# North Dakota Forest Health Report

## 2005-2006

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# Introduction

This report summarizes forest pest conditions observed in 2005 and 2006 and describes emerging forest health issues in relation to the sustainability and societal needs of North Dakota's forested resources.

The term 'forest health' does not denote the presence or absence of insect pests and diseases in the forest, nor is it equivalent to an arbitrary estimate of tree mortality. Forest health is more accurately portrayed as a depiction of forest sustainability; the robustness of the forest's ability to provide for human's social, economic, and cultural needs while maintaining its ecological functions.

All forests undergo succession, a natural change in vegetation over time. Forest succession is driven by biotic and abiotic pressures that influence the species composition of the forest and facilitate the death of weakened and less-fit individual trees. Abiotic pressures may include frost, snow, fire, wind, sun, drought, nutrients, and human-caused injury. Biotic pressures include fungi, insects, plants, animals, bacteria, and nematodes that attack trees.

Such pressures are a natural component of forest ecosystems and the damage they cause should not be viewed as an imbalance of nature, but rather a normal cycling and recycling of the forest. At times, however, the damage imposed by biotic and abiotic pressures may exceed our perception of normal or may conflict with our management objectives. Additionally, pressures resulting from the introduction of non-native insects and pathogens may substantially impair the long-term sustainability of forests.

This report attempts to characterize the condition of North Dakota's forested resources. For each forest resource category, a brief summary depicts the overall condition and potential threats to each of these forest resource categories. Additionally, forest pest surveys are summarized and specific forest insects, diseases, and damaging abiotic agents are described. The information presented in this report was compiled from various sources and methods including: site visits, forest surveys, and personal communication with natural resource professionals.

# Section I. Conditions of North Dakota's Forest Resources

North Dakota's forest resources can be separated into three categories: native forests, rural plantings, and community forests. These resources provide numerous ecological, social, and economic benefits to North Dakota residents. The following summaries describe the general conditions of each category of the state's forested resources. These narratives do not necessarily depict specific causal agents of tree/forest decline, but rather describe the factors that have led to the current condition of these resources.

## Native Forests

Native forests and woodlands are sparsely distributed across the state and represent approximately 1.5 percent of North Dakota's total land area (673,000 acres). Eastern deciduous forest types and western coniferous forest types are found in North Dakota.

Deciduous forest types comprise 98% of North Dakota's forests. Common deciduous forest types in North Dakota include: elm/ash/cottonwood, aspen/birch, and bur oak. These forest types are categorized by the dominance of one or a few tree species although numerous species may comprise each forest type. The elm/ash/cottonwood forest type is the most abundant and occurs along rivers, lakes, and streams throughout the state. Bur oak and aspen/birch forests are common in the Turtle Mountains, the Devils Lake Hills, and the Pembina Gorge. Only 2% of the state's forestland is classified as western conifer forests. These isolated stands comprised of ponderosa pine and Rocky Mountain juniper are located in the southwest counties of the state (Figure 1, Page 4).

Despite their limited acreage, native forests are important resources in North Dakota. These forests provide wildlife habitat, provide recreational opportunities, stabilize river banks, filter water runoff from adjacent agricultural lands, provide wood products, serve as seed sources for conservation tree production, and increase the botanical diversity of the state.

The forests of North Dakota are generally resilient to damage imposed by endemic insects and diseases. However damage caused by these agents coupled with other underlying factors may threaten the long-term sustainability of the state's forests. These factors include:

1. Over-maturity of existing stands and suppression of natural disturbances essential to regenerate forests.
2. Damage caused by non-native pests

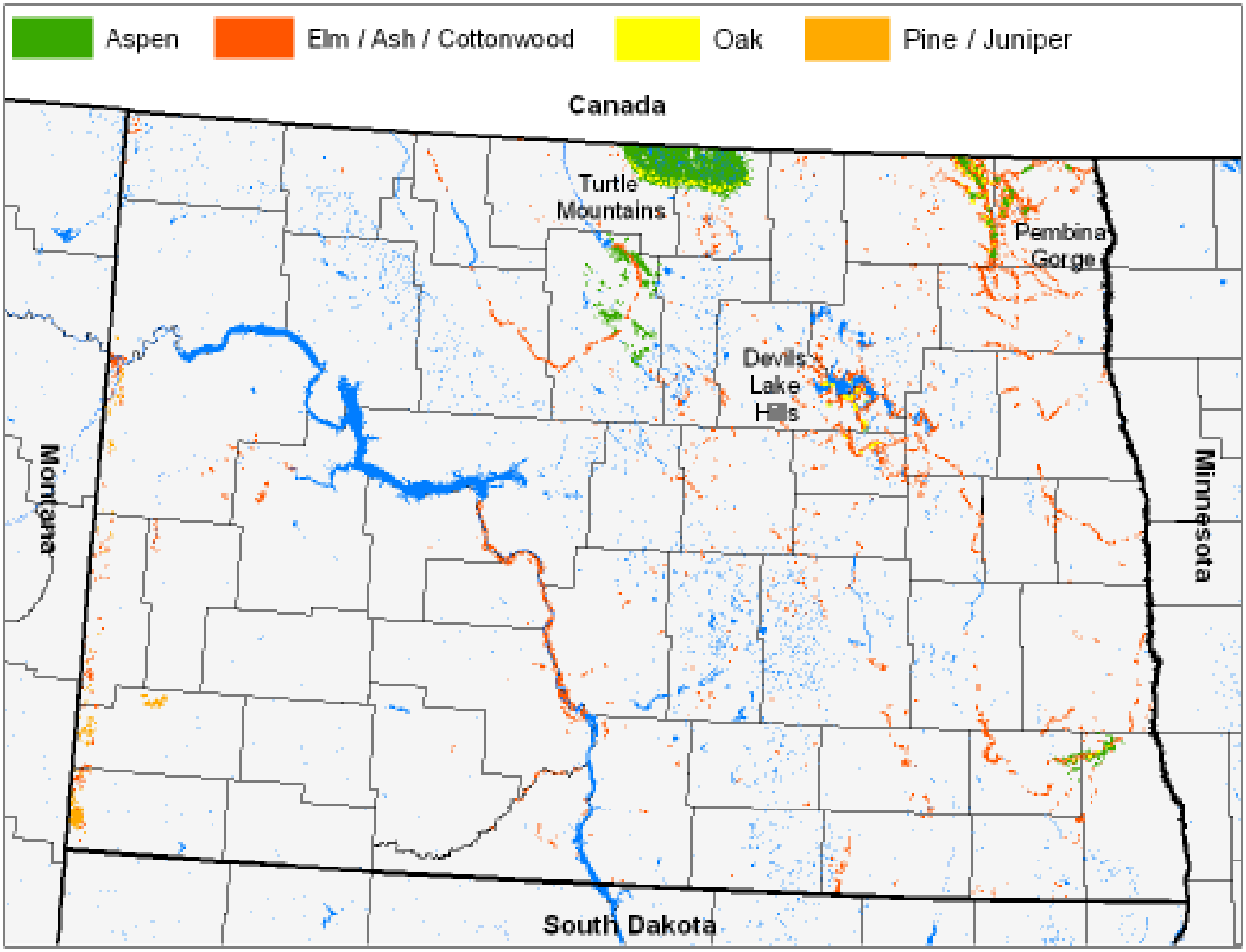


**Figure 1. Distribution of forest types in North Dakota.**

## Riparian Forests

Nearly one fifth of North Dakota's forests occur within 200 meters of a stream or lake. The majority of these forests are comprised of ash, elm, and cottonwood. The health and sustainability of these plant communities have important implications for water quality, flood control, wildlife habitat, and recreation opportunities.

The elm/ash forest type is the most abundant of all native forestland within the state. These forests have experienced significant alterations over the past decades due to damage caused by Dutch elm disease (*Ophiostoma ulmi* and *O. nova-ulmi*), overgrazing, altered water flows, and conversion to non-forest.

The cottonwood (*Populus deltoides*) forests that occur within the Missouri floodplain are in a poor condition that has resulted from progressive mortality of mature trees and the absence of natural regeneration to replace those that have died. Prior to flood mitigation, the Missouri floodplain experienced periodic inundation as high spring water flows deposited sand in low-lying areas. These moist sandbars serve as seedbeds for cottonwood and are critical for natural regeneration of the species. In the absence of flooding and subsequent sandbar formation, the cottonwood forests will continue to die-out as there are no young cottonwoods to replace the overmature trees that have succumb to old age and senescence.

## Aspen Forests

Nearly 17 percent of North Dakota's forestland is classified as the aspen/birch forest type. The majority of this forest type is located in the Turtle Mountains and represents the state's largest concentration of forestland. Lack of fire disturbance and/or harvesting has resulted in older stands with minimal natural regeneration within

these forests. The current condition of many stands are characterized by extensive stem decay caused by *Phellinus tremulae* and large stem mortality caused by hypoxylon canker (*Hypoxylon mammatum*). In addition, the Turtle Mountains are prone to periodic defoliation caused by the forest tent caterpillar (*Malacosoma disstria*). Defoliation reduces growth, predisposes trees to other damaging agents, and exacerbates the senescence of aging aspen stands. The declining aspen over story may succeed to hazel (*Corylus* spp.) shrub land in part due to the absence of shade tolerant conifers in North Dakota.

There have been recent opportunities over the past two years for forestland owners to harvest aspen. The vigorous regeneration of aspen that follows harvesting is important for the long-term perpetuation of this unique forested resource. Unfortunately, the future opportunities to harvest North Dakota's timber is likely to decrease as the result of decreasing demand for oriented strand board and increasing mill production costs.

## Rural Plantings

North Dakota is largely a rural state with an economy that is deeply rooted in agriculture. Rural tree plantings are an important component of many agricultural systems and improve the quality of rural living in the northern plains. Rural tree plantings generally refer to field windbreaks, farmstead shelterbelts, living snow fences, wildlife plantings, and others that are designed to achieve conservation, economic, and societal goals. For example, field windbreaks reduce soil erosion during years of drought, reduce water evaporation from adjacent cropland, and increase crop yields. Similarly, some plantings are designed to stabilize riverbanks, filter water runoff from adjacent agricultural lands, provide wildlife habitat, protect stretches of highways prone to severe snow accumulation, provide wind protection for livestock, or protect farmsteads and rural homes from snow and wind. Although many conservation tree plantings occur in areas where the historical vegetation type was prairie, these resources are critical for the present needs of rural residents that live in the current agricultural landscape.

Tree plantings of the northern plains are exposed to numerous pests and environmental conditions that hinder planting success, reduce their effectiveness, and limit long-term survival. Deterioration of tree plantings is often incited by drought, flooding, frosts, inadequate spacing, weed competition, herbicide exposure, defoliating insects, and foliar diseases. As trees become weakened, canker diseases and wood-boring insects may cause further damage to these plantings.

The damage to rural plantings caused by these interacting factors are more effectively prevented rather than treated. Incorporating various weed control techniques, manipulating planting density and arrangement, or selecting species most suitable for the site have been effective approaches to prevent the decline of tree plantings.

Limited species diversity is an underlying factor in the decline of many rural plantings. Plantings composed of one or few species often experience episodes of elevated tree mortality simply because all trees are equally vulnerable to the same damaging agents. Some examples of planting failure associated with limited species diversity include: decline of single-row Siberian elm field windbreaks due to herbicide exposure, marginal cold hardiness, and canker diseases and decline of Colorado blue spruce plantings due to yellowheaded spruce sawfly, rhizosphaera needlecast, and cytospora canker. The impacts of these damaging factors could have been greatly reduced had additional species been incorporated into these plantings.

In recent years, state, federal, and university forestry professionals have promoted species diversification in an attempt to avoid past experiences in tree planting decline. In practice, these techniques greatly enhanced the long-term survival of rural plantings. Despite this, identification of species and seed sources that perform well in the northern plains is still a critical need for conservation tree planting. The number of suitable native species for the northern plains is relatively limited in comparison to more forested regions. Therefore, the loss of a single species (due to the introduction of invasive pests or other factors) is magnified and further limits tree planting options and diversification efforts.

## Community Forests

Community forests include boulevard trees, trees planted within city parks, and trees that naturally occur within city limits or public right of ways. The management of such tree resources may fall under the responsibility of city foresters, public works departments, and/or community tree boards. The community forest also includes trees that are planted on private or commercial properties. As a whole, these tree resources provide many benefits to the community's residents including: reduced winter heating and summer cooling costs, wind and snow protection, beautification, recreational opportunities, and enhanced quality of life.

Trees that are planted within residential areas are exposed to numerous insects and diseases. The frequency and severity of pest damage often reflects the composition and abundance of host species within the community's

forest. In addition, trees growing within residential areas are exposed to many environmental stressors such as compacted soils, turf herbicides, lack of (or too much) watering, nutrient deficiency, and mechanical injuries. Such stresses exacerbate the damage caused by insects and disease.

Above all other insects, diseases, and abiotic stresses, Dutch elm disease continues to be the most damaging to community tree resources. This disease has eliminated many of the stately elms that once graced North Dakota communities. Several of North Dakota's larger communities have developed management programs to combat Dutch elm disease with notable success. However, smaller communities that lack the financial resources to support a forestry staff have been, and continue to be, severely impacted by this disease.

Ash species and cultivated varieties have been the most common replacements for elms killed by Dutch elm disease. As a result, many community forests that were once dominated by elm now have an overabundance of ash. Although ash performs well on a variety of sites and conditions, the over-reliance on this species has raised concerns since the recent discovery of the Emerald ash borer (*Agrilus planipennis*, an exotic ash-killing beetle) within the Midwest. Many North Dakota communities are realizing the vulnerability of their community tree resource and are beginning to embrace the concept of species diversification.

# Section II. Forest Pest Surveys: 2005-2006

## Denbigh Experimental Forest

The Denbigh Experimental Forest, located 13 miles west of Towner, ND is owned by the USDA Forest Service. The experimental forest was established to determine what tree species and seed sources would grow well in the northern Great Plains. Over 40 tree species from numerous seed sources were planted during the 1930s, 1940s, and 1960s. About half of the 636-acre experimental forest has been planted to trees. In addition, the forest is open to public uses such as hunting, hiking, birding, and outdoor classrooms. Research projects at the experimental forest have ended, but the forest is still a valuable collection of provenances that are suited for planting in this region. The North Dakota Forest Service tree nursery at Towner currently uses the experimental forest for seed collection of several species. The nursery produces 1.2 million seedlings per year that are sold for use in conservation tree plantings.

A survey was conducted in 2005 to assess the condition of provenance plantings within the Denbigh Experimental Forest. Specific objectives of this survey were to identify insect and diseases present within the provenances, assess the damage caused by such pests, and identify emerging management needs of the experimental forest.

A total of 19 provenances representing nine species were randomly selected and surveyed during July of 2005. Species surveyed included: ponderosa pine (*Pinus ponderosa*), jack pine (*P. banksiana*), Scotch pine (*P. sylvestris*), Rocky mountain juniper (*Juniperus scopulorum*), green ash (*Fraxinus pennsylvanica*), Siberian larch (*Larix sibirica*), cottonwood (*Populus deltoides*), Black Hills spruce (*Picea glauca*), and bur oak (*Quercus macrocarpa*). Provenances were surveyed using a line-point sampling method in which data was recorded for every fifth tree encountered. For each tree, the height and DBH was recorded. In addition, a condition rating ranging from 0 (dead) to 100 (healthy) was given to each tree and the presence or absence of disease was recorded. Within provenances, weed competition and stand density were noted.

Condition ratings and pest incidence (percentage of trees infected) for the nine species surveyed are summarized in Table 1. Green ash and Rocky mountain juniper had the poorest condition ratings of all plantings surveyed (60.2 and 58.2 respectively). The condition ratings were highest for Scotch pine and jack pine provenances. Disease incidence was highest for ponderosa pine and cottonwood provenances.

The incidence and severity of damage due to diseases were variable across all provenances surveyed. The most common diseases include: oak anthracnose, ash fomes, diplodia shoot blight, cytospora canker, septoria canker, and cedar apple rust. Although such diseases may contribute to the overall decline of these plantings, management of these diseases throughout the entire experimental forest requires consideration of long-term goals and cost effectiveness of treatment. Given the experimental objectives of this forest, such pests should not be perceived merely as threats to this forest resource. Rather, pest susceptibility should be assessed with other factors when determining provenance suitability for conservation tree plantings of the northern Great Plains.

Emerging management needs of the Denbigh Experimental Forest include: thinning of dense plantings and removal of encroaching woody species, reducing risk of wildfire, and weed management. Implementation of these management efforts will require a more thorough inventory of the experimental forest to prioritize efforts, determine management costs, and develop a long-term

**Table 1. Summary of species data for all provenances surveyed.**

| Species | Number of Provenances | HT | DBH | Condition Rating | Disease(s) Observed | Disease Incidence |
|---|---|---|---|---|---|---|
| Ponderosa Pine | 7 | 61.6 | 13.9 | 73.6 | Diplodia Shoot Blight | 42.9 |
| Scotch Pine | 1 | 57.9 | 15.7 | 83 | None | 0 |
| Jack Pine | 1 | 66.7 | 9.4 | 79 | None | 0 |
| Siberian Larch | 1 | 54.9 | 11.3 | 73.7 | None | 0 |
| Cottonwood | 1 | 64.9 | 15.8 | 65.4 | Septoria canker | 100 |
| Black Hills Spruce | 1 | 48.2 | 14.8 | 69 | Cytospora canker | 40 |
| Bur Oak | 2 | 31.1 | 6.7 | 81.7 | Oak Anthracnose | 40 |
| Green Ash | 2 | 30.6 | 6.1 | 60.2 | Ash Fomes | 26.7 |
| Rocky Mtn Juniper | 3 | 19.9 | 5.5 | 58.2 | Cedar Apple Rust | 28.9 |

forest management plan. Such a plan should address potential customer uses, current and future uses related to tree production by the Towner State Nursery, initial and future objectives of the forest. Although no research currently exists, the provenances remain as a valuable collection of suitable species for the northern Great Plains and new information may be derived from the forest.

In the absence of management, tree provenances comprising the Denbigh Experimental Forest will continue to decline and the risk of wildfire will continue to increase. Such factors threaten the long-term survival and the use of the forest for future generations.

## Post-fire Assessment of Ponderosa Pine Mortality in Southwestern North Dakota

Conifer forests comprise 2% of North Dakota's forestland. Approximately 4,300 acres of ponderosa pine (*Pinus ponderosa*) are scattered throughout the far southwestern areas of the state. These stands are a unique ecological and cultural feature of the state's western landscape.

Fire suppression efforts within recent decades have allowed fuels to accumulate, creating conditions conducive for intense wildfires within these stands. Such wildfire concerns were realized as a prairie fire spread into portions of the native ponderosa pine stands of Slope County in September of 2004 (figure 2). The fire (designated as the Deep Creek Fire) burned approximately 800-acres of privately-owned ponderosa pine. Many stands were severely damage by the fire as high winds coupled with heavy fuel loads intensified the fire. Tree mortality approached 100% within these stands as flames consumed nearly all live needles and caused extensive stem charring.

Fire intensity decreased during periods of cooler temperatures and lower wind speeds resulting in some areas sustaining low to moderate levels of damage. Estimations of tree mortality are less certain within these stands as some fire-injured trees may persist for several years before succumbing to death. A combination of factors such as crown injury, cambial injury, stem injury, and root injury have been shown to cause tree mortality

**Figure 2. The Deep Creek Fire varied in fire intensity creating a mosaic of tree mortality; ranging from severely burned stands (left) to low to moderate levels of mortality (above).**

within the two years following the fire. Often such fire injuries may predispose a tree to bark beetle (Coleoptera: Scolytidae) attack.

A survey was conducted to assess ponderosa pine mortality within stands subjected to low to moderate wildfire intensity. Such information may prove useful when determining desired fire behavior if prescribed burning is to be incorporated into the long-term management of North Dakota's pine resource.

During the spring of 2005, ponderosa pine stands located on the Logging Camp Ranch were inspected to identify areas sustaining low to moderate damage from the Deep Creek Fire of the previous fall. Three pine stands approximately five acres in size meeting this criteria were delimited. Within each of these stands, three 1/35$^{th}$ acre fixed radius plots were established. All live and dead ponderosa pine within the plots were marked with a metal tag and surveyed on June 13, 2005. For each tagged tree, the tree diameter at breast height (inches), tree height (ft), stem char height (ft, recorded on both uphill and downhill sides of the tree), and percent crown scorch were recorded. All survey plots were revisited in October 2005 and again in October 2006 to identify those trees that had died during the first and second growing seasons following the fire.

Table 2 summarizes the total ponderosa pine mortality two years after the fire within the nine plots surveyed. The average stem char height (estimated as the average char height of all trees within a given survey plot) ranged from 1.44 ft to 11.13 ft. Percent crown scorch (estimated as the average crown scorch of all trees within a given survey plot) ranged from 0.0% to 85.38%. Percent tree mortality within plots ranged from 0.0% to 82.35% by the end of the second growing season. Tree mortality corresponded with fire severity. Figures 3 and 4 show the linear relationship between tree mortality and crown scorch and stem char height respectively. The effects of fire on tree mortality can be useful information for the long-term management of North Dakota's pine resource including: predicting tree mortality following fire, determining desired fire intensity when prescribed fire is used, and making salvage harvesting decisions in the event of future wildfires.

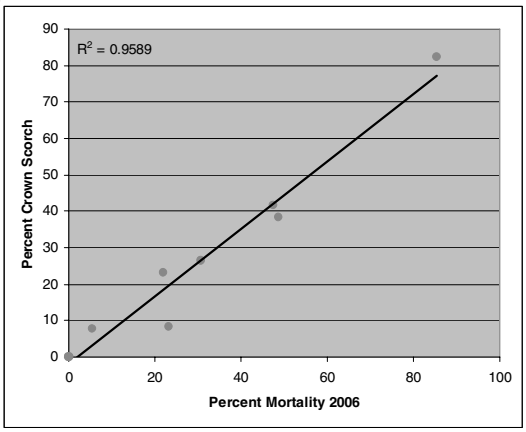


**Figure 3. Relationship of ponderosa pine mortality and percent crown scorch.**

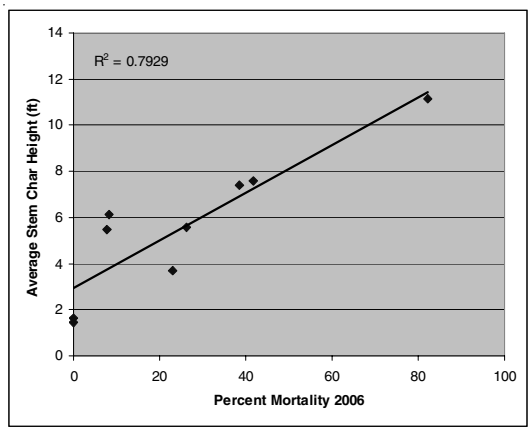


**Figure 4. Relationship of ponderosa pine mortality and stem char height.**

**Table 2. Summary of data obtained from survey plots within burned pine stands.**

| Stand | Plot | Plot BA | Average DBH | Average Tree Ht. | Crown Scorch | Avg. Char Ht. | Percent Dead October 06 |
|---|---|---|---|---|---|---|---|
| | | | (in) | (ft) | (%) | (ft) | |
| 1 | 1 | 167 | 9.73 | 35.25 | 23.33 | 6.13 | 8.33 |
| 1 | 2 | 168 | 6.70 | 31.71 | 47.50 | 7.58 | 41.67 |
| 1 | 3 | 152 | 8.68 | 34.46 | 48.85 | 7.40 | 38.46 |
| 2 | 4 | 160 | 5.56 | 26.74 | 85.38 | 11.13 | 82.35 |
| 2 | 5 | 115 | 7.35 | 28.38 | 21.92 | 3.71 | 23.08 |
| 2 | 6 | 86 | 5.61 | 22.39 | 0.00 | 1.44 | 0.00 |
| 3 | 7 | 108 | 6.18 | 28.53 | 30.79 | 5.59 | 26.32 |
| 3 | 8 | 105 | 6.33 | 23.78 | 0.28 | 1.63 | 0.00 |
| 3 | 9 | 148 | 9.77 | 40.62 | 5.38 | 5.48 | 7.69 |

## Dutch Elm Disease in North Dakota Communities

Dutch elm disease (*Ophiostoma ulmi* and *O. novo-ulmi*) is the most damaging infectious tree disease in North Dakota. This disease has significantly altered the native forests and rural tree plantings of the state over the past 35 years. The impact of Dutch elm disease (DED) continues to be felt in community forests (including boulevard trees, city park trees, and residential home landscapes). Every year, community forestry departments, utilities, and tree boards spend considerable time, effort, and money to minimize the impacts of DED.

Thirty North Dakota communities were polled to obtain information regarding DED trends in 2003 and 2004. An additional 20 communities provided DED information in 2005 and 2006. These communities represent a broad range of populations, geographical areas within the state, and provide baseline information for DED impacts. Each polled community was asked to provide information regarding: number of DED removals in 2003, 2004, 2005, and 2006. Since smaller communities have a smaller proportional tree resource, the communities were c ategorized based on population size: communities under 1,500 persons, communities with 1,500 to 10,000 persons, and communities over 10,000 persons. Generally, there was an increase in the incidence of DED from 2005 to 2006 for communities with populations under 1,500, 1,500 to 10,000, and over 10,000. The numbers of DED removals over the past four years are summarized in Figures 5, 6, and 7 for each population category.

Over the past four years communities under 1,500 saw a rise in DED despite the fact that the number of remaining elms in these communities are decreasing. Elms killed by DED remained relatively steady for communities with populations between 1,500 and 10,000. Communities over 10,000 population saw a decline of DED removals in 2005 and 2006 in comparison to the previous two years. A more thorough community forest inventory would shed additional light on DED as it is difficult to ascertain the impacts of this disease without converting DED losses into relative terms (total number of removals /total number of remaining elms in the community).

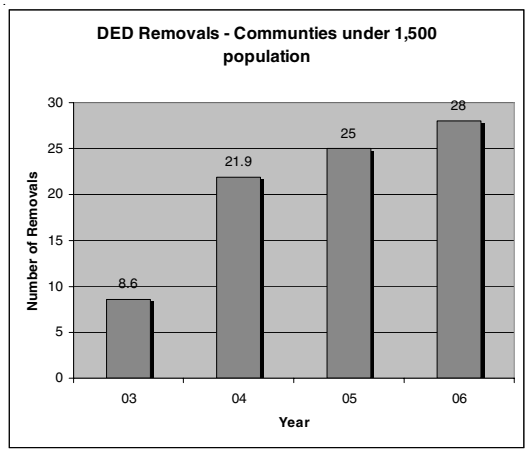


**Figure 5.**

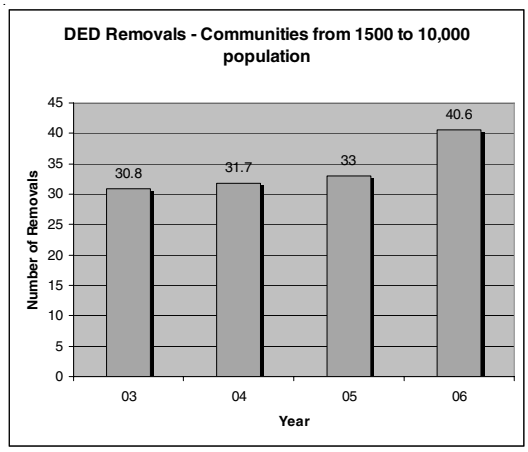


**Figure 6.**

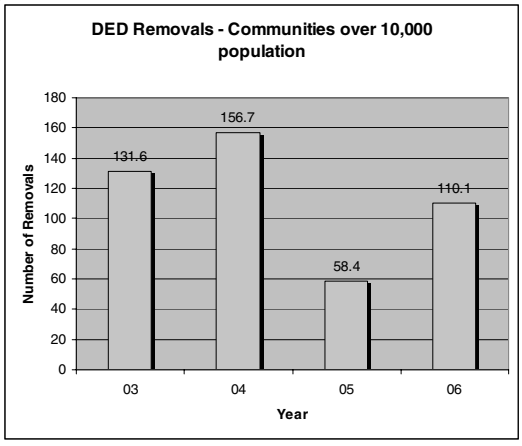


**Figure 7.**

# Section III. Specific Insect and Disease Trends and Weather-Related Damage 2005-2006

The following summaries describe recent trends for insect, disease, and weather related damage to trees observed in 2005 and 2006. These descriptions are not inclusive to all pests and events, but rather highlight the more notable changes in incidence and severity.

## Foliar Diseases of Deciduous Trees

Cool, wet conditions during 2005 were favorable for infection and disease development of several foliar diseases. Some of the commonly observed foliar diseases of deciduous species included: ash anthracnose (*Gnomoniella fraxini*), oak anthracnose (*Discula umbrinella*), septoria leaf spot (*Septoria musiva*) and melampsora rust (*Melampsora* spp.) of *Populus* spp. and *Salix* spp. Moisture conditions from late-May through July were well above average during 2005, resulting in higher foliar disease incidence and severity. The damage caused by these pathogens subsided in 2006 as drier conditions limited disease development throughout the mid-summer.

## New Fungus Found on Needles of Spruce

In 2006, a new fungus was confirmed on spruce samples received by the North Dakota State University Plant Diagnostic Lab. Symptoms were consistent with those observed for rhizosphaera needle cast, however, fruiting bodies and spore dimensions were not. The fungus was confirmed to be *Stigmina lautii*. Very little is known about the biology of *S. lautii* and it is not known whether the fungus is a pathogen, mycoparasite, or endophyte. Similarly, it is not known how long the fungus has been present within the state. Following confirmation, the fungus was found on Colorado blue spruce and white spruce in several locations of the state. Anecdotal evidence suggests that it has been present for several years and may have been misidentified as being *Rhizosphaera kalkhofii* based on symptoms observed in the field.

## Diplodia Shoot Blight

Shoot blight, caused by *Diplodia pinea* (syn. *Sphaeropsis sapinea*) has been confirmed in many ponderosa pine plantings throughout the state. Symptoms include shoot blight and twig dieback. Severely infected trees may be deformed and killed. Trees of all ages are susceptible, however, older, cone-bearing trees appear to sustain the greatest amount of damage.

Diplodia shoot blight has been found periodically throughout North Dakota in past years, however, the incidence and severity of this disease has increased in recent years. This trend may be attributed to moist conditions in recent years that favor infection and cone production associated with aging ponderosa pine windbreaks.

## Yellow-headed Spruce Sawfly

The yellowheaded spruce sawfly (*Pikonema alaskensis*) is a damaging defoliating insect of spruce plantings in North Dakota. The insect is found throughout the northern half of the state and is most damaging in the northern tier counties and counties of the north central region. Infrequently the insect is found in the southern half of the state however severe damage is rarely observed (figure 8).

There are no native spruce stands in North Dakota however spruce is commonly used in rural and landscape plantings. Open growing conditions associated with these plantings provide favorable egg-laying sites for the sawfly. Female sawflies lay eggs in needles during shoot expansion in the spring. Larvae emerge within 5 to 10 days and feed on the new spruce needles for four to five weeks. Once the new foliage has been consumed, the larvae migrate to older foliage and continue feeding. Under severe infestations, entire trees can be defoliated and killed. Even moderate defoliation can significantly reduce the efficiency of windbreaks and predispose spruce trees to other damaging agents.

**Figure 8. Yellowheaded spruce sawfly larvae.**

All species of spruce planted in North Dakota are susceptible to the yellowheaded spruce sawfly, however, Colorado blue spruce (*Picea pungens*) appears to be preferred by the insect and sustains the greatest amount of damage. Additionally, the insect is most damaging to young spruce trees (less than 15-years old) whereas older trees appear to be avoided by the insect. Sawfly outbreaks typically last for three to four years and often occur in intervals of seven to twelve years.

Sawfly damage has been most significant in the north-central and northeast parts of the state during the past four years. Damage was most severe in Benson and Wells Counties in 2005 and 2006.

## Cottony Ash Psyllid

A non-native, leaf-feeding insect known as the cottony ash psyllid (*Psyllopsis discrepans*) was detected in Fargo, Grand Forks, Minot, Hankinson, Dickinson, and Bismarck in 2005 and 2006. Black ash (*Fraxinus nigra*), Manchurian ash (*F. mandshurica*), and cultivated varieties/hybrids of the two are hosts to this insect. Insect feeding causes curling of leaves and defoliation under severe infestations (figure 9). Such damage may incite tree decline, particularly on drought-stressed trees.

Decline of black ash street trees have been observed in North Dakota communities during the past five to ten years. Although, the psyllid appears to have caused substantial damage near Bismarck during 2005 and 2006, the insect was not observed during a black ash street tree survey of Fargo in 2004, nor was it found in previous years. Consequently, the role of this new pest in the ash decline remains unclear. In addition to damage caused by the psyllid, stem cankers caused by *Cytospora* spp. (unidentified at species level) and alcohol flux have contributed to the decline of these cultivars. Similarly, declining cultivars have shown symptoms consistent with those caused by ash yellows.

**Figure 9. Adult psyllid on black ash leaflet (Justin Knott, NDDA).**

## Cankerworms

Defoliation caused by spring cankerworm (*Paleacrita vernata*) and fall cankerworm (*Alsophila pometaria*) was observed in several locations of the state in 2006. Outbreaks of these species occur periodically in North Dakota, however, no outbreaks have been observed since the late 1990s. Damage was most severe along the Knife River and Spring Creek in Mercer County in 2006. Lower levels of defoliation caused by cankerworms ware observed in several other counties as well. The increased number of reports in 2006 suggests that spring and fall cankerworm populations may be on the rise and damage to hosts may increase in the years to follow.

## Cottony Maple Scale

Several communities experienced outbreak levels of the cottony maple scale (*Pulvinaria innumerabilis*). This pest is common within communities but often goes unnoticed. The scale population exploded in 2006. Scale infestations were observed on several tree species, however, damage was most severe on silver maple.

## Weather-Related Damage

The prairie environment presents many unfavorable conditions for the health and survival of trees. Damage to many rural tree plantings is associated with unfavorable soil conditions such as high pH, poor drainage, and fluctuating water tables. Weather influences such as prolonged drought, unseasonable frosts, hail, and ice storms may cause damage as well. Other damaging factors include herbicide damage, wildlife damage, fire, and grazing. Such conditions of the prairie environment may predispose trees to secondary pests and exacerbate damage caused by others.

Very dry conditions were observed throughout North Dakota from mid-June until late August of 2006. Water deficiency stress may exacerbate damage caused by other pests, or if severe, may incite stress among trees. Trees most affected by the dry conditions include, recently planted trees, seedlings and saplings, and drought intolerant species. In addition, water deficit may result in increased winter desiccation of conifers.

Ice storms are a common occurrence in North Dakota. These storms tend to be most damaging when they occur in the early growing season after trees have broken dormancy and in the early fall prior to dormancy and when leaves remain on trees. Two such events occurred in 2005. A late spring ice storm caused considerable damage in the northeastern part of the state. Another ice storm in September of 2005 caused significant damage to trees in communities of western North Dakota.

# Section IV. Invasive Pest Issues of Concern

## Emerald Ash Borer – Not in North Dakota

The emerald ash borer (*Agrilus planipennis*) poses a serious threat to North Dakota's native and planted ash resources. The North Dakota Forest Service and the North Dakota Department of Agriculture coordinated sentinel trap tree surveys of five North Dakota communities during 2005. Although the likelihood of an emerald ash borer (EAB) detection within the state is low, such trapping efforts provide an opportunity to assess trapping effectiveness, identify native ash boring pests, and coordinate future efforts with city foresters. In addition to trap tree surveys, visual inspections were conducted at several parks and campgrounds throughout the state. As expected, EAB was not detected during any surveys.

Education and outreach efforts directed at city foresters, state agencies, decision makers and the general public have begun and will continue as an important component of the state's preparation for this potential threat. These outreach efforts have focused on firewood movement and nursery shipments from eastern states. In addition, diversification of community forests and rural tree plantings continues as an important message.

**Gypsy Moth**

The gypsy moth (*Lymantria dispar*) is a non-native defoliating insect pest that feeds on numerous deciduous trees. Since its introduction to the US in 1896, the moth has spread across the northeast and Midwest and damaged millions of acres of forestland.

The North Dakota Forest Service, North Dakota Department of Agriculture, the USDA Forest Service and the USDA Animal Plant Health Inspection Service conduct annual statewide gypsy moth detection surveys. There were 419 and 365 gypsy moth detection traps placed in 2005 and 2006, respectively. These traps were distributed throughout the state to encompass major forest types at risk of gypsy moth introduction.

There were no gypsy moths caught in 2005 and 2006. The gypsy moth has been detected periodically in past years as single egg masses and larvae can be transported long distances on cars, recreational vehicles, nursery stock and other items. One gypsy moth was detected in 2003 and two additional gypsy moths were detected in 2004. Despite those isolated detections, there are no known established gypsy moth populations in North Dakota as of this date and trapping efforts will continue in the future and include new areas of potential risk.

# Summary

Forest and tree resources provide numerous ecological, social, and economic benefits to North Dakota residents. These resources provide wildlife habitat, provide recreational opportunities, stabilize river banks, filter water runoff from adjacent agricultural lands, provide jobs, protect people and property from adverse weather conditions, and enhance the quality of life.

Although North Dakota's forested resources are generally resilient to damage imposed by pests and adverse weather conditions, sustainability issues have arisen in recent years. Some sustainability issues reflect over-maturity of existing stands and suppression of natural disturbances essential to regenerate forests, whereas, others are a consequence of damage imposed by non-native pests. Such pressures coupled with periodic outbreaks of native forest pests may hasten the decline of susceptible forest and tree resources. Direct suppression of forest pests is an unrealistic task to implement on broad scales and do not address the underlying sustainability issues. Indirect approaches aimed at preventing pest outbreaks, managing native woodlands to mimic natural disturbances, and incorporating species diversity may be more suitable for improving the condition of the susceptible forested resources within the state. Developing new financial opportunities that can offset the costs of such forest management techniques will be major challenges in the decades to come.

In addition to current pressures, the state's forested resources are at risk to new pests not yet established within the state. The recent expansion of the emerald ash borer (*Agrilus planipennis*) and the gypsy moth (*Lymantria dispar*) within the Midwest has generated great concern among natural resource professionals in North Dakota. Slowing the spread and preventing these and other invasive pests from becoming established in new areas will be major challenges for forestry and regulatory agencies in the immediate future.

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# Appendix 1. Forest Insect and Disease Notes 2005-2006

There are numerous insect pests, infectious diseases, and non-infectious diseases of trees and shrubs in North Dakota. Many of these damaging agents are frequently observed within the state, however, the imposed damage is often restricted to localized sites and have not warranted concern on a broader scale. Regardless, these pests are reported here to aid in interpretations of long-term trends. For each pest, the host range and known distribution within the state is listed. In addition, a damage code (listed below) is assigned that generally classifies its position in the tree decline process.

**Host Range:** *Hosts observed within North Dakota*

**State Distribution:** *Statewide, east, west, unknown, or specific counties listed*

**Damage Code:** ***Inciting*** *– a primary stressing agent that may incite the decline of an otherwise healthy tree:* ***Contributing*** *– an agent that may kill or damage a tree weakened by other factors;* ***Aesthetic*** *– a cosmetic pest that may alter the appearance of the tree but does not threaten the tree's health*

**Trend:** *Increasing over past 10 years, Decreasing over past 10 years, Static (unchanged), or Unknown etc.*

## Infectious Diseases

- Crown Gall of Willow (*Agrobacterium tumefaciens*)
  Host Range: *Salix* spp.
  State Distribution: Statewide, more common in Red River Valley
  Damage Code: Inciting
  Trend: Static
- Ash Rust (*Puccina sparanginoides*)
  Host Range: *Fraxinus* spp.
  State Distribution: Statewide
  Damage Code: Inciting/aesthetic – dependent on host and severity
  Trend: Static
- Cedar-apple rust (Several *Gymnosporangium* spp)
  Host Range: Juniperous and Rosaceous species
  State Distribution: Statewide, common
  Damage Code: Inciting/aesthetic – dependent on host and severity
  Trend: Increased during 2003, 2004, and 2005. Slight decrease in 2006.
- Ash Stem Decay (*Perenniporia fraxinophila*)
  Host Range: *Fraxinus* spp.
  State Distribution: Statewide, common
  Damage Code: Contributing
  Trend: Increasing over past 10 years
- Eutypella canker (*Eutypella parasitica*)
  Host Range: *Acer* spp.
  State Distribution: Common on Norway maple across the state
  Damage Code: Contributing
  Trend: Unknown
- Stem Cankers of Russian Olive (*Tubercularia*, *Phomopsis*, and others)
  Host Range: Russian olive
  State Distribution: Statewide, common
  Damage Code: Contributing
  Trend: static
- Cankers of Siberian Elm (*Tubercularia*, *Botryodiplodia* and others)
  Host Range: *Ulmus pulima*
  State Distribution: Statewide, common
  Damage Code: Contributing in conjunction with herbicide exposure, cankerworm defoliation and lack of cold hardiness
  Trend: Botryodiplodia increasing over past 10 years; Tubercularia decreasing over past 10 years
- Apple scab (*Venturia inaequalis*)
  Host Range: *Malus* spp.
  State Distribution: Statewide, common
  Damage Code: Inciting
  Trend: Increased during 2003, 2004, and 2005. Slight decrease in 2006.
- Botryosphaeria canker of Apple (*Botryosphaeria obtusa*)
  Host Range: *Malus* spp.
  State Distribution: Unknown
  Damage Code: Contributing
  Trend: Unknown
- Black Knot (*Apiosporina morbosa*)
  Host Range: *Prunus* spp.
  State Distribution: Statewide – less prevalent to the West
  Damage Code: Contributing
  Trend: Decreasing slightly since 2000
- Cytospora canker of Spruce
  Host Range: *Picea* spp.
  State Distribution: Statewide
  Damage Code: Contributing
  Trend: Static
- Fireblight (*Erwinia amylovara*)
  Host Range: Mountain ash, Apple, Cotoneaster, Crabapple, other Rosaceous hosts
  State Distribution: Statewide, common
  Damage Code: Inciting/aesthetic
  Trend: Increasing over past 10 years/Static
- Melampsora Leaf Rust (*Melampsora medusae*)
  Host Range: *Populus* spp.
  State Distribution: East/unknown – disease incidence unknown to West
  Damage Code: Inciting
  Trend: Above normal in 2004 and 2005. Decrease in 2006.
- Plum Pockets (*Taphrina communis*)
  Host Range: *Prunus* spp.
  State Distribution: Unknown
  Damage Code: Inciting/aesthetic – may limit fruit production
  Trend: Unknown
- Powdery Mildew (*Microsphaera*, *Erysiphe* species and others)
  Host Range: Numerous deciduous woody plants
  State Distribution: Statewide
  Damage Code: Inciting/aesthetic
  Trend: Increased in 2004 and 2005.

- Western Gall Rust (*Endocronartium harknessii*)
  Host Range: *Pinus* spp.
  State Distribution: Statewide
  Damage Code: Inciting – particularly to Asian *Pinus* hosts
  Trend: Increasing over past 10 years
- Verticillium Wilt (*Verticillium dahliae*)
  Host Range: Several species, most common on Elm and Maple
  State Distribution: Unknown
  Damage Code: Inciting
  Trend: Unknown
- Rhizosphaera needle cast (*Rhizosphaera kalkhoffii*)
  Host Range: Picea spp.
  State Distribution: Statewide, more prevalent in NE
  Damage Code: Inciting
  Trend: Increased in 2004 and 2005. Slight decrease in 2006.
- Wetwood (Numerous bacteria)
  Host Range: *Ulmus*/*Populus* spp.
  State Distribution: Statewide, common
  Damage Code: Contributing/aesthetic
  Trend: Static

## Noninfectious Diseases

- Iron Chlorosis
  Host Range: Silver Maple, some Birches and Hybrid Poplars
  State Distribution: Statewide/East – most common in Red River Valley
  Damage Code: Inciting/aesthetic
  Trend: Static
- Winter Injury of Conifers
  Host Range: Numerous conifer species, especially *Picea* spp.
  State Distribution: Statewide – most common in drier western sites
  Damage Code: Inciting/aesthetic
  Trend: Decreasing over past 3 years due to above normal moisture

## Insects

- Ash Bark Beetles (*Hylesinus* spp)
  Host Range: *Fraxinus* spp.
  State Distribution: Statewide, common
  Damage Code: Contributing
  Trend: Static
- Ash Lilac Borer (*Podosesia syringae*)
  Host Range: *Fraxinus* and *Syringia* spp.
  State Distribution: Statewide, common
  Damage Code: Inciting/Contributing
  Trend: Static
- Ash Flowergall Mite
  Host Range: *Fraxinus* spp.
  State Distribution: Statewide, common
  Damage Code: Aesthetic
  Trend: Increasing
- Redheaded Ash borer (*Neoclytus acuminatus*)
  Host Range: *Fraxinus*, *Tilia*, *Ulmus* and other spp.
  State Distribution: Statewide, common
  Damage Code: Contributing
  Trend: Static
- Ash Plant bug (*Tropidesteptes* spp)
  Host Range: *Fraxinus* spp.
  State Distribution: Statewide, common
  Damage Code: Aesthetic
  Trend: Static
- Carpenterworm (*Prionoxystus robiniae*)
  Host Range: Several species, common on ash and elm
  State Distribution: Statewide
  Damage Code: Contributing
  Trend: Static, remains at low level
- Chokecherry midge (*Contarinia virginianiae*)
  Host Range: *Prunus* spp.
  State Distribution: Unknown
  Damage Code: Aesthetic
  Trend: Unknown
- Cottony maple scale (*Pulvinaria innumerabilis*)
  Host Range: Several species, Maple, Elm, Boxelder, Linden
  State Distribution: Statewide, common
  Damage Code: Inciting
  Trend: Increased to outbreak level in 2006.
- European fruit lecanium scale (*Parthenolecanium corni*)
  Host Range: Ash and other deciduous species
  State Distribution: Statewide, common
  Damage Code: Inciting
  Trend: Unknown
- Fall webworm (*Hyphantria cunea*)
  Host Range: Chokecherry, ash, and other deciduous hosts
  State Distribution: Statewide, common
  Damage Code: Aesthetic
  Trend: Static
- Maple bladdergall mite (*Vasates quadripedes*)
  Host Range: Red and Silver Maples
  State Distribution: Statewide, common
  Damage Code: Aesthetic
  Trend: Above normal in 2005 and 2006.
- Oystershell scale (*Lepidosaphes ulmi*)
  Host Range: Several deciduous species
  State Distribution: Statewide
  Damage Code: Inciting
  Trend: Static
- Pine needle scale (*Chionaspis pinifoliae*)
  Host Range: Conifers, common of Spruce and Pine
  State Distribution: Statewide, common
  Damage Code: Inciting – more damaging to the west
  Trend: Unknown
- Poplar Borer (*Saperda calcarata*)
  Host Range: Aspen, Cottonwood, Poplar, Willow
  State Distribution: Statewide, common
  Damage Code: Contributing – particularly in west
  Trend: Static
- Spruce spider mite (*Oligonychus ununguis*)
  Host Range: Conifers, most common on Spruce
  State Distribution: Statewide, common
  Damage Code: Inciting
  Trend: Decreasing over past 10 years
- Spring Cankerworm (*Paleacrita vernata*) and Fall cankerworm (*Alsophila pometaria*)
  Host Range: Numerous deciduous species, particularly *Ulmus* and *Fraxinus*
  State Distribution: Statewide
  Damage Code: Inciting
  Trend: Increasing

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