cultivating, shearing, and beyond, has some bearing on pests.

For many years, pest control meant reaching for the pesticide sprayer anytime a spot or an insect appeared on a tree. Trying to kill every last pest was not only costly, but also environmentally reckless. Today, the goal is to reduce pest losses to a tolerable level by using a variety of control methods. Emphasis is on cultural and biological treatments, supplemented only when necessary by chemicals. Using all available pest control strategies in a complementary way is called IPM—Integrated Pest Management. Four general steps are involved in IPM.

Step 1. Plant the Right Species on the Right Site.

Choosing Your Trees


Two varieties of Scotch pine after a severe Wisconsin winter. The long-needled variety (left) is more resistant to winter injury than the short-needled variety (right).

Ideally, the species you plant should grow well on your site, be somewhat resistant to pests, and give a good return on your investment. Other important traits are form, hardiness, growth rate, and color at harvest time. Scotch pine has been popular because it has many favorable qualities, but also consider several other pines, spruces, firs, and eastern red cedar, especially if your site is better suited to them.

Because Scotch pine was a favored Christmas tree species for many years, several varieties have been developed to enhance certain genetic qualities. Some of these qualities relate to pest resistance. So if you are planning to plant Scotch pine, check with local growers and Extension agents for the pests most common to your area. Then use the table on the next page to select a variety that is most resistant to those pests.

Preparing the Site

Careful site preparation is another essential part of pest management. Poorly prepared planting sites put stress on trees, and stress invariably leads to pest problems.

If you are planting on a new site that has not had Christmas trees on it before, it is usually a good idea to

cultivate or treat the site with herbicides to remove vegetation that may compete with the seedlings for light, water, or nutrients. Using herbicides in the fall of the year, before planting, will also leave dead vegetation on the site that will hold the soil and reduce erosion. By controlling weeds and grasses after planting, you can continue to keep competition down, reduce mammal habitat, increase air flow, and destroy alternate hosts—plants that certain insects and diseases live on for part of their lives.

Table 1. RESISTANCE[1] OF MAJOR SCOTCH PINE VARIETIES TO NINE CHRISTMAS TREE PESTS

1 = very low 2 = low 3 = moderate 4 = high 5 = very high
The higher the number, the better the resistance. A dash (-) indicates resistance to this pest is unknown.

Origin and varietal name/ short-needled(s) medium(m) long-needled(l)	Brown spot & Lophodermium	Eastern pine shoot borer	European pine sawfly	Pine grosbeak	Pine root collar weevil	Winter injury[2]	White pine weevil	Zimmerman pine moth
Northern Eurasia								
Scandinavian (s)	-	3	4	1	3	5	2	3
Siberia (s)	-	3	4	3	3	5	3	2
Swedish (s)	-	4	4	1	4	5	5	5
Swedish (Riga) (m)	-	3	4	3	2	5	2	3
Ural Mountains(m)	-	3	5	3	3	5	1	1
Krasnoyarsk (m)	-	3	4	3	3	5	-	3
Central Europe								
Belgian (l)	3	3	2	4	2	5	2	1
Czechoslovakia (m)	3	3	3	4	2	5	3	2
East Anglia (l)	3	3	2	3	2	4	-	1
German (l)	3	3	3	-	2	4	-	-
Hungary (l)	3	2	2	5	2	5	1	3
Poland (m)	3	3	3	4	2	5	2	2
Western & Southern Eurasia								
Greece (s)	2	2	3	3	4	5	2	4
Italian (m)	2	2	3	3	4	5	-	4
N. Italy (m)	2	-	4	-	4	4	-	-
Scotland (m)	2	2	3	2	4	4[3]	-	2
S. French (s)	2	2	3	4	4	3[4]	2	4
Spanish (s)	2	2	1	4	4	1	5	4
Turkey (l)	2	2	3	3	4	4	3	4
Yugoslavian (m)	2	2	3	3	4	5	2	4

[1] Resistance, as used here, means the ability of a particular variety of Scotch pine to withstand attack by a given pest.
[2] Injury for areas such as Minnesota, Wisconsin, and the Upper Peninsula of Michigan. Varieties not listed in table: Austrian Hills (l) (3); Finland (m) (5); French Pyrenees (s) (l); Romania (5); Russia (5); Wales (4).
[3] Specific Scottish names: Spey Valley (4); Scottish Highland (3).
[4] Specific French names: Auvergne Haute Loire (3); Lu Puy Province Mountain Strain (3); Auvergne Loudes Haute Loire (2); Auvergne St. Nizier de Formas (2); French-Green (2).

Before planting on a site, you should consider potential pest problems. Are there pests on trees in nearby windbreaks or woodlots? If so, you may want to treat or remove these pest “reservoirs” before planting. If pests in the surrounding areas are difficult to manage, consider planting a tree species that can withstand injury or is resistant to the pests.

Before planting, send soil samples to your extension service or testing firm for analysis. They can tell you if fertilizer or soil treatments are needed to make your plantation more productive. You may even find out that your land needs too much work to make your venture worthwhile.

When replanting a harvested site it is wise to remove or destroy residue, unsalable trees, and old stumps that might lure pests to the site.

Planting

A little extra care at planting time will pay off in good survival and growth. Try to avoid planting on sites

that are prone to frost or where soils are stony, coarse-textured, or otherwise unsuitable for trees. Such sites invite pest problems. Instead, give your seedlings a head start on good growth by choosing sites that are well matched to the growing needs of the species you have selected.

Spacing is also important. Although some seedling suppliers or Christmas tree guides suggest planting 4'x4' or 4'x5', a better spacing is 5'x6' or 6'x6'. This extra space will give you fewer trees, but will help reduce insect movement and disease spread. Extra wide spacing and access lanes (i.e., 1 or 2 unplanted rows) make shearing easier and allow more room for spray or harvesting equipment.

Plant your seedlings in up- and down-hill rows rather than along the contours of the land. This increases air flow and drainage, allowing trees to dry quickly after rain with less chance of disease spread. It also pays to plant 3- or 4-year-old transplants, if available. These plants are hardier and tend to take root faster and survive better than younger seedlings. When handling seedlings, keep the roots moist to ensure survival and ease transplanting shock.

When you plant, try to spread the roots out in the planting hole to prevent them from growing in a J–shaped curve. Roots grown this way are especially vulnerable to white grubs during the first and second seasons after planting. J-rooted trees also tend to be weak and unstable.

Place seedlings so that the root crown is at or slightly below the surface of the soil at the same level it was in the nursery bed. Pine root collar weevils injure pines more readily when the root collar is more than 2 inches below the ground because an underground "collar" is available for them to girdle.

Step 2. Monitor for Pests


Inspecting your trees regularly can help you stay a step ahead of pest problems

Even if you do a good job in site preparation and planting, insects, diseases, and other pests can still injure your seedlings and trees. Walking through your nursery or plantation on a regular basis to keep track of tree condition, pest abundance, and damage is one of the most important things you can do to maintain healthy trees. If you are observant, you can usually spot the symptoms and signs of distress before widespread damage occurs.

Scouting or monitoring your trees can also help you:
• learn which tree species and varieties are most resistant to damage
• determine whether beneficial organisms are present
• anticipate and prevent pest damage
• gauge how much damage a tree can handle without a loss in grade
• decide whether control is needed
• judge the results of your management decisions.

It is good practice to inspect your trees weekly throughout the growing season and occasionally in winter. Although most pests are active during the warmest season, some diseases are more severe in cool moist weather, and birds and mammals do the most damage in winter when their normal food supply is scarce. When you scout, take notes and make maps of where damage has occurred. This will help you plan next year's scouting and control activities.

Monitoring should begin when your stock arrives from the nursery and continue until harvest. "Hitchhiking" nursery pests are particularly serious because even a few pests can destroy the small plants and quickly spread to other parts of your plantation. To be safe, keep careful records, buy locally grown seedlings, if available, and ask your seedling supplier about guarantees and pest-free certificates.

It also pays to know something about the habits of pests you find on your trees. Certain pests, even when numerous, may not seriously damage a tree if it is large enough. For example, dozens of European pine sawflies can strip most of the needles off a 5-foot pine, but because they eat only old needles, the tree is barely injured and recovers fully in 2 or 3 years. On the other hand, one or two Zimmerman pine moth larvae can kill or severely injure the same 5-foot pine in one season. Naturally, the more "significant" the pest, the more vigilant your monitoring should be. If your first inspection reveals no serious threats, keep at it. The situation can change quickly.

To keep abreast of local pest conditions check into the newsletters and pest monitoring programs available for Christmas tree growers in several states. These programs can provide historical as well as current information on pest problems.

For more information on pest monitoring, contact your county Extension office, your state Department of Agriculture, your state Department of Natural Resources, or the USDA APHIS office in your state or region.


Even healthy plantations contain pests. Keep pests at harmless levels by using a combination of controls.

Step 3. Use a Combination of Controls

When faced with a serious pest buildup, your best strategy may be a combination of simple treatments rather than a single drastic action. And, as mentioned before, although chemical control may be used to combat pests, it should only be used as a last resort. In this manual, you will find many good alternatives and supplements to pesticides. Not only are they safer, but in many cases, their effect outlasts the quick-fix of chemical control.

The strategies suggested here will not completely eliminate pests from your nursery or plantation. Instead, these strategies work to bring pest populations down to acceptable levels and keep them there. An acceptable level merely means the trees will not be dead or degraded at the time of harvest. You can keep pests at acceptable levels by practicing prevention and some combination of manual, mechanical, biological, cultural, and chemical control methods.

Most of the methods presented here have been used successfully in Christmas tree fields in the past. However, a few of these suggestions have not yet been extensively tested, so you may wish to try them and see if they work for you. One treatment may work well in one area and not as well in another, so continue trying new treatments or seek help if you have trouble managing a pest. (See “Where to Get Help.”)

Manual and Mechanical Control

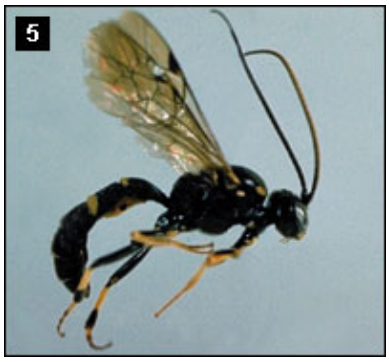
Hand methods or mechanical devices can be used in small plantings to control pests or to make the environment unsuitable for their survival. For instance, insect pests in low numbers can sometimes be hand picked or knocked off the tree and crushed. Fresh pieces of tree stem can be set out in the plantation to trap certain beetles. Predator calls recorded on tape can be broadcast in the field to drive off bothersome birds. Chipping or burning trees infested with Zimmerman pine moth larvae can prevent attacks on healthy trees. Sometimes these simple controls are all that is needed to discourage costly pest damage.


Clipping galls that house Cooley's spruce gall adelgid nymphs is an effective form of manual control.

Biological Control

Natural enemies, such as predators, parasites, and pathogens, can play an important role in pest control. When natural enemies become permanent residents in Christmas tree fields, pests are less likely to increase to damaging levels. The long-term nature of biological control makes it relatively inexpensive as well as environmentally safe.

Biological control can involve introducing beneficial organisms into your nursery or plantation or simply encouraging those that



are already in place. These beneficial organisms include lady bugs (which devour aphids and scales by the hundreds), lacewings, spiders, and predatory mites. Parasitic wasps and flies check pest numbers by laying their egg on the body of pest insects. And there are many diseases that can weaken or kill Christmas tree pests.

You can attract beneficial predators and parasites to your fields by leaving edge rows or occasional strips or clumps of certain flowering plants as a pollen and nectar source. Adult parasites of many insects need pollen or nectar for food and will search out pests in your plantation if flowering plants are available. For instance, leaving strips of wild carrot (Queen Anne's lace) will provide food for parasites of the European pine shoot moth.

Some of these beneficial predators and parasites can be bought commercially. For example, a bacterium called Bacillus thuringiensis var. kurstaki ("Bt" for short) that controls many caterpillars is available in liquid form. Bt can be sprayed onto your trees and will kill the caterpillars when they eat the needles. Best of all, the bacterium is not harmful to other nontarget organisms, including humans.

You may be able to buy commercial virus preparations for sawflies (e.g., redheaded pine sawfly), or you can make your own. The recipe is included in the sawfly writeups. Once introduced, a virus persists and affects new generations of sawflies year after year.

Keep predators and parasites working for you by minimizing the use of chemical insecticides. If you must use pesticides, apply the lowest recommended dose. Apply the product at the correct time and minimize pesticide drift to reduce harmful effects on beneficial insects. Also, try to spot-treat pests to further minimize pesticide use. You need not always treat an entire nursery or plantation if only a few trees or small groups of trees have been affected.

1. Ladybugs feasting on aphid pests
2. Ladybug adult
3. Ladybug larva preying on aphids
4. Lacewing adult
5. Parasitic wasp

Right: The white ladybug larvae are important predators of pine tortoise scale crawlers.

Cultural Control

Ordinary cultural practices such as weed control, mowing, shearing, pruning, and thinning, help make your nursery or plantation less appealing to pests. If you strategically modify and time these operations, you can manipulate pest habitat to prevent and control problems even more effectively. For example, you can discourage mice by mowing the grass they hide in. Pine needle rust can be reduced by removing nearby goldenrod and aster plants. Delaying shearing a few weeks can destroy the European pine shoot moth.


Discourage mice by mowing the grass where they hide

Pruning the lower branches from old trees helps control pine root collar weevil, European pine shoot moth, and some disease organisms.

The goal is to make the habitat less favorable so pests will not multiply as rapidly. Sometimes even a slight drop in population can avert a damaging pest buildup and reduce the number of pesticide applications needed for control.

Cultural controls are among the simplest and cheapest methods available because they can complement other management operations, and they are environmentally safe.

Legal Control

Forest and agricultural pests that overwinter, nest, or hide on nursery stock and Christmas trees are often carried into new locations as hitchhikers. Once they enter new areas, these pests can swell to epidemic levels. Lophodermium needlecast is a classic example of a serious fungal disease that moved on nursery stock to many Christmas tree plantations in states where it did not exist previously. New epidemics started when spores released from these newly planted seedlings spread to susceptible trees nearby. Sometimes, the only way to stop the spread of hitchhiking pests is through legal measures, such as quarantines or mandatory inspections.

The gypsy moth and the pine shoot beetle are two important hitchhiking pests to watch for. The gypsy moth is normally a hardwood pest, but frequently lays eggs on the stems and branches of Christmas trees. Look for egg masses of the gypsy moth on the trunks of Christmas tree seedlings and trees. You may find the pine shoot beetle inside shoots or burrowed into the lower stem of pine Christmas trees.

Many pests spend the winter on Christmas trees and may be inadvertently shipped to new areas at harvest time. Some pests, such as the European pine sawfly, can hatch in buyers' homes and become a nuisance. After the holidays, overwintering pests can be carried wherever old or unsold trees are discarded. Therefore, it is good practice to inspect all trees just before harvest to determine if they harbor pests that are regulated by federal or state quarantines. Failure to do so may lead to the introduction of pests into previously uninfested areas, the spread of disease epidemics, and the possible quarantine of valuable trees.


When timed correctly, routine shearing can slow down a pest buildup.


A shipload of untreated trees may carry pests into new areas. Inspect before harvest to avoid quarantines.

Chemical Control

Chemical pesticides can be among the most effective materials used to prevent, destroy, or repel pests, and because of this, they have been used too often in lieu of other control methods. If you must use chemical pesticides, it is important to choose the proper products, timing, and dosages to avoid mistakes.

Improper use of a pesticide might rid your nursery or plantation of a pest, but may very well trigger another more serious problem.

Overspraying, for example, often causes mites, aphids, and scales to rapidly build to damaging levels. Heavy dosages, poor timing, and careless application can kill valuable parasites and predators, allowing new pests to gain a foothold in your nursery or plantation. Because of these disadvantages, we stress using chemical pesticides only as a last resort.

To maximize the benefits and avoid the hazards of pesticides, choose formulations that pose the least threat to nontarget species. Adjust and calibrate application equipment so the proper amount of pesticide hits the target, and only the target. Time your treatment to avoid spray drift; windless days, early mornings, and evenings are good times to apply pesticides. We also suggest alternating pesticides to reduce the chances of a pest developing resistance to a particular type of pesticide.

When used as directed and in combination with other controls, pesticides can produce impressive reductions in pest populations. To help you with the proper uses of pesticides, this manual includes information about timing, equipment, and safety. We have purposely left out specific product names and application rates, however, because they change so frequently. Check the label on the pesticide container for application and registration information. University Extension offices and state regulatory agencies can also provide up-to-date information on pesticides registered in your state. **Step 4. Evaluate Your Control Efforts**

To be truly effective, pest management should be part of the day-to-day workings of your Christmas tree operation, from species selection to premarket inspection. This includes regular, careful monitoring, even after a control treatment. By evaluating your treatments, you can decide which management techniques were successful, and which were not. You can then continue using the best techniques and minimize pest damage by design, not by chance.

Symptoms and Signs of Tree Injury

When you are protecting your investment from very small insects, microscopic pathogens, or pests that feed underground, it helps to have an eye for detail. If you know what to look for when inspecting your trees, you can spot a pest problem in its early stages and greatly reduce losses and control costs.

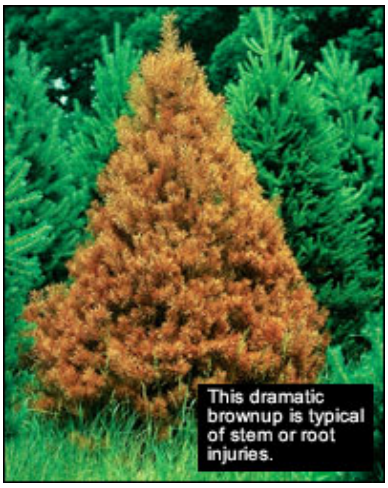
Most likely, you will see the results of pest activity long before you notice the pest. An injured tree will have symptoms such as unusual color, missing foliage, deformed parts, etc. Although these clues may help you diagnose the injury, they may also mislead you. For example, a symptom of one pest may look much like the injury caused by several other pests. To complicate matters further, two or more pests may injure the tree at the same time, producing a new symptom by their interaction. Symptoms also change; yellow foliage may redden, turn brown, or fall off entirely. Therefore, you cannot rely on symptoms alone when you diagnose tree injury.

Reading the signs of the pest as well as symptoms of the host is usually the best way to tell one type of injury from another. Signs are the physical evidence of insect and disease activity and include the pests themselves (eggs, larvae, fruitbodies), their enclosures (webs, cases, cocoons), debris (cast skins, wood slivers, pellets of waste), pitch flow, and associated insects or diseases, such as ants and sooty mold. Sometimes, two different pests will produce look-alike symptoms and leave the same signs. In that case, the pest itself must be examined and identified by you or by a pest specialist. (See “How to Submit Material for Identification.”)

The detective work involved in identification becomes more difficult as time passes because both symptoms and signs change. A vigorous tree may mask or outgrow the injury. On the other hand, a weak tree will become susceptible to invading insects and pathogens that can confuse the diagnosis by producing symptoms and signs of their own. Signs such as webs, waste, or cast skins will also breakdown with time.

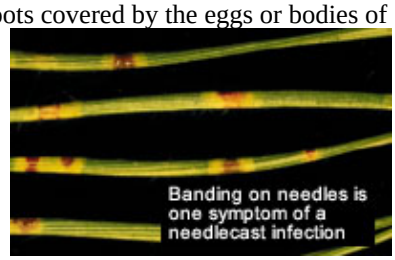
Therefore, the best time to read a symptom or sign is during the early stages of pest activity. To catch pests in action, start monitoring your trees at planting time and continue to examine them frequently throughout their lives. The following section describes the major symptoms and signs to watch for every time you inspect your nursery or plantation.

Discolored Foliage


This dramatic brownup is typical of stem or root injuries.

Discolored foliage can result from damage to any part of the tree—roots, trunk, branches, or needles. When a single needle or a small group of needles is discolored, damage is usually centered in the individual needles. For instance, needlecast fungi cause banding on the individual needles they infect. However, if an entire section of foliage on a shoot or branch is discolored (flagged), the injury is usually within or at the base of that section. Flagging may also be caused by drought, root injury, or a lack of nutrients—all problems occurring in the soil.

Blackened foliage and/or bark indicates soft scales, aphids, or spittlebugs. A black, sooty mold grows on the sugary “honeydew” and spittle produced by these insects. Needles and shoots covered by the eggs or bodies of insects may also look discolored. In these instances, you can directly identify the insects injuring your trees.


Banding on needles is one symptom of a needlecast infection

Herbicide damage, air pollution, and winter injury can also discolor foliage. When the whole tree is evenly discolored, the injury is usually on the main stem, root collar, or roots.

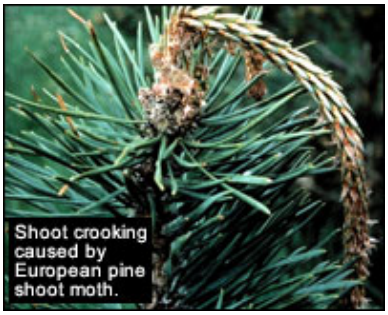
Missing Foliage

Needle loss is a common symptom of many insect and disease injuries. Foliage affected by winter injury or needlecast fungi will die and drop off early. Notched, broken, or hollowed-out needles indicate insect feeding. Insect foliage feeders will strip off clusters of needles, often in a characteristic pattern. Look for the insect or its frass, webs, cocoons, or cast skins on the surrounding foliage and beneath the injury; these are all signs of insect feeding. (See “Insect and Disease Parts and Structures.”)


Early needle loss thins and degrades infected Christmas trees.

Deformed and Stunted Tissue

Insects and diseases can cause galls, swellings, and other kinds of abnormal growth on needles, shoots,


Shoot crooking caused by European pine shoot moth.

stems, or roots. Past injuries from insects, diseases, or animals may eventually cause excessive branching, forking, and crooking. Stunted shoots are caused by drought and frost damage, insects feeding on shoots and roots, or infection by shoot-blight fungi. Once weakened by injury or stress, trees often grow more slowly. Although economically important, this growth loss may be difficult to detect and diagnose.

Pitch Flow


Pitch on mainstem formed by Zimmerman pine moth larvae.

When insects feed or tunnel in the shoots, branches, and stems of living conifers, a pitchy substance commonly surrounds or flows from the point where they entered the tree. Canker and shoot blight diseases may cause the same response.

Wood Shavings


Shavings left by weevils.

Insects living in dying or dead stems and branches often produce fine sawdust or coarse slivers of wood. Piles of this material may be on the ground or found adhering to the bark.

Insect and Disease Parts and Structures

Insects and pathogens often leave behind evidence. Learning to recognize this evidence can help you find and identify pest populations before damage becomes severe. For example, as insects feed and grow, they must periodically shed their outer skin to accommodate changes in size. Cast skins of nymphs, larvae, or pupae, as well as old eggs that have hatched, can sometimes be found near the injury. This evidence can often be used to identify the species of insect. Several species of foliage feeders will construct protective bags, webs, or cocoons that are also distinctive. Some wood-boring insects make pupal cells called chip cocoons in the wood where they feed.


Spittlebugs earn their name by turning plant sap and air into a spittlelike mass of bubbles.

Small pellets of waste (frass) left by foliage-feeding insects can often be found near or beneath damaged foliage. Spittlebug nymphs produce white, frothy masses resembling spittle on the twigs or branches of trees. Part the mass carefully to see the small, soft insect.

Fungi produce spores in reproductive structures called fruitbodies. These small structures are formed in the dead tissues of needles, shoots, and stems. Some species of fungi form characteristic sheets of fungal material called mycelial fans (see Armillaria root rot). Keep in mind that fungi found in dead tissues may or may not have killed the tree. Many fungi are secondary agents, which means they invade tissues after the tree has been killed by something else.


Dotlike fruitbodies on needle infected with Swiss needlecast.

In the next section, you will find descriptions and control recommendations for species of insect pests and diseases, grouped by the type of injury they cause. Step-by-step instructions on how to track down a specific pest can be found in the section entitled, “How to Use This Manual.”

Where to Get Help

Because so many pests cause look-alike symptoms, it is sometimes difficult to pinpoint the pest causing damage in your nursery or plantation. When in doubt, contact a professional. Your state forester, county Extension agent, or the staff at the plant disease and entomology clinics at your state university are familiar with local insects and diseases and can suggest practical, cost-effective controls. Christmas tree consultants are also available and can provide many of these services.

Some of the best advice may come from other growers who have dealt with a pest problem similar to yours. Joining a Christmas tree growers’ association is a good way to connect and compare notes with growers in your area.

How to Submit Materials for Identification

To identify the culprit damaging or killing your trees, your local pest specialist will have to gather clues and examine the evidence. You can help by providing some background information—

- location of plantation
- site conditions (wet, dry, etc.)

• age and species of affected trees
• part(s) of tree damaged
• pattern of damaged trees in plantations (scattered or grouped)
• extent of damage (number of trees or acres affected)
• management history (fertilization, pesticide and herbicide use, etc.)

In addition to these clues, you may need to send damaged plant tissue—foliage, branches, stems or roots—as evidence of insect or disease activity. Include any tissue that contains fungal fruitbodies, such as spore-filled blisters. These are telltale signs of disease.

Look on or around trees for physical evidence of insect activity, such as egg masses, pellets of waste, nests, or the insects themselves. If you spot insects on your trees, send both the damaged plant tissue and the insects to the specialist.

Packing Plant Tissue

To ensure correct identification, ship several examples of each type of injury, and follow these packing tips:
• Fresh plant samples are easier to identify than dry, wilted ones, so keep samples as cool as possible before mailing.
• Foliage—Pack green foliage samples in a plastic bag to keep them from drying out. Put dry paper towels in with the specimen to absorb water that might condense on the inside of the bag.
• Branches and stems—Cut samples at least 10 inches long and place in plastic bags with dry paper towels. Include apparently healthy portions of the same branch or stem section; often the junction of healthy and damaged tissue holds the key to identification.
• Roots—Pack roots in a plastic bag with some soil or litter and keep them cool and moist.

Packing Insects

• DO NOT SHIP LIVE INSECTS.
• Moths, butterflies, and beetles—First kill the insects with moth balls or crystals, then place them with egg masses, nests, or frass in jars or boxes. Loosely pack tissue paper above and below the specimens to protect them from damage.
• Soft-bodied insects, egg masses, pupae, and larvae (caterpillars, grubs)—Pack in vials filled with 70 percent alcohol (e.g., rubbing alcohol). Be sure to pad vials well enough to withstand rough handling in shipment.

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Needle Discoloration

Needle Discoloration or Distortion

Scattered, single needles or clumps of needles may be spotted, banded, stippled, or totally discolored- yellow, red, brown, or black. You may find fruitbodies, swellings, or scales on injured needles. Some may be distorted. If needles are chewed off, see next section. If shoots, branches, or entire trees are discolored, see other injury categories.

NEEDLE DISOLORATION

Air Pollution Injury

Air Pollution Injury

Hosts: All conifers, especially eastern white pine.

Importance: Air pollution reduces growth, causes early needle loss, increases vulnerability to diseases and insects, and occasionally kills trees.

Look For:

- *Yellowing, stunting, and early shedding of old needles.*
- *Yellow, red, or brown tips on current year needles.*
- *Yellow flecks, stipples, or bands on needles.*
- *Injury on nearby broad-leaved plants,* e.g., dead tissue at leaf

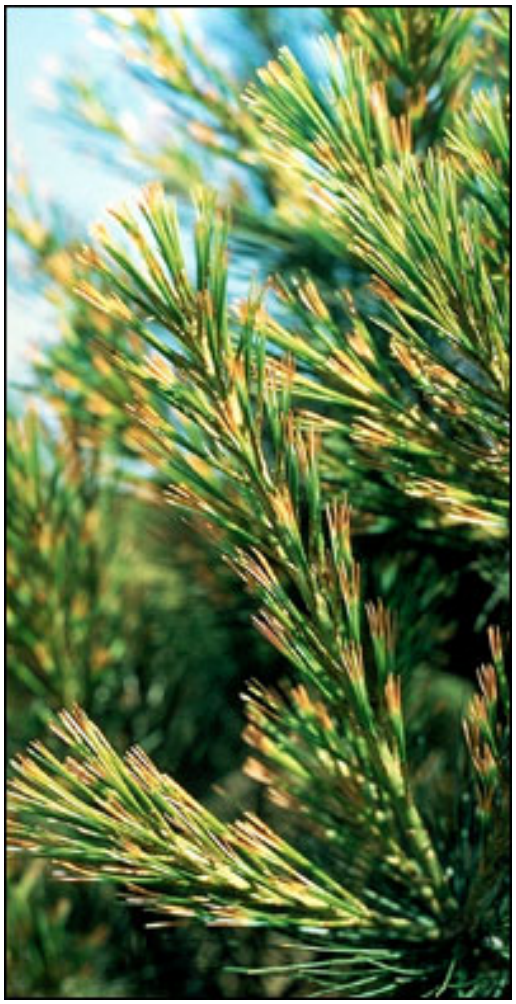
margins (fluorides), or between leaf veins (sulfur dioxide), or stippling (ozone). Aspen, birch, alfalfa, and sweetcorn are particularly sensitive to air pollution injury.

Factors that cause similar symptoms: Drought, herbicide injury.

Biology: Air pollutants produced by automobiles (ozone), industrial processes (fluorides), and coal- and oil-burning factories (sulfur dioxide), will injure a wide range of plant species in or near Christmas tree plantations. The amount of damage depends on the age of the needles, genetic make-up of the tree, pollutant concentration, weather, and how long the tree was exposed to the pollutant. New needles are most susceptible when elongating during early summer.

Monitoring and Control: Remove dead shoots and trees to prevent a buildup of other pests on this material.

NEXT CROP

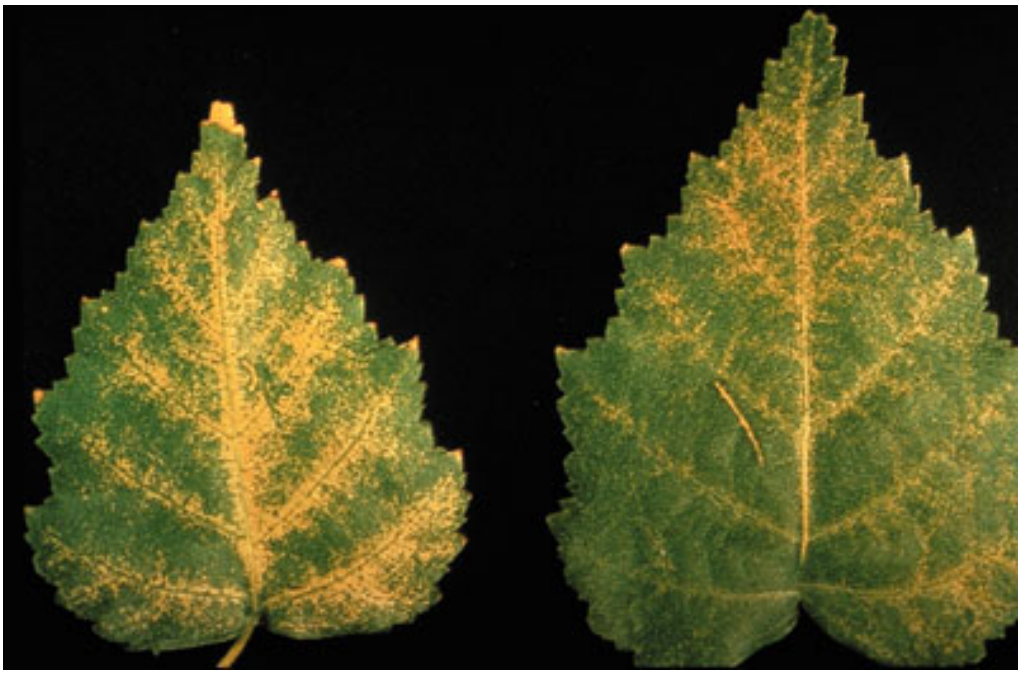


Above:
Yellow and brown tips on current-year needles.

Below:
Stippling on nearby leaves.

• Before choosing a new plantation site, check the surrounding area for industries that may produce damaging pollutants. Most damage occurs within 10 miles of these sources, however, ozone injury can also occur in remote areas.
• Plant seedlings that are genetically resistant to air pollution injury. For example, spruces are resistant to sulfur dioxide, ozone, and fluorides;

balsam fir, Fraser fir, Douglas-fir, and red pine are resistant to ozone.



Hosts: All conifers, especially eastern white pine.

Balsam Fir Needle Rust NEEDLE DISOLORATION

Balsam Fir Needle Rust

Uredinopsis spp. and *Milesina* spp.

Host: Balsam and white fir; potentially Fraser fir.

Alternate Host: Ferns

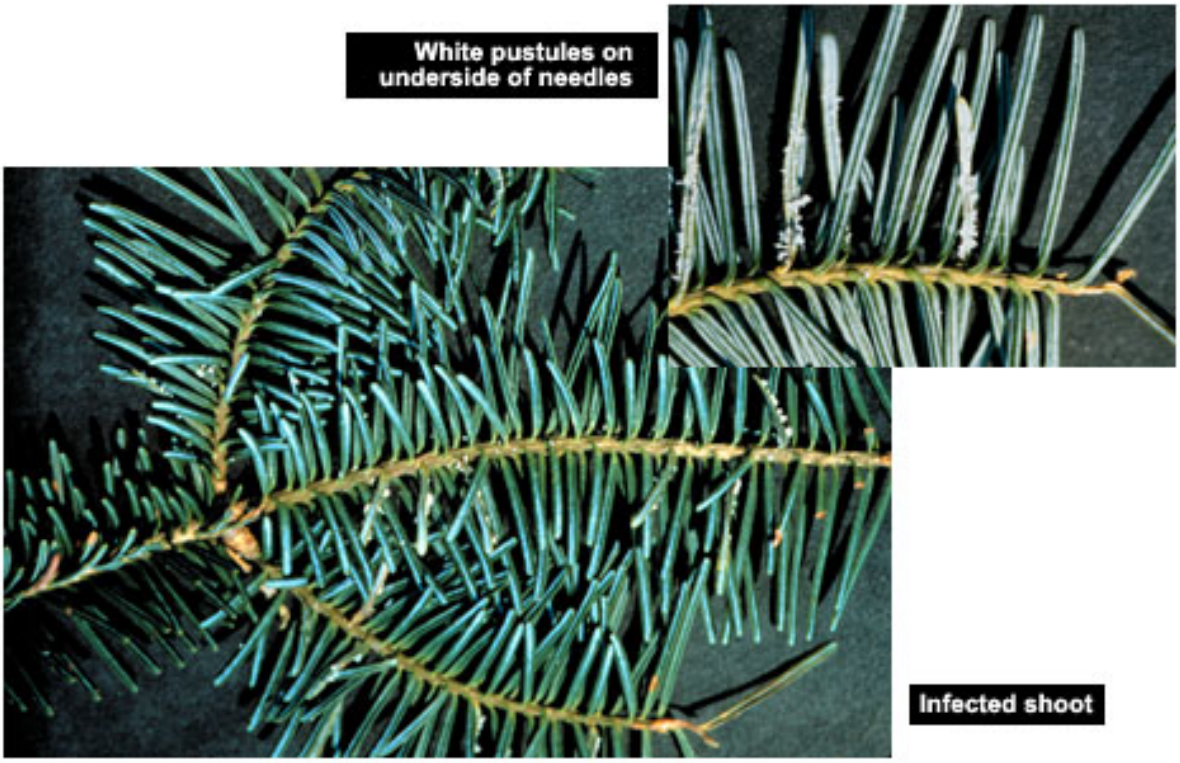
Importance: Current-year needles that are infected turn reddish-brown, shrivel, and drop to the ground before the end of the summer. Infected trees will have sparse foliage. Several years of repeated infection can reduce tree quality.

Look For:
JULY TO AUGUST
• *Current year needles that are yellow with white pustules on the underside.*

Biology: Current year's needles of fir become infected as shoots are elongating. As the growing season progresses, infected needles turn yellow and produce spores in white pustules. These spores infect various species of fern (depending on the species of rust). The fungus overwinters on dead fern leaves and produces spores in the spring that are wind-disseminated back to the fir. Infection of fir trees requires cool, moist conditions during shoot elongation. If weather conditions are too dry, infection will not occur.

Monitoring and Control: Examine your trees from July through mid August. Be on the lookout for the rare occurrence of severely affected trees where more than 50 percent of the current year's foliage is

infected and drops off. Consider management of the alternate host if you observe high disease incidence. This disease usually causes only a slight loss of current year's foliage. If disease incidence is low, management is probably not necessary. Infection is closely tied to specific weather conditions and will not occur every year.
• If disease incidence is high, mow or kill ferns in the plantation. Since spores are produced in the spring on dead fern leaves, expect lower levels of disease to begin one year after ferns are controlled.



Host: Balsam and white fir; poten

NEEDLE DISOLORATION

Balsam Gall Midge

Balsam Gall Midge

Paradiplosis tumifex Gagne

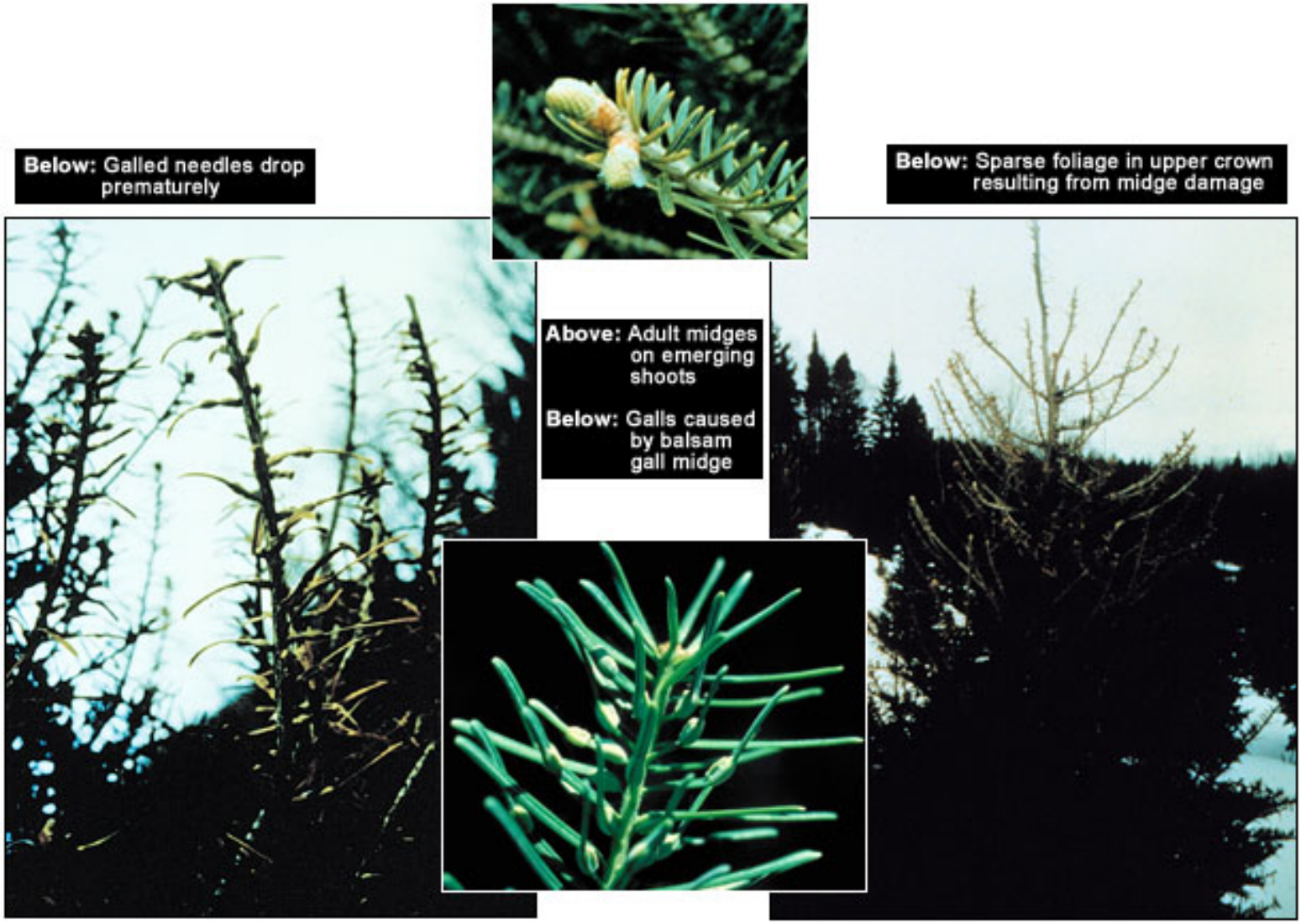
Hosts: Balsam and Fraser fir

Importance: The larvae of this tiny fly feed on new needles, causing small galls to form on the needles. Galled needles drop prematurely, leaving bare spots on branches, which may lower the market value of affected trees. However, shearing can remove some affected branches and injured trees will recover satisfactorily if trees are not heavily infested again for 3 or 4 years.

Look For:
OCTOBER TO APRIL
• *Thin foliage and bare branches* anywhere on the tree, particularly near the upper crown.
MAY

• *Adult female midges laying eggs* on newly emerged shoots. Adults are orange in color and resemble mosquitoes in size and appearance.
JUNE TO OCTOBER
• *Galls: globe-like swellings near the base of new needles.* In heavy infestations, there may be several galls per needle and more than 50 percent of new shoots may contain infested needles.
• *Small yellow or pink larvae inside galls*. Each gall may contain one or two larvae; larvae of two midge species may be present in the same gall.

Biology: Mature larvae drop from the needles in the fall and overwinter in the mineral soil beneath the tree. Pupation occurs in spring and flying adults emerge from the soil in late May to early June. Females lay eggs on newly emerging foliage. Developing larvae feed on the needles, causing galls to form. Parasites attack newly laid eggs and also feed on the larvae inside galls. Predators prey upon cocooned larvae in the fall and spring. Adult midges and their parasites are vulnerable to insecticides between late May and early June when they emerge to mate and lay eggs.



Hosts: Balsam and Fraser fir

Monitoring:
ADULTS: Emergence traps can be placed beneath previously affected trees to estimate timing of adult emergence and egg laying. Traps can consist of either a bottomless small wooden box or opaque plastic flower pots placed tightly over the soil. The trap should have a small hole in the side which contains a clear glass or plastic vial exposed to the light. Adults that have emerged from the soil can easily be seen in the vial as they try to escape toward the light. Traps should be placed beneath previously infested trees in early May. Place one trap below each of 10 trees that are at least 10 feet apart.

GALLS: Look for galls anytime between June and October, starting 3 to 4 years before harvest. Infestations tend to be heaviest in the upper crowns of individual trees and in trees located near forest edges containing native balsam fir trees.

Control:
• Remove and burn heavily infested branches or trees in late summer before larvae and needles drop to the soil. Removing affected trees in early spring will only encourage emerging adults to lay eggs on nearby and perhaps previously uninfested trees.
• Kill adult midges by spraying heavily infested trees with a systemic or contact insecticide within 7 days of adult emergence from traps. If traps are unavailable, examine at least 3 lateral shoots of upper-midcrown branches from at least 10 trees frequently from late May to early June. Treat after budbreak but before needles are 1 inch long. Avoid spraying trees in areas where only a few midges are emerging or where only a few galls were present. This will conserve natural enemies that keep midge populations in check.
• Kill larval midges inside developing galls with a systemic insecticide. If applied before mid June, galls will stop forming and needle drop at harvest should be slight. Control is not practical after mid June because larvae are protected by fully formed galls.

NEXT CROP
• Avoid planting balsam fir or Fraser fir where midges have previously been a problem.
• Avoid planting firs in the outer rows of fields near forests containing native firs. Planting nonhost conifers or, if available, resistant fir varieties in these areas may reduce infestation levels.

NEEDLE DISOLORATION

Balsam Twig Aphid

Balsam Twig Aphid

Mindarus abietinus Koch

Hosts: All species of fir, particularly balsam and Fraser; occasionally some spruce and pine species.

Importance: Balsam twig aphids feed on the sap of developing needles causing them to twist and distort in shape. Feeding causes aesthetic damage and stunting of new growth, which can reduce the value of Christmas trees for up to three years following attack. However, most of the needle curling straightens out once needles mature, and, if not, can be removed by shearing.

Look For:

JULY TO MARCH

• *Slight curling and stunting of previous years' needles.* Shoots may appear twisted and silvery.

APRIL TO EARLY MAY

• *Eggs or newly hatched nymphs on outer twigs, needles, and maturing buds*. Eggs are less than 1/16 inch

in size, black, and covered with fine white hairs. They are difficult to see without magnification. Newly hatched nymphs are yellow and often rest on the underside of the previous years' needles within 2 inches of buds.

MAY

• *As budbreak begins, nymphs mature and produce offspring rapidly*. The aphids form noticeable colonies on the expanding needles and their feeding causes distinctive curling of needles. Small amounts of woolly wax and honeydew are visible around groups of aphids. Insecticide treatment (unless systemic) from this time onward will likely do little to prevent damage; aphids are well protected within the shoots.

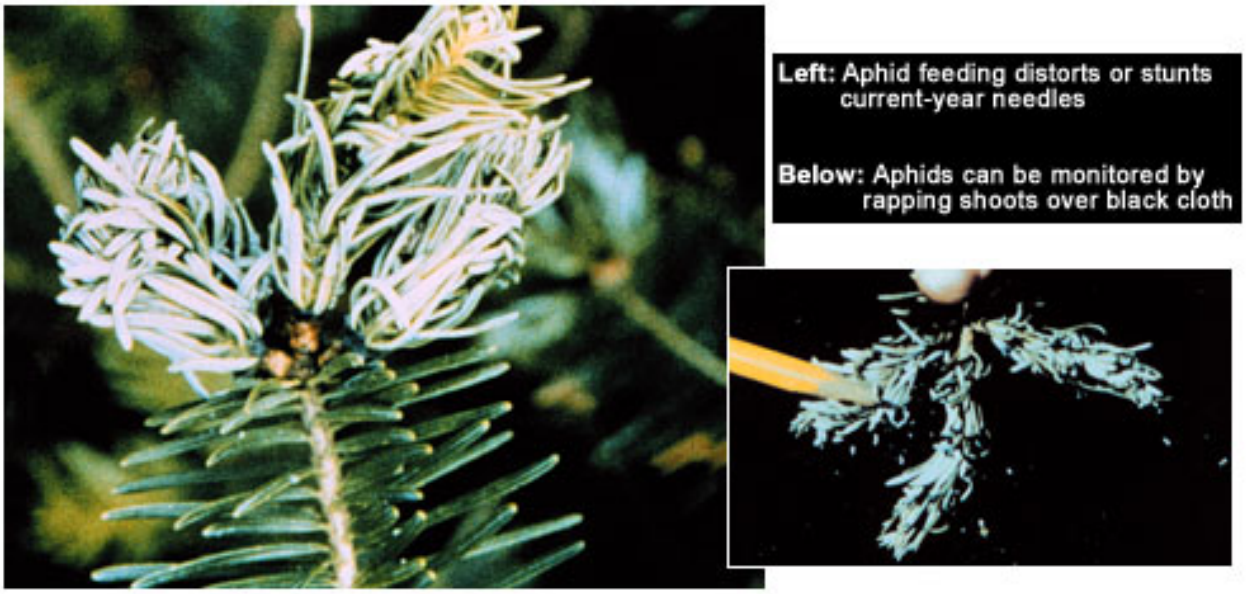
MAY TO JUNE

• *As infested shoots expand to 1 to 2 inches in length, green winged and wingless aphids covered with powdery wax and honeydew* are noticeable. Current-year needles are often curled and bees and ants may feed on the honeydew. Ladybird beetles, green lacewings, and flower flies can be seen feeding on the aphids. Insecticide treatment (systemic or contact) at this time is too late to prevent current needle damage and kills natural enemies that help keep other pests in check.

Biology: Overwintering eggs hatch in spring (late April to early May) and nymphs quickly mature into stages that feed on developing needles. Several overlapping generations produce winged and wingless aphids by mid to late June. Heavy rainfall at this time may cause some aphid mortality. Numerous aphid-eating predators such as ladybird beetles, syrphid fly larvae, and lacewing larvae, feed on the aphids. By early July, the nonfeeding adults have mated and laid eggs on stems and bases of needles of new growth. Applying nitrogen fertilizer when trees are young or before budbreak in previously infested areas tends to increase aphid numbers. Densely planted trees and trees lower in elevation on slopes also tend to have greater numbers of aphids.

Monitoring and Control:

BEFORE BUDBREAK: The first generation of aphids does little feeding. These aphids and their cast skins can be found on the stem and older needles within 1 to 2 inches of developing buds. This stage is the most susceptible to insecticide control and treatment at this time may prevent further generations from developing. Detect aphids by beating the outer 10 inches of midcrown foliage over a small black cloth. Black cloth held in an embroidery ring works well. Sample aphids on at least two sides of 15 or more trees that are similar in location, age, and stock. If most trees have more than 2 aphids, and trees were damaged the previous year, treatment may be needed.



Left: Aphid feeding distorts or stunts current-year needles

Below: Aphids can be monitored by rapping shoots over black cloth

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Hosts: All species of fir, particularly balsam and Fraser; occasionally some spruce and pine species.

INFESTED SHOOTS: Once aphids move onto new shoots and the second generation is produced, infestations are visible to the eye. Infested shoots may be covered with aphids, white, waxy wool, and honeydew. Infestation levels can be estimated by counting the number of infested shoots and uninfested shoots per 10-inch branch of outer midcrown foliage from 15 or more trees per area. If the average number of infested shoots is greater than 30 percent, infested trees may need to be treated.

- Spray infested trees with a registered systemic insecticide just before budbreak if the area has suffered annual infestations that have caused permanent needle curling.
- Spraying trees when the needles begin to curl will probably not prevent damage from occurring.
- Avoid spraying trees or surrounding vegetation with insecticides when helpful aphid predators, such as flower flies, lacewings, and lady bird beetles, are present.
- Do not ship previously infested trees or nursery stock because overwintering aphid eggs can hitchhike to new areas.

NEXT CROP

- In the Lake States, plant local balsam fir seed sources; East Coast seed sources may be more susceptible to aphids.
- Avoid planting trees in dense stands or in areas with poor air circulation.

NEEDLE DISOLORATION

Brown Spot Needle Blight

Brown Spot Needle Blight

Mycosphaerella dearnessii M.E. Barr

Host: Scotch pine.

Importance: The browning and early needle loss caused by this fungus makes injured pines unsalable as Christmas trees.

Look For:

• *Reddish-brown, resin-soaked spots with yellow margins*, on the needles. Spotted needles turn yellow, then brown.

• *Black fruitbodies* flush with the surface of dead dry needles. These fungal structures stick out from the needle when wet.

AUGUST TO OCTOBER

• *Brown needles*, especially on the lower branches and on the moist, shaded north side of trees. Needles turn brown from the tip towards the base of the shoot.

MAY TO JULY

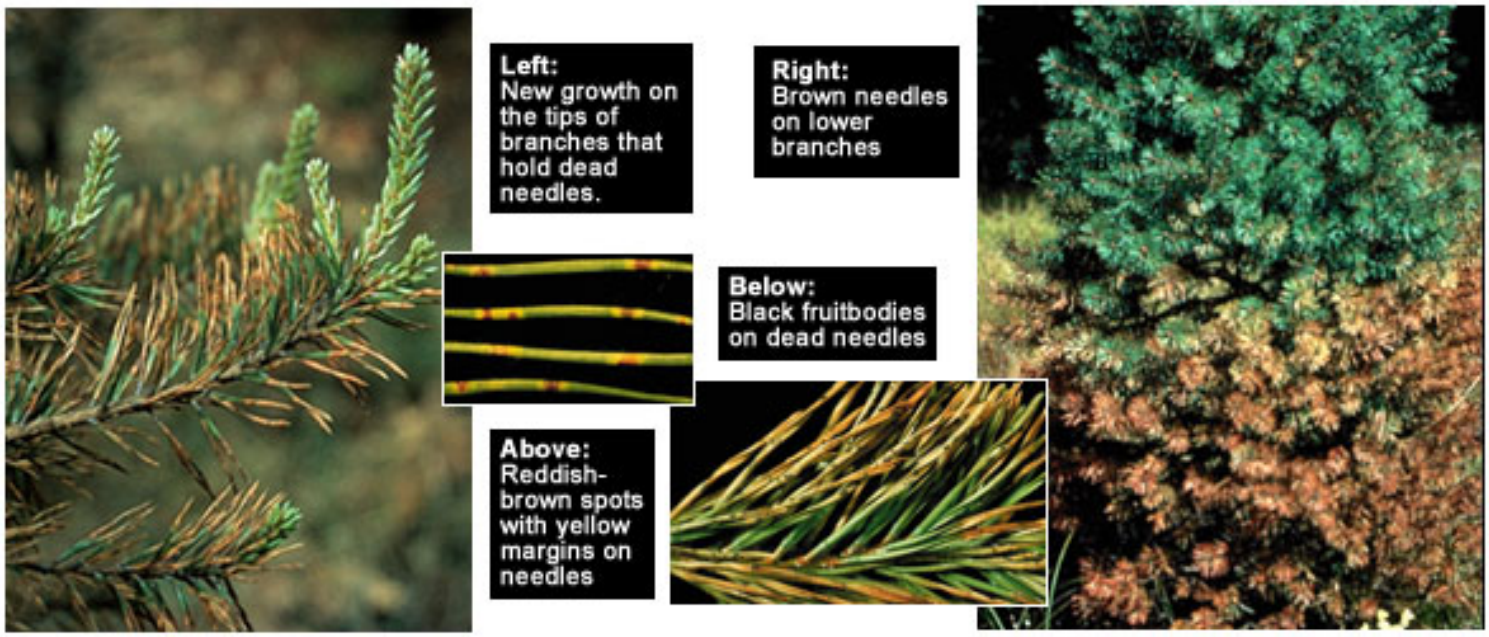
• *New shoot and needle growth* on the tips of branches that hold dead brown needles. Most dead needles fall off, leaving only tufts of new, green growth on the branch tips.

Pests that cause similar symptoms: Lophodermium needlecast, pine needle scale, winter injury.

Biology: Prolonged wet periods, particularly during June and July, provide favorable conditions for infection. Old needles are more resistant to infection than young ones.

Monitoring and Control: Inspect trees of all ages at least once between August and October. Randomly select 50 or more trees scattered throughout the plantation. Look for needle spots and browning on current-year and older foliage on the lower branches. If 15 percent of these trees are injured, consider treating the entire plantation next spring. If the infection occurs in small pockets, treat only the infected and surrounding trees.
• Cut and immediately remove small pockets of up to five infected trees. Trees that are within 30 feet of infected trees should be treated with a registered preventive fungicide.
• Or, if needed, apply a registered, preventive fungicide to all trees when needles are about half grown. Repeat two or three times, once every 2 to 3 weeks, to protect new growth and old foliage.
• Do not leave live infected branches on stumps of harvested trees because they serve as disease reservoirs.
• Do not shear infected trees during wet weather because spores released at this time may be carried from tree to tree on workers' clothes or shearing tools. Sterilize tools after shearing affected plantations by dipping in denatured alcohol for 3 minutes.
• Shear healthy plantations first so pathogen spores will not be carried into them from affected plantations.

NEXT CROP
• Plant only disease-free stock. If you suspect infection, have seedlings examined by a pest specialist.
• Plan disease-resistant varieties of Scotch pine, such as the long-needled varieties from Central Europe (see Table 1).
• Plant more than one species or variety so that one disease will not damage the entire crop.
• Do not plant Scotch pine seedlings next to Scotch pine windbreaks. Cut and chip or burn these windbreaks the year before planting a new stand. Also remove the stumps or treat them with a registered insecticide to prevent Pales and northern pine weevil attack.



Host: Scotch Pine.

Cyclaneusma Needlecast NEEDLE DISOLORATION

Cyclaneusma Needlecast (= Naemacyclus Needlecast)

Cyclaneusma minus (Butin) DiCosmo, Peredo, and Minter

Host: Scotch pine.

Importance: The early yellowing and needle loss caused by this fungus weakens and degrades Christmas trees.

Look For:
SEPTEMBER
• *Light-green spots on 2- and 3-year old needles.* Spots enlarge and lighten in color, and needles eventually turn yellow, then brown
• *Yellow needles with dark-brown horizontal bands.*
OCTOBER TO MAY
• *Shedding of yellow needles* anywhere on the tree.
• *Off-white, waxy fruitbodies on brown needles.* Most noticeable in wet weather due to swelling.

Pests that cause similar symptoms: Fall needle drop, pine needle scale, winter injury.

Biology: Needles of all ages are susceptible to infection. Most trees are infected between mid April and late June, but infection is possible through December. Cyclaneusma spores spread most readily after rainfall.

Monitoring and Control: Inspect trees of all ages in late fall and early spring. Examine 50 or more trees randomly scattered throughout the plantation. If 20 percent of the trees show symptoms of Cyclaneusma on the 2-year-old needles, consider treating entire plantation in early spring.
• Apply a registered preventive fungicide three times, once every 2 to 3 weeks between mid April and late June, starting before Scotch pine buds open. This control is about 50 percent effective. Continue spray schedule into late fall for complete control. This treatment may be too expensive for some growers.

NEXT CROP
• Buy planting stock from a nursery that uses preventive treatments for all diseases.
• If available, plant stock from seeds of trees that show genetic resistance to Cyclaneusma. The Northern European seed sources appear to be more resistant than the Mediterranean sources.
• Avoid planting next to old Scotch pine windbreaks.

Host: Scotch Pine.

NEEDLE DISOLORATION — Dothistroma Needle Blight

Dothistroma Needle Blight

Mycosphaerella pini Rostr.

Host: Austrian pine.

Importance: This fungus infects and kills needles of all ages. Severely affected trees can be killed or may become more susceptible to other diseases.

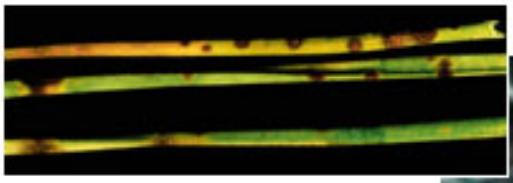
Look For:
FALL
• *Yellow to tan needle spots* that enlarge to form distinct brown to reddish-brown bands.
• *Dead needle tips* beyond the reddish-brown bands. Needle base remains green.
• *Black fruitbodies* in dead spots or bands on needles.

Pests that cause similar symptoms: Pine needle scale, winter injury.

Biology: Spores spread by wind and rain can infect needles throughout the growing season. However, new needles are not susceptible until they have emerged from the needle sheaths. Fruitbodies appear in the fall, and spores are released the following spring and summer.

Monitoring and Control: Check trees of all ages in the fall. If you find needle spots on any of your trees, consider treating the entire plantation next year. Take other preventive measures immediately to avoid spreading the pathogen.
• Do not shear trees when they are wet because spores released at this time may be carried from tree to tree on shearing tools.
• Apply a registered fungicide once between mid June and mid July to protect all foliage. For complete control, consider spraying once in mid to late May and again in mid June to mid July.
• Do not ship infected seedlings or Christmas trees because this fungus hitchhikes to new areas this way.

NEXT CROP
• Plant only disease-free nursery stock.
• Avoid planting Austrian pine. This tree is also very susceptible to winter injury.
• If you plant Austrian pine, plant disease-resistant varieties. Trees from a Yugoslavian seed source have shown resistance to Dothistroma.
• Do not plant Austrian pine near windbreaks of Austrian pine.



Above: Brown bands on needles.

Below: Dead needle tips.

Host: Austrian pine.

Drought Injury NEEDLE DISOLORATION

Drought Injury

Hosts: All trees.

Importance: Drought-stressed trees lose foliage, grow slowly, and become more susceptible to insect pests and diseases. This is especially true of younger trees. Severe drought may kill trees.

Look For:
• *Wilting, dying needle tips and discolored foliage* on the top branches. Symptoms may not appear until a year or more after trees have been stressed by drought.
• *Wilting of the current year's shoots.*
• *Dead tree top, short needles, and sparse foliage.* These indicate a general decline in vigor that becomes evident in the years following the drought.

Pests that cause similar symptoms: Air pollution, Armillaria root rot, Leucostoma canker, Sphaeropsis shoot blight and canker, eriophyid mites, herbicide injury, Rhizosphaera needlecast, Scleroderris canker.

Biology: Drought stress occurs when trees need more moisture than is available in the soil. This condition may be caused by one growing season of severe drought or several seasons of below-normal rainfall. Young trees are especially sensitive to drought because their root systems are less extensive than those of older trees.

Monitoring and Control: Inspect stressed trees of all ages for injury by invading pests during and after

periods of drought. Follow control recommendations for each pest as needed.
• Control weeds and grasses in and around plantations to reduce competition for water during dry periods.
• If drought conditions persist, irrigate to replace soil moisture in the root zone.
• Remove and chip or burn all dead trees as soon as possible; they may encourage other pest problems.

NEXT CROP
• Avoid planting on very sandy, drought-prone sites.
• Do not plant shallow-rooted species, such as true firs and spruce, in areas of low rainfall or on drought-prone sites.
• Remove weeds before planting.
• Irrigate during dry periods. This is especially important for young trees.
• Monitor planting closely; poorly planted trees are very susceptible to drought injury.

Hosts: All trees

NEEDLE DISOLORATION — Eriophyid Mites

Eriophyid Mites

Setoptus spp.

Hosts: Scotch, Austrian, red, and eastern white pine.

Importance: Immature and adult eriophyid mites discolor and distort foliage on pines by feeding on the buds and needles. Severe attacks degrade Christmas trees.

Look For:

• *Blotchy, pale yellow, stippled needles.* The shoots of infested trees may have an unusually large number of buds, and needles may be twisted or hooked.

APRIL TO OCTOBER

• *Tiny cream-colored mites* between needles or inside needle sheaths. To verify, pull the needle cluster apart until the needle sheath splits; then closely examine the lower part of the needle with a hand lens.

Factors that cause similar symptoms: Drought, herbicide injury.

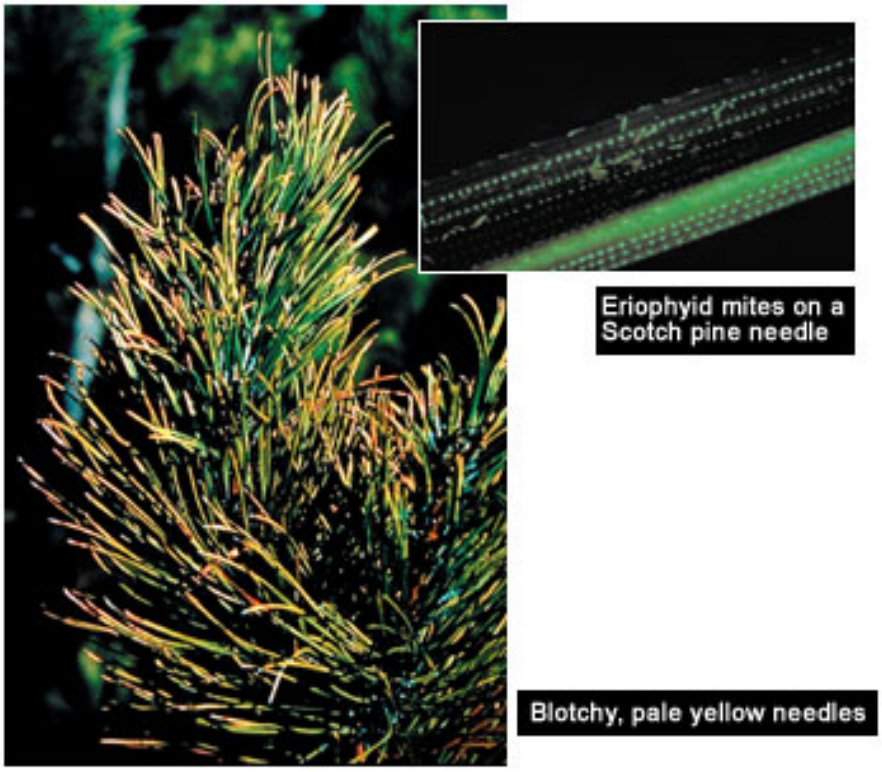
Biology: Several overlapping generations of eggs are laid on the needle sheaths, starting when the weather warms. Mites feed on the tree's sap under the needle sheaths. High numbers of mites result in discolored needles affecting tree appearance. Mite populations can swell when their natural enemies are inadvertently killed by repeated use of insecticides to control other pests.

Monitoring and Control: Inspect trees of all ages throughout the growing season. Treat infested trees as soon as you notice needles discolored by mites.

• Drench infested trees with a registered miticide (do not use an insecticide) anytime between May and September to kill adults. Depending on what miticide product is used, a second drench 10 to 14 days later may be needed to kill newly hatched mites. Be sure to follow directions on the pesticide label. The best time to treat for eriophyid mites is mid May to mid June, before needles fully elongate.

• Do not ship infested trees because overwintering mites hitchhike to new areas this way.

• Limit the use of insecticides to avoid killing mite predators.



Hosts: Scotch, Austrian, red, and eastern white pine.

Fall Needle Drop NEEDLE DISOLORATION

Fall Needle Drop

Hosts: All Christmas tree species.

Importance: Fall yellowing of inner foliage is a natural occurrence and does not harm Christmas trees before or at time of harvest. It is especially noticeable on eastern white pine and some varieties of Scotch pine.

Look For:
SEPTEMBER TO NOVEMBER
• *Yellowing and browning of the oldest foliage anywhere on the tree.*

Pests that cause similar symptoms: Cyclaneusma needlecast.

Biology: All conifers shed their oldest needles each year. These needles turn bright yellow or brown in September or October and drop off at or before the harvest period. A healthy pine should have at least 2 years of needles after the oldest needles drop. A healthy fir or spruce should still have 4 to 6 years of needles.

Monitoring and Control: Not necessary.

Hosts: All Christmas tree species.

NEEDLE DISOLORATION — Herbicide Injury

Herbicide Injury

Hosts: All conifers.

Importance: Herbicides that are improperly applied or that drift while being applied can kill and deform needles, shoots, and, occasionally, entire trees.

Look For:
• *Yellow, bleached, or brown needles*, especially new needles on the side of tree exposed to the herbicide.
• *Abnormal growth*; twisted needles, hooked, distorted, or swollen shoots.
• *Damage that often shows up as a pattern*; such as along one side of a field, along individual rows or trees, or only on one side of trees.

Pests that cause similar symptoms: Air pollution, salt injury, drought, distorted needles from balsam twig aphid (true firs), Cooley's spruce gall adelgid (Douglas-fir), or eriophyid mites.

Biology: There are many different types of herbicides with different modes of action. They can enter trees through needles or through the roots. Hormone-type herbicides cause abnormal, exaggerated growth. Others slow growth by inhibiting photosynthesis or other life processes. The type and degree of injury will depend upon the herbicide applied, the concentration reaching the tree, the time of year, and the condition

of the tree. Some products are lethal if applied when the trees are actively growing, but do not cause injury if applied when trees are dormant, such as in the late summer or fall. Other herbicides can be safely applied even during the active growth period.

Monitoring and Control: Check for injury during the first few weeks after herbicide application. Maintain a record of when and where applications occurred, the material applied, application rates, and information on weather conditions that occurred before and following applications.


Hooked shoots caused by picloram

• Prune dead shoots.
• Remove and chip or burn trees that are killed or severely affected by herbicides so that insects and diseases cannot build up on them and spread to nearby healthy trees.

NEXT CROP
• Follow label directions carefully.
• Avoid applying herbicides directly to the foliage of trees.
• Reduce the chances of drift: do not apply on windy days and use the proper equipment.
• Avoid planting Christmas trees near areas where herbicides are regularly used, e.g., powerlines, roadsides, and agricultural fields.
• Limit herbicide use and the number of applications whenever possible.

Hosts: All conifers.

Lirula Needlecast NEEDLE DISOLORATION

Lirula Needlecast

Lirula nervata (Darker) Darker;
Lirula mirabilis (Darker) Darker

Hosts: Balsam, Fraser, and white fir

Importance: Injury ranges from scattered brown needles to the loss of most 3- and 4-year-old needles. Over a period of years, repeated infection can reduce tree growth, cause bud and branch mortality on the lower portion of the tree, and kill seedlings. Medium to high levels of disease caused by this pathogen decreases the quality of Christmas trees and makes boughs unusable for wreath-making.

Look For:
JUNE TO JULY
• *Second-year needles that are pale-green with patches of darker green, slowly turning brown.* Blister-like

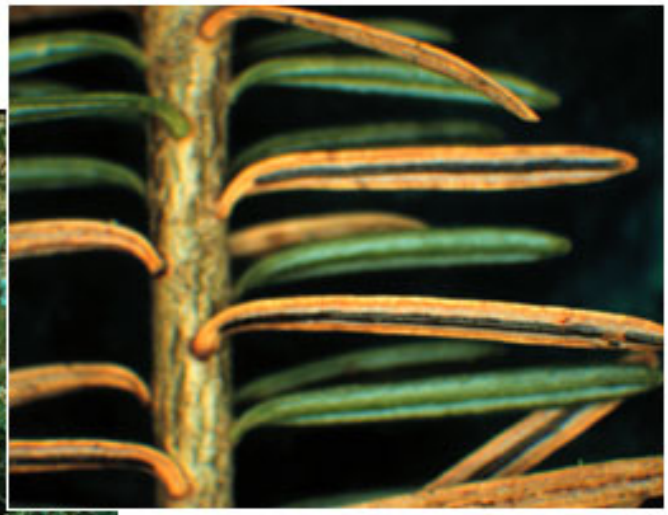
ridges develop on the upper surface of the brown needles. These ridges vary in color, shape, and location according to the specific species of fungus involved.
• *Third-year needles that are tan to brown with a dark line on the midrib of the lower surface or underside of the needle.*
AUGUST TO SEPTEMBER
• *Third-year needles that are shades of brown or gray; needles may be cast, broken off, or remain attached for several years.*

Pests that cause similar symptoms: Rhizosphaera needle blight.

Biology: Spores are released from infected needles during rainy periods in June, July, and August. These spores infect current-year's needles. Newly infected fir needles remain symptomless until the following spring when they begin to discolor. Infected needles then become pale and patchy green in color and slowly turn brown. Spore-producing fruitbodies develop in the upper surface of these brown needles in late spring of the second year and mature during summer. They appear as pustules or as blister-like ridges. In late summer of the second year, another type of spore-producing structure (ascoma) begins to form on the midrib in the lower surface of the needle. By the summer of the third year, this structure looks like a dark line along the lower midrib. Infectious spores are released from this structure and the cycle begins again.

Most injury occurs on small trees growing in cool, moist locations or on larger trees that are growing close to one another. Symptoms may be observed one to three years following a wet growing season. Damage is most evident on the lower branches (within 4 or 5 feet of the ground), where humidity is high and temperatures are lower. Disease is most prevalent in low-lying areas, shaded areas, and areas where trees are crowded together. Areas where young balsam or Fraser fir are surrounded by tall fir trees can be an ideal environment for high levels of disease. Young firs near windbreaks and trees adjacent to densely forested areas are commonly infected.


Damage usually occurs in the lower canopy


Single row of fruitbodies on lower surface of needle caused by *Lirula nervata*

Monitoring and Control: Examine trees of all ages at any time of the year. Look for second- and third-year needles that are various shades of brown and gray; these needles should also have one black line on the midrib of their lower surface.
• If disease incidence is low and infected trees are confined to the highly susceptible areas described under "Biology," cultural management should provide adequate disease control. If disease is widespread throughout a plantation, contact your local forest health specialist for the latest information regarding chemical control. There is currently no fungicide registered to control Lirula needlecast.
• Do not leave live, infected branches on stumps of harvested trees; they serve as disease reservoirs.
• Shear healthy trees first so spores will not be carried into them from infected trees.
• Do not shear infected foliage during wet weather because spores released at this time may be carried form tree to tree on shearing tools. Disinfect tools after shearing affected plantations by dipping them in alcohol for 3 minutes.
• Prune lower branches and control weeds around the base of trees to allow more air flow.

NEXT CROP
• Locate plantations in areas where there is good air drainage.
• Carefully examine fir trees for infected needles before planting. Do not plant infected nursery stock. Do not introduce these diseases into your plantation by transplanting infected native balsam or Fraser fir.
• Do not interplant balsam and white fir in areas of your plantation where the disease is present. This will perpetuate the disease in the stand.
• Provide adequate space between trees to increase air movement around lower branches.
• If needlecast is a repeated and economic problem in your plantation, grow a tree other than fir.

Hosts: Balsam, Fraser and white fir

Lophodermium Needlecast NEEDLE DISOLORATION

Lophodermium Needlecast

Lophodermium seditiosum Minter, Staley, and Millar

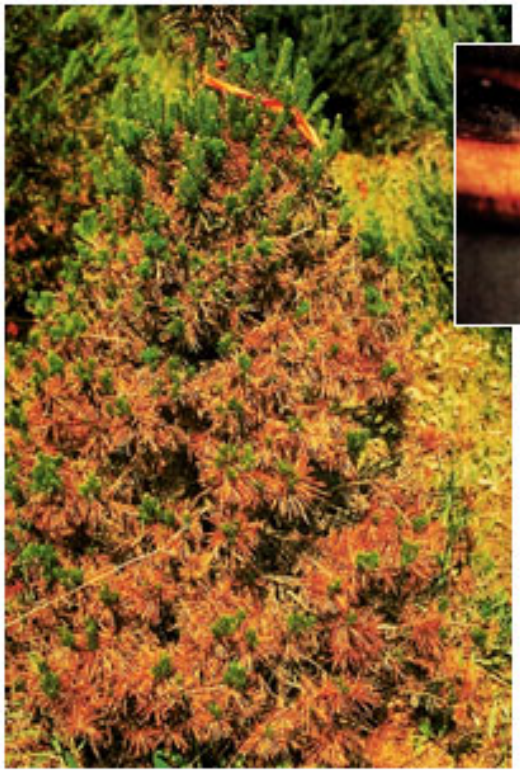
Hosts: Scotch and red pine.

Importance: This fungus kills red pine seedlings and causes dramatic browning on Scotch pines of all ages. Severely affected trees, weakened by early needle loss, are unfit for sale as Christmas trees.

Look For:
MARCH TO APRIL
• *Brown spots with yellow margins on the needles.* Eventually needles turn yellow, then brown.
MAY TO JUNE
• *Brown needles, especially at the bottom of the tree.* When severely affected, the whole tree will turn brown.
JUNE TO JULY
• *Fresh shoot and needle growth on the tips of branches that hold dead brown needles.* Most dead needles fall off in June, July, and August, leaving only tufts of new, green growth on the branch tips.
JULY TO OCTOBER
• *Black, football-shaped fruitbodies* on dead needles. Lophodermium fruitbodies have a lengthwise slit down the middle and stick out from the needle when wet.

Pests that cause similar symptoms: Brown spot needle blight, pine needle scale, winter injury.

Above: Lophodermium fruitbodies



Left: Brown needles on infected Scotch pine

Biology: Wind spreads Lophodermium spores from diseased needles to healthy needles in moist weather from August through October. The fungus overwinters in pine needles. In the spring, it destroys the water-conducting system in needles, causing the foliage to turn brown.

Monitoring and Control: Examine trees of all ages in May or June. Look for needle spots and brown foliage on the lower branches of 50 or more trees scattered throughout the plantation. If 10 percent of the trees are injured, consider treating the entire plantation starting in late July.

• Irrigate seedlings in the morning so that they will have time to dry in the afternoon. This will avoid the prolonged periods of moisture that favor infection.
• Do not ship infected nursery stock or Christmas trees because Lophodermium hitchhikes to new areas this way.
• Do not leave live, infected branches on stumps of harvested trees; they serve as disease reservoirs.
• Apply a registered, preventive fungicide 3 or 4 times, once every 2 to 3 weeks during the major infection period from late July through October. Apply more frequently if wet weather persists.

NEXT CROP
• Plant only disease-free stock. If you suspect infection, have seedlings examined by a pest specialist.
• Do not plant seedlings next to windbreaks of the same species. Cut and burn same-species windbreaks the year before planting a new stand. Remove the stumps, or treat them with a registered insecticide to prevent pales and northern pine weevil attack.
• Plant disease-resistant varieties, e.g., long-needled Scotch pines (see Table 1).

Hosts: Scotch and red pine.

Pine Needle Rust NEEDLE DISOLORATION

Pine Needle Rust

Coleosporium asterum (Dietel) Syd. and P. Syd

Hosts: Red and Scotch pine.

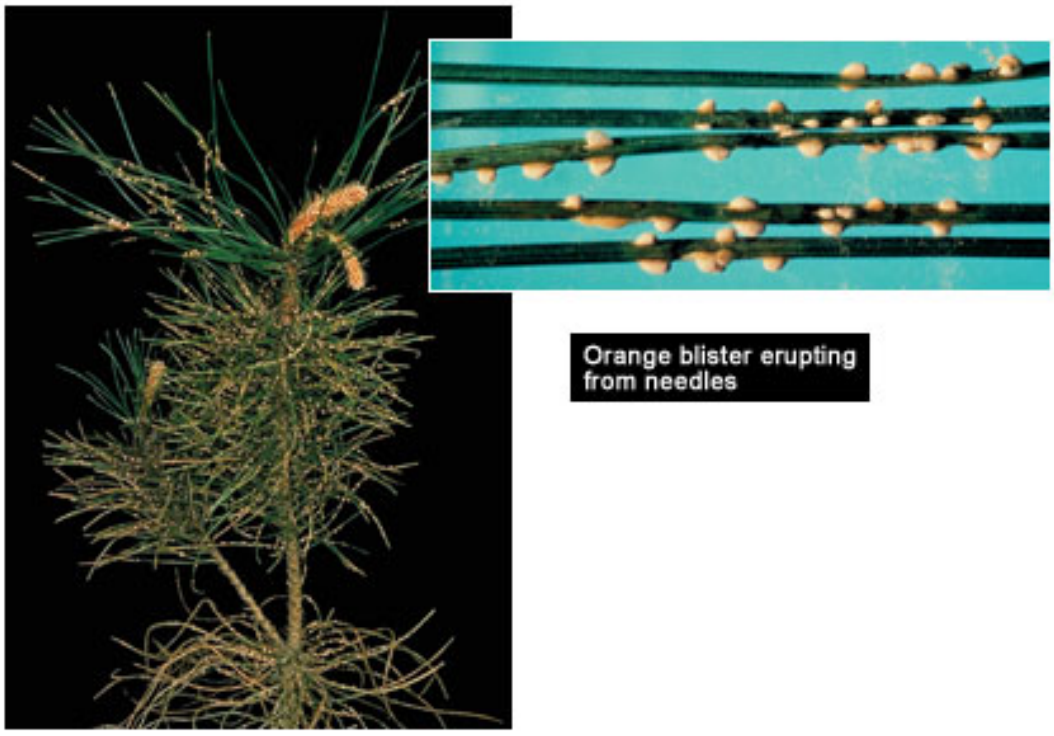
Alternate Hosts: Goldenrod, aster.

Importance: Most common on young trees up to sapling size, needle rust slows growth and causes unsightly foliage. When combined with insects and other agents that attack current-year foliage, needle rust may seriously damage or kill seedlings.

Look For (on pine):
APRIL TO MAY
• *Frosty-orange droplets* on needles at the onset of warm weather.
MAY TO JUNE
• *Orange blisters* erupting from needles on lower branches.

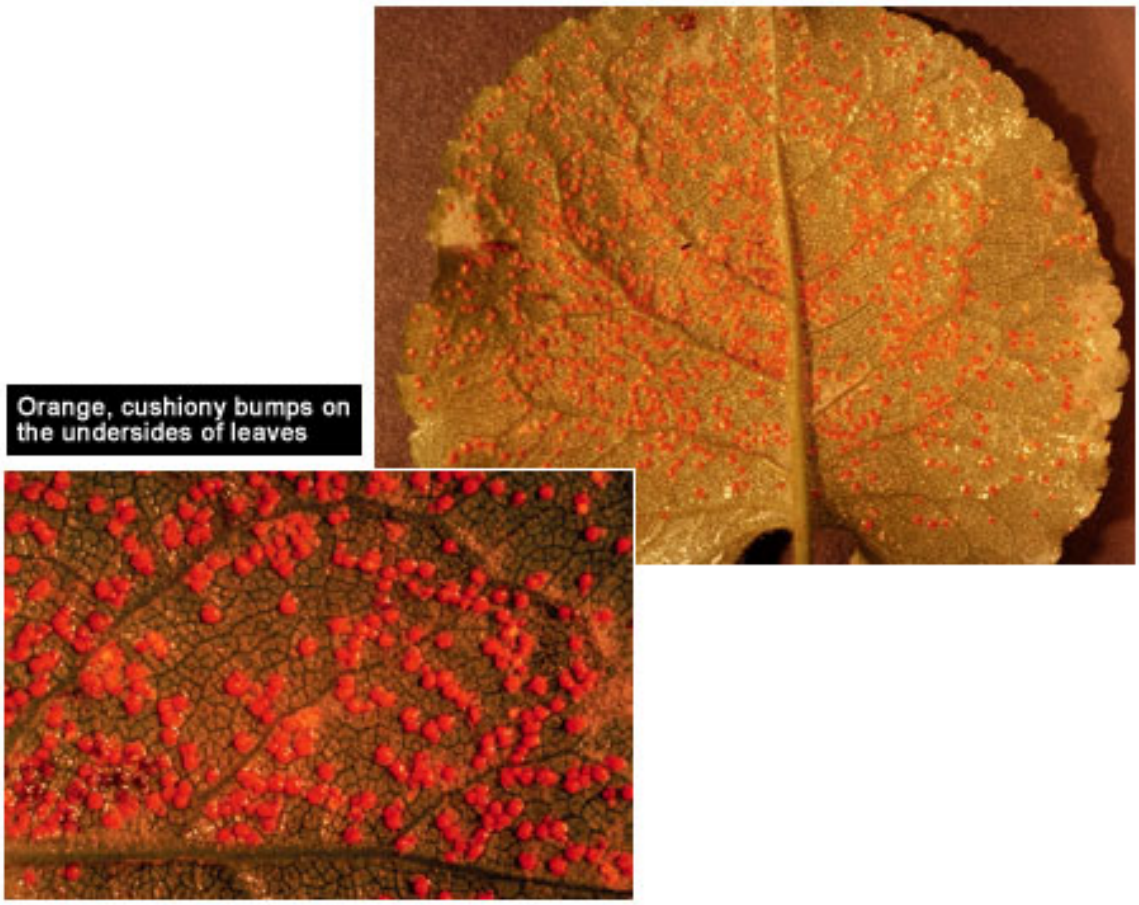
Look For (on goldenrod or aster):
JULY TO AUGUST
• *Orange spores* on the undersides of leaves.
AUGUST TO SEPTEMBER
• *Orange, cushiony bumps* on the undersides of leaves.

Biology: This fungus needs both pine and a herbaceous host to complete its 1-year life cycle. Pine needle rust spores produced on pine do not infect pine. Windborne spores from pine needles infect goldenrod or aster, and only spores produced on these alternate hosts can infect pines. Needle rust overwinters in pine needles. The fungus is perennial, so it can survive 2 consecutive years of unfavorable weather.



Monitoring and Control: Examine 3- to 6-year-old trees in May and June. Check the needles of at least 50 trees scattered throughout the plantation. If you find orange blisters and serious foliage loss on more than 25 percent of these trees, remove goldenrod and aster in and around the plantation before August.
• Mow goldenrod and aster before August to avoid using a herbicide. These plants are perennial and will need mowing each year until the trees are old enough for the rust to have little or no impact on tree quality.
• Or, kill goldenrod or asters concentrated within 1,000 feet of newly planted seedlings before August by applying a registered herbicide. Without its alternate host, the fungus will not be able to complete its life cycle or infect pines.

NEXT CROP
• If practical, remove tall grass, weeds, goldenrod, and aster in and around plantation before planting. Avoid planting on humid sites north or west of a stand of tall trees, and avoid steep, northern or western slopes.



Hosts: Red and Scotch pine

Pine Needle Scale NEEDLE DISOLORATION

Pine Needle Scale

Chionaspis pinifoliae (Fitch)

Hosts: All pines and spruces; Douglas-fir, eastern red cedar.

Importance: This insect weakens trees by sucking sap from the needles. Severely infested trees may have sparse, discolored foliage, low vigor, and dead shoots, and cannot be sold as Christmas trees.

Look For:

• *White-flecked or brownish foliage.*

• *Many white or light-yellow, oyster-shaped scales*, about 1¼10 inch long, covering the needles. Large scale populations can cause trees to look grayish green.

Pests that cause similar symptoms: Most needlecast diseases, sawflies (eggs look like scales).

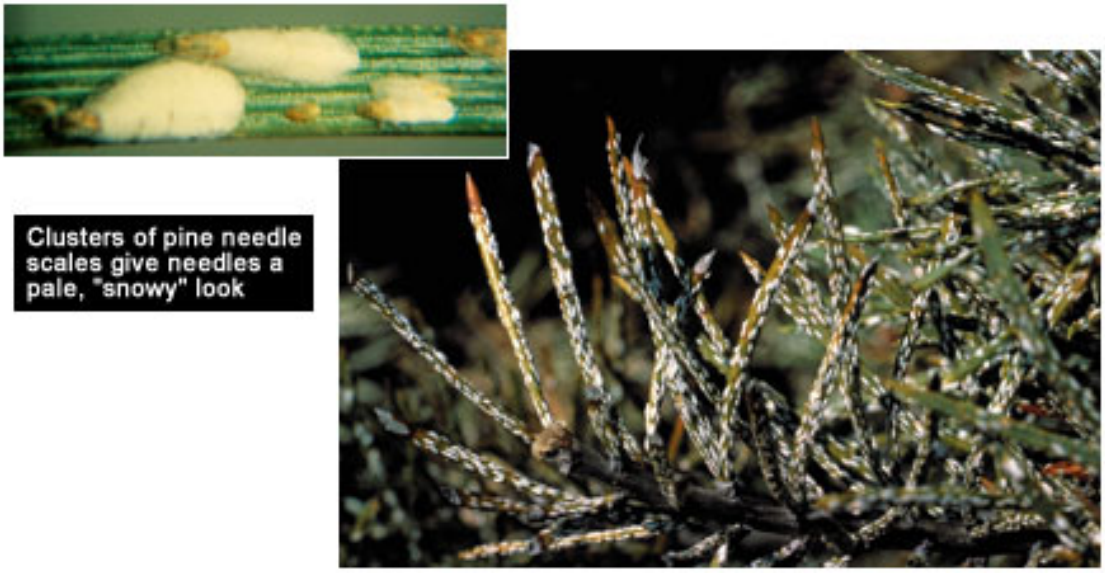
Biology: Small, reddish eggs overwinter on the needles beneath dead, female scales. The crawlers (nymphs) hatch in mid May, move to new hosts, and settle on the needles to feed and grow. The scales

mature in early July and produce a second generation of crawlers by mid July. While growing, the scales secrete and cover themselves with a waxy coating that most pesticides cannot penetrate.

Monitoring and Control: Inspect trees of all ages, looking for white flecks on the needles before lilacs bloom in spring. Be sure to check needles on lower branches where many infestations begin. Delay control of slight infestations on young trees, especially if predators such as ladybugs or lacewings are abundant on trees. These predators may curb an infestation. Treat individual trees when you see 5 to 10 white flecks per shoot. Treat all infested trees before shipping.

• Cut, remove, and destroy severely infested trees.
• Spray infested trees thoroughly with a registered insecticide or horticultural oil in mid to late May, when lilacs are in full bloom, to control first-generation crawlers. Spray again if needed in late July or early August when the second generation of crawlers hatch.
• Or, apply dormant oil in late fall or early spring when trees are dormant. This treatment will do little harm to scale predators.
• You should be able to spot treat individual infested trees.

NEXT CROP
• Reduce spraying for other pests in new plantings whenever practical. Scales often reproduce rapidly after repeated spraying for other insects because the insecticides kill both the target pest and the natural enemies of the scales.



Clusters of pine needle scales give needles a pale, "snowy" look

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Hosts: All pines and spruces; Douglas-fir, eastern red cedar.

Pine Thrips

Gnophothrips spp.

Hosts: Scotch and Austrian pines.

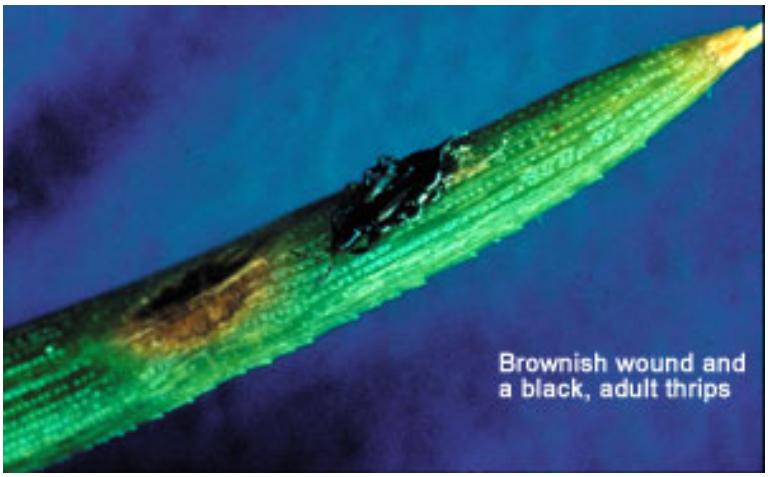
Importance: When severe, pine thrips feeding can distort needles and weaken, stunt, or kill Christmas trees or seedlings. Severely injured nursery seedlings are unfit for outplanting and injured trees are unsuitable for Christmas tree sale.

Look For:
• *Discolored, crooked needles, particularly on the upper branches*. Severely injured trees die and lose their needles.
• *Curled needles* anywhere on the trees. Needles growing from the same sheath may differ in size.
• *Brownish wounds*, 1⅛8 to 1¼4 inch wide, on the needles.
LATE APRIL TO OCTOBER
• *Orange-yellow or black insects*, up to 1¼16 inch long, on the buds or new needles. Use a hand lens to see them clearly.

Biology: The winged, black adult thrips lay their eggs in May. Several subsequent generations produce thousands of insects that feed on trees throughout the summer. Hot, dry weather favors their buildup.

Monitoring and Control: Inspect trees of all ages throughout the growing season. Examine 30 or more trees in late summer. If an average of 10 percent of the needles in the tops of the trees show damage, treat entire nursery or plantation next spring. Treated trees will usually outgrow the injury in 2 to 3 years.
• Irrigate nursery seedlings frequently during hot, dry weather. Water with overhead sprinkler system early in the morning to discourage thrips and to reduce the likelihood of needlecast disease.
• Do not ship infested nursery stock or infested trees because overwintering thrips hitchhike to new areas this way.
• Thoroughly spray trees with a registered insecticide once in late April or early May before eggs are laid to control adult thrips. If you delay treatment until later in the season, two or three applications may be needed for complete control.

NEXT CROP
• Do not bring infested transplant stock into fields.



Hosts: Scotch and Austrian pines

Rhabdocline Needlecast
Rhabdocline pseudotsugae Syd.

Host: Douglas-fir, especially Rocky Mountain variety.

Importance: The browning and early needle loss caused by this fungus make Douglas-firs unsalable as Christmas trees.

Look For:
LATE FALL
• *Yellow spots on infected needles*. Spots eventually enlarge and cause mottling.
EARLY SPRING
• *Yellowish-brown to reddish-brown needles*.
EARLY SUMMER
• *Shedding of brown needles*. Severely diseased trees will keep only their current needles.

Pests that cause similar symptoms: Pine needle scale, Swiss needlecast.

Biology: Fruitbodies that develop on the brown needles release spores during moist weather from May to July. Windborne spores infect only the young needles.

Monitoring and Control: Inspect 5- to 10-year-old trees in May. Examine the 2-year-old needles on 50 or more trees scattered throughout the plantation. If you find fruitbodies on 20 percent or more of these trees, consider treating entire plantation in early spring.
• Shear healthy trees first so fungal spores will not be carried on shearing tools from affected trees to healthy ones.
• If possible, remove severely affected trees early in the rotation to prevent disease buildup.
• Apply registered fungicides when buds burst; repeat every 7 to 10 days until the buds are fully open. Fungicides applied after buds are fully open will not be effective. Fungicide treatments used for Rhabdocline should also control Swiss needlecast caused by another fungus that infects Douglas-fir.
NEXT CROP
• Plant only disease-free nursery stock.
• Plant disease-resistant varieties of Douglas-fir. If you plant a Rocky Mountain variety, select seed sources that show resistance to Rhabdocline.

Host: Douglas-fir, especially Rocky Mountain variety.

NEEDLE DISOLORATION

Rhizosphaera Needle Blight of Firs

Rhizosphaera Needle Blight of Firs

Rhizosphaera pini (Corda) Maubl

Host: Balsam, Fraser, and other firs.

Importance: This fungus causes a blight of needles on stressed trees or trees growing in shaded, damp, and cool areas. It can infect any age foliage and causes needle droop, discoloration and death, reducing the quality and value of trees. Greatest damage is to needles on lower branches where it may result in branch death.

Look For:

• *Yellow to tan needles*. Needles turn grayish-tan and die. Needles may also droop. Before new growth occurs in the spring, all needles on individual severely affected branches may be dead from the tip of the branch to the tree trunk.

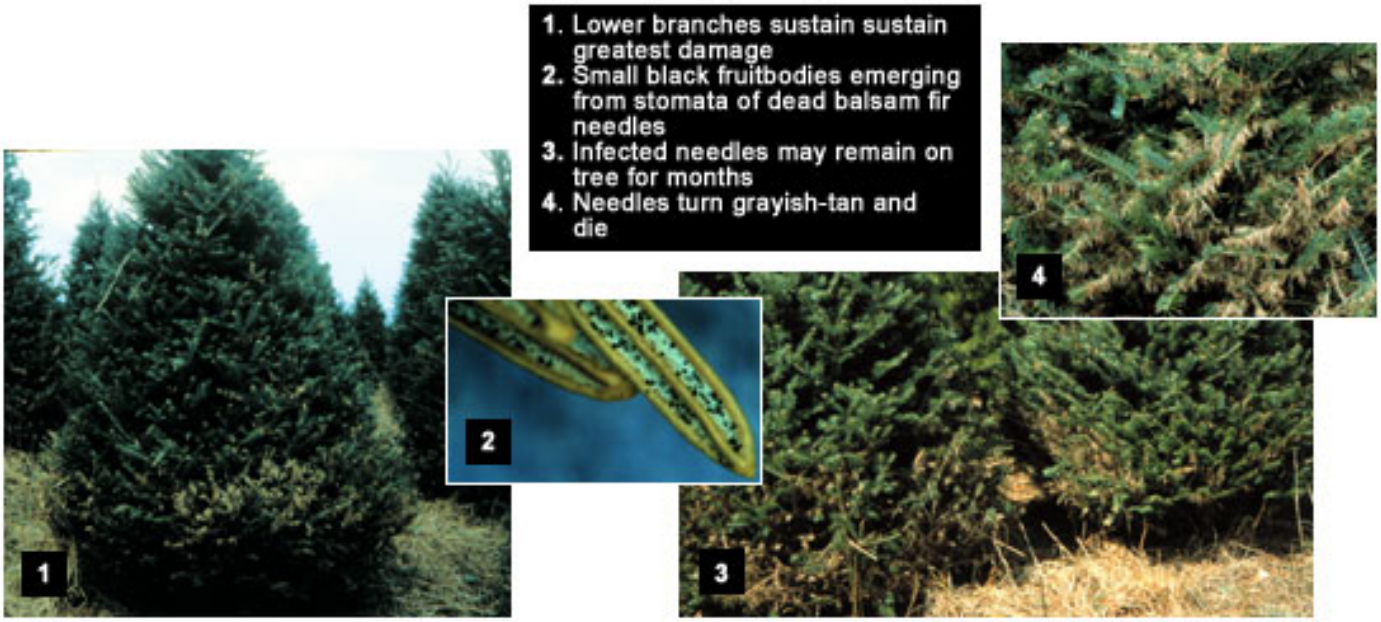
• *Tiny black fruitbodies on the undersides of green, yellow, and grayish-tan needles* that can be seen with a hand lens. The fruitbodies emerge from the needle stomata (tiny pore-like openings on the underside of needles), and often have a speck of white wax on top of them.

Pests that cause similar symptoms: Lirula needlecast.

Biology: Symptoms often appear after periods of rainy weather and cool temperatures, anytime during the growing season. Spore release and infections probably occur throughout the growing season whenever favorable environmental conditions develop. Needles of any age can be infected. The needle may discolor soon after infection before fruitbodies develop or fruitbodies can develop while the needle is still green. Many infected needles remain on the tree over winter and into the next summer.

Severe injury occurs on stressed trees or trees growing in shaded, damp, and cool areas. Damage is most evident on lower branches where conditions tend to be cooler and damper, but may occur anywhere on the tree.

Monitoring and Control: Examine trees and foliage of all ages throughout the year. Previous year's damage is most evident early in the spring before new growth develops, but symptoms and damage can develop anytime during the growing season. Fungicide recommendations have not been developed. The best control is cultural management to avoid stress and conditions favorable to the fungus.
• Promote good air movement by controlling weeds and pruning off lower branches.
• Do not shear during wet weather because spores could be carried to healthy trees on shearing tools. Disinfect tools after shearing. Shear healthy trees first.
• If infection is localized, remove and burn infected branches and trees. This should reduce but may not eliminate future infections.
• Do not leave live branches on stumps of harvested trees, as these can serve as disease reservoirs.
NEXT CROP
• Plant trees with adequate space between them to provide good air movement.
• Do not grow fir in shady areas or where cool, moist air collects.
• Plant only healthy stock, and do not interplant fir seedlings in fields where older, diseased trees are present.



Host: Balsam, Fraser and other firs

Rhizosphaera Needlecast of Spruce

NEEDLE DISOLORATION

Rhizosphaera Needlecast of Spruce

Rhizosphaera kalkhoffii Bubak

Host: Colorado blue spruce; occasionally white spruce.

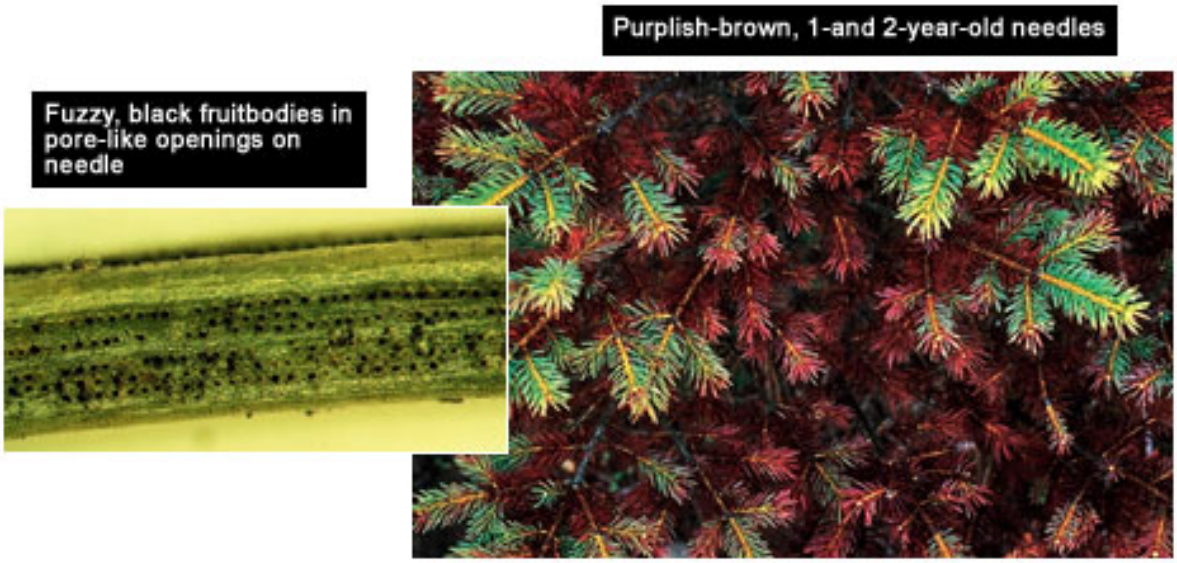
Importance: This fungus causes needles to turn purplish-brown and fall prematurely, thereby reducing the vigor and market value of Christmas trees. Three or four years of early needle loss kills branches and, in severe cases, the entire tree.

Look For:
LATE FALL OR EARLY SPRING
• **Fuzzy, black fruitbodies** sticking out of tiny, pore-like openings (stomata) on both green and yellow needles. Use a hand lens. The yellow needles later turn purplish brown.
JULY TO AUGUST
• *Purplish-brown, 1- and 2-year-old needles*, most commonly on the lower branches. Most of these needles drop off by late fall.

Pests that cause similar symptoms: Drought, pine needle scale, spruce spider mite.

Biology: Some infected needles remain on the tree throughout winter. The next spring, spores from infected foliage are rain-splashed or manually spread via equipment to newly emerging needles. Although infection is possible from mid April to October, it usually occurs during wet weather after bud break.

Monitoring and Control: Inspect trees of all ages during May. Randomly select 20 or more trees scattered throughout the plantation and remove three lower branches from each. Examine the white rows of stomata on the 2-year-old needles with a hand lens. If half the branches have fruitbodies on more than 10 percent of their needles, consider treating the entire plantation in spring and summer.
• Do not leave live, infected branches on stumps of harvested trees; they serve as disease reservoirs.
• Do not shear infected foliage during wet weather because spores released at this time may be carried from tree to tree on shearing tools. Sterilize tools after shearing affected plantations by dipping in denatured alcohol for 3 minutes.
• Shear healthy trees first so fungus spores will not be carried into them from affected trees.
• Apply a registered preventive fungicide when new needles are half elongated and again when needles are fully elongated. Two years of treatment should permit most trees to develop full foliage; severely affected trees may take longer. If treated early, Rhizosphaera needlecast can be controlled in 1 year.
NEXT CROP
• Plant only disease-free stock.



Host: Colorado blue spruce; occasionally white spruce

NEEDLE DISOLORATION — Salt Injury

Salt Injury

Hosts: Many conifers. White pine, red pine, and balsam fir are especially sensitive to salt. Scotch pine is moderately tolerant. Colorado blue spruce and Black Hills spruce are relatively tolerant of salt.

Importance: Salt injury causes early needle loss, thereby degrading or making Christmas trees unsalable. Severe injury can kill branches and small trees. Trees affected by salt are usually those growing next to major roads and intersections. Damaged trees are generally found only within one or two outer rows in a plantation, usually within 100 feet of roads.

Look For:
APRIL TO JUNE
• **Browning of needles** on the side of trees facing the road. These needles generally drop and new buds usually develop normally.

Pests that cause similar symptoms: Winter injury on most conifers, Brown spot needle blight on Scotch pine, Dothistroma needlecast on Austrian pine, Lophodermium and Cyclaneusma needlecast on Scotch pine.

Biology: Damage originates from both salt spray (salt deposited through the air onto needles, buds, and twigs), and soil salt (salt deposited in the soil occupied by the roots). The browning is often concentrated on the side of the tree facing major roads. Trees growing where salt accumulates, such as small depressions that drain water from roads or ditches along roads, can also be damaged. The affected foliage falls off during the spring and early summer, thinning the crown. New growth will make the tree appear

otherwise healthy. However, trees repeatedly affected by salt often become stunted and grow slowly. They may eventually be killed by prolonged exposure to salt. Weakened trees may be killed by insects or disease.

Monitoring and Control: Monitor plantations between April and June. Look along the edges of plantations that are adjacent to major roads. The amount of injury can vary greatly between years, depending upon the amount of salt used on roads during the winter.
• Harvest trees as soon as possible after an injury-free winter.
NEXT CROP
• Avoid planting susceptible species, such as white pine, red pine, and balsam fir, along major roads.

Hosts: Many conifers, especially white pine, red pine and balsam fir

Spruce Needle Rusts

Chrysomyxa spp.

Hosts: Black, white, and Colorado blue spruce; occasionally Norway spruce.

Alternate Hosts: Labrador tea; leather leaf.

Importance: During spruce needle rust epidemics, infected trees will lose 25 to 75 percent of their new needles, leaving them unfit for Christmas tree sale. Repeated infections will slow growth but will rarely kill trees.

Look For:

JULY TO AUGUST

• *Yellow current-year needles* anywhere on tree.

• *Whitish blisters filled with yellow spores on the undersides of current year needles.*

AUGUST TO SEPTEMBER

• *Shedding of infected needles.*

Biology: The fungi that cause spruce needle rusts need an alternate host to complete their life cycles. During the summer, windborne spores released from fungal blisters on spruce infect swamp heath plants such as Labrador tea or leather leaf. The fungi overwinter on these alternate hosts and spores released from them reinfect spruce the following spring.

Control:

NEXT CROP

• Avoid planting spruce near swamps that contain Labrador tea and leather leaf.

• Plant resistant species of spruce, such as Norway or Black Hills. White spruce is moderately resistant, but black and Colorado blue spruce are extremely susceptible.

Hosts: Black, white, and Colorado blue spruce; occasionally Norway spruce

Spruce Spider Mite

Oligonychus ununguis (Jacobi)

Hosts: All Christmas tree species.

Importance: Mites may discolor, degrade or kill nursery stock and Christmas trees of all ages. Injury is most common during prolonged dry periods, on droughty soils, and where overuse of pesticides has killed the natural enemies of the mites.

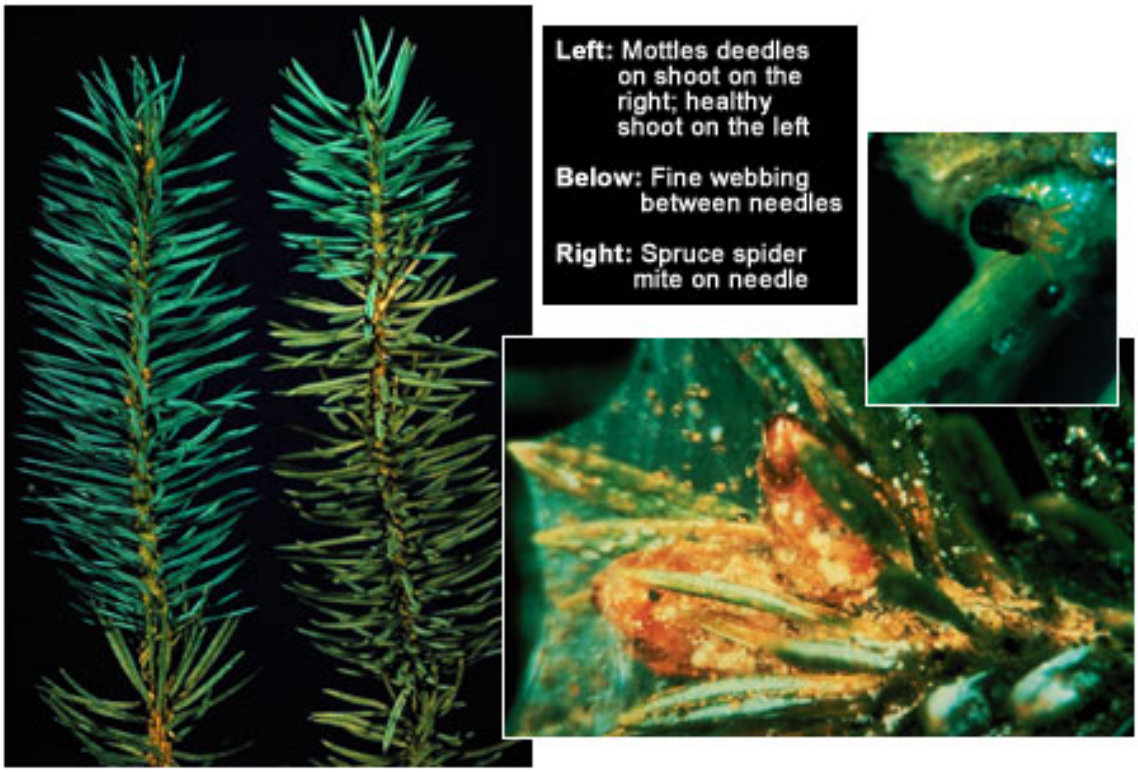
Look For:
• *Yellowish to rusty-brown shoots*. Look closely to see yellow mottling on needles.
• *Fine webbing between the needles*. This may require a hand lens.
• *Dark-green to brown mites*, less than 1¼50 inch long, on needles or webbing. To see mites, shake an injured branch over a piece of white paper, and focus a hand lens on the tiny moving specks.

Pests that cause similar symptoms: Rhizosphaera needlecast.

Biology: Mite eggs overwinter on shoots. Nymphs hatching in May or June feed on tree sap and spin webs. Adults appear in June or early July; three or more generations follow at 21¼2- to 3-week intervals until the weather turns cold. Mites are windblown to new areas or carried on infested nursery stock.

Monitoring and Control: Examine trees of all ages throughout the growing season, beginning in June. Delay control if injury or webbing is barely noticeable or if rainfall/humidity is high. However, if injury occurs during dry weather or if trees are to be harvested that year, treat individual infested trees as soon as you notice symptoms.
• Spray infested trees with a registered miticide in early June to early July when you first see mite activity. Some miticide products should be applied only once a year, ideally in early summer. Other miticide products may need to be applied at 2–week intervals to kill mites emerging from eggs. Be sure to follow application directions on the label.
• Or, spray trees thoroughly with a dormant oil early next spring before growth starts.
• Do not ship infested nursery stock or Christmas trees because overwintering mites hitchhike to new areas this way

NEXT CROP
• Avoid planting on droughty soils, especially when planting spruce.
• Plant only pest-free nursery stock.



Hosts: All Christmas tree species

Swiss Needlecast NEEDLE DISOLORATION

Swiss Needlecast

Phaeocryptopus gäumanni (T. Rohde) Petr.

Host: Douglas-fir

Importance: The browning and early needle loss caused by this fungus results in trees that are unfit for sale as Christmas trees.

Look For:
SPRING AND FALL
• *Rows of fuzzy black fruitbodies* in tiny, pore-like openings (stomata) on the undersides of both green and yellow needles. Use a hand lens to see them. Yellow needles later turn brown.
JULY TO AUGUST
• *Brown, 2- and 3-year-old needles, especially on the lower branches.* These needles fall off in late August.

Pests that cause similar symptoms: Pine needle scale, Rhabdocline needlecast.

Biology: Airborne spores infect needles on new shoots during wet weather at the time of bud break. The fungus is commonly spread on infected nursery stock.

Monitoring and Control: Inspect 4- to 10-year-old trees during May. Randomly select 20 or more trees scattered throughout the plantation, and remove three sample branches from each. Examine the white rows of stomata on the 2-year-old needles with a hand lens. If half of the branches have fruitbodies on more than 10 percent of these needles, consider treating the entire plantation before summer.

• Do not shear infected foliage during wet weather because spores released at this time may be carried from tree to tree on shearing tools. Sterilize tools after shearing affected plantations by dipping in denatured alcohol for 3 minutes.

• Shear healthy plantations first so fungus spores will not be carried into them from affected plantations.

• Apply a registered, preventive fungicide in spring when the new shoots are 1¼2 to 2 inches long. Apply again in 2 to 3 weeks, and once again if rainfall is abnormally high. Two years of treatment should restore most trees to full foliage; severely affected trees may take longer. Treat nursery stock every 2 weeks from bud break to mid August.

NEXT CROP

• Inspect planting stock carefully. Plant only disease-free stock.

Host: Douglas-fir

NEEDLE DISOLORATION

Winter Injury

Winter Injury

Hosts: Short-needled Scotch pine varieties; Austrian and white pine; Norway spruce; white fir; Fraser fir; occasionally other Christmas tree species.

Importance: Winter burn and winter drying cause needles to turn brown and fall off, thereby degrading or making Christmas trees unsalable. Severe injury for several years may kill branches and occasionally kill trees.

Look For:

• *Lack of foliage, especially on the south side of trees* where injury is usually most severe.

APRIL TO JUNE

• *Browning of entire tree or brown needles above the winter snowline* at the onset of warm weather. These needles drop and new buds usually develop normally.

Pests that cause similar symptoms: Brown spot needle blight on Scotch pine, Dothistroma needlecast on Austrian pine, Lophodermium and Cyclaneusma needlecast on Scotch pine, salt injury.

Biology: Water cannot move easily in soil and in trees in the winter, so when moisture is lost, it cannot always be replaced in sufficient amounts. When the soil around tree roots is frozen, warm winds can dry out and damage needle, bark, and bud tissues. Winter burn causes needles to turn brown during fast temperature changes, particularly on the south side of trees where exposure to the sun is greatest. Temperatures change quickly at sunset and sunrise or when sunlight is suddenly blocked by other trees, hills, or buildings. Sometimes winter burn and winter drying will occur together, occasionally complicated by drought. The amount of injury depends on climate and on how well the Christmas tree species or variety can withstand winter conditions. Exotic trees (those grown outside their native ranges) tend to be especially susceptible to winter injury.

Monitoring and Control: Select 50 or more trees of any age scattered throughout the plantation and look for browning between April and June. Keep accurate records of winter injury throughout the life of the trees. If more than 10 percent of them are periodically degraded by winter injury, avoid replanting the same species or variety on that site.
• Harvest old, susceptible trees as soon as possible after an injury-free winter.
• Figure the cost-benefit of keeping young, susceptible trees. If not profitable, destroy the trees and replant with resistant ones (see Table 1).
NEXT CROP
• Plant resistant species and varieties, such as the long-needled Scotch pine varieties; red pine; white, blue, and Black Hills spruce; Fraser fir; and balsam fir (see Table 1).
• Avoid planting susceptible species and varieties, such as Spanish Scotch pine, Austrian pine, or Norway spruce. If you do plant susceptible trees, plant them in areas that are protected from the wind or in southern areas where temperatures are not as extreme.

Winter injury causes trees to lose needles, browup above the snow-line, or turn completely brown.

Hosts: Short-needled Scotch pine varieties; Austrian & white pine; Norway spruce; white fir; Fraser fir; others

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Needle Feeding

Needle Feeding

Portions of needles or entire needles are chewed off. Several needles may be clipped and webbed together into tubes, bags, or nests. Search for pellets of waste on the ground beneath injury to verify that damage is due to feeding and not simply needle drop.

Bagworm

Thyridopteryx ephemeraeformis (Haworth)

Hosts: Eastern red cedar; spruce; fir; eastern white pine.

Importance: Bagworm feeding results in trees with thin foliage and brown cases attached to twigs. Injured trees are unfit for Christmas tree sale and may be killed if larvae strip off all the foliage. This insect is most common in the southern portions of the north central region.

Look For:

• *Sparse or stripped foliage, especially at the top of the tree*. Shoot tips may be flagged (discolored and deformed).

• *Conspicuous, brown, silk bags*, 1 3/4 to 2 inches long, disguised with needle particles from the host tree.

Biology: The wingless female moths lay eggs in the fall inside silken bags. Larvae emerge, feed, and spin silken bags during June and July. In late August, they secure the bags to twigs. Because caterpillars move only short distances and females never leave the securely attached bag, damage may be confined to a single tree.

Monitoring and Control: Begin monitoring trees of all ages in May and continue throughout the growing season. Treat by hand unless infestation is severe or widespread.
• Hand pick and destroy silken bags, which will contain eggs, moths, or caterpillar, depending on the time of the year.
• Cut out and destroy individual trees that are severely infested.
• For widespread infestations, spray trees with a Bt (Bacillus thuringiensis var. kurstaki) solution from late May to early July to control the young feeding caterpillars.
• As a last resort, spray trees with a registered insecticide other than Bt once between early June and mid July to control feeding caterpillars.
• Do not ship infested trees because overwintering bagworms hitchhike to new areas this way.

NEXT CROP
• Before planting, remove infested trees in natural stands or windbreaks near the site.
• Plant less eastern red cedar, or replace with nonhost conifers.
• Increase spacing between trees when planting to reduce the spread of bagworms.

Hosts: Easstern red cedar; spruce; fir; eastern white pine.

European Pine Sawfly

NEEDLE FEEDING

European Pine Sawfly
Neodiprion sertifer (Geoffroy)

Hosts: Scotch, Austrian, and red pine.

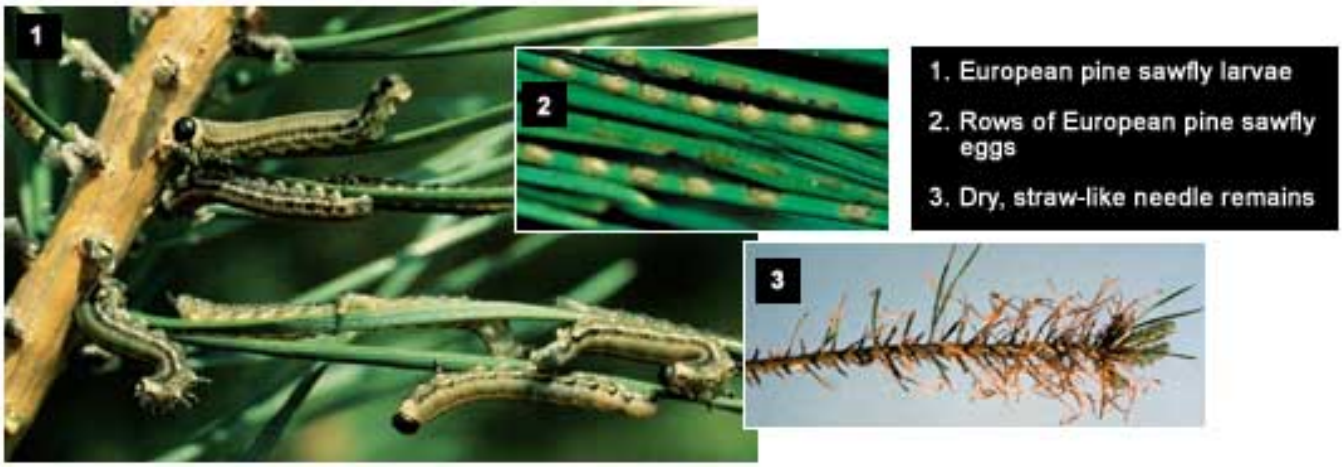
Importance: The larvae of this sawfly strip the old needles from pine Christmas trees, giving them a thin look in autumn. The trees outgrow the injury and recover their full, dense foliage in 2 or 3 years.

Look For:
• *Sparse or missing old foliage anywhere on the tree*.
APRIL TO MAY
• *Tufts of dry, straw-like needles remain* behind new, green growth.
APRIL TO JUNE
• *Green-striped larvae* up to 1 inch long, with shiny black heads, in clusters on the old foliage. There may be as many as 100 larvae in a cluster.
SEPTEMBER TO APRIL
• *Rows of yellow eggs in slits* in the needles.

Biology: Adult females lay their eggs in clusters in the needles in September and October. The eggs overwinter and hatching begins in mid April to early May. Young larvae feed in groups on the outer edges of old needles and produce tufts of dead needles. Older larvae eat entire needles and leave only the needle sheaths. One larval colony of 80 to 100 larvae can eat all the old foliage off a tree 2 feet tall; 15 to 20 colonies can completely defoliate a tree 6 feet tall. When full grown, larvae drop to the ground, spin cocoons, and pupate.

Monitoring and Control: Begin inspecting trees 3 years before harvest, or when many small trees are repeatedly defoliated. Look for eggs from September to April, and look for larvae or damage from April to June. Treat infested trees as soon as you see larvae.
• If colonies are few and scattered, knock the larvae off and crush them.
• Treat larvae with a virus that is known to kill that species. If a specific virus is not commercially available, you can make a virus suspension from the diseased larvae in your plantation. Look on partially defoliated windbreak or plantation trees for freshly-killed, diseased larvae that are soft and black and hanging head-down from the foliage. At this stage, the larvae are like sacks full of virus particles. Place 100 to 150 dead larvae in a pint of chlorine-free water (distilled or rainwater), and allow them to disintegrate until the following winter or early spring. Then, filter the solution through a fine, cotton cloth or stocking to remove the debris. The pint of stock solution is then ready to use. For knapsack or hydraulic sprayers, prepare a spray solution with 2 or 3 teaspoons of stock solution per 6 gallons of water. Add 5 level teaspoons of powdered milk or some other “sticker” to each gallon to help the spray solution adhere to the trees. Drench larvae and surrounding foliage shortly after the larvae emerge from the eggs. The virus will usually kill larvae in 4 to 10 days and continue to control the sawfly until the trees are harvested.
• If a virus suspension is not available, apply a registered insecticide directly to larvae. Bt (Bacillus thuringiensis) will not control sawflies.
• Do not ship nursery stock or Christmas trees that have sawfly eggs in the needles. Larvae may hatch in buyers’ homes and feed on the trees at Christmas.

NEXT CROP
• Plant more resistant varieties of Scotch pine, such as Swedish (Riga), N. Italian, or others (See Table 1).



Hosts: Scotch, Austrian and red pine

NEEDLE FEEDING

Grasshoppers

Grasshoppers

Melanoplus spp.

Hosts: All Christmas tree species.

Importance: Grasshoppers of many species will eat Christmas tree foliage when field crops or other preferred vegetation is in short supply. Large numbers of grasshoppers can kill seedlings planted in grassy areas or devour the needles and bark of larger trees, making them unsalable for several years.

Look For:

• *Ragged needles* that have been partly or completely chewed off.

• *Scarred bark on twigs and branches covered with hardened globs of pitch.* Seedlings may be almost completely eaten.
MID JULY TO OCTOBER
• *Large numbers of grasshoppers,* up to 1¼ inches long, feeding or resting on needles.

Biology: Grasshoppers become Christmas tree pests when their own food supply—grasses and field crops—is scarce. Therefore, damage is most likely to occur during a drought.

Monitoring and Control: In areas where grasshopper injury is likely, examine trees of all ages regularly from mid July through October. Treat if 5 percent of Christmas tree foliage is injured. If noticed early enough, only the several rows nearest the edge of the plantation may need treatment.
• Apply a registered insecticide directly to trees when grasshoppers are present, usually in August or September.

NEXT CROP
• Reduce grassy vegetation on or near the site before planting.

Hosts: All Christmas tree species

Gypsy Moth NEEDLE FEEDING

Gypsy Moth

Lymantria dispar (L.)
Hosts: Many hardwood species; pines, spruces, occasionally fir and eastern red cedar.

Importance: Gypsy moth larvae feed on foliage of many species, but rarely cause significant damage to Christmas trees. However, this exotic insect is currently regulated by strict federal and state quarantines. Trees grown in counties known to be infested by gypsy moth must be inspected by state regulatory agencies before harvest. If gypsy moth egg masses or any other life stages are found during inspections, the field will be restricted and trees cannot be shipped outside of the infested area. In some infested states, trees that will be shipped to uninfested areas must be sprayed with approved insecticides at appropriate times to reduce the chance of introducing gypsy moth to new areas.

Look For:
ALL YEAR
• *Egg masses on the stem and branches of Christmas trees,* even when defoliation is not noticeable. Gypsy moth egg masses are tan, covered with fine hairs, and may be 1 to 3 inches long.
MAY TO EARLY JULY

• *Gypsy moth caterpillars*, up to 3 inches long, with long hairs and blue and red spots on their backs. Their head is mottled yellow and black.
JULY TO AUGUST
• *Reddish-brown pupal cases*, often found in protected places on the lower side of branches, in bark crevices and on stems.
JULY TO SEPTEMBER
• *Adult moths;* males are dark tan with darker markings, have feathery antennae and are good fliers. Female moths have white wings with black markings and do not fly.

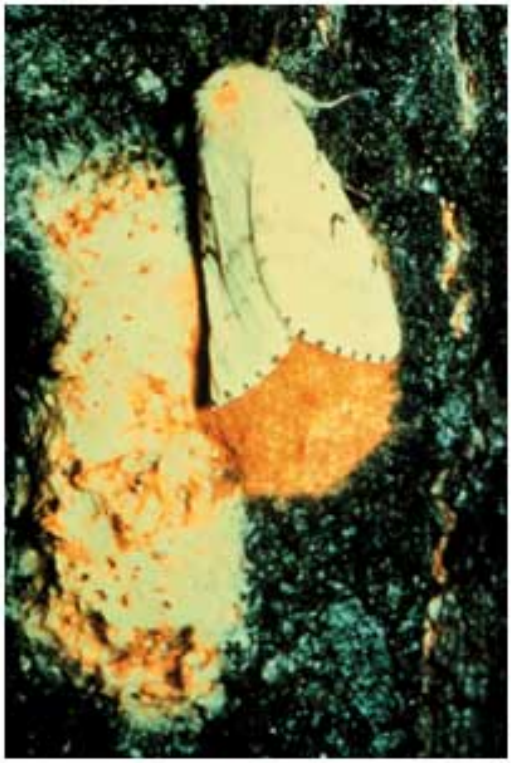
Biology: After hatching from eggs in April or May, tiny caterpillars climb to the tops of trees, drop off on a silken thread, and are blown about by wind currents. When they land on a suitable tree species, they begin feeding. They prefer to feed on oaks, aspen, and other hardwood species, especially when they are young. However, caterpillars will also feed on eastern white pine, Colorado blue spruce, and other conifer species. Feeding continues for about 6 weeks. As larvae complete their development, they may wander about, searching for a dark protected site for pupation. Adult moths emerge from pupal cases in 1 to 2 weeks. Female moths do not fly and usually lay their egg masses near the pupal case from which they emerged. Pupal cases and egg masses are often found on tree stems and the undersides of large branches.

Left: White female gypsy moths, pupal case and tan male moth

Above: Gypsy moth larva

Monitoring and Control: Gypsy moth is especially difficult to manage when Christmas tree fields are near or adjacent to woodlots with oaks, aspen, or other tree species preferred by gypsy moth larvae. Look for egg masses on trees in the woodlot and on Christmas trees bordering woodlots throughout the year. Watch for egg masses on the stems, undersides of branches, root collar and other protected areas on Christmas trees. Trees of all ages should be monitored.
If you have a gypsy moth population in your area, monitor egg masses in April and May to determine when egg hatch occurs. This will help you time your scouting and insecticide applications.
• Contact your state regulatory agency for current gypsy moth regulations in your area. In some states, trees

must be sprayed with approved insecticides during the larval feeding period if the trees will be shipped out of the infested area.



Far left:
Female moth laying a new egg mass near an egg mass from previous year

Left:
Gypsy moth egg mass on trunk

• Look for egg masses whenever Christmas trees are scouted, sheared, or pruned, sprayed or harvested. Be sure to look at the stem and turn over harvested trees to check for egg masses on the undersides of branches. Be especially vigilant when Christmas trees are grown near oak, aspen, or other species favored by gypsy moth.
• Egg masses should be scraped off and destroyed by burning or soaking in soapy water.
• When gypsy moth larvae are present, consider spraying trees with an insect growth regulator or registered insecticide. If you plan to ship trees to areas not infested with gypsy moth, contact your state regulatory agency for a list of approved products and spray periods.
• Monitor gypsy moth populations in woodlots adjacent to Christmas tree fields. Consider treating the borders of the woodlots with a microbial insecticide, such as Bt (Bacillus thuringiensis var. kurstaki), if gypsy moth populations are high. If you do not own the woodlot, you must obtain permission from the landowner before applying any spray.
• Contact your county Extension office or regulatory agency for information on gypsy moth biology, identification, feeding preferences, and management options.

NEXT CROP
• Plant new fields away from oak, aspen, and other stands dominated by species preferred by gypsy moth.

Hosts: Many hardwood species; pines, spruces, occasionally fir and eastern red cedar

Introduced Pine Sawfly

Diprion similis (Hartig)

Hosts: Eastern white pine; less frequently Scotch, red, and Austrian pine.

Importance: Larvae consume the needles of Christmas trees. Slightly defoliated trees might be degraded for a year or two, but severely defoliated ones are usually unfit for sale. This insect is usually not abundant enough to cause injury because natural enemies and low winter temperatures keep it at tolerable levels.

Look For:

• *Scattered patches of sparse or missing foliage* anywhere on the tree. Entire tree may be defoliated.

JUNE TO SEPTEMBER

• *Blackheaded larva*, up to 1 inch long, with yellow and white spots on a black background. It feeds alone or with a few other larvae in a loose cluster on the needles.

• *Brown cocoons*, about ¼ inch long, among the needles at the base of small branches or on the tree trunk.

Biology: Clusters of eggs are laid in slits in the needles from mid May to mid June, depending on weather. The larvae hatch about 2 weeks later and feed in clusters for a short time before dispersing. They spin cocoons on the host in July and August. A second overlapping generation usually follows and feeding occurs again into September in the Lake States and into November in the central states. The second generation overwinters in cocoons on the tree.

Monitoring and Control: Inspect white pines of all ages from June to September. Look for larvae or injury on 50 or more trees scattered throughout the plantation. Treat nurseries or young plantations (1 to 4 years old) when you notice 10 or more larvae per tree. Treat older plantations when foliage injury becomes so obvious that degrade is likely.

• Spray severely infested trees with a registered insecticide to control larvae.

NEXT CROP

• Do not plant near windbreaks or stands of eastern white or Scotch pine.

• If possible, plant eastern white pine away from other species.

Sawfly cocoon

Introduced pine sawfly larva

Hosts: Eastern white pine; less frequently Scotch, red, and Austrian pine

NEEDLE FEEDING Jack Pine Budworm

Jack Pine Budworm

Choristoneura pinus pinus Freeman

Hosts: Scotch, red, and Austrian pine.

Importance: Budworms defoliate trees and make them unfit for sale as Christmas trees. Lightly defoliated trees recover after a few years, but severely defoliated ones are degraded, attacked by other pests, or killed. Injury is most severe on trees that are beneath or next to large infested host trees, generally jack pine. This insect is usually important only within the range of jack pine in the Lake States.

Look For:
JUNE TO NOVEMBER
• *Defoliated shoot tips or branches with webbed clusters of brownish needles* attached to the twigs with silk. Most of the webbed needles wash off the tree by winter.
MID MAY TO EARLY JULY
• *Caterpillars*, up to 1 inch long, feeding in the webbed foliage. Each has a black head and a brown body when young. When mature, the body is reddish-brown with small cream-colored spots along the sides.
MID JULY TO MID AUGUST
• *Tan or brown pupae or pupal skins* within the webbed foliage.
• *Green egg masses* on the undersides of needles.

Biology: Jack pine budworms overwinter on the bark of the tree as very small caterpillars. In spring, they crawl out to the ends of shoots or are windblown to new hosts. They feed on current-year needles and opening buds and attach the uneaten portions of the needles to the shoots with silk. When concealed in these clusters of webbed needles, budworms are difficult to control. The budworm's parasitic enemies usually cannot keep the population at a satisfactory level.

Monitoring and Control: If your Christmas tree field is adjacent to a jack pine stand, inspect trees of all ages in mid May when shoots first begin to expand. Examine 1 shoot on each of 25 to 50 trees. Treat entire plantation if you find an average of 1 to 2 budworms per 10 shoots.
• Spray trees with Bt (Bacillus thuringiensis var. kurstaki) after larvae emerge in May or June.
• Or, thoroughly spray trees with a registered insecticide other than Bt when most of the larvae emerge in the spring. Spray when they are abundant—usually the first to third week in June. Repeat spray 7 to 10 days later if needed.

NEXT CROP
• Plant trees at least 500 feet away from jack pine windbreaks or stands.

Hosts: Scotch, red, and Austrian pine

Pine Chafer (Anomala Beetle)

Anomala oblivia Horn

Hosts: All pines.

Importance: Adult pine chafers damage new needles by gnawing through needle sheaths. Old needles and some bark tissues are eaten after most of the new needles are destroyed. Affected needles turn brown and drop, leaving a ragged display of shoots that degrades the trees.

Look For:
JUNE TO SEPTEMBER
• *Broken green or brown needles.* Severely injured trees may look scorched in July because of brown needles. After August, the needles are short and have ragged ends.
• *Robust beetles,* 1/3 inch long, feeding on the shoots from mid June to late July. The female beetle is tawny or buff; the male is brown with a greenish-bronze head.

Pests that cause similar symptoms: Pine needle midge.

Biology: Female beetles lay eggs in the soil of grassy areas near trees. The larvae feed only on grass roots and do not harm the trees. Adults emerge from the soil and begin feeding on shoots in June and July, depending on location.

Monitoring and Control: Examine trees of all ages regularly in June and July. Treat entire plantation if 5 percent of the needles on trees within 3 years of harvest are broken or discolored. On younger trees, treat if 20 percent of their needles are injured.
• Shear to remove some of the injured foliage, and the tree will outgrow the rest of the injury in 2 to 3 years.
• If control is needed, spray the trees once with a registered insecticide in late June when most of the beetles are feeding on the trees, but before they cause much injury. Apply the insecticide a week or so earlier if the beetles are abundant.
NEXT CROP
• Reduce grasses in surrounding areas before planting.

Hosts: All pines

Pine Needle Midge

Contarinia baeri (Prell)

Hosts: Scotch and red pine; occasionally other pines.

Importance: The larvae of this European midge (small fly) feed on the needles of Christmas trees, causing the needle to droop, die, and drop prematurely. The bare leaders and holes in the crown caused by heavy feeding degrade the tree. Injured trees may be unsalable in the year of the attack, but they outgrow the injury in 2 to 3 years if the insect is managed.

Look For:
• *Needle loss*, mostly on the leader and upper crown.
MAY TO JULY
•*Needles bent over*, either green or brown.
• *One or more small yellow maggots*, 1/32 inch long, that form a brown lesion between the needles inside the needle sheath. You will have to remove the suspect needles and pull them apart to see the larvae and lesion. A hand lens may be needed.

Biology: Larvae overwinter in cocoons in the leaf litter. After the insect pupates in the spring, the adults emerge and fly to trees where they lay their eggs inside the needle fascicles. In early spring, eggs hatch and larvae feed in the fascicles, causing the needles to bend over and die. Full-grown larvae drop to the ground in mid summer and spin cocoons in the litter.

Pests that cause similar symptoms: Pine chafer.

Monitoring and Control: Verify this insect by locating the larvae or lesion between the needles.
If more than 5 percent of the trees in a plantation show midge injury, consider treating the entire plantation the next spring after adults emerge. Monitor for larvae in needles from late May to late June, depending on

latitude. For example, at the latitude of the southern Lower Peninsula of Michigan, larvae usually emerge in late May. At mid state, the midge larvae emerge the first week of June; and at the upper tip of Michigan's Lower Peninsula, they emerge about the third week of June. Control the insect as soon as you locate the first midge.

• Apply a registered insecticide when larvae begin feeding (late May to late June depending upon latitude).

Left: Midge feeding causes needles to bend or droop

Above: Yellow midge larva between needle

Below: Sparse foliage caused by pine needle midge

Hosts: Scotch and red pine; occasionally other pines

Pine Tube Moth

NEEDLE FEEDING

Pine Tube Moth

Argyrotaenia pinatubana (Kearfott)

Host: Eastern white pine.

Importance: Pine tube moth caterpillars bind needles together into a tube and feed on the needle tips. This injury is cosmetic and usually insignificant.

Look For:
• *Tubular clusters of 5 to 20 needles* bound with silk and squared off at the tips. Break the tubes open to find a yellow-green caterpillar or pupa, up to 1/2 inch long.

Biology: The pupae overwinter in the tubes and become small moths in spring. Female moths disperse and lay eggs on needles, producing two generations during the summer. Natural enemies can usually keep the population in check.

Monitoring and Control: Begin checking 2 years before harvest, in fall, winter, or early spring. Treat entire plantation only if tubes become obvious enough to degrade trees.
• When practical, clip off and destroy tubes to kill the caterpillar or pupae.
• If necessary to control first-generation caterpillars, apply a registered insecticide between mid May and mid June while tubes are being formed (rarely necessary).
• Or, apply a registered insecticide in mid to late July to control second generation caterpillars.

Tubular cluster of needles bound with silk and squared off at the end

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Host: Eastern white pine

NEEDLE FEEDING — Pine Tussock Moth

Pine Tussock Moth

Dasychira pinicola (Dyar)

Hosts: Eastern white and red pine; occasionally spruce, Fraser fir and balsam fir.

Importance: Pine tussock moth caterpillars can readily strip the needles from any size Christmas tree. Severely defoliated trees often die and partially defoliated ones cannot be sold as Christmas trees. Generally this insect has only been a problem in Wisconsin and Minnesota, although it occurs throughout the northeastern United States.

Look For:
• *Missing needles and ragged needle clumps* on some branches or on entire tree. Check for pellets of insect waste on the ground beneath trees to be sure needles were eaten and have not merely fallen off. If they have fallen off, suspect a needlecast disease.
MAY TO EARLY JULY
• *Light brown or reddish-brown caterpillars*, up to 1 1/2 inches long, with four prominent tufts of gray hair on their backs.
JULY TO SEPTEMBER

• *Gray-brown hairy cocoons or whitish egg masses*, about 1 1/2 inches long, attached to needles.
Pests that cause similar symptoms: Redheaded pine sawfly.

Biology: Caterpillars overwinter at the base of the needles or under the bark of the tree, and feed on needles during the spring. Feeding peaks in late June as the caterpillars mature. The insects then pupate and lay eggs on the remaining needles. The eggs hatch in late summer. The young caterpillars do not feed extensively until the following spring.

Monitoring and Control: Examine trees of all ages from May through early July, looking for feeding caterpillars and/or injured needles. Treat nursery or plantation if caterpillars are abundant and easily located.
• Apply Bt (*Bacillus thuringiensis* var. *kurstaki*) in late April to control feeding larvae as soon as you notice caterpillars.
• Or, apply a registered insecticide other than Bt to the trees in late April or early May as the weather warms to control young caterpillars before extensive feeding occurs.
• Do not ship infested Christmas trees because overwintering caterpillars may emerge in the warmth of a home and feed on the tree during the holiday.

NEXT CROP
• Avoid planting susceptible hosts near jack pine, the insects' preferred host.

Above: Shoots with missing needles

Right: Pine tussock moth larva

Hosts: Eastern white and red pine; occasionally spruce, Fraser fir and balsam fir

Redheaded Pine Sawfly

Neodiprion lecontei (Fitch)

Hosts: Red and Scotch pine; occasionally spruce if it is interplanted with susceptible pines.

Importance: Larval colonies strip the needles from Christmas trees, killing branches, tree tops, or whole trees. Severely defoliated Christmas trees are unfit for sale. This insect becomes an important pest every 10 to 12 years, causing injury for 2 or 3 years before subsiding. It prefers trees weakened by poor soil, drought, or competition from other plants.

Look For:
• *Sparse foliage on shoots or branches* anywhere on the tree. Entire tree may be defoliated.
JUNE AND AUGUST (Central States) OR JULY (Lake States)
• *Tufts of dry, straw-like needle* remains from feeding on new growth.
JUNE TO OCTOBER (Central States) OR JULY TO SEPTEMBER (Lake States)
• *Yellow, black-spotted larvae* up to 1 inch long, with red heads, found in clusters on the foliage.

Pests that cause similar symptoms: Pine tussock moth.

Biology: The redheaded pine sawfly found in the Lake States usually has one generation, while those in the Central States may have two or more. Pupae overwinter in cocoons spun in the litter or topsoil. Adults emerge in June in the north and May and July farther south. Each female deposits 100 to 120 eggs in clusters on the needles. In 3 to 5 weeks, eggs hatch and larvae begin to feed in groups. One colony of 100 larvae can completely defoliate a tree 2 feet tall; 15 to 20 larval colonies can completely defoliate a tree 6 feet tall. Larvae feed for only 5 or 6 weeks, except in areas where a second generation is produced in the same season. In these areas, the second generation may completely defoliate and kill trees. After feeding, full-grown larvae drop to the soil and spin cocoons.

Monitoring and Control: Begin checking trees of all ages in June and continue through September (Lake States) or October (Central States). Treat individual trees as soon as you notice colonies. Treat entire plantation when larvae are too abundant to control by hand methods.
• Knock occasional scattered colonies of larvae off and crush them. • If available, apply a registered virus to young larvae.
• Or, spray larvae with a registered insecticide.
• Control competitive plants, particularly bracken fern, with herbicides to increase tree vigor.

NEXT CROP
• Destroy dense weeds and bracken fern with herbicides before replanting.
• Do not plant trees on dry, nutrient-poor soils.

Sparse or missing foliage on shoots and branches

Redheaded pine sawfly larvae

Hosts: Red and Scotch pine; occasionally spruce if it is inter-planted with susceptible pines

NEEDLE FEEDING — Spruce Budworm

Spruce Budworm

Choristoneura fumiferana (Clemens)

Host: All spruces and firs; occasionally pines growing with fir or spruce.

Importance: Budworm caterpillars defoliate trees, making them unfit for Christmas tree sale. Slightly defoliated trees recover after a few years, but severely defoliated ones are degraded, attacked by secondary pests, or killed. Injury is most severe on trees that are beneath or next to large infested host trees. This insect is usually important only within the spruce-fir range in the Lake States.

Look For:
JUNE TO NOVEMBER
• *Defoliated shoot tips or branches with webbed clusters of brownish needles* attached to the twigs with silk. Most of the webbed needles wash off the tree by winter.
MID MAY TO EARLY JULY
• *Caterpillars*, up to 1 inch long, feeding in the webbed foliage. Each has a black head and a light-brown body when young. When mature, the body is gray-brown with small, cream-colored spots along the sides.
MID JULY TO MID AUGUST
•*Green egg masses* on the undersides of needles.

Biology: Spruce budworms overwinter on the tree as small caterpillars. In spring, they crawl to other parts of the host or are windblown to new hosts. They feed on needles and opening buds and attack the uneaten portions of the needles to the shoots with silk. When concealed in these clusters of webbed needles, budworms are difficult to control. During outbreak years, the budworm's parasitic enemies cannot keep the population at a satisfactory level.

Monitoring and Control: Inspect trees of all ages in May when buds first begin to expand. Examine 1 bud on each of 25 to 50 trees. If trees will be harvested within 3 years, treat entire plantation when you find an average of 1 to 2 larvae per 10 spruce buds; or 1 to 2 larvae per 20 fir buds. If trees are young and 4 or more years from harvest, treat entire plantation when you find an average of 2 to 4 larvae per 10 spruce buds; or 1 to 2 larvae per 10 fir buds.

• Spray trees with Bt (*Bacillus thuringiensis* var. *kurstaki*) after larvae begin feeding in mid to late May.
• Or, thoroughly spray trees with a registered insecticide after most of the larvae emerge in May. Repeat spray 7 to 10 days later if needed.

NEXT CROP

• Plant trees at least 500 feet away from stands of mature balsam fir or spruce trees.

Hosts: All spruces and firs; occasionally pines growing with fir or spruce

Spruce Needleminers

Endothenia albolineana (Kearfott); *Epinotia nanana* (Treitschke)

Host: All spruces.

Importance: Needleminer caterpillars tunnel into the needles of spruce trees. They cut and web needles into small, unsightly nests that mar the trees' beauty. Lightly infested trees recover in 2 to 3 years, but heavily infested ones are unfit for sale and may die. The green spruce needleminer and the spruce needleminer are the two most common needlemining pests of spruce.

Look For:

• *Small clusters of discolored needles webbed tightly together* and flattened against the branch. Small trees may be injured anywhere in the crown. The webbing on larger trees is mostly on the inner parts of the lower branches.
• *Hollowed-out needles, with a small hole usually near the base* of each needle.

JUNE TO MID APRIL

• *Brown, gray, or reddish larvae*, up to ¼ inch long, in the needles or within webbed foliage.

Biology: Immature larvae overwinter in nests of hollowed-out needles and waste held together with silk. They feed for a few weeks in spring and then pupate. Adult moths begin emerging between mid May (Central States) and mid June (Lake States) and lay eggs on the needles. In about 2 weeks, larvae hatch and begin mining needles. As they grow, they hollow out, cut, and web the needles together to form a nest-like enclosure.

Monitoring and Control: Inspect trees of all ages anytime during the growing season. Treat entire plantation if you notice injury on more than 10 percent of trees that are within 3 years of harvest. On younger trees, treat if more than 25 percent of the needles are damaged.
• Spray trees thoroughly with a registered insecticide in mid June (Central States) or mid July (Lake States) to control larvae just after they emerge from the eggs. A repeat spray 10 to 14 days later may help.
• Or, spray trees in spring after larvae begin feeding again. Repeat 10 to 14 days later if needed.

NEXT CROP

• Do not plant near infested spruce.

Hosts: All spruces

NEEDLE FEEDING — Webworms

Juniper Webworm
Dichomeris marginella (Fabricius)
Pine Webworm
Tetralopha robustella Zeller;
Pine False Webworm
Acantholyda erythrocephala [L.])

Hosts: All pines; eastern red cedar.

Importance: Webworm caterpillars can kill or stunt Christmas tree seedlings by eating all the needles off the branches. Their unsightly webbed nests also reduce tree quality. Webworms on eastern red cedar are usually a more serious problem than those on pines. Important nest-building webworms include the pine webworm, the pine false webworm, and the juniper webworm.

Look For (on pine):
• *Conspicuous, elongate, or globe-like nest*, 2 to 6 inches wide, made of brownish needles and pellets of insect waste spun together with webbing. Needles near the nest have been chewed off.
MAY TO JUNE
• *Green larvae*, 3/5 to 7/8 inch long with 3 pairs of legs, in the nest (pine false webworm).
JULY TO AUGUST
• **Yellow-brown larvae**, 3/5 to 7/8 inch long with 8 pairs of legs, in the nest (pine webworm).

Look For (on eastern red cedar, juniper webworm):
• **Brownish nests**, 2 to 3 inches long, made of webbed shoots. Needles near the nest have been chewed off. SEPTEMBER TO EARLY JUNE
• *Several light brown larvae*, ½ inch long, in the nest.

Biology: These heavy feeders build waste-filled nests and enlarge them as they feed on needles and develop. Depending upon species, anywhere from a few to more than 70 larvae may inhabit a single nest.

Monitoring and Control: Examine trees of all ages and treat when nests are too numerous to destroy by hand. If you easily find mined needles on new growth of eastern red cedar during the summer, treat entire nursery or plantation next spring.
• Clip and/or destroy nests if they are few and scattered.
• Or, spray trees with a registered insecticide when you see larvae feeding and building nests.
• Spray for pine false webworm (green larvae in a nest on pine) in May or June.
• Spray for pine webworm (yellow-brown larvae in a nest on pine) between July and August.
• Spray for juniper webworm (brownish larvae on eastern red cedar) in April or May when the weather warms.
• Do not ship infested eastern red cedar because webworms hitchhike to new areas this way.


Webworm nest


Pine ffalse webworm larva

Hosts: All pines; eastern red cedar

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Shoot/Branch Injury

Shoot/Branch Injury

Needles on shoots or branches uniformly discolored - usually red, yellow, or brown. Foliage may be black from sooty mold fungus. Frothy spittlemasses, aphid colonies, or scales may be on bark. If needles on shoots are cut off and webbed together, see previous section. If galls are present, see next section.

SHOOT/BRANCH INJURY

Adana Tip Moth 

Adana Tip Moth
Rhyacionia adana Heinrich

Hosts: Scotch, Austrian, and red pine.

Importance: The caterpillars of this moth bore into the buds and developing shoots of seedlings and Christmas trees. This kills and deforms shoots, stunts growth, and degrades trees. Adana tip moth is most commonly carried into plantations on infested nursery stock.

Look For:
• *Dead and dying, stunted*, or stubby shoots anywhere on the tree or seedling. Shoots are killed before the needles fully expand.
• *Small hole at the base of the dead shoot*
MAY TO JUNE
• *Yellowish to reddish-brown blackheaded larvae*, up to 3/8 inch long, on or inside the new shoot.
AUGUST TO APRIL
• Pupae in soil-covered cocoons attached to the root collar of the tree (where the mainstem and the roots meet, under the soil).

Pests that cause similar symptoms: Sphaeropsis shoot blight, European pine shoot moth, pine shoot beetle.

Biology: Adult moths emerge in April as the weather warms, and the females lay their eggs on the needles. Hatching larvae soon bore into and mine (hollow out) needles near the bud. By early June, larvae leave the needles and tunnel into developing shoots, killing the shoots before they fully elongate. This insect overwinters as a pupa in a cocoon attached to the root collar of the tree.

Monitoring and Control: Inspect trees of all ages when shoots begin to expand in April or May. Treat entire plantation if injury becomes too extensive to control with normal shearing. If trees are too small to shear, consider treating the plantation if 10 percent or more of the trees are injured.
• Shear off and destroy crooked, injured leaders and shoots to restore trees to good form.
• Spray trees or seedlings with a registered insecticide in mid to late April to kill emerging larvae. Repeat if needed in late May or early June.
• Do not ship infested nursery seedlings in fall or spring because the pupae hitchhike to new areas this way.
NEXT CROP
• Plant only pest-free nursery stock.

Hosts: Scotch, Austrian and red pine

Aphids SHOOT/BRANCH INJURY

Aphids

Cinara spp.; *Eulachnus agilis* (Kaltenbach); *Cinara strobi* (Fitch)

Hosts: All Christmas tree species.

Importance: Aphids suck juices from branches, shoots, and needles of Christmas trees. Affected trees may lose their needles, attract secondary pests, and become unfit for Christmas tree sale. The spotted pine aphid is one of the most common aphids on pine Christmas trees.

Look For:
• *Discolored sparse foliage anywhere on the tree.* Scattered groups of needles turn yellow or red in summer and drop off in fall. Surrounding foliage may look sooty and glisten as if lacquered. Bees and ants may be abundant on the foliage.

MAY TO NOVEMBER

• *Small, winged or wingless insects* clustered on the shoots or needles. Aphids may be yellow-green, brown, or black, and are usually 1/8 inch long. The spotted pine aphid, which is greenish with black spots, grows to 1/4 inch long. Some species are naked, and others are covered with a woolly wax (see Pine bark adelgid).

Biology: Most aphids overwinter on trees as eggs. Nymphs hatch in spring and quickly mature and reproduce. Several overlapping generations can produce large populations by late summer. Droughty weather at this time will increase needle fall. Applying nitrogen fertilizers when trees are young tends to increase aphid numbers.

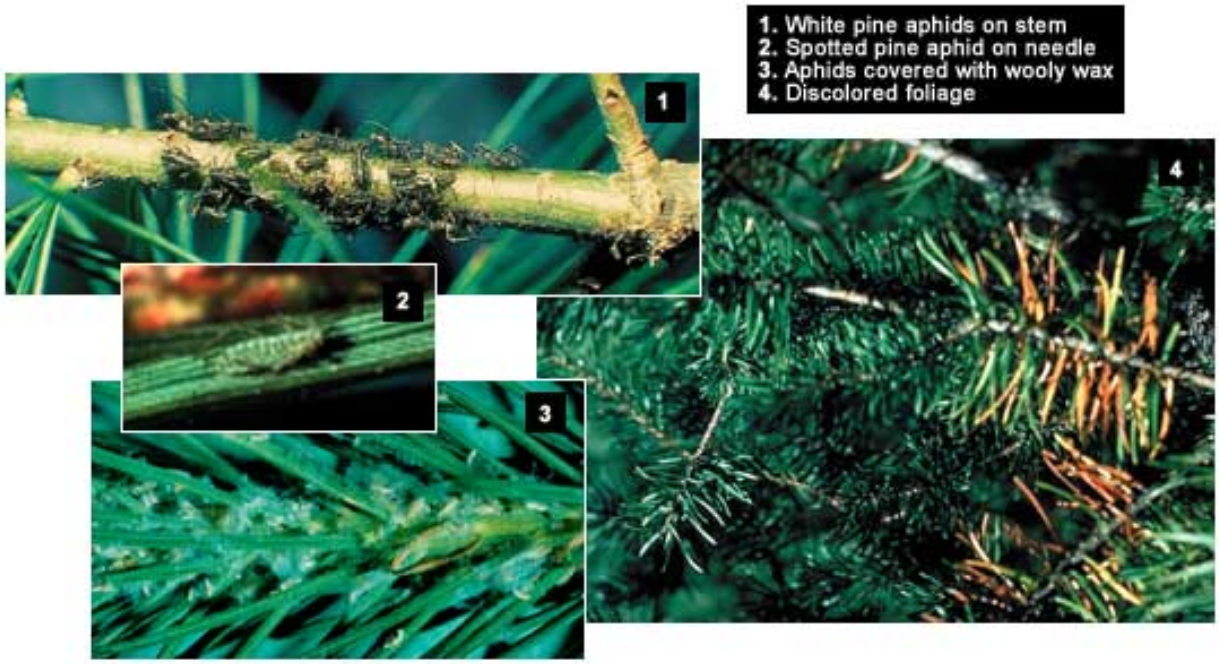
Monitoring and Control: Begin checking trees 2 years before harvest, starting in early summer and continuing regularly until frost. Control may not be needed in the years before harvest if lady bugs and other predators are abundant. Treat individual, infested trees only if more than 30 percent of the shoots have aphid colonies. However, treat all infested trees if fields will be harvested in the current year.

• Wash off black discoloration caused by sooty mold by spraying affected tree parts with a solution of 4 ounces liquid detergent mixed in 100 gallons of water. Apply under high pressure in late afternoon, leave overnight, and then rinse trees with water the next morning.

• Limit the use of broad-spectrum insecticides that kill helpful aphid predators.

• Control mound ant colonies; these ants protect aphids by discouraging the natural enemies of aphids (see Allegheny mound ant).

• Spray trees if necessary with a registered insecticide to control large aphid populations. An insecticidal soap may be a good alternative to a conventional insecticide and will be less harmful to beneficial insects.



Hosts: All Christmas tree species

Broom Rust of Fir

Melampsorella caryophyllacearum J. Schrot
Host: Balsam, Fraser, and white fir.

Alternate Host: Chickweed.

Importance: This disease causes the formation of witches' brooms within the trees, reducing quality. The incidence of infected trees is usually very low within a plantation, thus this disease is rarely considered a major threat to Christmas trees.

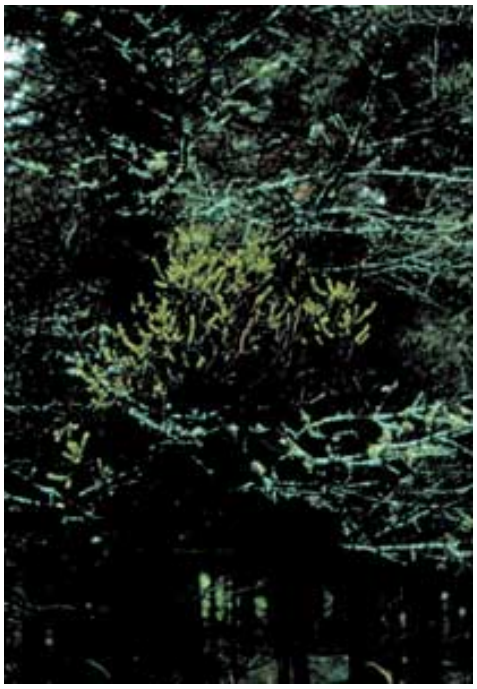
Look For:
JUNE
• *Short, thick, upright shoots that contain stunted, thickened, pale green needles.*
JULY TO AUGUST
• *Yellow needles in the broom.* Orange-yellow pustules on the underside of the needles in the broom.
SEPTEMBER
• *Needles in the broom falling to the ground,* leaving a mass of stunted, thick shoots.

Biology: Buds are infected in the spring by wind-blown spores from chickweed and the fungus moves into the branch. One year after infection, stunted, thick shoots grow upright out of the infected branch. Spores are produced on the foliage within the broom. Shoots within the broom will produce foliage each year which will in turn produce spores in the summer. These spores infect chickweed, the alternate host. This disease is only a problem when chickweed is present in the area.

Monitoring and Control: Examine your trees in July and August. The yellow brooms will be conspicuous. Disease incidence will rarely reach a level that causes concern. If it does, consider controlling the chickweed within the plantation.
• Cut brooms off of infected trees. Once the foliage and woody broom material dries out, the fungus will die.
• If disease incidence is high, mow or kill chickweed in and around plantation.
• There are currently no fungicides labeled for broom rust.

NEXT CROP
• Inspect nursery stock before planting; do not plant infected trees.
• Examine areas around potential plantation sites. If broom rust is present in the native balsam or Fraser fir, be prepared to accept some level of disease or plant species other than balsam, Fraser, or white fir.

Witches' broom on balsam fir trees


Host: Balsam, Fraser and white fir

Deer — SHOOT/BRANCH INJURY

Deer *Odocoileus virginianus* Miller

Host: All pines, Douglas-fir, Fraser fir and other true firs, Norway spruce, and white spruce.

Importance: Deer feed on the shoots of young trees. In large numbers, these animals can cause extensive damage to tree plantings. Heavily browsed trees may be too deformed to be sold as Christmas trees.

Look For:
• *The ragged, squared-off ends of deer browsed twigs*, ½ inch or less in diameter, on the lower 6 feet of the tree. Shredded bark and wood may hang from cut twigs.
• *Deer droppings and tracks* near trees.
• *Strips of shredded or damaged bark on stems* of large seedlings and saplings. Bucks may rub the bark off when polishing their antlers against stems in early fall.

Pests that cause similar symptoms: Rabbit and hare.

Monitoring and Control: Examine trees of all ages throughout the year, especially in the early spring. If 5 to 10 percent of the trees are injured, contact a conservation officer or a wildlife pest control specialist to help determine if reduction of the deer population is appropriate under local conditions. No control is needed if injury is random and infrequent.
• Use a deer repellent for short-term control (2 to 6 weeks) when appropriate.

Keep in mind that some deer repellents are often ineffective
and all must be reapplied frequently, at intervals of 2 to 12 weeks.
• If damage is often severe, consider fencing fields with permanent woven wire fencing 8 feet high or 7–wire high tensile strength steel electric fence to exclude deer.
• In some states, wildlife management agencies may offer programs to assist landowners in reducing deer numbers. Contact the appropriate agency in your state for information on hunting and crop depradation programs.

Above right:
Deer may rub the bark off when polishing their antlers

Right:
Deer-browsed branches on lower half of tree

NEXT CROP
• Avoid planting vulnerable species where deer are known to congregate during the winter. Consider planting Colorado blue spruce or balsam fir in vulnerable areas.
• Consider fencing fields to exclude deer if damage is often severe.

Host: All pines, Douglas-fir, Fraser fir, Norway spruce, and white spruce

SHOOT/BRANCH INJURY Eastern Pine Shoot Borer

Eastern Pine Shoot Borer

Eucosma gloriola Heinrich

Hosts: All pines; white spruce; Douglas-fir.

Importance: The caterpillar of this small moth usually attacks new lateral (side) shoots. When abundant, larvae can damage the general shape of the crown by killing many shoots. The terminal leader of pines is sometimes attacked, affecting tree form.

Look For:
JUNE TO OCTOBER
• *Flagged (discolored) shoots* on pine and spruce. The 6- to 8-inch long ends of shoots turn yellow and then red. Douglas-fir shoots wilt and droop before yellowing, curling into the shape of a shepherd's crook. (Do not confuse shepherd crooking with white pine weevil injury, which looks similar, but occurs only on the terminal (topmost) shoot and down to the stem below the first whorl of branches.)
• *Terminal leaders or large branch ends broken over near their bases*, leaving distinctive, flat stubs.
• *An oval hole at the base of the injury* through which the caterpillar has escaped.
• *Caterpillars feed down the center of shoots, packing sawdust-like frass into the tunnel behind them.*
Identify pest by cutting shoot lengthwise with a knife. If cut before mid July, you may find a single, dirty white to gray larva, up to ¾ inch long, in the shoot.

Pests that cause similar symptoms: Sphaeropsis shoot blight, European pine shoot moth, jack pine tip beetle, pine shoot beetle, white pine weevil.

Biology: Female moths emerge in May and lay eggs on the new shoots. Young larvae bore into and feed in the center of elongating shoots. After chewing a hole at the base of the feeding tunnel, mature larvae emerge and drop to the ground to pupate and overwinter.

Monitoring and Control: Examine trees of all ages from midsummer to frost. If you find more than 10 injured shoots per tree and trees are within 2 years of harvest, treat entire plantation next spring.
• A registered insecticide can be applied to trees in mid May to kill larvae before they bore into shoots. Do not delay treatment. By the time injury is apparent, most larvae have left the shoots, and control will not be effective.
• Most injured shoots are removed when trees are sheared. Forked trees should be correctively pruned by removing excess terminals. You may want to clip off damaged shoots on trees before marketing.

NEXT CROP
• Plant resistant varieties of Scotch pine, such as Swedish, Riga, or Scandinavian.

Hosts: All pines; white spruce; Douglas-fir

European Pine Shoot Moth

Rhyacionia buoliana (Denis & Schiffermuller)

Hosts: Scotch, red, and Austrian pine.

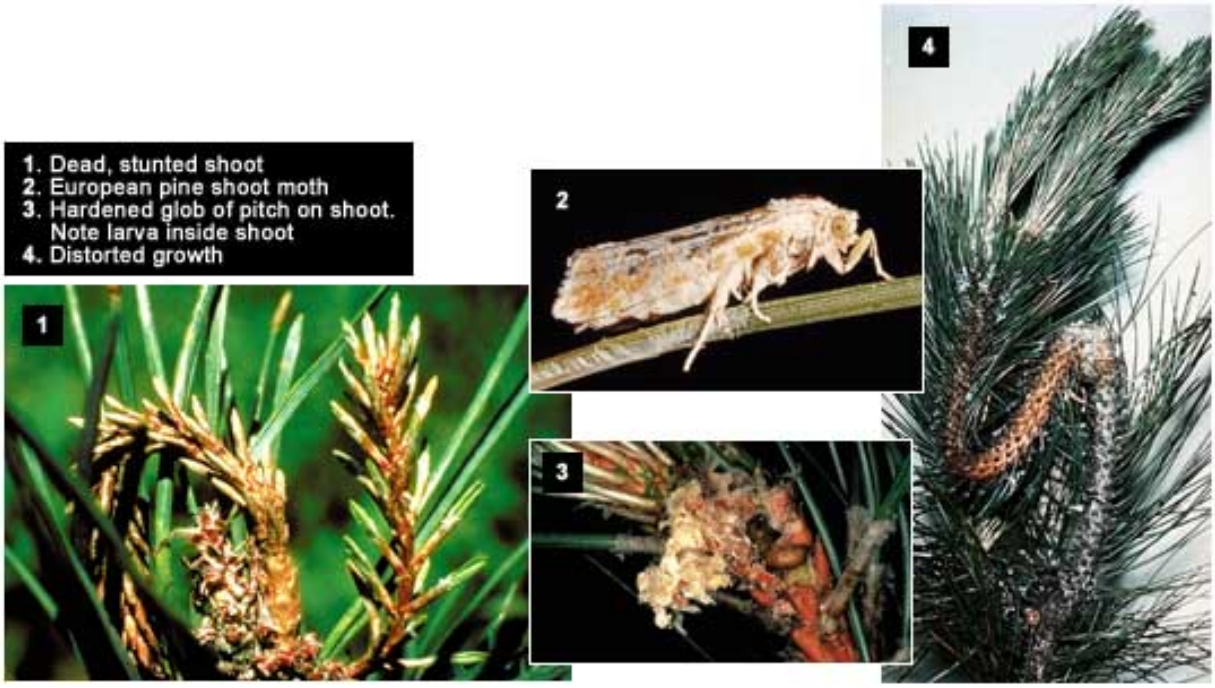
Importance: The caterpillars of this moth bore into the buds and developing shoots of Christmas trees. This kills or deforms shoots, stunts growth, and can make Christmas trees unfit for sale. This insect's range is limited by very cold weather. It is rarely found in the northern half of Wisconsin, Minnesota or in the western half of upper Michigan.

Look For:
• *Dead, stunted, or stubby shoots* anywhere on the tree. Shoots usually die before needles expand.
• *Hardened globs of pitch* where larvae have bored into shoots.
• *Distorted, bushy, or multileadered trees.*
MID APRIL TO EARLY JUNE
• *Brownish, caterpillars with black heads*, up to 5/8 inch long, on or inside new shoots.

Pests that cause similar symptoms: Adana tip moth, Sphaeropsis shoot blight, Nantucket pine tip moth, pine shoot beetle.

Biology: In the spring, caterpillars bore into healthy shoots to feed and pupate. New adults emerging in June and July produce caterpillars that bore into needles and buds to overwinter. During particularly cold winters, only caterpillars that are insulated on branches below the snowline will survive. Dry weather and poor soil conditions encourage population buildup.

Monitoring and Control: Inspect trees of all ages in April and May. Randomly select 30 to 50 trees scattered throughout the plantation and look for larvae and injury. Consider treating entire plantation if 10 percent or more of the young trees are injured or if the older trees average more than 5 injured tips per tree.
• If attacks are light and scattered, prune and destroy attacked shoots before June.
• Wait to shear trees until mid July when shearing will remove most of the eggs or larvae on shoot tips.
• Prune crooked, injured leaders and branches while shearing to restore trees to good form.
• Remove the lower whorl(s) of branches from your best Christmas trees to prevent larvae from overwintering below the snowline and surviving. This will also give the trees "handles" and make harvesting easier.
• Do not ship infested nursery stock or Christmas trees because overwintering larvae hitchhike to new areas this way.
• If necessary, spray trees with a registered insecticide during the first 2 weeks of April to kill larvae as they migrate to new shoots. Trees can be treated again in late June or early July after larvae hatch from the eggs.



Hosts: Scotch, red and Austrian pine

SHOOT/BRANCH INJURY — Frost Injury

Frost Injury

Hosts: Balsam fir; Fraser fir; Douglas-fir, spruce; occasionally pine.

Importance: Below-freezing temperatures in early spring can kill emerging shoots and degrade Christmas trees. Susceptible trees may become stunted or bushy if injured by frost several years in a row.

Look For:
MAY TO JUNE
• *Brown, wilting and dying shoots* of the current year's growth. New shoots will develop next to the dead ones.
• *Live, crooked shoots.*
AUGUST TO OCTOBER
• *Dead shoots remaining on trees* until late autumn. They may not drop until spring.

Brown, wilting and dying shoots

Monitoring and Control: Examine trees of all ages after a late spring frost. Take recommended actions if any noticeable damage occurs.
• Remove dead shoots when shearing.
• Harvest trees growing in frost pockets—low areas where damaging frost frequently occurs—as soon as possible.
NEXT CROP
• Avoid planting highly susceptible species, such as true firs and Douglas-firs, in frost pockets. Pines may prove to be less susceptible. However, most frost

pockets are not good sites for
growing any conifer and should be avoided.

Hosts: Balsam fir; Fraser fir; Douglas-fir, spruce; occasionally pine

Jack Pine Tip Beetle — SHOOT/BRANCH INJURY

Jack Pine Tip Beetle

Conophthorus banksianae McPherson

Hosts: Scotch and red pine.

Importance: The larvae (grubs) of this small beetle kill terminal (top) and lateral (side) shoot tips by feeding in shoots. Dead shoot tips fall off the tree by autumn, producing a harmless effect similar to shearing. Trees may be degraded by forking if two or more lateral buds develop and become leaders. Problems occur mostly when Christmas trees are planted next to a jack pine stand.

Look For:
MAY TO OCTOBER

• *Yellow or red shoot tips*, mostly toward the top of the tree. The top 1 inch of the tip dies and leaves a flat stub where broken off.
• *A small pitch tube*—glob of pitch with a hole in it—about ½ inch behind the bud.
• *A dark-brown beetle*, about 1/16 inch long, or several smaller, white larvae inside the injured tip. Peel away the bark on the shoot tip to find the insect.

Pich tube below the bud

Pests that cause similar symptoms: Eastern pine shoot borer, pine shoot beetle, and Sphaeropsis shoot blight.

Monitoring and Control: Inspect trees 2 years before harvest, and treat during regular shearing.
• Shear injured tips during routine trimming. Injured tips missed in shearing will probably fall off naturally.
• Prune excess leaders to prevent forking.

NEXT CROP
• Avoid planting susceptible pines within 50 feet of jack pine.

Hosts: Scotch and red pine

SHOOT/BRANCH INJURY — Leucostoma Canker

Leucostoma Canker
(=Cytospora Canker)

Leucostoma kunzei (Fr.:Fr.) Munk
Hosts: Spruces, especially Colorado blue and Norway.

Importance: This fungus usually infects trees older than 15 years that are stressed by drought, winter injury, or other diseases. Branch cankers degrade trees by killing foliage and branches. Stem cankers can eventually kill trees.

Look For:
• *Brown needles on lower branches.* Dead needles may drop off immediately or stay on the tree for up to a year. Leucostoma canker gradually kills lower branches, then spreads to higher branches.
• *Large, white patches of pitch* at canker sites. Cankers are hard to spot if pitch is not present because the bark looks normal. Use a hand lens to find tiny black fruitbodies in the bark above the canker. Cut away bark to see the dead brown areas of the inner bark.

Factors that cause similar symptoms: Drought.

Biology: Spores ooze from the fruitbodies in threadlike masses during wet weather and are spread by rain, wind, and cultural activities, such as pruning. The fungus infects stressed trees through wounds.

Monitoring and Control: Inspect old trees, especially those 15 years or older. Look for brown needles on dead lower branches at any time of year. Treat individual trees as soon as you notice injury.
• Remove infected branches. Do not prune or shear infected trees during wet weather because spores released at this time may be carried from tree to tree on pruning tools.
• Improve tree vigor through cultural practices, such as fertilization and weed control.
• Sell trees growing on poor sites as soon as possible if Leucostoma has been a problem in your plantation. These trees are more likely to be infected than those growing on good sites.
• Avoid wounding trees because wounds are entry points for the fungus that causes Leucostoma canker.
NEXT CROP
• Do not plant susceptible species on poor sites.

Hosts: Spruces, especially Colorado blue and Norway

Nantucket Pine Tip Moth SHOOT/BRANCH INJURY

Nantucket Pine Tip Moth

Rhyacionia frustrana (Comstock)

Hosts: Scotch, Austrian, and red pine.

Importance: The caterpillars of this moth kill and deform shoots of nursery and plantation Christmas trees. The trees may become bushy and misshapen and are therefore degraded as Christmas trees. This pest occurs mainly in the southern portions of the North Central Region.

Look For:
• *Dead or dying new shoots with expanded needles* anywhere on seedlings or trees.
MID MAY TO AUTUMN
• *Brown to orange larvae*, up to 3/8 inch long, on or inside new shoots.
• *Small, tent-like webbing* on surface of needles or at base of shoots.

Pests that cause similar symptoms: Sphaeropsis shoot blight, European pine shoot moth, pine shoot beetle.

Biology: Pupae overwinter in hollowed out shoots. Adult moths emerge and lay eggs on the shoots in April when the weather warms. Newly hatched larvae feed on new, expanding shoots under small, tent-like webs, and then pupate 3 to 4 weeks later. One or more generations follow. Dry weather and poor soil conditions encourage population buildup.

Monitoring and Control: Examine trees of all ages, especially in nurseries and during the first 5 years after planting. Check trees closely in mid to late April.
• If the attack is light (less than 5 percent of trees) and scattered, prune and destroy the injured shoots.
• Shear when larvae are feeding to remove infested shoots.
• If attacks are on more than 5 percent of the trees, thoroughly spray shoot tips with a registered insecticide between mid May and mid June (timing depends on latitude) to control young larvae before they conceal themselves. You may need to treat again between mid July and late August to control additional generations of larvae.
• Do not ship infested nursery seedlings or Christmas trees because overwintering pupae hitchhike to new areas this way.

NEXT CROP
• Plant only pest-free nursery stock.

Dead shoots with expanded needles

Nantucket pine tip moth larva inside shoot

Hosts: Scotch, Austrian and red pine

SHOOT/BRANCH INJURY Northern Pine Weevil 

Northern Pine Weevil

Pissodes approximatus Hopkins
Hosts: All pines and spruces.

Importance: This insect causes minor damage in Christmas tree plantations where weak or dead pines are left standing, or where many fresh stumps are available for weevil breeding. Heavy feeding by adults may kill some shoots, leaving dead spots in the crown and slightly degrading Christmas trees. Heavy feeding may kill seedlings. Larvae may be found infesting young trees (2 to 5 years old) that are growing very slowly, generally because of heavy grass competition.

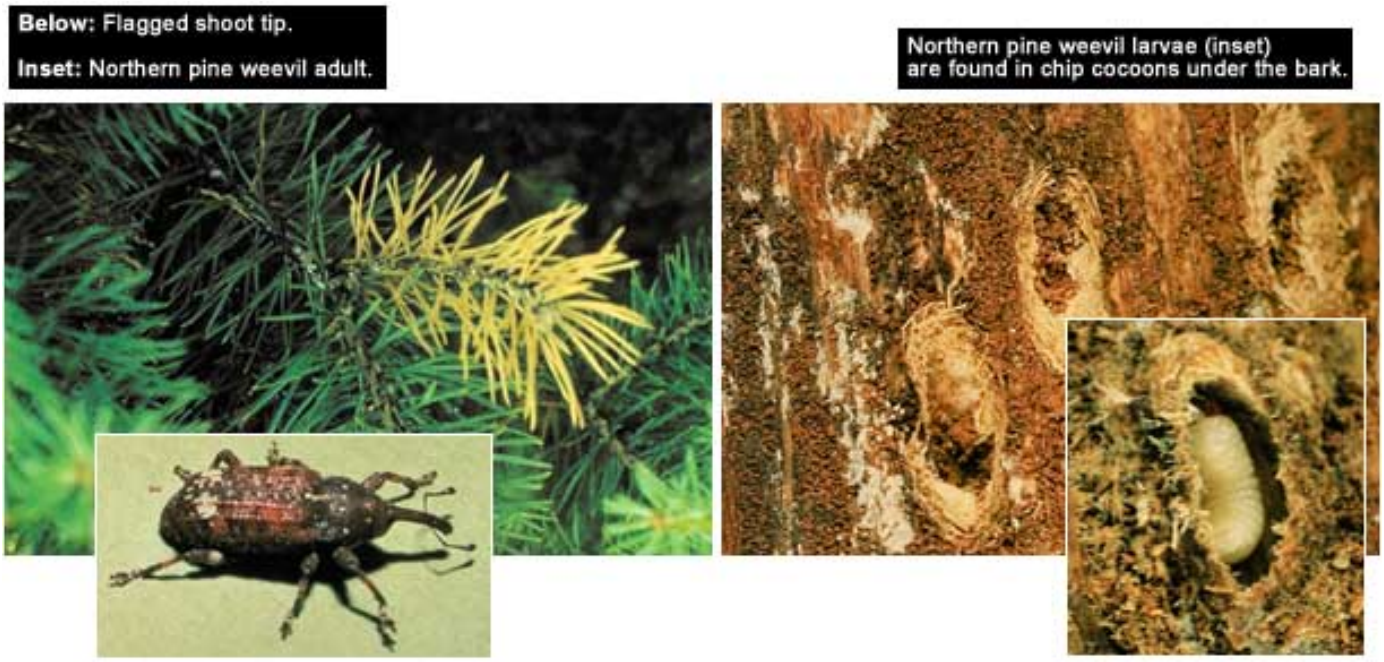
Look For:
• *Flagged (discolored and deformed) shoot tips* anywhere on trees or seedlings.
• *Small, circular feeding wounds* ("drill holes") at the base of injured shoots. Pitch may ooze from the wounds.
• *Small, white pupae or C-shaped larvae*, 1/3 inch long, beneath the bark of dead trees or stumps.
• *Elliptical chambers in the wood* beneath the bark, each covered with a ½ inch-long chip cocoon, made of fine wood shavings.
• *Light-brown, white-spotted weevils*, l/3 inch long, feeding on pine shoots after dark.

Pests that cause similar symptoms: Pales weevil causes more widespread damage by stripping off bark; Saratoga spittlebug.

Biology: Female weevils lay eggs in the spring on the inner bark of stumps and recently dead, dying, or severely stressed trees. Larvae mature under the bark and make chip cocoons to pupate-in. After pupating in August, weevils emerge and feed on the inner bark of twigs and small branches. They overwinter in the litter around infested trees.

Monitoring and Control: Inspect trees of all ages, especially where fresh stumps are available. In June, look for pitchy "drill holes" or flagged tips on seedlings or older trees. Treat entire nursery or plantation if seedlings show any injury or if older trees have 5 or more flagged tips per tree. Infestations lighter than this do not need control because most flagged shoots will fall off before harvest.
• Remove, chip, or burn dead or dying pines and fresh stumps before late spring to eliminate the weevils' breeding material.
• Or, in April to mid May, drench fresh stumps and nearby soil once with a registered insecticide to kill the egg-laying adults. A similar drench in August will kill emerging adults.
• Spray living trees once with a registered insecticide in August or September to kill the feeding adults.
• When harvesting, leave one whorl of live pest-free branches on each stump to keep it alive and therefore unattractive to the weevils. Destroy these stumps within 3 years. Caution: Do not leave live branches that have needlecast diseases.
• Control grass competition around young trees.

NEXT CROP
• Delay replanting a cutover area for 2 years unless stumps are removed or treated to prevent weevil attack.



Hosts: All pines and spruces

Pales Weevil SHOOT/BRANCH INJURY

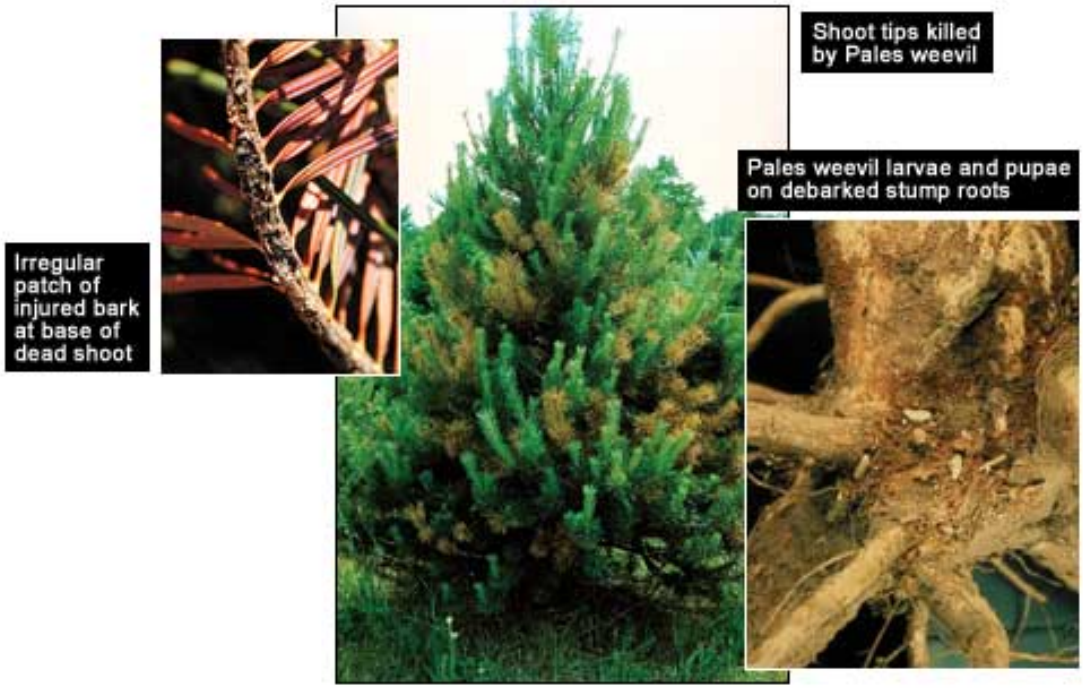
Pales Weevil

Hylobius pales (Herbst)

Hosts: Eastern white and Scotch pine; Douglas-fir; occasionally other pines, true firs, and some spruces.

Importance: This insect is a chronic problem in Christmas tree plantations where periodic harvests leave many pine stumps suitable for weevil breeding. The adults feed on the stem bark of seedlings and on the shoot and branch bark of older pines and other conifers. Seedlings die. Heavy feeding girdles and kills shoots, thereby thinning and degrading Christmas trees.

Look For:
JUNE TO AUGUST
• *Dead seedlings.*
• *Dead shoot tips* on large trees.
• *Small, irregular patches of exposed wood* on seedling stems or at the bases of flagged shoots on large trees. Pitch may ooze from the wounds, or the scars may be partially callused.
• *White, C-shaped larvae or pupae*, ½ inch long, beneath the bark of the roots of fresh pine stumps. The insects are in chambers (galleries) that run along the grain of the wood. Remove root bark with a knife to see insects.
• *Reddish-brown to black, robust weevils,* 1/3 inch long, under the litter around live trees and stumps. Adults are on the trees during warm nights (temperature above 50ÞF) from April to September. To locate them, put a sheet under the tree after dark and shake the tree. Weevils will fall onto the sheet. Or, bait the weevils in spring by placing freshly cut pieces of pine stem on the ground near trees. Look for adults under the cut pieces during the day.



Pests that cause similar symptoms: Dead shoot tips can be caused by Sphaeropsis shoot blight, Saratoga spittlebug, white pine blister rust, eastern pine shoot borer, and pine shoot beetle. Pine root collar weevil, and pine root tip weevil adults are nearly identical to pales weevil and have similar life cycles. Wood borers and bark beetles carve distinctive galleries in the stump collar above the pales weevil galleries. Wood borers leave holes in the tops of old stumps.

Biology: Drawn by the odor of fresh pine resin in spring, female weevils lay eggs in the inner bark of new stumps. Larvae tunnel a few inches to several feet into the roots during the summer. Adults emerge in late summer to early fall. They spend the day in the litter around the trees and move onto trees at night to feed on the bark of shoots or seedlings. Later in the fall, they move to the litter to overwinter. Pales weevil commonly occurs along with the northern pine weevil.

Monitoring and Control: Examine trees of all ages in June, especially where fresh stumps are present. Examine 50 or more trees scattered throughout the plantation. Treat entire nursery or plantation if seedlings show any injury or if older trees average 5 or more flagged tips per tree.
• Remove new stumps by early spring to eliminate the weevils' breeding material.
• Or, once between early April and mid May, thoroughly drench the stumps and nearby soil with a registered insecticide to kill egg-laying adults. A similar drench in August will kill emerging adults.
• Or, apply a registered insecticide to live trees between mid August and mid September when adults move onto trees to feed on shoots.
• When harvesting, leave one whorl of live, pest-free branches on the stump to keep it alive and therefore unattractive to the weevils. Destroy these stumps within 3 years. Caution: Do not leave live branches that have needlecast diseases.

NEXT CROP
• Delay replanting a cutover area for 2 years unless stumps are removed or treated to prevent weevil attack.
• Dip the above-ground portion of seedlings in a registered, residual insecticide before planting to prevent weevil feeding.

Pine Grosbeak — SHOOT/BRANCH INJURY

Pine Grosbeak
Pinicola emicleator lecura (Müller)

Hosts: Scotch pine; occasionally eastern white and red pine, and spruce.

Importance: Pine grosbeaks feed on the buds of Christmas trees, stunting height growth and thinning crown foliage. This feeding causes dormant buds to develop into bushy clusters of shoots that deform and degrade trees. The extent of damage varies from year to year, depending on the number of birds and the supply of other food available during the winter months.

Look For:
WINTER
• *The pine grosbeak*—a robin-sized bird with a large, cone-shaped beak. Adult males are gray with a rosy-red coloring in the crown, rump, and breast. In females, these areas are suffused with yellow.
• *Buds missing from the topmost shoot and the upper branches* of trees.
• *Broken leaders on trees taller than 5 feet.*
MAY TO JULY
• *Bushy foliage in the upper part of the tree*, sprouting from lateral (side) buds that normally remain dormant.

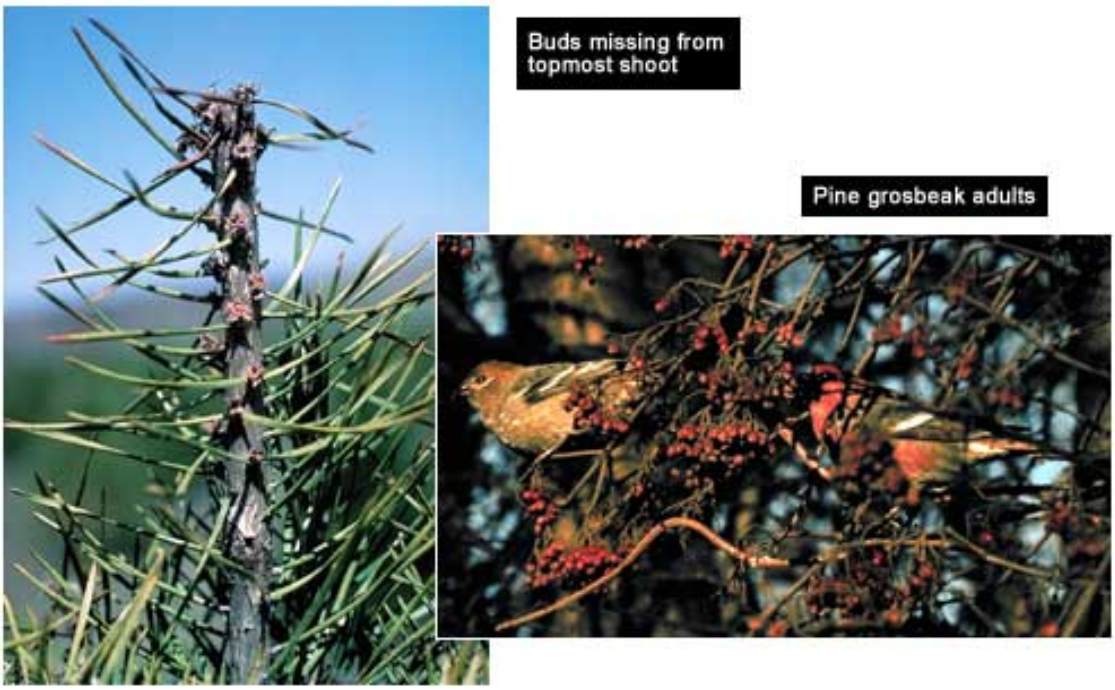
Biology: During the winter months when their normal food supply is depleted, grosbeaks may migrate from the northern forests south to areas that provide adequate food and shelter, such as Christmas tree plantations. Normally this only happens once every 4 or 5 years.

Monitoring and Control: Inspect trees within 2 or 3 years of harvest and protect them if you notice flocks of grosbeaks daily during the winter.
• If practical, install an electric noise broadcasting system to repel birds. Alter the kinds of sounds broadcasted every 3 to 5 days.
• Place a plastic mesh sleeve over the topmost shoot after the tree has become dormant, and remove it the

following spring. This control is most practical for protecting high-value trees ready for harvest.
• Shear damaged trees to help restore good form.

Note: The pine grosbeak is protected by the Federal Migratory Bird Treaty Act.

NEXT CROP
• Plant resistant varieties of Scotch pine, such as S. French, Poland, Belgian, or Czechoslovakia (see Table 1 for resistance rankings of Scotch pines).



Hosts: Scotch pine; occasionally eastern white and red pine, and spruce

SHOOT/BRANCH INJURY — Pine Root Tip Weevil

Pine Root Tip Weevil

Hylobius rhizophagus Millers, Benjamin, & Wagner

Hosts: Scotch and red pine; eastern white pine if mixed with Scotch pine.

Importance: Larvae (grubs) of this weevil feed on the root tips of Christmas trees, preferring trees grown from stumps (tip-ups) because of the large root systems on these second-crop trees. Injured Scotch or red pines become discolored and may die. White pine may be attacked if grown near susceptible pines, but few will be killed. This weevil is found mostly in the northern Lake States.

Look For:
• *Flagged (deformed and discolored) shoots and branches* anywhere on the tree. Some trees may be dead.
• Debarked, hollowed-out root ends where root tips have been chewed off.
• White, C-shaped larvae, up to ½ inch long, which may be in the root.

Pests that cause similar symptoms: Sphaeropsis shoot blight, pine spittlebug, Saratoga spittlebug and Scleroderris canker. Pales weevil adults and pine root collar weevil adults are nearly identical to pine root tip weevil adults in appearance.

Biology: Larvae and adults overwinter underground. Adults emerge in April and lay eggs in June. Newly hatched larvae feed on the rootlets and then tunnel into the main lateral (side) roots as they grow. After overwintering, the larvae continue to root feed until July, when they pupate. New adults emerge in late summer.

Monitoring and Control: If you suspect pine root tip weevil, ask a pest specialist for help in diagnosis. Treat if recommended.
• Spray trees with an insecticide registered for weevils in late July or early August to kill adult weevils as they move onto trees to feed. This treatment has not been tried for pine root tip weevil, but does control similar weevils.

NEXT CROP
• Remove any abandoned Scotch pine trees that are adjacent to areas planned for planting.
• Avoid growing trees from stumps (tip-ups).
• If the problem is serious, consider planting a nonhost species after harvest.

Hosts: Scotch and red pine; eastern white pine, if mixed with Scotch pine

Pine Shoot Beetle

SHOOT/BRANCH INJURY

Pine Shoot Beetle

Tomicus piniperda L.

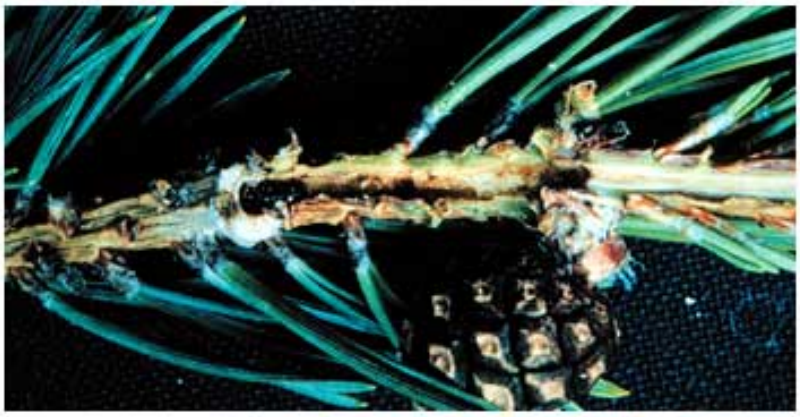
Hosts: All pines.

Importance: Pine shoot beetle is an exotic pest that can develop and feed in shoots of most pine species grown in North America. Shoot feeding by adult beetles kills shoots and could reduce growth if populations were high. However, pine shoot beetle is most important because it is a quarantine pest. Federal and state quarantines regulate shipments of pine Christmas trees from counties known to be infested with pine shoot beetle. The goal of these regulations is to reduce the risk that pine shoot beetle will be transported to new areas.

Look For:
• *Reddish boring dust* on the bark of stumps or cut trees in spring when parent beetles are colonizing brood material.
• *Egg and larval galleries under the bark* of recently cut pine stumps and cut trees that have been colonized by parent beetles. Egg galleries run parallel with the grain of the wood and have a slight bend at the end. Larvae feed in tunnels that are roughly perpendicular to the egg gallery.
JUNE TO DECEMBER
• *Attacked shoots on live pine trees with a round hole*, often surrounded by a small glob of pitch. Beetles feed in tunnels down the center pith of the shoots. Tunnels are hollow and are not filled with frass. Two to five tunnels may be found on a single shoot. Attacked shoots eventually die, break off, and drop.

Pests that cause similar symptoms: Other bark beetles infest pine logs, cut trees, and stumps. Specialists can help you distinguish their galleries from pine shoot beetle galleries.

Damage caused by shoot-feeding beetles is similar to injury caused by Sphaeropsis shoot blight, eastern pine shoot borer, European pine shoot moth, and jack pine tip beetle. Shoots killed by Sphaeropsis will not have tunnels. Shoots attacked by eastern pine shoot borer and European pine shoot moth will have fine, sawdust-like frass packed into the tunnel. Jack pine tip beetle constructs hollow tunnels in shoots like pine shoot beetle; contact a specialist to tell the two insects apart.



Adult beetle tunneling in shoot

Biology: Adult beetles overwinter in a niche in the bark at the base of live pine trees. In early spring, adult beetles fly to recently cut or dying pine trees, logs, or stumps. This spring flight may occur between mid February and mid April in North Central states. Adults bore into the inner bark, mate, and females construct egg galleries. Eggs are laid along the sides of the gallery and hatch within a few weeks. Larvae feed in the inner bark for 6 to 10 weeks and pupate. New adults emerge in early summer, often in early to late June. These reddish-brown adults feed in current-year or one-year-old shoots on live pine trees until October or November. During this maturation feeding, adult beetles darken to a shiny black color. After a few hard frosts, beetles move to the base of trees to overwinter.

Monitoring and Control: If you plan to ship trees outside of your county, contact your state regulatory agency for current information on the pine shoot beetle quarantine and regulations. If you are in a regulated county, you may wish to enroll your fields in the Pine Shoot Beetle Compliance Program, a voluntary integrated management program. You may also request a preharvest inspection of fields to certify that trees are not infested with pine shoot beetle. Any evidence of pine shoot beetle infestation may cause your field to be restricted.

• Check live trees throughout the summer and fall for evidence of shoot-feeding beetles. Clip off discolored or dead shoots and split them lengthwise to find a black or reddish-brown beetle feeding in a hollow tunnel.

• The key to controlling pine shoot beetle is to reduce availability of pine stumps, cut or dying trees, and similar material needed by breeding beetles. Chip or burn culled or unsold trees in spring before the new generation of beetles can complete development.

• Cut stumps as low to the ground as possible during harvest in autumn or the following spring. Stumps can also be sprayed with an approved insecticide in late spring before new adult beetles emerge.

• Freshly cut pine trees or logs can be set along edges of fields in early spring to attract parent beetles. These trap logs must be collected and destroyed by chipping or burning before the progeny beetles emerge.

• Spraying foliage with an approved, registered insecticide can help control pine shoot beetle, but is rarely 100 percent effective. Time your spray to coincide with emergence of the new generation of beetles.

Larvae feed in galleries in the inner bark

NEXT CROP

• Continue to chip or burn culled trees, cut stumps low, and practice good sanitation in fields to prevent populations of pine shoot beetle from building to damaging levels.

Pine Spittlebug

Aphrophora parallela (Say)

Hosts: Scotch, Austrian, and eastern white pine; all spruces and firs.

Importance: Spittlebug nymphs and adults suck sap from shoots of Christmas trees. Unless abundant, they seldom do more than flag (discolor and deform) an occasional branch tip. However, the Sphaeropsis fungus may invade weakened pines through spittlebug feeding wounds and shoot blight may heavily flag or kill trees.

Look For:
• *Flagged shoot tips* anywhere on the tree (especially on pines). Foliage may look sooty and glisten as if lacquered. Some trees may be dead.
• *One or more creamy yellow to black nymphs*, up to ¼ inch long in spittlemasses.
MAY TO EARLY JULY
• *Frothy white spittlemasses* on shoots or trunk.
• *Symptoms of Sphaeropsis shoot blight* on pines.
MID JUNE TO MID SEPTEMBER
• *Oval-shaped adults*, about 1/3 inch long, on needles or branches. They jump when approached or touched.

Pests that cause similar symptoms: Flagged shoots could be caused by jack pine tip beetle, Pales weevil, pine shoot beetle, pine root tip weevil, Saratoga spittlebug, Scleroderris canker, or Sphaeropsis shoot blight. Sooty, lacquered foliage could be due to aphids or pine tortoise scale.

Biology: Nymphs hatch in May from eggs laid under the bark of shoots. For the next 6 to 7 weeks, they feed on the tree's sap and produce the characteristic, frothy spittlemasses from partially digested sap. Black sooty mold grows on the sugary sap splashed from the spittlemasses. Adults appearing in July also suck the tree's sap, but form no spittlemasses. The Sphaeropsis shoot blight fungus enters the feeding wounds and causes shoot tips to turn brown.

Monitoring and Control: Examine trees of all ages, especially those under stress, from May through June. A few scattered spittlemasses need no treatment if trees are otherwise healthy. If insects seem abundant—as if trees are partially coated with "snow"—look for flagging in late summer and early fall. If trees are flagged, or if Sphaeropsis shoot blight is also present, treat entire plantation next summer.
• Apply a registered insecticide in early to mid July to control the adults. To determine spray date, start examining spittlemasses in early July, and spray when 95 percent of them are empty. Manage Sphaeropsis shoot blight if needed.
• Wash off the black discoloration caused by sooty mold by spraying the affected tree parts with a solution of 4 ounces liquid detergent mixed in 100 gallons of water. Apply under high pressure, preferably in late afternoon. Leave overnight and rinse tree with water the next morning.

NEXT CROP
• Select appropriate species for site conditions. Trees stressed by drought, poor growing conditions, or other factors are more susceptible to spittlebug and shoot blight injury.

Hosts: Scotch, Austrian, and eastern white pine; all spruces and firs

SHOOT/BRANCH INJURY Pine Tortoise Scale

Pine Tortoise Scale

Toumeyella parvicornis (Cockerell)

Hosts: Scotch, Austrian, and red pine.

Importance: This scale extracts sap from the woody shoots and branches of Christmas trees, and may stunt growth. High populations cause needles and shoots to become discolored, leaving trees unfit for sale. Heavy attacks may kill branches or even trees. Infested trees often become coated with black sooty mold.

Look For:
• *Discolored needles and dying shoots or branches*, particularly on the lower branches. Needles may look black and sooty and glisten as if lacquered. Many bees and/or ants may be on the needles, and some trees may be dead.
• *Reddish-brown, mottled, helmet-shaped scales*, up to ¼ inch in diameter, on the bark of injured shoots.

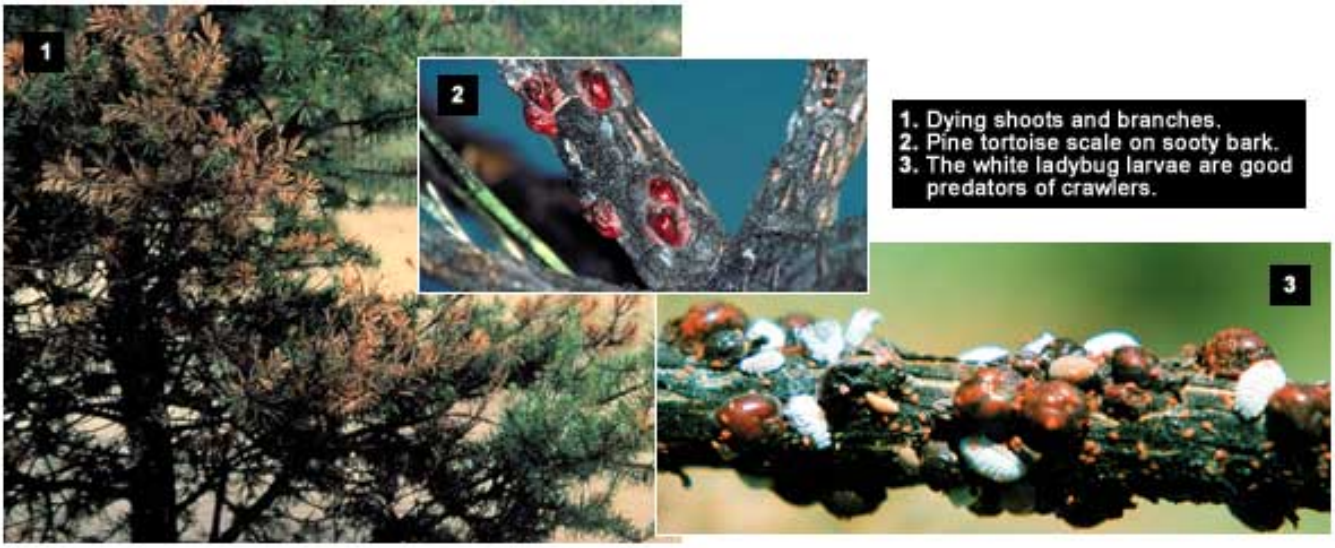
Pests that cause similar symptoms: Sooty mold can also occur on trees infested with aphids or pine spittlebug. Scattered dead branches can be caused by Sphaeropsis shoot blight, Saratoga spittlebug, or pine spittlebug.

Biology: Young females overwinter on the bark of shoots and branches and produce hundreds of eggs in the spring. In June or July, tiny crawlers (nymphs) hatch and crawl out from under the scales. Adult and

larval ladybugs frequently feed on the crawlers at this time, and can usually control light infestations before trees are injured. The female crawlers attach themselves permanently to the tree and develop into soft scales. While feeding they secrete a shiny, sugary waste product called honeydew, which coats the nearby branches. Black sooty mold grows on the sugary honeydew, turning needles and shoots black. Bees and ants feed on the honeydew.

Monitoring and Control: Examine trees of all ages from May to June, looking for sooty needles. Treat individual infested trees and seedlings if scales are obvious or if trees are ready for harvest.
• Cut and burn heavily infested trees before mid June to reduce spread of crawlers.
• Coat trees completely with dormant or superior oil before buds break in spring to kill immature scales.
• Or, spray each infested tree once with a registered insecticide between mid June and mid July to kill emerging crawlers. Use a hand lens to check for pinkish eggs or small, crawling insects on the undersides of scales in mid June. The best time to spray is when almost half of these crawlers have emerged. If timing is incorrect, a second treatment may be needed.
• Control mound ants because they may protect scales from predators.
• Wash off the black discoloration caused by sooty mold by spraying affected tree parts with a solution of 4 ounces liquid detergent mixed in 100 gallons of water. Apply under high pressure, preferably in late afternoon. Leave overnight and rinse with water the next morning.
• Do not ship infested trees because scales hitchhike to new areas this way.

NEXT CROP
• Plant only pest-free stock.
• Do not plant susceptible pines next to a scale-infested stand or windbreak without first treating to control scales. Jack pine is a common host, so avoid jack pine windbreaks.



Hosts: Scotch, Austrian, and red pine

Porcupine

Erithizon dorsatun L.

Hosts: All Christmas tree species.

Importance: Porcupines eat the inner bark of limbs and trunks, girdling them, and may clip off tree limbs.

Look For:
• *Limbs or trunk that is debarked and girdled.*
• *Smooth, clean, slanted cuts* on high branches snipped by porcupines.

Pests that cause similar symptoms: Voles, hares, and rabbits.

Monitoring and Control:
Examine trees of all ages for evidence of porcupine feeding, especially in winter.
Porcupines can be trapped with wire box traps baited with salted corn cobs.


Porcupine injury

Hosts: All Christmas tree species

Saratoga Spittlebug

Aphrophora saratogensis (Fitch)

Hosts: Scotch and red pine; occasionally eastern white pine, Fraser fir and balsam fir.

Alternate Hosts: Sweetfern; brambles (raspberry and blackberry); broad-leaved weeds.

Importance: Spittlebug adults feed on shoots of conifers and can discolor foliage, stunt or kill branches, and leave trees unfit for Christmas tree sale. Heavy feeding for 2 or 3 years can kill Scotch and red pine Christmas trees.

Look For:
• *Reddish or reddish-brown (flagged) branches*, particularly in the upper part of the tree. Severely injured trees brown up and die.
• *Tan or brownish flecks on the wood* under the bark of older portions of branches. Peel bark away with a knife to see the flecks.
• *Dense ground cover with sweetfern or other alternate hosts.*
MID MAY TO EARLY JULY
• *Frothy masses of spittle-like bubbles at the base of sweetfern, brambles or other alternate hosts.*
• *Small, red and black or chestnut-brown insects* in these spittlemasses.

LATE JUNE TO SEPTEMBER

• *Tan and white boat-shaped insects*, 1/3 inch long, on the tree. Each has a white arrow-shaped marking on its front end. Spittlebug adults will jump away when disturbed.

Pests that cause similar symptoms: Sphaeropsis shoot blight, meadow spittlebug (green insects in spittlemasses in the tops of weeds and grasses, not a Christmas tree pest), northern pine weevil, Pales weevil, jack pine tip beetle, pine shoot beetle, pine root tip weevil, pine spittlebug, or Scleroderris canker on pine.

Biology: Nymphs hatch in spring and drop from trees to feed on alternate host plants. They cover themselves with the characteristic spittlemass made of fluids from the host plants. In late June or early July, adults return to the trees to suck sap from the shoots and lay eggs. This feeding scars the inner bark and wood and blocks vessels that carry water and nutrients to the rest of the tree.

Monitoring and Control: Examine sites before planting and check between rows of young trees after planting. Look for and eliminate pockets of sweetfern, blackberry, and raspberry if they occupy more than 20 percent of the open ground cover. Randomly select five Christmas trees scattered throughout the plantation. Scrape the bark off the 2-year-old shoot portion of any branch in the upper half of each tree, and look for flecks (feeding scars) on the wood. Consider treating adult spittlebugs if there are more than 20 flecks per 4 inches of branch length.

• Use a herbicide to limit sweetfern and brambles to less than 20 percent of the ground cover within 20 feet of the trees. Spittlebugs cannot complete their life cycle without these alternate hosts.

• Apply a registered insecticide to the trees in early to mid July to kill emerging adults before they lay eggs. The best time to treat trees is when 90 percent of the spittlemasses on sweetfern or brambles are empty.

NEXT CROP

• Use a herbicide to destroy the alternate hosts before planting trees. Limit alternate hosts throughout the growing cycle to less than 20 percent of the ground cover.

• Avoid very dry sandy soils that are prone to drought stress. These areas often have sweetfern growing on them.

Left: Saratoga spittlebug adult.
Right: Flagged branches
Below: Tan or brownish flecks on wood beneath bark

Hosts: Scotch and red pine; occasionally eastern white pine, Fraser fir and balsam fir

SHOOT/BRANCH INJURY Scleroderris Canker

Scleroderris Canker (=Gremmeniella Canker)

Gremmeniella abietina (Lagerb.) M. Morelet

Hosts: All pines; occasionally spruces, firs, and Douglas-fir.

Importance: The European strain of this disease kills trees of all ages, causing extensive losses in plantations. The North American strain only kills trees less than 6 feet tall and can seriously damage Christmas trees during the first 5 years after planting. Only the North American strain is present in the upper Midwest.

Look For:
• *Cankers: oblong, sunken areas* on the stem and branches, commonly inconspicuous. Remove the bark and look for a slight swelling on the wood surface.
• *Green discoloration beneath the bark* of dead branches.
MAY TO JUNE

• *Orange discoloration at the bases of needles*, usually on the lower 3 feet of the tree. These needles fall off easily.
• *Dead buds on shoots* that have discolored needles.
JULY TO NOVEMBER
• *Brown needles and branch tips*. Needles fall off when touched.
DECEMBER TO APRIL
• *Dead branch tips with no needles*.

Pests that cause similar symptoms: Sphaeropsis shoot blight and canker, drought, pine root tip weevil, pine spittlebug, Saratoga spittlebug on pine.

Biology: Branch tips usually become infected in May and June, but infection sometimes takes place from February through November. Spores are windblown or rain-splashed from infected nursery stock and infected cut Christmas trees.

Monitoring and Control: Examine trees of all ages in May or June when orange needle discoloration is most obvious. Check the lower branches of trees in low spots in the plantation, and remove infected branches immediately. Continue to check branches each year, especially if this canker is present in natural stands within ¼ mile of your plantation.
• Remove all infected branches.
• Do not shear infected foliage during wet weather because spores released at this time can be carried from tree to tree on shearing tools. Sterilize tools after shearing infected trees by dipping in denatured alcohol for 3 minutes.
• Shear healthy trees first so spores will not be carried from infected trees to healthy ones. Note: chemical controls are available to protect nursery stock, but may be too expensive for plantation use.

NEXT CROP
• Plant only pest-free nursery stock.
• Plant resistant species, such as spruce or fir, in areas where Scleroderris canker is present.
• Avoid planting in frost pockets.

Right: Green discoloration on a dead branch

Below: Orange discoloration at the bases of needles

Hosts: All pines; occasionally spruces, firs, and Douglas-fir

Sphaeropsis Shoot Blight & Canker

SHOOT/BRANCH INJURY

Sphaeropsis Shoot Blight and Canker (= Diplodia)

Sphaeropsis sapinea (Fr.:Fr.) Dyko and B. Sutton

Hosts: Red, Scotch, and Austrian pine.

Importance: This fungus kills current–year shoots on trees of all ages, and usually kills nursery seedlings within the first year. Repeated infection over several years eventually kills older trees. Girdling cankers are formed when Sphaeropsis infects wounds on the stem and branches.

Look For:
• *Stunted or curled current-year shoots*. Infected tissue will be resin soaked.
• *Black fruitbodies* on dead needles or shoot tissue.
• *Cankers: oblong sunken areas* on branches or stem. The top of the tree above girdling cankers will be killed.
• *Olive-green streaking* on the resin–soaked tissue beneath the bark.

Pests that cause similar symptoms: Adana tip moth, drought, European pine shoot moth, Nantucket pine tip moth, pales weevil, pine root tip weevil, pine shoot beetle, Scleroderris canker, spittlebugs.

Biology: Sphaeropsis overwinters in pine shoots, bark, cones, or litter and infects growing shoots in the spring. Spores are released during wet weather from spring through fall. Trees that are stressed because of poor sites, drought, snow damage, or insect activity are very susceptible to this disease. Wounds, such as those made by hail, shearing, or insects, serve as entry points for Sphaeropsis. For instance, this fungus frequently infects trees that have been wounded by pine spittlebug feeding.

Monitoring and Control: Inspect trees of all ages in late spring or early summer. Randomly select 50 or more trees scattered throughout the plantation and look for stunted or curled current-year shoots. If more than 10 percent of these trees are unsalable because of Sphaeropsis, consider treating the entire plantation next spring. Take other preventive measures immediately to avoid spreading the fungus.
• Control insects that are weakening trees and creating entry points for Sphaeropsis.
• Do not shear infected trees during wet weather because spores released at this time may be carried from tree to tree on shearing tools.
• Apply a registered, preventive fungicide four times, once every 2 weeks during shoot elongation, to prevent shoot blight from spreading to healthy trees.

NEXT CROP
• Plant disease-free stock.
• Avoid planting susceptible species, such as Austrian or red pine, on poor sites where they will be more vulnerable to both insect and fungal attack.
• Do not plant trees next to windbreaks that are affected by Sphaeropsis. Examine windbreaks closely; although shoots may not be infected, cones may still harbor Sphaeropsis.
• Take preventive measures as described above to protect new foliage.

Hosts: Red, Scotch, and Austrian pine

SHOOT/BRANCH INJURY — Spruce Bud Scale

Spruce Bud Scale

Physokermes piceae (Schrank)

Hosts: All spruces.

Importance: This scale sucks fluids from the shoots and branches of Christmas trees, but usually does not damage trees. Heavy attacks, however, may kill a few trees or stunt new shoots, leaving trees unfit for sale.

Look For:
• *Discolored needles and dying shoots, particularly on the lower branches.*
• *Dusty red-brown globe-like scales*, up to 3/16 inch in diameter, that look like abnormal buds at the bases of current shoots.

Biology: Young females overwinter on the bark of shoots and branches and produce hundreds of eggs in the spring. In June or July, tiny crawlers (nymphs) hatch and crawl out from under the scales. Ladybugs frequently feed on the crawlers at this time. The female crawlers attach themselves permanently to the tree and develop into soft scales.

Monitoring and Control: Examine trees the year before harvest. Ladybugs will usually control light infestations. However, if predators are not effective or if you notice scales on trees that are ready for harvest, consider control options.
• Cut and burn heavily infested trees before mid June to reduce spread of crawlers.
• Coat trees completely with dormant oil before buds break in spring to kill immature scales.
• Or, spray infested trees once with a registered insecticide between mid June and mid July to kill

emerging crawlers. Use a hand lens to check for pinkish eggs or small crawling insects on the undersides of scales in mid June. The best time to spray is when almost half of these crawlers have emerged. If timing is incorrect, a second spray may be needed.
• Do not ship infested trees because overwintering scales hitchhike to new areas this way.

NEXT CROP
• Plant only pest-free nursery stock.

Hosts: All spruces

White Pine Blister Rust SHOOT/BRANCH INJURY

White Pine Blister Rust

Cronartium ribicola J.C. Fisch.

Host: White pine.

Alternate Hosts: Gooseberry, currant, *Ribes* spp.

Importance: White pine blister rust causes cankers that kill branches and lower the market value of Christmas trees. Cankers on the trunk can girdle and kill trees.

Look For (on pine):
• *Patches of brown bark with yellow borders*. This signals the first year of infection.
• *Spindle-shaped swellings* that appear on the branches or trunk during the second year of infection.
• *Signs of resin flow and rodent feeding* on mature yellow-bordered cankers.
• *Reddish-brown needles* on dead branches and tree tops above trunk cankers.
MAY
• *Cream-colored blisters* pushing through the diseased bark. These break open and release orange-yellow spores.
JUNE TO JULY
• *Yellow-brown blisters* on the canker that produce a sticky orange fluid that later hardens and turns black.

Look For (on gooseberry and currant):
JUNE TO AUGUST
• *Orange spores* on the undersides of leaves.
AUGUST TO OCTOBER
• *Brown hair-line fungal growths* on the undersides of leaves.

Pests that cause similar symptoms: Pales weevil, pine root collar weevil.

Biology: This fungus needs both pine and an alternate host to complete its life cycle. It spreads from pine

to gooseberry or currant, but cannot spread from pine to pine. The disease is usually most severe in regions where weather is cool and moist in August and September. Thus, the farther north, the greater the hazard of blister rust.

Monitoring and Control: Inspect 5- to 10-year-old trees in May. Randomly select 50 or more trees scattered throughout the plantation, and look for branch flagging and orange blisters on branches or trunks in May. If more than 10 percent of these trees are infected, remove cankers and control alternate hosts before August.

• When shearing Christmas trees, prune off all brown branches that have cankers. This prevents the fungus from entering the trunk and killing the tree.
• Destroy and remove trees with trunk cankers.
• Remove or kill alternate hosts with a registered herbicide.

NEXT CROP

• For best results, plant white pine in low-hazard southern zones where trees are less likely to be killed by white pine blister rust.
• Avoid planting white pine where alternate hosts are abundant, especially in high-hazard northern areas. If you do plant in these areas remove alternate hosts to reduce the likelihood of infection.
• Avoid planting white pine in areas where cool air congregates, such as at the base of a slope or in a depression.

White Pine Weevil

Pissodes strobi (Peck)

Hosts: Eastern white and Scotch pines, spruces; other pines are also susceptible.

Importance: The larvae of this common pest deform and degrade Christmas trees by killing the terminal leader and the top 2 to 4 years of growth. Damage will delay harvest for 1 to 3 years until those trees recover enough to be suitable for sale.

Look For:
• *Dead or dying terminal leader* (topmost shoot on the mainstem), curled into the shape of a shepherd's crook. Lateral (side) branches on the upper whorls may also die.
MARCH TO APRIL
• *Small round holes or pitch flow on terminal leader* where adult weevil is feeding or laying eggs.
JUNE TO AUGUST
• *Slightly curved white larvae,* up to ¼ inch long, under the bark or in the wood of the damaged terminal.
• *Clumps of fine white slivers of wood under the bark* in late summer. These woody chip cocoons may contain white pupae or brownish weevils, ¼ inch long.

Pests that cause similar symptoms: Frost injury on tree tops, white pine blister rust, eastern pine shoot borer.

Biology: On warm spring days overwintering adults move from the litter to the tree tops to mate and lay eggs in feeding wounds on the bark of the terminal leader. The larvae soon hatch and bore downward under the bark, eventually girdling the top of the stem and the upper one to three whorls of branches. Larvae pupate in woody chip cocoons and emerge as adults from late July to late August. Adults feed on the bark of small branches before dropping to the litter to overwinter.

Monitoring and Control: Begin checking for dying and dead terminals in late June and concentrate on trees that will be harvested in 3 or 4 years. Treat entire plantation when injury becomes too severe to correct with pruning.
• Prune and burn infested leaders before mid July to kill the insects. Cut back all but one live lateral (side) shoot by at least half their length to maintain single-stem dominance.
• Spray the terminal leader of trees with a registered insecticide as soon as weather warms to control egg-laying weevils. Eggs are usually laid in early May in the Lake States and April in the Central States. A

second spray between mid August and late September may be needed to control newly emerged adults. The second spray should be applied to the upper half of the tree canopy.

NEXT CROP

• Avoid planting highly susceptible white pine and Norway and Colorado blue spruce. If you do plant these species, isolate them from less susceptible pines and spruces.
• Plant resistant varieties of Scotch pines, such as the Swedish variety, if available.
• If practical, remove old stands of eastern white pine or jack pine in and around plantations before planting.

Hosts: Eastern white and Scotch pines, spruces; other pines are also susceptible

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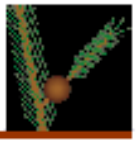
Shoot/Branch Galls

Shoot/Branch Galls

Irregular or globelike swellings occur on shoot, branch, or mainstem. You may also find small pitch blisters in branch crotches that look like galls.

SHOOT/BRANCH GALLS

Cedar-Apple Rust 

Cedar-Apple Rust

Gymnosporangium juniperi-virginianae Schwein

Host: Eastern red cedar.

Alternate Host: Apple and crabapple trees.

Importance: This rust kills branch tips and causes unsightly galls (globe-like swellings) to form. When numerous, galls may slow growth and kill seedlings.

Look For: • *Brown warty galls*, ½ to 2 inches in diameter, on twigs of red cedar.
MAY TO JUNE
• *Yellow-orange jelly-like fingers growing from galls*, especially during rainy weather.
JULY TO SEPTEMBER
• *Orange leaf spots on nearby apple trees*.

Biology: After warm spring rains, cedar-apple rust spores are produced in the yellow-orange fingers that erupt from round, woody galls on red cedar twigs. These spores spread to nearby apple trees where they cause orange spots on leaves and fruits. In summer and early fall, another type of spore produced on the apple trees infects nearby red cedar and causes new galls to form.

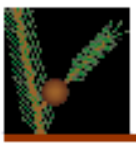
Monitoring and Control: In spring, look for galls on red cedar of all ages. If galls are too numerous to hand clip and are killing seedlings or making older trees unsalable, consider treating galls with fungicides.
• Clip off galls on red cedar.
• If practical, remove nearby apple trees to reduce infection on red cedar.
• Apply a registered fungicide to the orange jelly-like galls once during the spring, and/or spray red cedar foliage three times, once every 2 weeks, beginning in midsummer.

NEXT CROP
• Avoid planting red cedar near apple and crabapple trees.

Brown, warty gall

Jelly-like fingers growing from galls

Host: Eastern red cedar



Cooley Spruce Gall Adelgid SHOOT/BRANCH GALLS

Cooley Spruce Gall Adelgid

Adelges cooleyi (Gillette)

Hosts: Colorado blue and occasionally other spruce species; Douglas-fir.

Importance: The nymphs of this species cause long curved persistent galls to form on the new shoot tips of blue spruce. These attacks may kill shoots, deform the tree, and lower its value as a Christmas tree. On Douglas-fir, nymph feeding discolors and distorts needles, but does not produce galls.

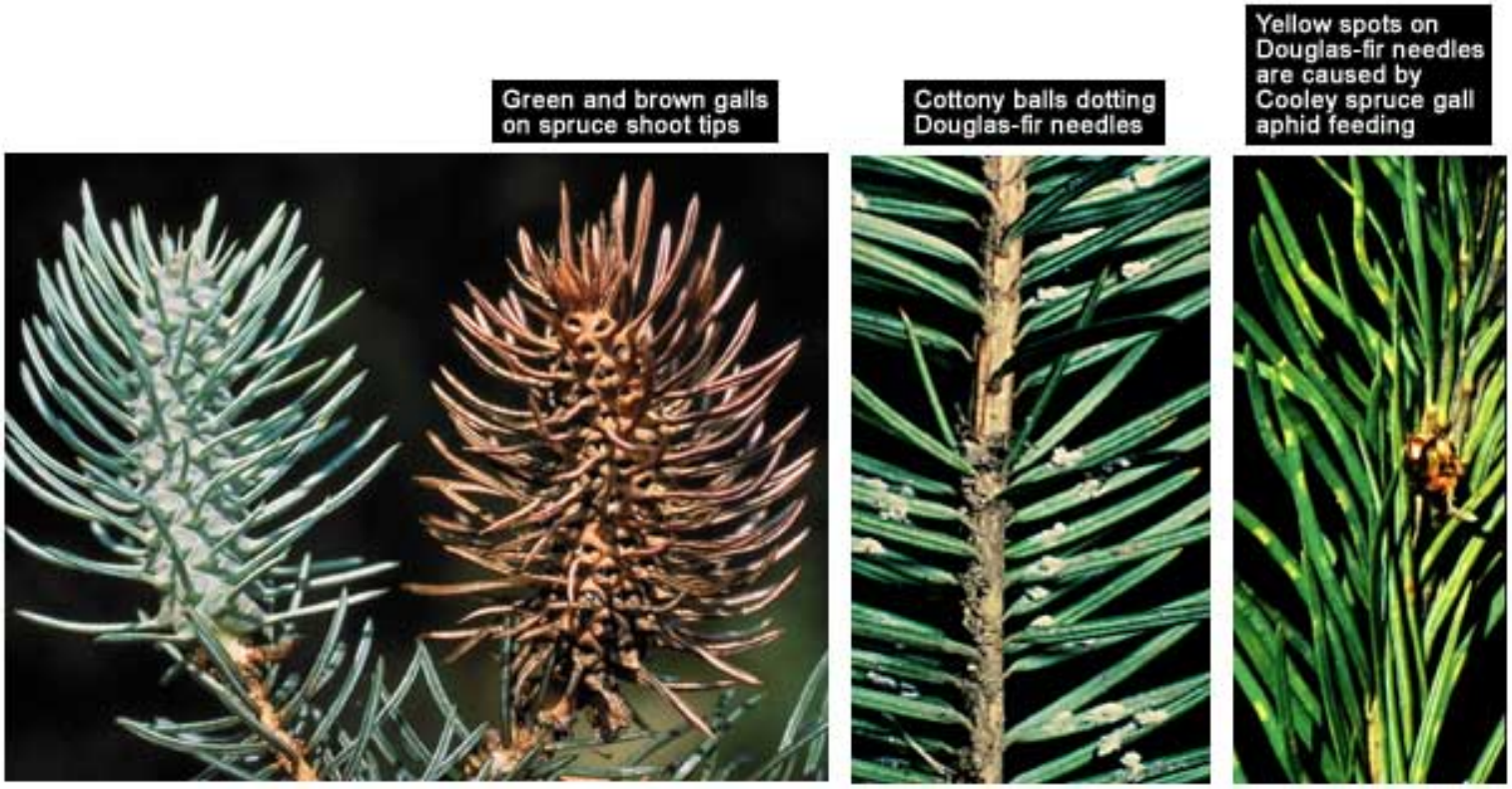
Look For (on spruce):
• *Galls: cone-like, green, purple, or brown swellings*, 2 to 2 ½ inch long, on the tips of new shoots.

Look For (on Douglas-fir):
• *Yellow spots on bent or curled needles,* caused by nymph feeding.
• *Small cottony balls* dotting the undersides of needles.

Biology: On spruce, young females lay eggs in the spring under a mass of white, cottony wax near the terminal (end) bud. Nymphs hatch and feed at the needle bases of expanding buds, producing galls that enclose and protect them. After galls dry up in midsummer, the exposed nymphs will either continue their life cycles on blue spruce or fly to Douglas-fir to lay eggs. Feeding on Douglas-fir does not cause galls to form. The nymphs overwinter, and the next spring the winged forms may fly back to spruce, where they reproduce gall-forming adelgids and thus complete the life cycle. These adelgids can complete their life cycle on 1 or 2 hosts; however, injury tends to be more serious when they move between two hosts.

Monitoring and Control:
On blue spruce: Look for brown galls on trees of all ages in August. If galls are few and scattered, remove by hand. If galls are too numerous to hand clip, treat entire plantation this fall or the next spring.
• Clip off and destroy green scattered galls before they turn red and open in July.
• Cut and chip or burn heavily affected trees.
• If needed, spray trees with a registered insecticide just before spruce buds break in late April or early May.
• Or, apply a dormant oil in early spring or late fall when trees are dormant.
On Douglas-fir: Monitor trees of all ages throughout the growing season. If you find small cottony balls on the undersides of needles, treat entire plantation.
• To control overwintering aphids, apply a registered insecticide to trees in early October or just before Douglas-fir buds break in April or early May. Spray trees when the temperature is above 60° F.
• An application in late June to mid July may be needed to control later stages.
• Or, apply dormant oil in early spring or late fall when the trees are dormant.

NEXT CROP
• Keep Colorado blue spruce and Douglas-fir apart to limit the problem.



Hosts: Colorado blue and occasionally other spruce species; Douglas-fir

Eastern Spruce Gall Adelgid

Adelges abietis (L.)

Hosts: Norway, red, white, Black Hills, and black spruce.

Importance: The nymphs of this species cause swellings or galls to form at the base of young shoots. The galled shoots become brown, stunted, and deformed, making the tree unfit for sale. A single tree may have hundreds of galls and can be repeatedly attacked.

Look For:

• *Pineapple-shaped green or brown galls*, ¾ to 1 inch long, at the bases of new shoots.

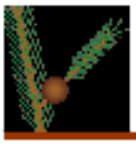
Biology: Females overwinter near end buds and lay eggs at bud bases in spring when buds begin to break. Nymphs hatch and feed in clusters on new needles, which collectively swell into the characteristic gall. The gall opens between mid August and October, allowing the adults to emerge, disperse, and reproduce.

Monitoring and Control: Look for brown galls on trees of all ages in mid to late summer. If galls are too numerous to hand clip, treat infested trees this fall or the next spring.
• Clip off and destroy green galls before they turn red and open in late July.
• Cut and destroy severely injured trees.
• Spray infested trees with a registered insecticide in early April just before the buds begin to swell, or mid to late September after galls have opened.
• Keep trees vigorous to avoid infestation.

NEXT CROP
• Consider planting alternative tree species.

Pineapple-shaped, green galls

Hosts: Norway, red, white, Black Hills, and black spruce



Gall Rusts

SHOOT/BRANCH GALLS

Eastern Gall Rust
Cronartium quercuum (Berk.) Miyabe ex. Shirai

Western Gall Rust
Endocronartium harknessii (J.P. Moore) Y. Hiratsuka

Hosts: Scotch pine.

Alternate Hosts:
Eastern Gall Rust: oak.
Western Gall Rust: none.

Importance: Rust infections on stems slow growth and gradually kill older trees. Young seedlings are girdled and killed quickly. Rust infections on branches kill individual branches, but not trees.

Look For:
• *Galls: globe-like or spindle-shaped swellings* on trunk or branches.
• *Red needles* on recently killed branches.
APRIL TO JUNE
• *Cream-colored blisters filled with orange spores,* located on the surface of galls.

Biology: Windborne spores of pine (western) gall rust spread directly from pine to pine. Eastern gall rust completes part of its life cycle on oak.

Monitoring and Control: Randomly select at least 50 trees scattered throughout the plantation and look for branch and stem galls at anytime during the year. If trees up to 7 years old average more than three galls per tree, consider treating entire plantation. Treat alternate hosts found within ¼ mile of plantation. If no alternate hosts are present, prune galls to prevent the spread of pine-pine gall rust.
• Destroy and remove alternate hosts from plantations so that rust fungi cannot complete their life cycle.
• Control pine-pine gall rust by removing galls from trees before they produce spores that can infect other pines.
• Control rusts in nurseries by applying a registered, preventive fungicide. Have a pest specialist identify the rust and prescribe the best treatment and timing for your area.

NEXT CROP
• Before planting, inspect stock for swelling caused by rust infection.
• Replant failed plantations with a nonhost species.

1. Globelike gall.
2. Swelling on seedlings.
3. This stem gall is producing spoors and is a telltale mark of a gall rust infection.

Host: Scotch pine

SHOOT/BRANCH GALLS Northern Pitch Twig Moth 

Northern Pitch Twig Moth (=Pitch Nodule Maker)

Petrova albicapitana (Busck)

Host: Scotch pine.

Importance: The caterpillars of this moth remove small amounts of bark in the crotches of young branches. This kills or deforms a few branch or stem tips, but seldom degrades Christmas trees. This pest usually occurs only within the range of jack pine, its preferred host.

Look For:
• *A hollow, thin-walled, brownish pitch blister* (nodule), about ½ to ¾ inch in diameter, in a branch crotch. Branch may be flagged (discolored and deformed) beyond the blister.
• *Small, reddish-brown caterpillars*, ½ inch long, inside the blister.

Pests that cause similar symptoms: Flagged branches may be caused by eastern pine shoot borer, Sphaeropsis shoot blight, Pales weevil, pine root tip weevil, pine shoot beetle, or pine spittlebugs.

Biology: This insect needs about two seasons to complete a full life cycle. The young larva constructs a small blister-like nodule on a growing tip and overwinters there. The next spring, the larva moves to a twig notch and forms a larger nodule—the one normally seen on the tree. After pupating, the moth emerges, lays eggs, and the cycle is repeated.

Monitoring and Control: Begin looking for pitch blisters when trees reach shearing age. Treat by hand if common.
• Break open pitch blisters and crush the larvae.
• Clip off flagged, broken, or crooked branches and leaders while shearing, or simply wait for broken branch tips to fall off.

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Dead Tree and Stem/Root Injury

Dead Tree and Stem/Root Injury

Whole or most of the tree is dead or dying. Needles fade from green to yellow to red or brown and may eventually fall off. Some trees may be leaning or fallen over.

Evidence of stem injury includes masses of pitch, holes in bark, and girdling (bark removal). Your tree may be in the advanced stages of injury caused by other pests, so if you cannot find the agent here, check pests in other injury categories.

DEAD TREE AND STEM/ROOT INJURY

Allegheny Mound Ant

Allegheny Mound Ant

Formica exsectoides Forel

Hosts: All Christmas tree species.

Importance: Mound ants kill all vegetation within 20 feet of their mounds (nests), including seedling or sapling conifers. The ants will also kill large trees that are as far away as 50 feet if those trees shade the ant mounds.

Look For:
• *A group of dead or dying trees.* Search the bases of affected stems for symptoms of injury, such as small blister-like swellings.
• *A large ant mound*, 1 to 3 feet high and 2 to 6 feet across, located among the injured trees.
• *Large ants*, ¼ inch long, with either black or reddish-brown front ends and red tail ends. Look for ants on the mound or on live trees.

Pests that cause similar symptoms: Pocket gopher.

Biology: These ants kill trees that shade their mounds by injecting formic acid into the bark of the lower trunk. The ants also protect aphids and scales on live trees by discouraging the aphids' natural enemies (parasites and predators).

Monitoring and Control: Look for mounds between trees or rows of trees in stands of all ages throughout the growing season. Treat individual mounds as soon as you find them.
• Kill adult ants by applying a registered, residual insecticide to mounds any time between mid April and October. Either level the mound with a rake before treating, or mix the insecticide into the upper 2 to 3 inches of the mound. For best results, apply just before a heavy rain. Treat again if a new mound appears. Be careful; these ants will bite.
• Keep aphid and scale populations low.

NEXT CROP
• Level and treat mounds before planting a new crop of trees.

Hosts: All Christmas tree species

Armillaria Root Rot

DEAD TREE AND STEM/ROOT INJURY

Armillaria Root Rot (Shoestring Root Rot)

Armillaria spp.

Host: All trees.

Importance: This fungus kills by girdling trees at the root collar. Trees under stress and trees in cutover hardwood stands are most susceptible to infection.

Look For:

- *Yellowing, then browning of all needles.*
- *Resin on the bark at the root collar,* where the stem and roots meet.
- *Creamy white, leathery sheets of fungus* under the bark at the root collar.

Pests that cause similar symptoms: Drought, pine root collar weevil, wood borers, and bark beetles.

Biology: Black fungal strands (rhizomorphs or "shoestrings") from infected stumps grow through the soil and infect nearby conifers.

Monitoring and Control: No active monitoring is required.
• Remove dead trees, infected stumps, and large roots.
• Reduce stress by treating for other diseases, insects, and environmental factors that damage or weaken trees. Healthy, vigorous trees are more resistant to Armillaria infection than diseased, weak ones.

NEXT CROP
• Choose a site that is well suited to the growth needs of the desired species. Avoid planting on cutover sites, especially those with many large hardwood stumps.
• If practical, remove stumps and large roots before planting.
• Maintain healthy, vigorous trees.


White sheets of fungus under bark at root collar

Host: All trees

DEAD TREE AND STEM/ROOT INJURY — Voles

Meadow Vole (=Meadow Mouse)
Microtus pennsylvanicus (Ord)
Pine Vole
Microtus pinetorum LeConte

Hosts: Most Christmas tree species.

Importance: Meadow voles, commonly called meadow mice, feed on bark around the base of the trunk or on lower branches, weakening trees, slowing growth, and discoloring needles. Meadow voles may kill trees by removing a complete ring of bark from the trunk (girdling). Pine voles feed on the bark of tree roots, causing short needles, yellowing of needles and slow growth. Trees may be killed or weakened, making them vulnerable to other pests.

Look For:
• *Active mouse runways*, 2 inches wide, devoid of live vegetation. Look for runways in areas of heavy vegetation.

• *Piles of droppings and small caches of clipped grass*.
• *Burrows 1 inch in diameter, 2 to 4 inches deep (meadow voles) or burrows 18 inches deep or deeper (pine voles).*
MARCH TO APRIL
• *Girdling of the trunk near the soil line*, especially on trees in heavy grass (meadow voles); girdling of the tree's roots below the soil (pine voles).
MAY TO JULY
• *Lack of new developing shoots, yellowing foliage, short needles.*
• *Completely brown trees* killed by girdling.

Pests that cause similar symptoms: Rabbits, hares, and porcupines cause girdling. Scattered dead trees can be caused by pine root collar weevil, drought, or Armillaria root disease.

Biology: The meadow vole, commonly found in grassy fields, feeds mainly on grasses and other succulent vegetation throughout the growing season. The pine vole, commonly found in shrubby, weedy fields, feeds on broad-leafed plants and their seeds. During the winter when vole populations are high and normal food supplies dwindle, voles turn to eating tree bark. Feeding generally occurs below the snow line in areas of dense matted vegetation, so injury may not be discovered until the snow melts.

Monitoring and Control: Look for dead trees and injury in stands of all ages throughout the growing season. If you see voles and their runways or burrows frequently in the fall during harvest, use poison baits to protect trees. Voles often invade tree plantations from adjoining areas under the snow.
• Prune off girdled branches. Nothing can be done to save trees with girdled trunks.
• Mow close to the ground or apply herbicide around trees to destroy vole habitat.
• Apply a registered herbicide to eliminate vole cover.
• If needed, place registered poison baits in covered bait stations so song birds or other wildlife cannot reach them. Because high vole populations occur in cycles, poisoning is not needed every year.

NEXT CROP
• Remove grassy vegetation on or around site before planting and continue to control vegetation throughout the life of the trees in areas where voles are a problem.
• Encourage predators, such as hawks, owls, and snakes, to hunt voles in the plantation by providing nest boxes, hunting perches, and hibernaculums.

Hosts: Most Christmas tree species

Phytophthora Root Rot

*Phytophthora cinnamomi*Rands;
Phytophthora spp.

Hosts: Various species of the fungus Phytophthora are present throughout the United States and are known to infect fir, spruce, and pine trees.

Importance: Phytophthora cinnamomi is the most important species causing root rot of Fraser fir, primarily in the southeastern United States. This species requires warm, wet soil and is intolerant of temperatures below freezing. Therefore, it is not likely to become established in plantations in the Lake States and north central region. Other species of Phytophthora can survive in cold climates and are considered a threat. Infection of roots by this fungus causes root mortality and eventually can kill the whole tree.

Look For:
• *Foliage of seedlings or older trees changing from green to yellow to red-brown in color*. All foliage on tree is likely to be affected.
• *Rotted and discolored roots*. Root tissue may be water-soaked and soft. The root cortex (outer layer of root tissue) may easily be pulled off. Infected roots will often be some shade of red or brown. Some red-brown discoloration may also be present under the bark in the root collar region.

• *Stunted new growth; wilting new growth.*

Biology: Phytophthora species are most common in poorly drained soils or heavier soils. This fungus produces spores that swim through free moisture in the soil. The fungus may survive in the soil as thick-walled resting spores or in dying plant material (roots) as thread-like hyphae. Seedlings with low levels of infection may leave the nursery undetected and transport this fungus to new fields. If conditions are favorable for the fungus to develop, infection will continue in the plantation and may spread to other healthy trees.

Monitoring and Control: Prevention is the key to managing this disease. Prevent introduction of Phytophthora by inspecting stock before planting. Do not plant seedlings or trees that show symptoms of Phytophthora root rot.

Action should be taken in the nursery if Phytophthora root rot is detected at any level of incidence. Inspections should be conducted regularly. A laboratory confirmation is recommended for this disease to ensure that correct management techniques are aimed at the specific fungus species.

If the site is poorly drained or has very heavy soil, consider a crop other than Christmas trees; Phytophthora and other root rot pathogens can thrive under such conditions.

Hosts: Fir, spruce and pine

Pine Bark Adelgid
Pineus strobi (Hartig)

Hosts: Eastern white pine; occasionally Scotch and Austrian pine.

Importance: Pine bark adelgids weaken pine trees by sucking sap. Heavily infested trees grow poorly, become discolored, and lose their value. Some trees may die or become weak and susceptible to other pests during dry periods.

Look For:
• *Discolored, stunted, weakened, or dying trees* with small but conspicuous lumps of white woolly wax on the main stem and branches. The trunk may look whitewashed.
• *Yellow or purplish insects*, less than 1/25 inch long, under the woolly wax. Use a hand lens.
MAY TO JUNE
• *Dark blue-green nymphs covered with white waxy material*, found in clusters on elongating shoots.

Biology: Mature females covered with woolly wax overwinter on the tree. Eggs laid in the spring produce wingless and winged forms that infest new hosts.

Monitoring and Control: Inspect trees of all ages throughout the growing season. Look for white woolly wax and blue-green nymphs early in the growing season. Treat infested trees if you notice this adelgid in any stage. Only infested trees need to be treated.

• Spray trees with a dormant oil before growth starts in the spring. Do not spray until the temperature stays above 40° F for 24 hours. Inspect the woolly wax in early May with a hand lens to make sure the insects underneath are dead.
• Or, thoroughly spray trees with a registered insecticide in mid May when the insects are active.

NEXT CROP
• Avoid planting eastern white pine, especially near Scotch and Austrian pine.

Heavily infested eastern white pine

Adelgids secrete white waxy material as they feed

Aphids under wooly wax on trunk

Hosts: Eastern white pine; occasionally Scotch and Austrian pine.

Pine Root Collar Weevil

DEAD TREE AND STEM/ROOT INJURY

Pine Root Collar Weevil
Hylobius radicis (Buchanan)

Hosts: Scotch, Austrian, eastern white, and red pine.

Importance: The grub-like larvae of this weevil girdle the root collar (where the stem and roots meet) and roots of young pine Christmas trees larger than ½ inch in diameter at the soil line. Complete girdling kills trees. Young trees weakened by weevils may fall over and die 1 to 4 years after being attacked. Larger trees can also be attacked.

Look For:
• *Yellow to red needles on entire tree*. Some trees, including some with green foliage, may be leaning or fallen.
• *Black pitch-coated bark at the root collar* and beneath the soil. Soil around tree may also be pitch-soaked.
• *Yellow-white legless C-shaped larvae,* up to 1/3 inch long, with amber brown heads. Look for them in tunnels in the bark or in adjacent soil.
LATE JUNE TO EARLY SEPTEMBER
• *White pupae*, up to 1/3 inch long, in the bark and soil where larvae are found.

Pests that cause similar symptoms: Scattered dead trees can be caused by vole feeding, Armillaria root rot, wood borers, or bark beetles. Pales weevil adults and pine root tip weevil adults are nearly identical to pine root collar weevil in appearance.

Biology: In the spring and summer, adult weevils lay eggs at the base of pines during the day and move onto the trees at night to feed. Weevils normally move only short distances, but will occasionally fly to other locations. The larvae feed on the inner bark of the root collar and pupate in the nearby soil. Adults emerging in late summer feed on the trees for a short time before entering the litter to overwinter. Most will live for more than 1 year.

Monitoring and Control: Begin inspecting when trees reach 1 inch in diameter at the base. If some trees are dying, treat all trees except healthy-looking ones that are ready for immediate harvest. If trees are not dying, look for injury at the base of 20 to 30 scattered trees sometime before mid May and again before mid August. Treat entire plantation if 50 percent of the inspected trees are injured.
• Prune off the lower one to three whorls of branches. This will allow more sunlight to reach the root collar area, making conditions unfavorable to weevils. Removing branches growing within 1 foot of the ground will also make it easier to treat trees with an insecticide.
• Drench the root collar and a 1 foot radius of soil around each tree with a registered insecticide during warm weather to kill adults. The best time to treat is in mid May, before the adults lay eggs. Apply again in mid August to control newly emerging weevils.

NEXT CROP
• Delay replanting of harvested areas for 1 year to deprive weevils of newly planted seedlings. If you do replant immediately or interplant with seedlings, do not plant pines.
• Do not mix pine species. Separate different pine species in the same stand by at least 100 feet. • Plant Scotch, Austrian, or red pine at least ½ mile away from weevil-infested pines.
• Plant resistant varieties of Scotch pine, particularly the short-needled varieties, such as S. French, Turkish,

or others from western or southern Eurasia.
• Completely remove any adjacent older Scotch pine plantings not being used for Christmas tree production.

Hosts: Scotch, Austrian, eastern white, and red pine

DEAD TREE AND STEM/ROOT INJURY — Pine Wood Nematode

Pine Wood Nematode

Bursaphelenchus xylophilus (Steiner & Buhrer) Nickle

Hosts: Pines, especially Scotch pine.

Importance: When present in large numbers, these microscopic worms can kill the pine saplings they infest. The number of trees killed by nematodes increases during periods of drought. Nematodes are often found in trees that are dying from other causes.

Look For:
• *Yellowing, then browning of all needles* during the growing season. Brown needles remain on dead trees.
• *A lack of resin flowing from wounds.*

Pests that cause similar symptoms: Wood borers and bark beetles.

Biology: Pine wood nematodes are spread from dead to healthy or stressed pines in the spring by long-horned beetles. Nematodes reproduce rapidly in the wood of infested trees during the summer, usually killing trees by fall.
Monitoring and Control: No active monitoring is required.
• Have a pest specialist examine the wood of a recently killed tree to determine if nematodes are present.
• Destroy infested trees by burning or chipping before beetles emerge from them in the spring.

NEXT CROP
• Avoid planting on dry sites.

Hosts: Pines, especially Scotch pine

Pocket Gopher

DEAD TREE AND STEM/ROOT INJURY

Pocket Gopher

Geomys bursarius (Shaw)

Hosts: Most Christmas tree species.

Importance: Pocket gophers weaken or kill trees by feeding on their roots. Pocket gophers are found in the Great Plains area, mainly in the western half of the north central region. In the Lake States, they are rarely seen east of Wisconsin.

Look For:
• *Ridges in the soil* caused by underground burrowing.
• *Semicircular mounds of soil*.
• *Dead trees* near mounds and ridges. These trees may be pulled easily from the ground and may have no roots remaining.
• *Destroyed tree roots.*
• *Note* that star-nosed moles also create ridges and mounds of soil, but do not harm trees.

Pests that cause similar symptoms: Allegheny mound ant, meadow vole, pine vole, thirteen-lined ground squirrel.

Biology: The pocket gopher is a burrowing rodent 5 to 8 inches long, including a short, sparsely haired tail. These animals have small eyes and ears, short necks, chisel-like teeth, and long, strong claws on their feet.

Coat color ranges among species from almost white, to brown, to black. Solitary for much of their lives, they are active day and night but are seldom seen above ground. Christmas tree plantations are a favorite feeding ground for gophers because the soil is usually easy to work.

Monitoring and Control: Inspect trees of all ages in spring. Consider controlling gophers if mounds are numerous and more than 10 percent of your trees die because of injured roots.

• For small-scale problems, trap and hand-bait pocket gophers.

• For larger populations, use a burrow builder—a tractor-drawn device that digs underground runways—and bait them with poison. Drive the machine back and forth at regularly spaced intervals (about 25 feet apart) to make a series of parallel burrows that will intercept the natural gopher burrow systems. Gophers will explore these artificial tunnels and eat the poisoned bait within.

Tree roots chewed off by pocket gohpers

Semi-circular mounds of soil left by pocket gophers

Hosts: Most Christmas tree species

Rabbit
Sylvilagus floridanus (J.A. Allen)
Hare
Lepus americanus Erxleben

Hosts: All pines; occasionally spruce and fir.

Importance: Rabbits and hares feed on the bark and the lower branches of young pines. In large numbers, these animals can cause great damage to pine plantings. Severely injured trees may be girdled and killed or may be too damaged to be sold as Christmas trees.

Look For:
• *Dead or dying trees.*
• *Exposed wood* where stem and branches have been bark-stripped or girdled. Rabbits and hares will feed as high up on the stem and branches as they can reach by standing on their hind legs.
• *Tooth marks*, 1/10 inch wide, running horizontally across the stem.
• *Smooth, clean, slanted cuts* where rabbits have clipped off branches.
• *Rabbit or hare droppings and tracks* near trees.

Pests that cause similar symptoms: Deer and mice.

Biology: Rabbits and hares may feed on tree bark during the winter if there is an overabundance of these animals and if their normal, preferred foods are scarce.

Monitoring and Control: Look for damage on trees of all ages in the spring, especially in areas with heavy brush (good rabbit and hare habitat). No control is needed if injury is random and infrequent. If damage is serious, check with a conservation officer or a wildlife pest control specialist to see if control is appropriate under local conditions.
• Discourage rabbits and hares by removing necessary cover, such as brush piles and bushy field borders.
• When appropriate, rabbit or hare repellent can provide good control for up to 90 days.
• Hunting can be helpful in reducing rabbit or hare populations.
• Box trapping can be effective if started in late summer and continued intensively through late winter.
Contact the appropriate wildlife management agency in your state for information on hunting and trapping permits.

Hosts: All pines; occasionally spruce and fir

Thirteen-Lined Ground Squirrel — DEAD TREE AND STEM/ROOT INJURY

Thirteen-Lined Ground Squirrel

Spermophilus tridecemlineatus (Mitchill)

Hosts: Most Christmas tree species.

Importance: Thirteen-lined ground squirrels weaken or kill trees by burrowing along their roots.

Look For:
- *Burrow openings*, approximately 2 inches in diameter.
- *Semicircular mounds of soil* by burrow openings.
- *Dead trees* near mounds and burrows.
- *Damaged tree roots*.

Pests that cause similar symptoms: Allegheny mound ant, meadow vole, pine vole, pocket gopher.

Biology: The thirteen-lined ground squirrel is a burrowing rodent 5 to 8 inches long, including a sparsely-haired tail. These animals have short ears, short necks, and chisel-like teeth. Coat color is brown with about 13 cream-colored stripes alternately solid and spotted. They are active by day and can be seen above ground. Christmas tree plantations with grassy cover are a favorite feeding area for ground squirrels and the

soil is usually easy for the squirrels to work.

Monitoring and Control: Inspect trees of all ages in spring. Consider controlling ground squirrels if burrows are numerous and more than 10 percent of your trees die because of injured roots.
• For small-scale problems, trap or apply poison baits in ground squirrel burrows.
• For larger populations, use a burrow builder—a tractor-drawn device that digs underground runways—and bait them with poison. Drive the machine back and forth at regularly spaced intervals (about 25 feet apart) to make a series of parallel burrows that will intercept the natural ground squirrel burrow systems. Ground squirrels will explore these artificial tunnels and eat the poisoned bait within.

Left: Burrow opening is about 2 inches in diameter

Below: Thirteen-lined ground squirrel

Hosts: Most Christmas tree species

DEAD TREE AND STEM/ROOT INJURY

White Grubs

White Grubs

Phyllophaga spp.

Hosts: All Christmas tree species.

Importance: The larvae of June beetles, called white grubs, feed on the roots of Christmas tree seedlings, killing many seedlings, and slowing the growth of the rest. Injury usually occurs during the first two growing seasons after planting, and is most severe on abandoned farmland that has recently been converted to Christmas tree plantings.

Look For:

• *Dead or dying seedlings* scattered throughout the stand.
• *Fibrous roots missing from dead seedlings.* Dig or gently pull up seedlings to examine roots.

MAY TO SEPTEMBER

• *White C-shaped larvae*, up to 1 inch long, with brownish heads and six brown legs. Dig in the upper 6 inches of soil.

Biology: White grubs normally feed on grass roots, but will eat roots of tree seedlings, especially when grass roots are scarce. In May or June, the adult beetles emerge from the soil and feed on broad-leaved hardwoods near the field. They return to the field to lay eggs in the soil. The hatched larvae burrow deeper in the soil and feed on roots for two to five growing seasons before becoming adults. Seedlings that are J-rooted because of careless planting are often killed first.

Monitoring and Control:

Before Planting: Check planting sites in July and August of the year before planting, except during long periods of drought. Run a furrow and look for grubs. If you find 1 grub per 10 linear feet, treat seedlings or site just before or during planting.

After Planting: Check monthly throughout the growing season for 3 years after planting. Treat infested blocks in the plantation if you find any grub-killed seedlings.

• Application of a fertilizer with high potassium and phosphorus and low nitrogen in fall may stimulate root production on damaged seedlings.
• Apply a registered insecticide following directions on the label.

NEXT CROP

• Apply a registered, granular insecticide before planting as described above. Use a broadcast and disk treatment for nursery beds.
• Or, dip seedling roots in a registered insecticide solution before planting.
• Spread roots out in planting hole to prevent J-rooting.
• Use herbicides to control grasses before August in the year before planting. Do not plant seedlings in areas with heavy grass cover.

Hosts: All Christmas tree species

Wood Borers and Bark Beetles — DEAD TREE AND STEM/ROOT INJURY

Wood Borers and Bark Beetles *Monochamus* spp., etc.; *Ips* spp.

Hosts: All Christmas tree species.

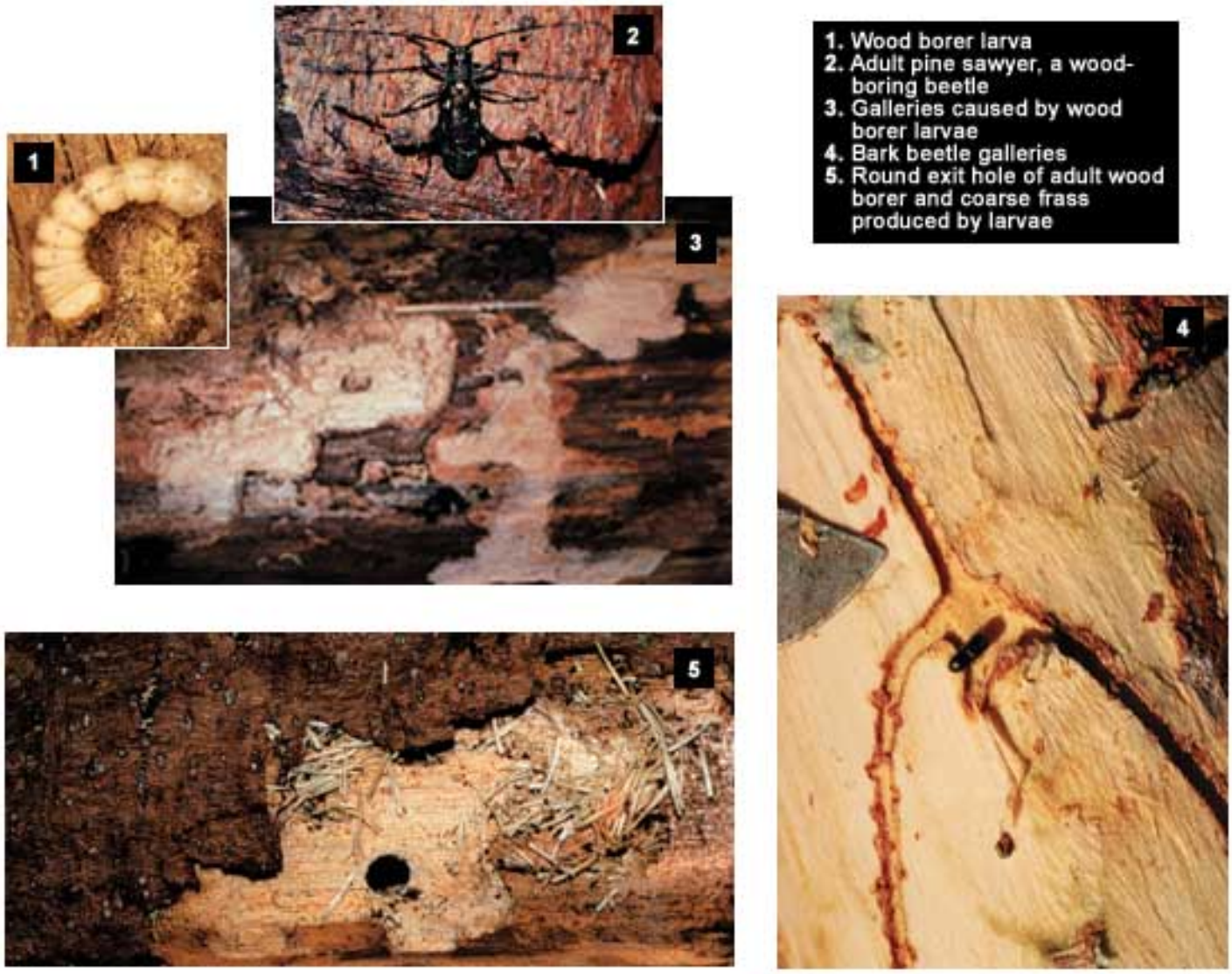
Importance: The larvae of wood borers and bark beetles attack and destroy the woody tissues—branches, stems, and roots—of weak, dying, or dead Christmas trees. A few species of bark beetles can kill very weak trees that might have survived if left unattacked.

Look For:
• *Dead or dying trees or parts of trees.*
• *Galleries (chambers) and tunnels under loose bark* that have been made by bark beetles or wood borers. They may contain white larvae, 1/16 inch to 1 inch long, or adult beetles. Listen for borers gnawing on the wood.

Pests that cause similar symptoms: Pine root collar weevil, pine wood nematode, and Pales weevil carve galleries in the roots below wood borers and bark beetles. (See also pine shoot beetle.)

Biology: Adult wood borers and bark beetles lay eggs in the bark of weak and dead Christmas trees. The larvae tunnel in and feed on the bark and woody tissues, often sharing the host with several different insect species. Bark beetles may eventually emerge from one tree and attack surrounding weak trees.

Monitoring and Control: Inspect trees of all ages during and after periods of drought, grass fire, and other disturbances. Look for pockets of dead trees and treat accordingly.
• Remove and burn or chip dead or infested trees to get rid of the insects.
• Look for the primary source of the problem, i.e., what is weakening or killing trees before the borers or beetles infest them.
• Maintain vigorous trees; fertilize or irrigate as needed.
NEXT CROP
• Do not replant on stressful or marginal sites until you have identified and controlled the problem that weakened the trees.



Hosts: All Christmas tree species

DEAD TREE AND STEM/ROOT INJURY

Yellow-Bellied Sapsucker

Yellow-Bellied Sapsucker

Sphrapicus varius L

Hosts: Scotch and Austrian pine; occasionally other conifers.

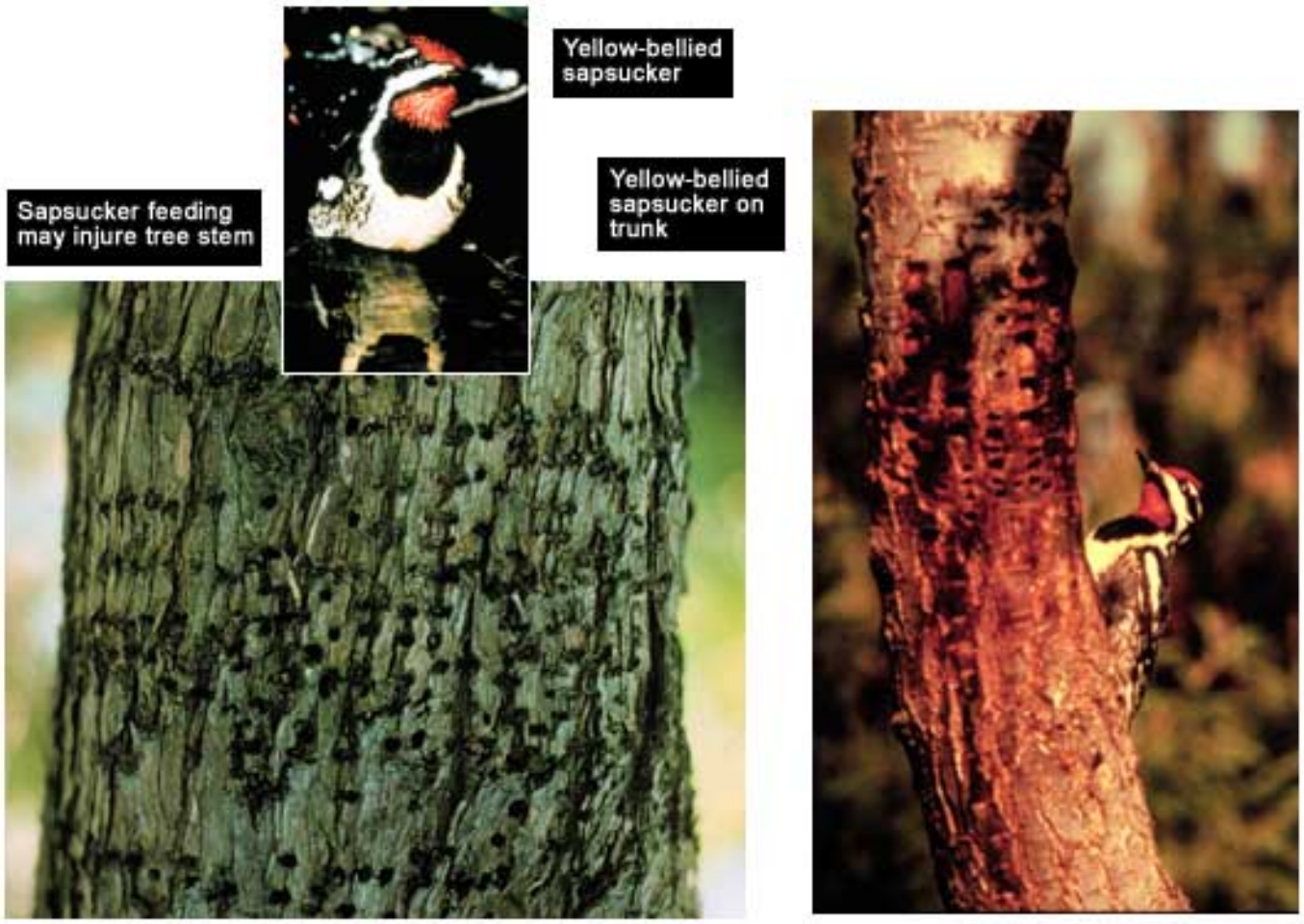
I**mportance:** Sapsuckers peck holes in the bark of sapling Christmas trees, causing trees to bleed sap. Individual trees are often repeatedly attacked, and when severely injured, they may die. The injury also permits insects and pathogens to enter the tree.

Look For:
• *Evenly spaced rows of large pits or holes ¼ inch or larger on trunk of tree.*
• *Upper portion of tree dead or dying.*
• *Robin-size woodpecker* with bands of red, black, and white on the head. The belly is yellow and the back is white and black.

Biology: The sapsucker is a forest bird that feeds on tree sap, the inner bark of trees, and the insects that get caught in the sap flowing from wounds on the trunk. This migratory bird is a fairly common summer resident, but rarely a winter resident.

Monitoring and Control: Examine trees within 3 years of harvest. If you notice any damage that might degrade or kill trees, take action to discourage the birds.
• Sapsuckers often peck on stressed trees. This can include trees planted on the wrong site (e.g., too wet, dry, or infertile), or trees affected by insect, disease, or mechanical injury. When conditions causing the stress are corrected, sapsucker attacks usually stop.
• Apply a very thin 2- or 3-inch band of a sticky substance such as Tanglefoot® just below and above the newly made row of holes to discourage the birds. Repeat if they attack new trees. Keep in mind that control is difficult and may not be justified in most cases.

NOTE: The yellow-bellied sapsucker is protected by the Federal Migratory Bird Treaty Act.



Hosts: Scotch and Austrian pine; occasionally other conifers

Zimmerman Pine Moth

DEAD TREE AND STEM/ROOT INJURY

Zimmerman Pine Moth

Dioryctria zimmermani (Grote)

Hosts: All pines, especially Scotch and Austrian; rarely spruces and firs.

Importance: Caterpillars feed just under the bark on tree stems, large branches or sometimes on the terminal leader. Feeding may result in dead shoots or a dead leader. Pitch masses on the stem may reduce tree value. Repeated stem attacks may cause trees to break off at the injury site.

Look For:

• *Coagulated pitch mass* on the stem, often at a branch whorl or on shoots near the terminal leader. Reddish frass may be mixed in with the pitch. The main stem may be swollen above the mass, or broken off if tree is heavily injured. On Scotch pine, the attack site may be on a gall caused by one of the gall rusts of pines.

• *Discolored or broken leader* (sometimes a lateral), directly above a mass of coagulated, white or pinkish pitch.

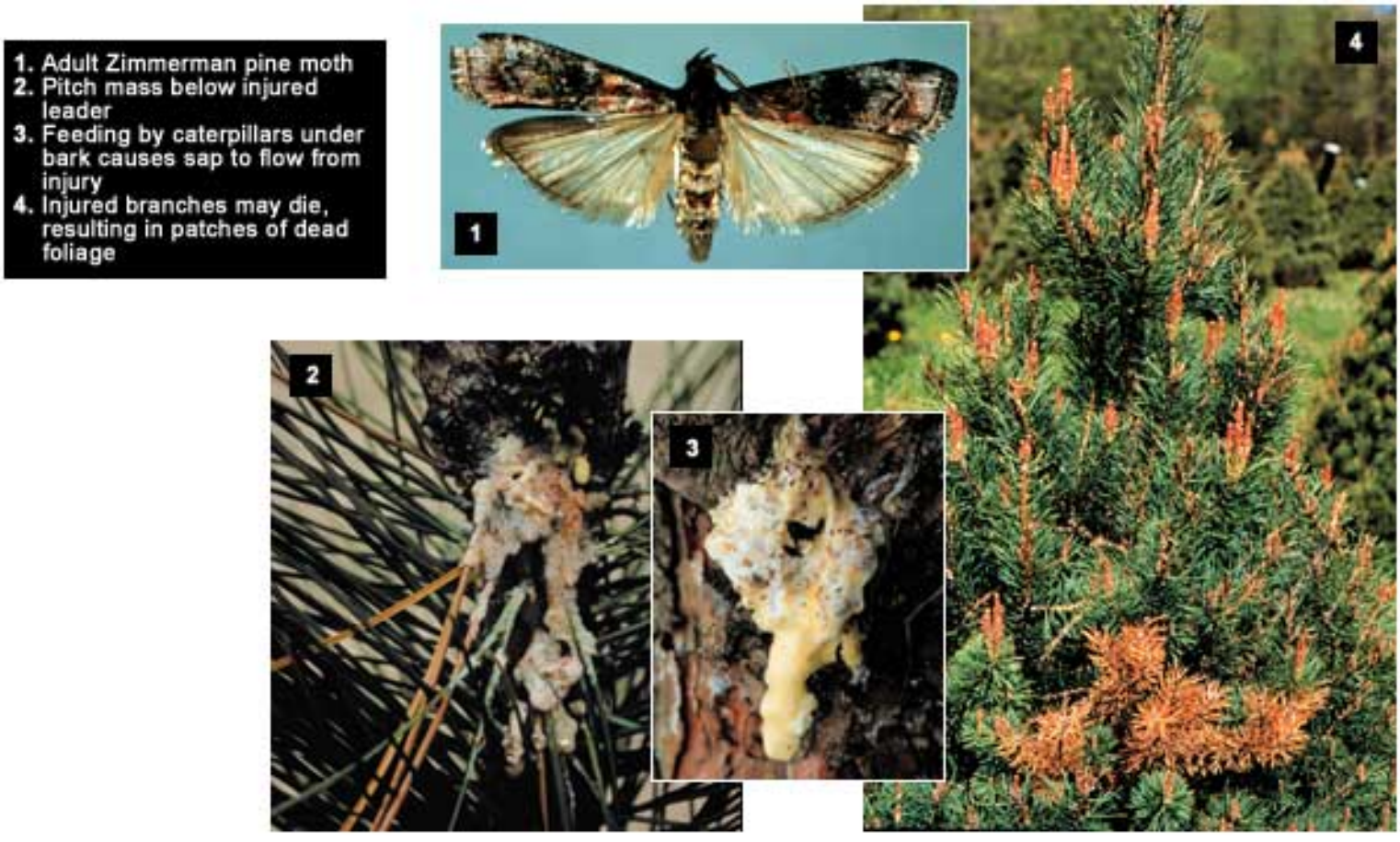
LATE MAY TO AUGUST

• *Pinkish-green larvae*, up to ¾ inch long, located in tunneled area under pitch masses. Brown pupae, ¾ inch long, can be found at the exit of feeding tunnels from mid July to late August.

Biology: Tiny caterpillars overwinter in bark crevices. They become active between early April and early May and bore under the bark and into the shoot, stem, or rust gall. They form a characteristic pitch mass at the entrance to the tunnel where they feed and later pupate. Adults emerge between mid July and late August and lay eggs on the bark. The hatched caterpillars spin and overwinter in silken cases.

Monitoring and Control: Inspect plantations regularly throughout the growing season. On Scotch and Austrian pine, look for pitch masses on the main stem. On other pines, including Austrian, look for pitch masses on shoots near the terminal leader.
• Cut out area with pitch mass on main stem using a pocket knife or shearing tool.
• Hand prune and destroy occasional injured shoots.
• Remove and destroy (by chipping or burning) infested trees by early July to prevent adult moths from attacking other trees.
• When insect is abundant or repeatedly attacks the main stem, apply a persistent registered insecticide between early April and early May as the weather warms. Emerging larvae are most vulnerable to pesticides at this time before they bore under bark. Use enough nozzle pressure and water to drench stem and branch bark.
• Do not ship infested trees because overwintering larvae hitchhike to new areas this way.

NEXT CROP
• Plant resistant varieties of Scotch pine, particularly the short-needled varieties, such as Greece, Turkey, or others from West and South Eurasia (see Table 1).



Hosts: All pines, especially Scotch and Austrian; rarely spruces and firs

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PESTICIDES

What You Should Know About Pesticides

When used correctly, pesticides can be an indispensable tool in Christmas tree culture. They are, in many cases, the fastest, most effective, and most economical way to control pests. When misused, however, pesticides can harm beneficial insects and other organisms, wildlife, the environment, and workers who handle the material. Overuse may also favor pests that are genetically resistant to pesticides. To minimize the hazards and get the most for your control dollar, make sure your field personnel are well versed in the basics of safe, effective pesticide use.

PESTICIDE INFORMATION

Types

Chemical pesticides can be classified based on the kind of pest they control. Types of pesticides commonly used in Christmas tree culture include:
• avidicides to control birds
• fumigants used in nurseries to control soil-borne fungi, nematodes, insects, and weeds
• fungicides to control fungi
• herbicides to suppress weeds
• insecticides to control insects
• miticides to control mites
• repellents to keep animal pests away, not kill them
• rodenticides to control mice, rats and other rodents

Pesticide Name

The trade name (first letter capitalized; Lorsban, for example) is used when a pesticide is sold under only one well-known brand name. The accepted common name of a pesticide is used when it is sold under several brand names; chlorpyrifos, for example, has dozens of trade names (Lorsban is probably the most common). Some well-known brand names may be given in parentheses following the common name; for example, carbaryl (Sevin).

Dry Formulations
The amount of active ingredient(s) in a dry formulation is given as a percentage in the formulation. For example, 50% WP indicates a wettable powder formulation containing 50 percent active ingredient.
A—aerosol; pesticide applied as an aerosol spray.
B—bait; pesticide applied mixed with some attractant material that is applied without mixing with water.
D—dust; a finely ground pesticide intended for use without mixing with water.
G—granule; a coarse particle intended for use without mixing with water.
WP—wettable powder; a finely ground pesticide intended to be mixed with water for application.
SP—soluble powder; a finely ground pesticide to be dissolved in water for application.

Liquid Formulations
The amount of active ingredient in a liquid formulation is given as pounds active ingredient per gallon. This is usually cited with the ingredients statement on the label. For example, “3.2 lb/gal EC” indicates an emulsifiable concentrate that contains 3.2 pounds active ingredient per gallon.
EC = emulsifiable (or soluble) concentrate; a solution of pesticide intended to be mixed with water for application.
F = flowable; a suspension of pesticide intended to be mixed with water for application.
ULV concentrate (ultra low-volume concentrate); a solution of pesticide intended to be applied by aircraft without mixing with water.

This section was adopted, in part, and modified from USDA Forest Service Christmas Tree Pest Manual 1st Edition, Chemical Control of Insects & Nematodes in Field & Forage Crops (Extension Bulletin E-1582, October 1991) by D. A. Landis, G.W. Bird, L.G. Olsen, and F. Warner, Michigan State University, and Control & Management of Christmas Tree Insect Pests in Michigan (Extension Bulletin E-2572, April 1995, written by D.G. McCullough and T. Ellis, Michigan State University.

Labeling

The label on every pesticide container has vital information about that chemical's toxicity, handling, mixing, and application, as well as recommended treatments in case of accidents. Read and become more familiar with labels when planning a project, before mixing or storing pesticides, and before disposing of pesticides and empty containers.

Toxicity

Pesticides fall into four categories of toxicity. A quick glance at the signal word on the label will tell you which category of chemical you are handling. The following table summarizes and compares the categories.

Classification	Signal Words	Average Lethal Dose
CATAGORY I Highly toxic	Danger-Poison	1 teaspoon
Catagory II Moderately toxic	Warning	1 teaspoon to 1 tablespoon
Catagory III Slightly toxic	Caution	1 ounce to 1 pint
Catagory IV Relatively non-toxic	Caution	1 pint to 1quart or more

Exposure

•**Acute**—A single exposure to a pesticide.
•**Chronic**—Repeated or continuous exposure to a pesticide.

Entry Route

• **Skin** (dermal)—Pesticides are most commonly absorbed through the skin, and most rapidly absorbed through the genital area and mucous membranes. Liquids are the most readily absorbed type of formulation.
• **Mouth** (oral)—Swallowing pesticides can cause serious illness, injury, or even death.
• **Lungs** (inhalation)—inhaling pesticides can severely damage nose, throat, and lung tissues. Total hazard

is great because these tissues rapidly absorb pesticides.
• **Eyes** (ocular)—The sensitive tissues of the eyes are very absorbent, so hazard is great.

Guidelines for Safe Use of Pesticides

Selecting Pesticides

Always thoroughly read the label and the supplemental labeling material for any pesticide that you may consider using. Understand the label instructions and limitations. Make certain that your operations will use the pesticide only for the purposes listed and in the manner directed on the label. Select only those pesticides that are labeled for the crop you wish to use it on and the pest(s) you wish to control. To do otherwise will cost you in terms of effective and economical product performance, and may lead to unacceptable risks to humans, the crop, and the surrounding environment.

Planning

Safety should be a concern before and after as well as during pesticide application. To avoid possible health and environmental hazards, use the following checklist of precautions to plan and conduct your control operations.
When drawing up a safety plan, consider the following:
• the size of area to be treated
• target pest and host plant
• possible damage to nontarget plants or animals, e.g., bees, birds, fish and nearby trees
• active ingredient, formulation, and application method
• quantities of pesticides and additives needed (remember that leftover pesticide may create disposal problems)
• storage and mixing facilities
• special equipment for safe mixing and application
• protective equipment and clothing
• first aid supplies
• operating procedures at the mixing and loading area
• monitoring for exposure to pesticides
• emergency procedures in case of an accident or spill
• location and phone number of medical facilities in case of an accident
• cleanup and decontamination procedures
• disposing of unused pesticides and empty containers

Keeping Pesticides Out of Groundwater

Many people who live in rural areas get their drinking water from wells. Since well water is groundwater, it is easy to see why you should be concerned about keeping pesticides out of groundwater.

A pesticide that is not volatilized, absorbed by plants, bound to soil, or broken down can potentially move through the soil to groundwater. The movement of groundwater is often slow and difficult to predict. Substances that enter groundwater in one location can turn up years later in other locations. A major difficulty in dealing with groundwater contaminants is that the sources of pollution are not easily

recognized. The problem is occurring underground, out of sight.

It is very difficult to clean contaminated groundwater. The best solution is to prevent contamination in the first place. The following pesticide application practices can reduce the potential for surface and groundwater contamination.

Use integrated pest management programs—Keep pesticide use to a minimum by combining chemical control with other pest management practices.
Consider the geology of your area—Be aware of the water table depth and the permeability of the geological layers between the surface soil and groundwater. Sinkholes can be especially troublesome because they allow surface water to reach groundwater quickly.
Select pesticides carefully—Pesticides that are highly soluble, relatively stable, and not readily adsorbed by soil tend to be the most likely to leach. Read labels carefully and consult a specialist from a county Extension office, or your chemical dealer, if necessary.
Follow label directions—The label carries crucial information about the proper rate, timing, and placement of the pesticide
Calibrate accurately—Calibrate equipment carefully and often to avoid over- or under application.
Measure accurately—Carefully measure concentrates before they are placed into the spray tank. Do not add a little extra to ensure the pesticide will do a better job.
Avoid back-siphoning—The end of the fill hose should remain above the water level in the spray tank at all times to prevent back-siphoning of chemicals into the water supply. Use an antibackflow device when siphoning water directly from a well, pond, or stream.
Consider weather and irrigation—If you suspect heavy rain will occur, delay applying pesticides. Control the quantity of irrigation to minimize potential pesticide leaching and runoff.
Avoid spills—But when spills occur, contain and clean them up quickly with an absorbent material, such as cat litter.
Mix on an impervious pad—Mix and load pesticides on an impervious pad if possible, where spills can be contained and cleaned up. If mixing is done in the field, change the location of the mixing area regularly.
Dispose of wastes properly—Obey laws regulating the disposal of pesticide wastes. Triple rinse containers. Pour the rinsewater into the spray tank for use in treating the site or the crop.
Store and mix pesticides away from water sources, such as wells, ponds, and springs.

Protect Nontarget Organisms

Bees and other pollinating insects are essential for successful production of tree fruits, small fruits, most seed crops, and certain vegetables. Many insecticides are highly toxic to pollinating honeybees and wild bees. Be aware of how bee poisonings can occur from applying pesticides and how to prevent them. Take the following precautions to reduce the chance of bee poisoning.

•Do not apply insecticides that are toxic to bees if the site contains a crop or weeds that are in bloom. Mow cover crops and weeds to remove the blooms before spraying.

•Select insecticides that are least harmful to bees, and select the safest formulation. Dusts are more hazardous to bees than sprays. Wettable powders are more hazardous than emulsifiable concentrates or water soluble formulations. Granular insecticide formulations are generally the least hazardous to bees. Microencapsulated insecticides are extremely hazardous because the minute capsules can be carried back to the hive.

•Reduce drift during application. Use drift control materials whenever possible.

•Time pesticide applications carefully. Evening applications are less hazardous than early morning; both are safer than midday applications.

•Do not treat near hives. Bees may need to be moved or covered before using insecticides near colonies.

The best way to avoid injury of **beneficial insects and microorganisms** is to minimize insecticide use. Use selective insecticides whenever possible and apply only when necessary as part of a total pest management program.

Pesticides can be harmful to all kinds of vertebrates, such as **fish and wildlife**. Most recognizable are the direct effects from acute poisoning. Fish kills can result from water pollution by a pesticide (usually insecticides). Pesticides can enter water via drift, surface runoff, soil erosion, and leaching.

Bird kills from insecticides can occur when birds ingest the toxicant in granules, baits, or treated seed; drink or use contaminated water; or feed on insecticide-contaminated prey.

Pesticide Emergency

When purchasing a pesticide, ask the chemical dealer for a complete specimen label of the product you bought. This label and labeling information packet is an exact duplicate of the label information that is affixed to and/or must accompany the pesticide container. Use the specimen label material as a reference during any pesticide emergency. Bring the specimen label material along with any person who has become poisoned and needs medical attention.

Closely follow all the warning statements outlined in the PRECAUTIONARY STATEMENTS section on the pesticide label. Be certain that you use all protective clothing and equipment as specified by the label. Make certain all persons involved in the operation of the farm know and can carry out the STATEMENT OF PRACTICAL TREATMENT that is given on the front panel of all pesticide labels.

Transporting Pesticides

Have agricultural chemicals delivered by your dealer directly to your pesticide storage facility if possible. Transporting pesticides, especially large quantities, can involve a high degree of assumed liability by the grower. Department of Transportation shipping rules must also be followed for transporting large quantities of pesticides, including proper placarding of the vehicle, liability insurance, special handling requirements, etc.

Storing Pesticides

Pesticides must be stored in a facility that will protect them from temperature extremes, high humidity, and direct sunlight. The storage facility should be heated, dry, and well ventilated. It should be designed for easy containment and cleanup of pesticide spills and made of materials that will not absorb any pesticide material that leaks out of a container. Keep a fire extinguisher handy. Periodically inspect containers for corrosion or leakage. Store only pesticides in such a facility and always store them in their original containers. Do not store any feed, seed, food, or fertilizer with pesticides. Do not store any protective

clothing or equipment in the pesticide storage facility. Try to store herbicides separate from insecticides and fungicides because volatile materials will cross-contaminate other materials. Keep the facility locked at all times when not in use to prevent animals, children, and irresponsible adults from entering and becoming poisoned. Post the facility as a PESTICIDE STORAGE FACILITY to warn others that the area is off limits. Always read and follow the STORAGE AND DISPOSAL section of all pesticide labels. For further information on proper storage, and plans for constructing a facility, consult Midwest Plan Service 37 and MSU Bulletin E-2335.

Handling and Mixing Pesticides

Always wear protective clothing and equipment when handling, mixing, and applying pesticides and during the clean up of application equipment. Protective clothing may include full coverage clothing, chemical resistant gloves and boots, eye protection, hard hat, and a MSHA/NOISH approved respirator with a chemical absorbent material appropriate for the pesticide being used.

Mix pesticides downwind and keep containers below eye level. Avoid excessive splashing and sloshing. If pesticides are spilled on you, wash them off immediately with lots of water and change clothing. Resume spraying only after cleaning up any spills. Try to use closed handling/mixing systems when appropriate. Do not eat or smoke while handling pesticides.

Mix only what is required for the area to be sprayed according to label directions. Avoid mixing excessive amounts. To do otherwise will create a hazardous waste that is difficult and expensive to dispose of. Keep unauthorized persons out of the areas where you handle pesticides.

Applying Pesticides

Before any application, the equipment used must be thoroughly checked for sound operation and accurately calibrated. Poor maintenance and calibration practices will lead to excessive residues on the crop and could harm humans, animals, and the environment. Inspect the application equipment during use to prevent the unintentional release of chemicals. If the equipment needs repair, stop the application operation and fix the problem before completing the spray job. Spray only the label directed rate to the target area.

Do not spray on days when the wind is greater than 10 miles per hour and/or weather conditions (e.g., temperature inversions) are conducive to pesticide drift away from the target area. Make every effort to AVOID PESTICIDE DRIFT.

Warn all unauthorized persons to leave the target area during the pesticide application. Warn occupants of properties abutting the target area when such precautions are specified by the label of the pesticide being used.

Handling and Disposing of Pesticide Containers

All pesticide containers are considered HAZARDOUS WASTE unless they are triple rinsed or pressure rinsed and the rinsate is used as additional dilution in the spray mixture. After triple rinsing (or equivalent) all emptied pesticide containers, perforate both ends so that the container cannot be reused. All metal and plastic triple-rinsed containers should be offered for recycling. If this option is not available, dispose of them in a state licensed sanitary landfill. Dispose of all paper containers in a sanitary landfill or municipal

waste incinerator. Do not bury or burn any pesticide containers. Do not reuse any empty pesticide containers for any purpose.

Cleaning Pesticide Application Equipment

Follow all specific label directions for cleaning application equipment. If such instructions are not given on the pesticide label, then triple rinse the entire inside of the application equipment, spraying the rinsate on a labeled site not exceeding labeled rates. Wash off the outside of the equipment in the target area. Only after rinsing the equipment out with fresh water should you clean the spray system with an appropriate cleaning solution. Do not spray any cleaning solution onto any crop; dispose of the cleaning solution as you would any municipal waste. Follow the equipment manufacturer's guidelines for routine and year-end cleaning and maintenance.

Unused and Unwanted Pesticides

Unused and unwanted pesticides are considered HAZARDOUS WASTE by both federal and state regulations. To be exempt from the stringent requirements for the disposal of hazardous pesticide waste, make every effort to purchase the exact amount of pesticides that will be needed during the growing season. Take extreme care in the calibration and application of any pesticide so that leftovers are not generated at the end of the job. Use any pesticide-containing rinsates and unused pesticides exactly according to label USE directions. If these procedures cannot be met, contact the Department of Environmental Quality Hazardous Waste Division, your pesticide supplier, county Extension agent. or the Environmental Protection Agency for instructions on the legal disposal of pesticide waste.

Spills

Clean up spills as soon as they happen. First, protect yourself from exposure; then, contain the spill with a barrier of sawdust, kitty litter, or soil. If the spill is indoors, be sure there is adequate ventilation. Check label for specific decontamination instructions. Many pesticides can be detoxified with water mixed with detergents and/or bleach. If the spill looks too big to handle, call the manufacturer at the emergency telephone number on the label. If this is unsuccessful, you may contact a team of specialists from the National Agricultural Chemicals Association (NACA) by calling a 24-hour, toll-free number (1-800-424-9300). If necessary, they will even send a safety team to assist in the cleanup.

Worker Protection Standard

Federal rules for farm worker protection issued in 1992 require farmers to provide additional training and notification to farm workers to prevent accidental or occupational exposure to pesticides. Farmers should contact Extension agents to learn the details of this standard and availability of training materials for education of workers and handlers.

Read and follow the label instructions on **Restricted Entry Intervals (REI)** for every pesticide used. Some pesticide labels require both an oral warning and posted signs to notify workers of pesticide applications. If the label doesn't require both forms of notification, notify workers either orally or by posting warning signs at entrances to treated areas. When using posted signs, post 24 hours or less before the pesticide application and remove signs within three days after the end of the restricted entry interval. Keep workers out during the entire time the signs are posted (except for early-entry workers wearing the proper personal protective

equipment).

Keeping Records

The 1990 Farm Bill requires that all applicators who apply restricted use pesticides (RUP) keep records and maintain them for two years. Records to be kept include

1. brand or product name and the EPA registration number of the RUP that was applied;

2. total amount of the RUP;

3. address or location, the size of the area treated, and the crop, commodity, or stored product to which the RUP was applied;

4. month, day, and year on which the RUP application occurred; and

5. name and certification number of the certified applicator who applied or supervised the application of the RUP.

As of October 1992, a Drift Management Plan is required. The purpose of the plan is to show that reasonable care has been taken by the grower to prevent drift of pesticides during application.

Be sure to record all pesticide applications properly. Your county extension office can help provide forms and suggestions for record keeping systems. Penalties are up to $500 for the first violation and up to $1,000 for subsequent violations. Provisions for protecting the identity of individual producers are included in the law.

Endangered Species Act

To minimize the adverse impact of pesticides on endangered species, the EPA has initiated **The Endangered Species Act.** Every implicated pesticide will have an endangered species warning statement regarding use of the product within the geographic area when endangered species restrictions apply. Users must obtain a county-specific endangered species bulletin from their local county Extension office, which will identify the specific area where use restrictions apply. Application of listed pesticides in the identified geographic areas in that county will be restricted or prohibited.

SARA Title III Emergency Planning and Community Right to Know Act

The Community Right to Know law, under SARA Title III, requires farmers to notify their State Emergency Response Commission (SERC), Local Emergency Planning Committee (LEPC), and local fire department that they store extremely hazardous materials. Check with the state Department of Environmental Quality or county Extension office to receive a list of EPA established extremely hazardous substances and their planning threshold quantity.

The SERC, LEPC and local fire chief may request maps of your storage facility and detailed lists of materials you store.

This law also requires that, in the event of a spill, the SERC, LEPC and National Response Commission be

notified. The reportable quantities for spills are much less than for storage and can be obtained from the above sources. Your county Extension office may be able to assist you in preparing an emergency response plan for your farm.

Farmers are protected from nuisance law suits under the Right to Farm law if you follow acceptable management practices. These practices are completed for pesticides and nearly ready for fertilizers. Contact your local county Extension office or regional Department of Agriculture office to obtain copies.

Pesticide Poisoning

Symptoms of pesticide poisoning may be barely noticeable or dramatic, depending on the dose absorbed. Project personnel should be able to recognize symptoms, gauge severity of poisoning, and be familiar with emergency first aid procedures.

Poisoning Symptoms

Mild Poisoning can produce fatigue, headache, dizziness, numbness in the hands and feet, nausea and vomiting, excessive sweating, salivation, abdominal cramps, and diarrhea.

Moderate Poisoning can produce most of the symptoms listed for mild poisoning as well as the inability to walk, difficulty talking, muscular twitching, general weakness, and contracted pupils.
Severe Poisoning can cause all of the above symptoms as well as extreme shrinking of the pupils, secretions from the mouth and nose, convulsions, difficulty breathing, and unconsciousness. If victims of severe poisoning are not treated immediately, they usually die.

EMERGENCY ACTION

1. Move victim away from the pesticide, remove any contaminated clothing, and thoroughly wash off all pesticides.

2. Start first aid (see below). If breathing has stopped, give artificial respiration. Keep victim quiet, warm, and comfortable. Call ahead to alert a physician; do not stop first aid.

3. Rush victim to a doctor or hospital. REMEMBER, always take a *pesticide label* along with the victim. Tell the doctor if atropine has been given.

First Aid

ON THE SKIN—Rip off contaminated clothing, flush affect areas thoroughly with running water, and then wash with soap and water.

IN THE EYES—Hold eyelids open and flush eyes with a gentle stream of clean running water for at least 15 minutes.

INHALED—Immediately move victim to an open area, preferably outdoors, to get fresh air. The rescuer should wear protective respiratory equipment. Give artificial respiration if necessary.

SWALLOWED—Induce vomiting only if instructed to do so by the pesticide label or physician. If recommended on the label, give an antidote. NOTE: Never give anything by mouth to an unconscious person.

CHEMICAL BURNS—Remove contaminated clothing, flush skin with large amounts of water, and then loosely cover the affected area with a clean dressing. *Do not* apply any medications to the affected area.

After first aid, carry out emergency action step 3.

PESTICIDE INFORMATION

Poison Control Centers

The “800” numbers listed below are for use only within the specific state involved. The state coordinators are primarily administrative; for emergencies, contact the Regional Poison Control Centers or Hospital Poison Control Centers first. Address all correspondence or phone calls to the “Poison Control Center” of that organization.

ILLINOIS

State Coordinator
Division of Emergency Medical Services and Highway Safety
Springfield, IL 62761
(217) 785-2080

Illinois Poison Control Center

222 South Riverside Plaza
Suite 1900
Chicago, IL 60606
800-942-5969 (Illinois only)

Rush Presbyterian/St. Luke's Medical Center
1753 West Congress Parkway
Chicago, IL 60612
(312) 942-5969

Swedish American Hospital
1400 Charles Street
Rockford, IL 61104
800-543-2022

INDIANA

Indiana Poison Center
Methodist Hospital of Indiana
I-65 at 21st
P.O. Box 1367
Indianapolis, IN 46206-1367
800-382-9097 (Indiana only)
(317) 929-2323

IOWA

State Coordinator
Hoover Control Center
Department of Health
Des Moines, IA 50318
(515) 281-4952

Iowa Methodist Hospital
1200 Pleasant Street
Des Moines, IA 50308
(515) 283-6254
800-362-2327

Mercy Medical Center
Mercy Drive
Dubuque, IA 52001
(319) 588-8050

University of Iowa Hospital

Poison Information Center
Iowa City, IA 52240
(319) 356-2922
(319) 356-2600
800-272-6477

McKennan Poison Center
P.O. Box 5045
800 E. 21st Street
Sioux City, IA 57117-5045
800-952-0123
(605) 322-3894

St. Luke's Poison Center
St. Luke's Regional Medical Center
2720 Stone Park Boulevard
Sioux City, IA 51104
800-352-2222
(712) 277-2222

MICHIGAN

State Coordinator
Department of Public Heath
Lansing, MI 48909
(517) 373-1406

University Hospital
1405 E. Ann Street
Ann Arbor, MI 48104
(313) 764-5102

Southeast Regional Poison Center
Children's Hospital of Michigan
3901 Beaubien
Detroit, MI 48201
(313) 494-5711
800-572-1655
800-462-6642

Children's Hospital of Michigan
Poison Control Center
4160 John R.
Suite 425
Detroit, MI 48201
800-764-7661

(313) 745-5711

Blodgett Regional Poison Center
1840 Wealthy, S.E.
Grand Rapids, MI 49506
800-764-7661 (Michigan only)

Michigan Poison Center
Borgess Medical Center
1521 Gull Road
Kalamazoo, MI 49001
(616) 383-7070
800-632-4177

Marquette General Hospital
420 West Magnetic Drive
Marquette, MI 49855
(906) 228-9440
800-562-9781

Munson Medical Center
6th Street
Traverse City, MI 49684
(616) 947-6140

MINNESOTA

State Coordinator
State Department of Health
Minneapolis, MN 55404
(612) 623-5000

Hennepin Regional Poison Center
Hennepin County Medical Center
701 Park Avenue
Minneapolis, MN 55415
(612) 347-3141

International Poison Center
(industrial poisonings)
8009 34th Avenue South
Suite 1050
Minneapolis, MN 55425
(612) 814-7100

Minnesota Regional Poison Center

8100 34th Avenue South
P.O. Box 1309
Minneapolis, MI 55440-1309
800-222-1222 (MN only)
(612) 221-2113

St. Paul Ramsey Hospital
640 Jackson Street
St. Paul, MN 55101
(612) 221-2113
800-222-1222

MISSOURI

State Coordinator
Missouri Division of Health
Jefferson City, MO 65102
(573) 751-2713

University of Missouri Medical Center
807 Stadium Blvd.
Columbia, MO 65201
(314) 882-8091

St. John's Medical Center
2727 McClelland Boulevard
Joplin, MO 64801
(417) 781-2727 Ext. 2305

Children's Mercy Hospital
2401 Gilham Road
Kansas City, MO 64108
(816) 234-3430

Cardinal Glennon Memorial Hospital for Children
1465 South Grand Avenue
St. Louis, MO 63104
(314) 772-5200
800-392-9111

Ozark Poison Center
Lester E. Cox Medical Center
1423 North Jefferson Street
Springfield, MO 65802
(417) 831-9746
800-492-4824

OHIO

State Coordinator
Department of Health
Columbus, OH 43216
(614) 466-5190

Children's Hospital
281 Locust
Akron, OH 44308
(216) 379-8562
800-362-9922

Drug and Poison Information Center
University of Cincinnati Medical Center
231 Bethesda Avenue
Cincinnati, OH 45267
(513) 872-5111

Greater Cleveland Poison Control Center
11100 Euclid Avenue
Cleveland, OH 44106-6010
(888) 234-4455 (OH only)
(216) 231-4455

Academy of Medicine
11001 Cedar Avenue
Cleveland, OH 44106
(216) 231-4455

Central Ohio Poison Center
700 Children's Drive
Columbus, OH 43205-2696
800-682-7625 (Ohio only)
(614) 228-1323

Medical College of Ohio Poison & Drug Information Center
3000 Arlington Avenue
Toledo, OH 43614
800-589-3897 (419 & 517 area codes only)
(419) 381-3897

Ohio Poison Center
Medical College Hospital
P.O. Box 6190

Toledo, OH 43679
(419) 381-3897

Mahoning Valley Poison Control Center
St. Elizabeth Hospital and Medical Center
1044 Belmont Avenue
Youngstown, OH 44501
(216) 746-2222

PENNSYLVANIA

State Coordinator
Director, Division of Epidemiology
Department of Health
P.O. Box 90
Harrisburg, PA 17108
(717) 787-2307
800-521-6110

Penn State University Hospital
Milton S. Hershey Medical Center
P.O. Box 850
500 University Drive
Hershey, PA 17033
800-521-6110 (Pennsylvania only)
(717) 531-6111

Poison Control Center of Philadelphia
3600 Market Street
Suite 2000
Philadelphia, PA 19104-2641
800-722-7112 (Pennsylvania only)
(215) 386-2100

Pittsburgh Poison Center
3705 Fifth Avenue
Pittsburgh, PA 15213
(412) 681-6669

WISCONSIN

State Coordinator
Department of Health and Social Services
Division of Health
Madison, WI 53701

(608) 267-7174

Green Bay Poison Control Center
St. Vincent Hospital
835 S. Van Buren Street
Green Bay, WI 54305
(414) 433-8100

Madison Area Poison Center
University Hospital and Clinic
600 Highland Avenue
Room F6/133 CSC
Madison, WI 53792
800-815-8885 (Wisconsin only)
(608) 262-3702

Milwaukee Children's Hospital
1700 West Wisconsin
Milwaukee, WI 53233
(414) 931-4114

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