CHAPTER 6

Forest Insects and Diseases

North Shore Highlands, Toimi Uplands, and Laurentian Uplands Subsections

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               (VanArsdel)
6.1 Introduction

The Role of Forest Insects and Disease Organisms in the North Shore/Toimi Uplands/Laurentian Uplands (NSH/TU/LU) Subsections

Native forest insects and disease organisms influence forest ecosystem dynamics as pests and agents of stress but also play a beneficial role in the natural processes. Many native insects and diseases are an essential natural component of healthy forests and may contribute to compositional, structural, and functional diversity. By selectively affecting tree growth and mortality rates, they alter forest composition, structure, and succession. They thin and prune host populations reducing density and competition. They can slow or stall the process of succession or they can accelerate it. Through decay and biomass decomposition they contribute significantly to carbon cycling, nutrient cycling, and energy flow in forest ecosystems. Insect and disease organisms serve as food for many invertebrates and vertebrates. Of vertebrates, birds consume the most tree-feeding insects, but many mammals consume insects to some degree as well. Insects and diseases create structural habitat for shelter and nesting. Many species of woodpeckers are attracted to trees with decay where they excavate cavities for nesting. Many animals use dead wood to roost, nest, or forage.

These same native forest insect and diseases are perceived as problems or pests when occurring at a level or on a site where they interfere with human goals, plans, and desires for trees and forests. Native insects and diseases can reduce timber production, lumber grade, site aesthetics, wildlife habitat, water quality, increase the hazard of falling trees and branches, increase fire hazard, etc. Data from the 1990 Forest Inventory and Analysis (FIA) for Minnesota indicates that 37 percent of the wood volume produced by all species annually is lost due to tree mortality. Insects and disease organisms account for more than 53 percent of this loss or more than 143 million cubic feet of wood (Miles, Chen, Leatherberry, 1995). The Minnesota Department of Natural Resources Division of Forestry has conducted surveys of oak and birch mortality triggered by drought and attacks by boring insects and root rot organisms. These surveys indicated that more than 300,000 oaks and 200 million birch trees were dying during the late 1980s and early 1990s (Albers, 1998). More than 40 percent of the birch type in Minnesota was affected.

What is perceived to be beneficial from one perspective may be viewed as detrimental from another. A very low level of decay would be required on a site being managed for high timber productivity, a higher level of decay may be acceptable on a site being managed under extended rotation, while any level may be acceptable on an old growth site. Some level of decay will occur on every site regardless of the level of management. A forest tent caterpillar outbreak might be viewed as both beneficial and detrimental. The outbreak may benefit some birds that eat them, but be detrimental to others by leaving nests exposed to predators and bright sunlight that can overheat, dehydrate, and kill young birds in nests. A forest tent caterpillar outbreak may increase the growth of shade tolerant understory trees because of increased nutrients from insect droppings and dead caterpillars and increased sunlight penetrating the defoliated overstory canopy. The
same outbreak is detrimental to the overstory aspen because of slower growth and increased mortality caused by the loss of leaves.

While native insect and disease organisms have co-evolved with native trees and forests, exotic insects and disease organisms have not. Exotics do not have a natural “role” in our native ecosystems and have and will continue to alter forest ecosystem diversity, function, and productivity. Exotics historically have caused intensive and severe disturbances over large areas. In extreme cases they have virtually eliminated their host species. The elm resource has been devastated by introduction of the Dutch elm disease fungus and its bark beetle vector. The white pine blister rust fungus accidentally introduced near the start of the twentieth century has played an important role in reducing the amount of white pine in Minnesota. While not yet established in Minnesota, gypsy moths are established in Wisconsin and Michigan and will become established here. While future impacts of gypsy moth in Minnesota are difficult to predict, especially in the northern aspen-birch forest, it has the potential to cause widespread mortality and will alter the composition and structure of the forests.

An ecosystem perspective requires that strategies to maintain forest health consider the beneficial as well as the detrimental effects of insects and disease organisms. Forests must be considered as an ecosystem and manipulation to one part of that ecosystem affects the other parts. Pests have long influenced forest management but forest management also affects pest populations. Vigorous trees tend to suffer less damage from pests. Forest management aims to promote stand vigor by matching tree species to the planting site, manipulating rotation age, stand density and species composition, avoiding wounding and root damage during thinning and harvesting, removing diseased and infested trees during harvesting operations, etc. Forest management does not attempt to eliminate native insect and diseases or their processes but rather to control their activity and impact to a level that allows goals for timber production, water quality, aesthetics, recreation, wildlife, etc., to be realized.

In contrast, a much more aggressive approach is needed with exotic (non-native) organisms. It is important to avoid the introduction of exotics and attempt to contain and eradicate them when first found. Once established, it is often not possible to eradicate or contain exotics. Attempts to slow their spread and management techniques to minimize their damage are then needed. Dutch elm disease and white pine blister rust are exotics that have become permanent components of our ecosystem. We have had to learn to live and deal with them. This will also happen with gypsy moth after it becomes established in Minnesota.
6.2 Insects and Diseases in the North Shore Highlands/Toimi Uplands/Laurentian Uplands (NTL) Subsections

This section assesses the significant forest insects and diseases known to cause tree mortality, growth loss, and timber grade reductions in the Northern Superior Uplands Section and where possible, specifically in the North Shore Highlands, Laurentian Uplands, and the Toimi Uplands subsections. The presence of forest insect and disease problems, as well as animal and abiotic problems in Minnesota, have been documented in reports by the Minnesota Department of Natural Resources, Forest Ecosystem Health Team; the USDA Forest Service, State and Private Forestry; and the North Central Forest Experiment Station. The gypsy moth, an exotic insect not yet known to occur in these subsections, is also included because of the potential for significant impact in the future.

Each description of the selected insects and diseases gives the common name, scientific name, brief description, damage caused, and potential for damage in the future or trend. Decisions on which pests and information to include in this assessment were based on literature, surveys, and reports of state and federal agencies and university forest pathologists and entomologists as well as on personal experience.

6.2a Insects and diseases affecting aspen and balm of Gilead (balsam poplar) in the NTL subsections

- **Poplar borer** - *Saperda calcarata*
  Poplar borer insects occur wherever aspen grow. Larvae bore into sapwood and heartwood, and trees that have been attacked have swollen scars and holes in the trunk and larger branches. Moisture bleeds out of the holes producing varnished-looking streaks running down the trunk. Extensive tunneling can girdle small trees and makes large trees susceptible to wind breakage. Attack is often concentrated in brood trees that are usually the larger and faster-growing trees in stands. Damage in forest stands can be severe. Infestations tend to increase with as stand density decreases. The best management practice is to maintain well-stocked stands that are clear-cut at maturity.

- **Hypoxylon canker** - *Entoleuca mammata (=Hypoxylon mammatum)*
  A common disease of aspen, Hypoxylon canker causes mortality and is the most destructive pathogen of young aspen in the Lake States. It is estimated that Hypoxylon canker infects 12 percent and kills 1 to 2 percent of the aspen in the Lake States each year (Schipper and Anderson, 1976). Hypoxylon canker is primarily a disease of quaking aspen, but bigtooth aspen is also occasionally infected. Aspen of all age classes is susceptible; however, mortality is usually greatest in young trees. The fungus kills the trees by girdling the stem, which leads to stem breakage. Some clones (genetically related stands of aspen) appear to be much more susceptible to Hypoxylon canker than others, and mortality in susceptible clones may approach 100 percent. Infection levels are not strongly correlated to site characteristics but do appear to be related to stand density. Insect wounds made by cicadas, poplar-gall saperdas, and tree hoppers serve as infection courts for the fungus-causing Hypoxylon
canker. These insects prefer open grown stands and stand edges. Because of this preference, there tends to be a greater amount of insect wounding and Hypoxylon canker incidence in the more open grown stands and along stand edges (Ostry, et al, 1989).

- **Stem Decay (White trunk rot) - *Phellinus tremulae***
  White trunk rot is the major cause of decay in aspen. It starts to show up in stands at about 20 years of age and increases as the stands age. There does not seem to be a strong correlation between amount of decay and site factors. The genetic susceptibility to decay of individual clones seems to override any observable correlations between decay and site factors. The best external indicator of decay is the presence of conks (Jones and Ostry, 1998). However, only about 50 percent of the trees with decay have visible conks, and lack of conks generally leads to an underestimation of decay. Wounds and branch stubs serve as infection sites. Stands with a larger incidence of wounds from such things as equipment scrapes, fire, hail, and storm breakage may have higher levels of decay. Studies have indicated that the pathological rotation age (the age at which the loss of wood volume from decay begins to exceed the annual increment of sound wood) is from 40 to 50 years (Schmitz and Jackson, 1927). Others indicate that in many parts of the Lake States, aspen stands begin to deteriorate rapidly when they reach 50 to 60 years (Ostry and Walters, 1984). Some stands (or clones) may have relatively little decay even when they exceed 50 years of age while others may suffer high losses before 50 years. (Christensen et. al, 1951)

- **Forest tent caterpillar - *Malacosoma disstria***
  Forest tent caterpillar is a native defoliator that likely has been causing outbreaks for hundreds or thousands of years. These outbreaks generally occur about once a decade and usually last about three to four years although some have lasted for five to eight years. Outbreaks result in defoliation of most hardwood tree species especially aspen, birch, basswood, and oaks within the outbreak area. The last outbreak peaked in Minnesota in 1990 when defoliation occurred across approximately 4 million acres. Another outbreak began in 2000. Defoliation was high in 2001 and is expected to again be high in 2002 and possibly 2003 before returning to endemic levels. Tree mortality is not very common unless the outbreak is unusually long or concurrent with a severe drought. However, significant growth loss is widespread during the outbreak.

- **Large aspen tortrix - *Choristoneura conflictana***
  Large aspen tortrix is a native defoliating insect of aspen. It is also found on birch and some other hardwoods associated with aspen. Defoliation reduces the growth rate of trees but outbreaks generally last only two to three years. This is seldom long enough to cause mortality. This defoliator has exhibited explosive outbreaks in the past covering millions of acres in northern Minnesota. An outbreak occurred in 1999 and 2000, but the build-up of forest tent caterpillar out-competed the large aspen tortrix or masked its presence in 2001. The outbreak appears to have collapsed.
Trends - Insect and Disease Management of Aspen and Balm of Gilead (Balsam Poplar)
Management techniques are changing from the traditional practice of clear-cutting stands at the end of the rotation age to 1) using more intermediate cuts to capture mortality, 2) partially harvesting stands at the end of the rotation, or 3) leaving scattered patches of standing live aspen in the stand at the end of the rotation. As the techniques change, the incidence and severity of poplar borer and Hypoxylon canker are likely to increase due to the influence of lower stocking levels and the creation of more open-grown stands.

As aspen stands are set aside to meet extended rotation and old growth targets or aspen clumps are left behind to meet leave tree guidelines, white trunk rot is expected to increase as the ages of these aspen stands increase. Harvesting strategies that reduce the number of acres of older aspen will decrease the amount of decay. Partial harvesting of aspen stands requires multiple entries into the stands; each entry is an opportunity to wound the residue trees. An increase in wounding will increase decay incidence. If wounding is done early in the life of the stand, time will become an enemy in producing sound wood volume. The longer the decay is present in aspen, the less sound volume there will be since white trunk rot is able to breach the trees’ defenses and continue to grow unchecked throughout the infected trees.

It is difficult for management practices to predict and influence defoliator occurrence and impacts. However, defoliators reduce the growth. In extended outbreaks or outbreaks combined with severe drought, defoliators can cause mortality.

6.2b Insects and diseases affecting black spruce in the NTL subsections

**Eastern dwarf mistletoe - *Arceuthobium pusillum***
Dwarf mistletoe is a parasitic seed plant that infects and kills black spruce. It is the major mortality agent of black spruce. It primarily affects black spruce but is found occasionally on white spruce and tamarack. It causes “witches brooms” on infected trees; trees of all sizes become infected and killed. In the past, natural fire was the major factor that kept this disease in check. Once a stand is infected, it stays infected until fire harvesting or shearing kills all the mistletoe-infected trees. Residual infected trees left behind on the site or in surrounding stands after harvesting introduce the disease to the regenerating stand. Mistletoe spreads locally by seeds that are explosively discharged and can travel up to 60 feet. Seeds stick to bird feet and feathers and can carry seed long distances. When an even-aged stand becomes infected, large trees die and create openings in the stand. Young trees seed into these openings and become infected. The stand then gradually changes to an all-aged stand with heavy infections of all ages which have very little to no merchantable volume.

Trends - Insect and Disease Management of Black Spruce
Incidence of Eastern dwarf mistletoe is increasing due to the absence of fire and because there is no practical means of killing all infected trees on the harvest site as well as bordering the site at the time of harvest. Shearing after the harvest has also met with a
variety of successes and rarely eradicates mistletoe from the stand. Even young trees that are infected will live long enough to continue the cycle of dwarf mistletoe in the regenerating stand. These young, infected trees are nearly impossible to kill in the absence of fires. If dwarf mistletoe is not aggressively eradicated from black spruce stands the incidence and losses will continue to increase.

6.2 c  Insects and diseases affecting tamarack in the NTL subsections

- **Stem decay** - Various fungi species
  All tree species are subject to stem decay by an array of fungi. Stem decay in all species increases as trees age increases. Wounds such as fire scars, logging injuries, and dead branch stubs serve as sites where decay can enter the trees. Wounds that occur to residual trees during a partial harvest or other management activities can be critically important. Potential keys to control the amount of stem decay include 1) minimizing wounding during logging, 2) maintaining a level of stocking to promote natural branch shedding, and 3) rotation age management. The older a tree becomes, the more wounds and dead branch stubs it accumulates and the greater its potential for decay. Many tree species are able to confine decay to the stem at the time of wounding, but with multiple wounds, decay columns tend to coalesce and the total amount of decay in the stem increases significantly. As forests age, the proportion of trees in the stand with decay will increase and the volume of decay in each tree will increase. Stem decay does not kill trees outright, but decay does lead to more stem breakage from wind and reduces the merchantable volume.

- **Larch sawfly** - *Pristiphora erichsonii*
  Larch sawfly is the most destructive defoliator of larch in North America and has historically been considered the major mortality-causing pest of larch in Minnesota. The larvae eat tamarack needles; repeated defoliations eventually kill the trees. Larch sawfly has been a historically spectacular insect defoliator across North America. Between 1910 and 1926, this defoliator killed and estimated one billion board feet of timber in Minnesota (Baker, 1972). Another outbreak occurred in northern Minnesota in the late 1940s and early 1950s. Forest managers introduced parasites into Minnesota in the 1970s to try to keep this insect under control and reduce tree mortality. In the past 20 to 25 years, relatively small pockets of defoliation have occurred frequently, but have collapsed after a couple of years. It is not known if this pattern of small outbreaks of short duration will continue or if large destructive outbreaks will occur again. Historic levels of damage show that larch sawfly should not be ignored.

- **Larch beetle** - *Dendroctonus simplex*
  This is a native bark beetle that attacks and kills tamarack and exotic larches. Beetles overwinter in attacked trees. Adults emerge in the spring and seek live trees or fresh slash to attack. Eggs are laid, larvae construct galleries under the bark, and adults are produced. Most adults stay in the tree until the following spring. Eastern larch beetles
attack trees of all most any age or diameter class, on the full range of sites from wet lowlands to drier uplands.

Widespread outbreaks in the 1970s and 1980s killed large numbers of trees in eastern North America and Alaska. Infestations are often associated with trees under stress. Flooding, drought, defoliation, and old age have been associated with larch beetle attacks. Populations can build up in tamarack logging slash and then attack and kill live trees left for seed production as well as live trees in surrounding stands. However, not all outbreaks have been associated with obvious stress events. Larch beetles appear to be capable of attacking and killing trees when no predisposing condition or factor is apparent. Presently, populations and attacks are increasing in northeastern Minnesota, and in some stands in the state have observed over 75 percent tree mortality.

**Trends - Insect and Disease Management of Tamarack**

Stem decay will continue to increase as tamarack stands age. Larch beetle is currently causing high levels of mortality in many stands and the beetles will likely continue to spread, at least in the near future.

Larch beetle outbreaks are often associated with trees under stress but it appears that a predisposing factor is not necessary—in many stand currently being attacked, predisposing factors do not appear to be present. Logging slash can provide brood material for beetles to build up high population numbers. High populations of beetles can successfully attack apparently healthy trees. Residual trees left for seed production or biodiversity objectives are often quickly killed by larch beetle attack.

Management activities should not affect the incidence of larch sawfly. However, older trees will not be able to tolerate as much defoliation as younger trees, and outbreaks of the sawfly may kill stands or patches preserved to meet extended rotation or leave tree objectives.

### 6.2 d  Insects and diseases affecting white cedar in the NTL subsections

- **Stem decay** - Various fungi species
  
  See the description of stem decay under the Tamarack cover type.

**Trends - Insect and Disease Management of White Cedar**

While *products* of cedar wood are resistant to decay, living trees are very susceptible to decay. Stem decay will increase as white cedar is allowed to age.
6.2 e  Insects and diseases affecting jack pine in the NTL subsections

- **Jack pine budworm** - *Choristoneura pinus pinus*
  Jack pine budworm (JPBw) larvae eat the needles of jack pine and cause defoliation, top kill and mortality. In the Lake States, JPBw outbreaks tend to occur at roughly six to 12 year intervals but can greatly vary locally. Budworms generally persist for two to four years, then decline. Poorly stocked stands, over-stocked stands, over-mature stands, or stands with low-vigor trees are most susceptible to build-up of JPBw populations. These stands also sustain the highest level of damage and mortality. Defoliation of jack pine occurred in the Northern Superior Uplands Section (primarily in the Border Lakes Subsection) between 1982 and 1986, and peaked in 1985 at 200,000 acres. Defoliation was generally in the moderate category and did not cause much top kill or mortality. However, since most of the defoliated area was in the BWCAW it was never examined on the ground. Jack pine budworm can cause considerable defoliation, top-kill, and mortality in Minnesota. Its future impact in the subsection can’t be predicted accurately based on recent history.

- **Bark beetle** (pine engraver beetle)- *Imps pini* and others
  Many species of bark beetles exist in Minnesota. The pine engraver beetle is very common and sometimes very abundant. Bark beetles feed and reproduce in the moist cambium of freshly cut, recently killed, or blown-down red pine, jack pine, and occasionally white pine. In Minnesota, up to three generations of *Ips pini* can develop during a growing season; however in the Northern Superior Upland section, it’s more likely only two generations will develop due to the cool climate. After developing in the dead material, the new adults may attack standing live trees nearby. Barks beetles make successful attacks on trees under stress, but massive attacks often are able to overwhelm and kill healthy trees. Dead trees generally occur in patches or pockets because emerging beetles tend not to fly far but attack trees adjacent to where they emerged. Attacks often begin in tree tops and progress downward. Stress from drought and overcrowding, equipment and fire scarring, and weather events such as hail and snow and ice breakage can reduce tree vigor and predispose the trees to bark beetle attack. Stressed trees cannot defend against bark beetle attacks, creating situations that make it easy for the beetles to kill the trees. Preventing bark beetle problems requires careful selection of trees left as “course woody debris” and as “leave trees” on harvest sites.

- **Stem Decay (Red Rot)** - *Phellinus pini*
  This organism is the most destructive decay organism in the United States. It attacks most softwoods and causes significant decay. It is a “canker rot” organism. This type of decay organism cannot be walled off and confined to the portion of the stem present at the time infection takes place. This organism will grow and cause decay throughout the stem as the stem increases in size. Stem decay does not kill trees outright but leads to more stem breakage from wind and reduces the merchantable volume. It is similar to the decay fungus that causes white trunk rot of aspen. It is difficult to predict occurrence and extent of red rot in pine stands. Research has not correlated, with any degree of confidence, decay with site characteristics. Most
infections occur through dead branch stubs. Decay incidence increases with tree age. Fruiting bodies that would predict red rot are not prominent and are easily missed during inventory and cruising. Often red rot is not discovered until harvesting. Stem decay is an important ecological process involved in nutrient recycling, providing cavity nesters with cavities, etc. For more details see both discussions of stem decay for the aspen and tamarack cover types.

**Trends - Insect and Disease Management of Jack Pine**

As jack pine stands become 50 years and older they become more vulnerable to jack pine budworm (Jones and Campbell, 1986). Although jack pine budworm has not been a problem in the subsections covered by this plan in the past 25 years it should not be ignored. Jack pine budworm has caused defoliation over a wide area within the Northern Superior Uplands section.

As stands age the incidence of decay will also increase. Harvest strategies to reduce the acres of older jack pine would decrease the amount of decay. Harvest strategies to increase the acres of older jack pine would increase the amount of decay. Partial harvests of jack pine increase the opportunities to wound residual trees that would increase the incidence of decay.

Bark beetle problems can increase if care is not taken in selecting trees to be left as course woody debris and leave trees on harvest and partial harvest sites.

### 6.2 f  Insects and diseases affecting ash in the NTL subsections

- **Stem decay** - Various fungi species
  See stem decay description under Tamarack cover type.

**Management Implications - Ash**

Stem decay will continue to increase as ash stands are allowed to age. Ash is a long-lived tree species relatively free of potential catastrophic pest problems.

### 6.2 g  Insects and diseases affecting balsam fir in the NTL subsections

- **Stem decay** - Various fungi species
  See stem decay description under Tamarack cover type.

- **Spruce budworm** - *Choristoneura fumiferana*
  Spruce budworm is a native insect defoliator. Outbreaks of this defoliator have periodically occurred for hundreds of years. The larvae prefer the needles of balsam fir and white spruce causing defoliation, top kill, and mortality. On balsam fir, top-kill can begin after two to three years of heavy defoliation and tree mortality after three to five years of feeding. Outbreaks tend to occur when there are extensive and continuous areas of mature and over-mature balsam fir. Losses of balsam fir are
highest in stands with the highest abundance of fir and where surrounding stands also contain fir. Mortality in mature and over-mature fir stands may approach 100 percent. Damage tends to be higher in older-age fir, but in outbreaks fir of all ages can be killed. Stands with multiple ages of fir often experience greater levels of damage to the young fir trees than would normally occur in single age stands. Spruce budworm has defoliated an average of 250,000 acres per year in northern Minnesota between 1954 and 2000 and caused widespread mortality. Presently there is a general budworm population decline statewide. However, the pattern of the past 50 years indicates that outbreaks with high levels of defoliation and mortality can be expected to continue as balsam fir stands mature (see maps at end of this chapter).

**Trends - Insect and Disease Management of Balsam Fir**

Given the pattern of the past 50 years, outbreaks with high levels of defoliation and mortality can be expected to continue in northeastern Minnesota. Management strategies that increase the component of balsam fir on the landscape would contribute to future outbreaks of the spruce budworm. A comparison of the relative abundance of balsam fir from the public land survey records with the 1990 forest inventory analysis data indicate that various land type associations within the North Shore plan area have had increases in balsam fir and others have had decreases. Balsam fir has increased two to three times in the Toimi Uplands and three to five times in portions of the North Shore Highlands and the Laurentian Uplands. In a small portion of the Laurentian Uplands, balsam fir has increased five to ten times. Partial cuts or thinnings to produce multiple age stands of balsam fir and/or white spruce will result in high levels of defoliation and mortality of the understory fir and spruce during outbreaks. When regenerating spruce and fir stands, managers should emphasize regenerating white spruce (not balsam fir) and increasing the number of non-host tree species, such as pines and hardwoods, in the stand.

**6.2 h Insects and diseases affecting lowland hardwoods in the NTL subsections**

- **Dutch elm disease** - *Ophiostoma ulmi*

  Dutch elm disease is an exotic disease that has reshaped Minnesota’s forested landscape. First detected in Minnesota in 1961, it quickly spread throughout the entire state. The disease kills individual branches and eventually the entire tree within one to several years. The disease can infect and kill all species of elm in the state. The disease remains active in the forest, killing most elm trees before they can reach a size much over four or five inches in diameter. The disease did not eliminate all elms because many trees are able to grow long enough to set seed and reproduce before being killed. But it has eliminated elm as a tree of large stature. Dutch elm disease often exhibits “wave years of infection” when infections are very heavy for a number of years. Then very few new infections occur for a period of years. As the “new generation” of elms begins to reach the pole size, it appears we are beginning to see a return of the wave years of infections.
Stem decay - Various fungi species
   See stem decay discussion under the Tamarack cover type.

Trends - Insect and Disease Management of Jack Pine
When managing lowland hardwood stands with a component of elm, the elm should be harvested before it is lost to another wave of Dutch elm disease. As lowland hardwood stands age, the incidence and severity of decay will increase.

6.2 i Insects and diseases affecting white spruce in the NTL subsections

Spruce budworm - *Choristoneura fumiferana*
See spruce budworm discussion under the balsam fir cover type. Balsam fir is the preferred host of budworms. However since 1990 budworm has caused defoliation, top-kill, and mortality in plantations of white spruce that are 25 years and older.

Spruce beetle - *Dendroctonus rufipennis*
Spruce beetle is a native bark beetle in Minnesota but until recently was seldom found. It is currently causing a considerable amount of mortality to white spruce in the North Shore Highlands subsection from near Silver Bay north to the Canadian border. Most of the mortality appears to be restricted to within five or six miles of Lake Superior. However it would not be surprising if future surveys reveal damage in other parts of the North Shore Highlands as well in the Toimi and Laurentian Uplands. Spruce beetle is often associated with trees stressed by defoliation, old age, drought etc. The current outbreak may be related to stress resulting from root rots, shallow soils, and the spruce budworm outbreak in Cook County that occurred during most of the 1990s. However, many of the trees currently being attacked and killed appear quite healthy with full crowns. Trees being killed are often the largest in the stands. The beetles prefers trees 10 to 12 inches in diameter and larger but has been found in trees as small as six inches in diameter at breast height (DBH). Spruce beetle is also able to develop large populations in wind-throw; however, the current outbreak does not appear to be related to the 1999 windstorm.

Trends - Insect and Disease Management of White Spruce
The occurrence of spruce budworm in white spruce plantations may be related to the plantations being overcrowded and not managed. Managers must commit to do periodic thinnings in white spruce plantations. Partial cuts or thinnings that result in multiple age stands of balsam fir and/or white spruce will result in high levels of defoliation and mortality of the understory fir and/or spruce during outbreaks. When regenerating spruce and fir stands, managers should emphasize regenerating white spruce (not balsam fir) and increasing the number of non-host tree species, such as pines and hardwoods, in the stand.
The future impact and trend of the spruce beetle is not known but the outbreak appears to be increasing. Spruce beetles are most likely to attack and kill older (larger) trees (extended-rotation or old-growth stands, trees left as residuals on harvest sites).

6.2 j Insects and diseases affecting **birch** in the NTL subsections

- **Birch decline**
  Birch decline is a complex disease caused by a combination of factors including stress from drought, high temperatures, defoliation, and the bronze birch borer, *Agrilus anxius*. Birch decline starts as a thinning of the crown with dieback of branches. As the stress continues, the bronze birch borer begins to make successful attacks on the birch and mortality often results. The amount of mortality due to birch decline can increase dramatically as a result of severe and lengthy drought. A study of the effects of the drought in the early 1990s estimated that 40 percent of the birch on forest inventory analysis (FIA) plots in Minnesota died between 1988 and 1992 as a result of birch decline. Based on the findings on the FIA plots, it was estimated that 228 million birch trees died during this period (Anonymous, 1992).

**Trends - Insect and Disease Management of Birch**
Birch decline depends on stressors such as drought and disturbance. This makes it difficult to predict a trend in birch decline over the life of the plan. Older and declining birch stands will reflect stress conditions and resultant dieback and decline before younger, vigorously growing stands. The vulnerability to birch decline will increase if birch stands are set aside or rotations are extended. Partial harvesting of birch stands can stress the residual trees by increasing soil temperatures as the stands are opened up. Partially harvesting birch and using birch to provide “leave tree” clumps will likely lead to significant mortality of these stands and residuals.

6.2 k Insects and diseases affecting **white pine** in the NTL subsections

- **White pine weevil** - *Pissodes strobi*
  White pine weevil larvae kill the terminal leaders of white pine resulting in crooked or forked stems that lead to reductions in volume and lumber grade. A report in Ontario claims that 80 percent of stem decay in white pine trees was associated with damage caused by white pine weevil. Weevils prefer trees growing in the open sunlight. Damage is most significant on trees less than 20 feet high. The weevil will attack other trees including jack pine and white and Norway spruces, but the weevil usually does not cause significant damage to these species.

- **White pine blister rust** - *Cronartium ribicola*
  White pine blister rust is an exotic fungus, first found in Minnesota in 1916. Blister rust is found throughout Minnesota wherever white pine is grown. This disease has changed where and how white pine is grown in northern Minnesota. The fungus requires both white pine and the alternate host (species of *Ribes*) to complete its life
cycle. Infected trees display injuries such as dead branches, stem cankers, and mortality. Infection levels of 80 percent or more of the trees in a stand or plantation have been reported in northern Minnesota. Levels of infection can vary greatly from site to site due to micro-site climate differences, age of trees, presence and abundance of Ribes, topography, and forest stand structure. No major gene for resistance has been found in eastern white pine, but breeding efforts continue to try to produce a more resistant tree. White pine blister rust does not significantly injure Ribes species.

Trends - Insect and Disease Management of White Pine
As more white pine is planted, the incidence of both white pine weevil and blister rust will increase. Van Arsdel developed a hazard zone map for Minnesota based on the likelihood of infection (Anderson, 1973). The “Very High Hazard Zone” (zone 4) occurs within the North Shore Highlands, Toimi Uplands, and Laurentian Uplands subsections (see map). The “…probability of a stand experiencing high levels of blister rust mortality is great in this zone. Choosing planting sites based on microclimatic factors is critical.” (Jones, 1989) Establishing white pine as an understory tree will help mitigate the impacts from both the weevil and blister rust. Basal pruning to remove the most susceptible lower branches will also reduce mortality. However in zone 4 infections are also very common on the tops of the tallest pine trees.

6.2 Insects and diseases affecting red pine in the NTL subsections

- **Diplodia tip blight and canker** - *Sphaeropsis sapinea*
  Diplodia tip blight damage can be at high levels locally on sites where taller infected red pine and jack pine are left on or next to sites being regenerated to red pine or jack pine. The large trees harbor the fungus and rain spores that infect the regenerating trees. Diplodia causes tip blight and/or cankers that can girdle branches and stems and kill trees. It spreads most during wet weather when it can infect through wounds; however, Diplodia does not require a wound for infection. A strain of this fungus can cause latent infections. Infected trees may develop no symptoms until they become stressed from stressors such as drought, overcrowding, or j-rooting. Once the trees are stressed, the fungus becomes active and may kill the trees.

- **Sirococcus shoot blight** - *Sirococcus conigens*
  Damage from this fungus can be at high levels locally on sites where taller infected red pine are left on or next to sites being regenerated to red pine or in uneven-aged stands. This fungus kills only current year shoots, but multiple years of infection will kill young trees.

- **Scleroderris canker** - *Ascocalyx abietina*
  The North American strain has been found locally in young red pine plantations in the North Shore subsection. It is most serious in areas north of 45 degrees latitude, where summers are cool and the frost-free growing season is fewer than 90 days. The fungus infects and kills the branch tips, then grows down the branch and into the main stem where it forms a canker and kills the tree. It is primarily a problem on small
trees, which it kills. Once trees are over six feet tall, the canker may kill lower branches but it will not normally kill the tree.

- **Bark beetle** (pine engraver beetle)- *Ips pini*
  See bark beetle discussion under the jack pine cover type.

**Management Implications – Red Pine**
Concerns are more directed at young stands regenerating under existing stands of pine. As management strategies lead to more partial harvests, development of all-aged stands, and leave residual red pines or pockets of red pines, understory pines will be susceptible to both *Diplodia* and *Sirococcus*. *Scleroderris* appears to be very site-related and can cause locally high levels of infection. Bark beetle problems could decrease if managers take care to select trees to be left as “coarse woody debris” and “leave trees” on harvest sites.

### 6.3 Other Significant Damage Agents in the NSH/TU/LU Subsections

- **Root rots** - *Armillaria* spp. and others
  All tree species are susceptible to root rot diseases caused by fungi such as *Armillaria* spp. Root rots reduce tree growth, and if severe, result in death or windthrow. Damage and death from root rots are likely very common, but impact is not well documented since the damage is hidden below ground. *Armillaria* root rot is present on most or all sites and attacks both hardwoods and softwoods. It is able to use stumps as a food base and extend its rhizomorphs through the soil that infect live roots. This is especially a concern in sites where hardwoods are converted to softwoods. Partial cutting has also been shown to increase *Armillaria* root rot. Trees weakened by drought, defoliation, wounding, soil compaction, and old age can be predisposed to *Armillaria* root disease.

**Management Implications – Root Rots**
As stands are allowed to age, the incidence and impact of root rots will increase. Also multiple entries into stands for management and partial harvest can injure root systems and root collars resulting in an increase in root rot.

- **Gypsy moth** - *Lymantria dispar*
  Gypsy moth is an exotic insect pest spreading across the U.S. and Canada, but is not currently established in Minnesota. This assessment includes this insect because it has occurred in Wisconsin and will eventually spread and become established in Minnesota. In fact, permanent populations are likely to become established in some locations in Minnesota during the this plan’s timeline. Natural spread of the gypsy moth is slow, but the unintentional spread by humans can be rapid. Egg masses are transported on cars, recreational vehicles, logs, firewood, and nursery stock. Gypsy moth caterpillars feed on most hardwood trees and shrubs, and when populations are high they will also feed on conifers. Repeated defoliations lead to tree decline and...
death. Defoliated trees that are already under stress will suffer higher levels of mortality. Aspen, birch, basswood, willows, mountain ash, and oaks are among the tree species gypsy moth prefer. The extent and severity of impact in northern Minnesota is unknown at this time. However, in areas where gypsy moth becomes established, forest composition is often changed. The occurrence of gypsy moth will make management planning more difficult and will likely adversely impact tourism and homeowners.

**Trends – Gypsy Moths**

A risk rating map and silvicultural guidelines are currently being prepared to help focus management on high-risk stands to mitigate the potential adverse impact of an established gypsy moth population. Access and use of these tools should be a part of this plan when determining management prescriptions on stands and landscapes.

**6.4 Additional Information**

Additional information on these and other insects and diseases of forest trees in Minnesota can be obtained by referring to the *Minnesota Forest Health Reports* prepared by the MN DNR Division of Forestry, Forest Health Unit. They can be found in the DNR Library in St. Paul and in various other libraries in the state. They have been printed on annually since 1974. The title has varied over the years from the *Forest Pest Report*, to the *Forest Insect and Disease Report*, to the current title of *Minnesota Forest Health Annual Report*. These reports contain data on the insect and diseases included in this assessment as well as other insects and diseases. The reports include observations and annual survey results. Current information can be found in the MN DNR *Forest Insect and Disease* newsletter which is published four or five times during the growing season and is accessible on-line through the DNR web page at [www.dnr.state.mn.us](http://www.dnr.state.mn.us).

Other sources of information include reports from the USDA Forest Service, University of Minnesota, and the Minnesota Department of Agriculture.

This chapter prepared by Mike Albers, Forest Health Specialist, Northeast Region, Grand Rapids, MN.

**Literature Cited**


6.5 Insect and Disease Maps

Figure 6.5a

1987
1988
1989
1990
1991

Light to moderate defoliation
Heavy Defoliation
**Figure 6.5b**

<table>
<thead>
<tr>
<th>Year</th>
<th>Acres of Defoliation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1983</td>
<td>3,237</td>
</tr>
<tr>
<td>1984</td>
<td>998,548</td>
</tr>
<tr>
<td>1985</td>
<td>1,204,063</td>
</tr>
<tr>
<td>1986</td>
<td>970,416 scattered</td>
</tr>
</tbody>
</table>
Figure 6.5c
Spruce Budworm Defoliation in the Northeast Region (1951-1999)
Figure 6.5c (continued)
Spruce Budworm Defoliation in the Northeast Region (1951-1999)
Figure 6.5c (continued)
Spruce Budworm Defoliation in the Northeast Region (1951-1999)
Figure 6.5c (continued)
Spruce Budworm Defoliation in the Northeast Region (1951-1999)
Figure 6.5c (continued)
Spruce Budworm Defoliation in the Northeast Region (1951-1999)
Figure 6.5c (continued)
Spruce Budworm Defoliation in the Northeast Region (1951-1999)

1994  1995

1996  1997

1998  1999
Figure 6.5d
White Pine Blister Rust Hazard Zones in Northeastern Minnesota (VanArsdel)

Also, see http://www.nrri.umn.edu/rustmap/ for the white pine blister rust hazard rating research project completed by the Natural Resources Research Institute in 1999, Identification of Risk Factors for Blister Rust on Eastern White Pine.