Biennial Forest Health Report

North Dakota 2015-2016

NDSU

North Dakota Forest Service
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Overview

This report summarizes forest pest conditions observed in 2015 and 2016 and describes emerging forest health issues in relation to their effect on the sustainability and societal value 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, or the robustness of the forest's ability to provide social, economic and cultural benefit while maintaining its ecological functions.

All forests undergo succession, a natural change in vegetation through 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, nutrient gradients and various human-caused injuries.

Biotic pressures include fungi, insects, plants, animals, bacteria, phytoplasmas and nematodes that attack trees.

Such pressures are often 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 what is normal or conflict with our management objectives.

Additionally, pressures resulting from human activity and the introduction of non-native insects and pathogens may impair the long-term sustainability of forests substantially.

Report was compiled and written by Lezlee Johnson, Forest Health Manager, North Dakota Forest Service, and formatted by Dave Haasser, Graphic Designer, NDSU Agriculture Communication.

Cover photo of the Pembina Gorge: Aaron Bergdahl, NDFS

Forestland Ownership Distribution

Forests are an important part of North Dakota's natural resource heritage. Forests provide access to outdoor educational and recreational opportunities and managed wildlife habitat, and play an important role in protecting watersheds.

Roughly 68 percent (475,000 acres) of forestland in North Dakota is categorized as privately owned (Figure 1). The federal government, primarily the U.S. Forest Service, is responsible for the management of roughly 167,000 acres, or 24 percent, while the state and local entities manage just more than 56,000 acres, or 8 percent, of the forestland. (Haugen et al. 2012).

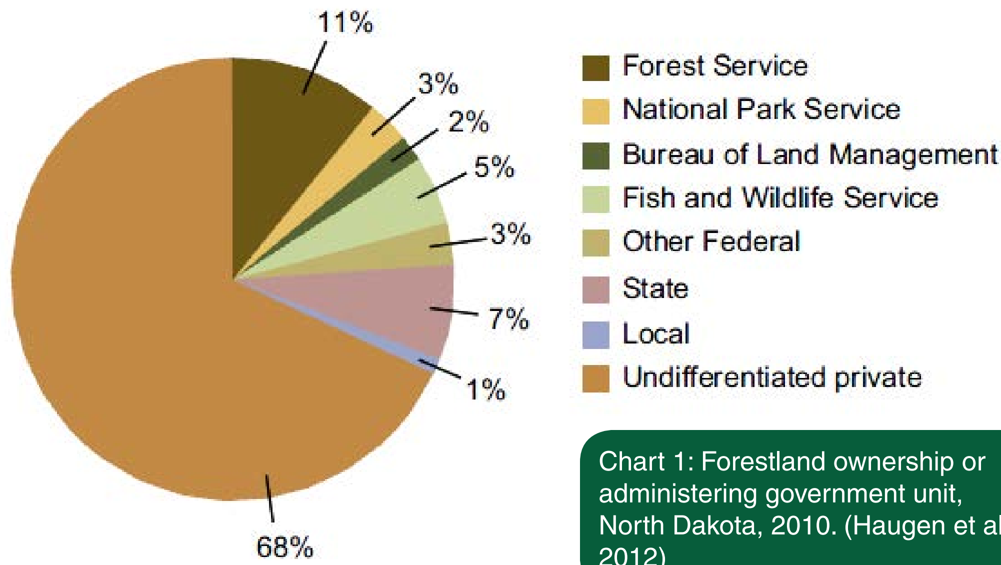


Chart 1: Forestland ownership or administering government unit, North Dakota, 2010. (Haugen et al. 2012)

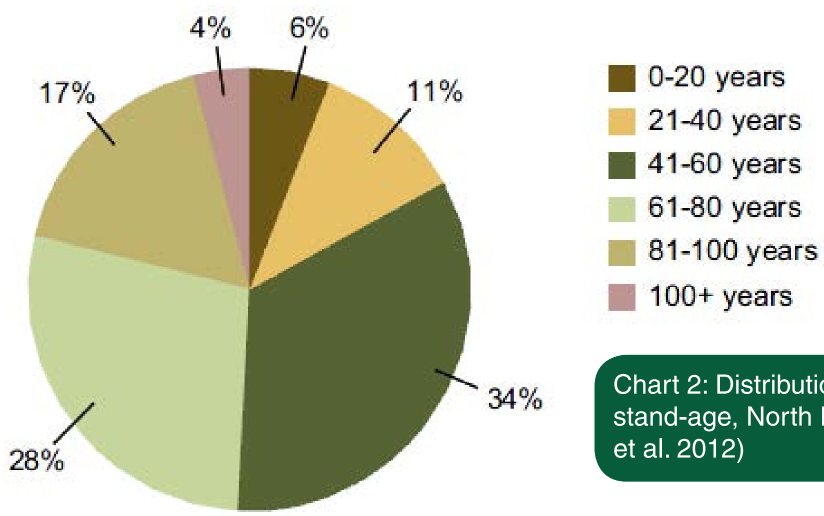


Chart 2: Distribution of forestland by stand-age, North Dakota. (Haugen et al. 2012)

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 distributed sparsely across the state and cover 753,600 acres, approximately 1.5 percent of North Dakota's total land area (Figure 1 and Appendix 1). Eastern deciduous and western coniferous forest types are found in North Dakota. This creates a unique ecological transition zone, with forest species, including forest pests, representing both forest types.

Figure 1: North Dakota's largest native forests are found in the Turtle Mountains in Bottineau and Rolette counties. (Aaron Bergdahl, NDFS)

Deciduous forest types account for 98 percent 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 be included in 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 (north-central), Devils Lake Hills (center of northeastern quarter) and Pembina Gorge (northeastern corner).

Only 2 percent of the state's forestland is classified as western coniferous forests. These isolated stands consisting of ponderosa pine and Rocky Mountain juniper are in the southwestern counties of the state (Appendix 1).

Native forests provide wildlife habitat, 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. They 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:

- Reduced species diversity due to damage caused by non-native forest pests
- Overmaturity of existing stands in the absence of disturbances essential to regenerate forests (Chart 2)
- Lack of forest regeneration due to heavy deer browsing pressure and alteration of natural flood plains along rivers

Riparian Forests

Nearly one-fifth of North Dakota's forests occur within 200 feet of a stream or lake (Haugen et al. 2011) (Figure 2). The majority of these forests consist of ash, elm and cottonwood. The health and sustainability of these plant communities have important implications for water quality, flood control, wildlife habitat and recreational opportunities.

The elm/ash forest type is the most abundant of all native riparian forestland in the state. These forests have experienced significant alterations during the past decades due to damage caused by Dutch elm disease (*Ophiostoma ulmi* and *O. nova-ulmi*), overgrazing, altered water flows and conversion to nonforestland. The threat of the emerald ash borer is another significant issue with the potential to drastically affecting the elm/ash forest type along riparian areas due to the overall abundance of ash. Emerald ash borer has not been detected in North Dakota.

The cottonwood (*Populus deltoides*) forests that occur within the Missouri River flood plain are in poor condition, which 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 River flood plain 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, riparian cottonwood forest acres will continue to decline because no young cottonwoods will be available to replace the overmature trees that have succumbed to old age and senescence. While historic flooding along the Missouri and Souris rivers during the 2011 growing season has re-created a situation that would benefit the regeneration of cottonwood, the extent of regeneration is yet to be seen. Due to the infrequency of flooding events such as that in 2011, sustainability of cottonwood regeneration on the Missouri River is not likely without direct management.

Figure 2: Riparian forest resources, such as the pictured area on the Missouri River forming the border between Burleigh and Oliver counties, are the most common type of forestland in North Dakota. (Aaron Bergdahl, NDFS)

Figure 3: Native, predominantly aspen forests in the Killdeer Mountains of Dunn County, N.D. (Aaron Bergdahl, NDFS)

Aspen Forests

Nearly 17 percent of North Dakota's forestland is classified as the aspen/birch forest type (Figure 3). The majority of this forest type is in the Turtle Mountains, where the state's largest concentration of forestland is represented. 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 is 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 (FTC) (*Malacosoma disstria*) and, more recently, large aspen tortrix (LAT) (*Choristoneura conflictana*). Defoliation reduces growth, predisposes trees to other damaging agents and exacerbates the senescence of aging aspen stands. The declining aspen overstory may succeed to hazel (*Corylus spp.*) shrub land, in part due to the absence of shade-tolerant conifers in North Dakota.

Forestland owners have not actively pursued the harvest of aspen in the past two years. The vigorous regeneration of aspen that follows harvesting is important for the long-term perpetuation of this unique forested resource. Unfortunately, future opportunities to harvest North Dakota's timber likely will decrease due to the scarcity of sawmills, increasing mill production costs and decreasing demand for aspen wood products from local sources.

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 (Figure 4).

Rural tree plantings generally refer to field and farmstead windbreaks, living snow fences, wildlife plantings and other plantings 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 and increased gains for livestock, or protect farmsteads and rural homes from snow and wind, therefore saving energy while beautifying the homestead and surrounding area.

Figure 4: Farmstead and shelterbelt plantings in Pembina County, N.D. (Aaron Bergdahl, NDFS)

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 who live in the current agricultural landscape.

Tree plantings of the northern Plains are exposed to numerous pests and environmental conditions that reduce their effectiveness, hinder planting success and limit long-term survival. Deterioration of tree plantings often is incited by drought, flooding, wildland fire, early or late 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 is more effectively prevented 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 the decline of single-row Siberian elm and single-row green ash field windbreaks due to herbicide exposure, marginal cold hardiness and canker diseases, and the decline of Colorado blue spruce plantings due to yellowheaded spruce sawfly (*Pikonema alaskensis*) (predominantly in the western half of the state), Stigmina needlecast (*Stigmina lautii*) and, less commonly, Rhizosphaera needlecast (*Rhizosphaera kalkhoffii*) (both predominantly in the eastern half of the state), and Cytospora canker (*Cytospora kunzei*), which commonly occurs statewide. The impacts of these damaging factors could have been reduced greatly had additional species been incorporated into these plantings.

Community Forests

Community forests include boulevard trees, trees planted in city parks and trees that naturally occur in city limits or public rights of way. 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 (Figure 5).

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 planted in 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 in the community's forest. In addition, trees growing in 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 compound 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, many smaller communities lacking the financial resources to support a forestry staff have been and continue to be severely impacted by this disease.

Ash species have been the most common replacements for elms killed by Dutch elm disease. As a result, many community forests once dominated by elm now have an overabundance of ash. Although ash performs well on a variety of sites and conditions, the reliance on this species has raised concerns since the recent discovery of the emerald ash borer (*Agrilus planipennis*, an exotic ash-killing beetle) that is as close as Minneapolis and Duluth, Minn.

Many North Dakota communities are realizing the vulnerability of their community tree resource and are beginning to embrace the concept of species diversification. Overall, ash trees make up 48 percent of municipal tree populations (Johnson 2015).

Figure 5: Aerial view of the community forest resources of Velva, N.D. (Aaron Bergdahl, NDFS)

Section I

Weather-related Trends

In North Dakota, daily high temperatures above 50 F historically have occurred from mid-May to mid-October. In 2015 and 2016, these conditions occurred earlier in the spring – mid-April in 2015 and mid-March in 2016. Warmer conditions persisted into mid-November in 2016. The extended and wet spring in 2015 encouraged the development of leaf diseases across the state (Figure 6, left).

Ash anthracnose led to premature ash defoliation in several areas, and kabatina shoot blight of junipers (*Kabatina juniperi*) developed in conservation plantings in the southwest. Bacterial leaf spots of chokecherry and fungal oak leaf diseases were prevalent in 2015 – typical of years with similar spring precipitation patterns.

Foliar pathogens characterized by cyclic infection remained common in a few specific wetter areas of the state. Drier weather later in the summer across most of the state (Figure 6, right) limited further development of these foliar diseases.

During the 2016 growing season, North Dakota received near-normal rainfall except for drier-than-normal counties in the west (Figure 7). Rainfall in May was spotty and associated with severe storms, and June was very dry. Most of the state received slightly above-normal precipitation during July and August. A warmer and drier 2016 spring led to fewer reports of the leaf diseases dependent on cyclical infection.

During the 2015 and 2016 growing seasons, 66 tornadoes and 436 hail events were reported. The hail events led to increased reports of fungal cankers affecting Russian olive across the state in 2015.

These conditions have the potential to worsen infection by pathogens such as diplodia shoot blight (*Diplodia pinea*) of ponderosa pine and fire blight (*Erwinia amylovora*) in rosaceous hosts. In addition, damaged and downed trees and limbs are brood sites for wood-boring beetles, including Dutch elm disease vectors. While not immediately apparent, this damage may be more likely in coming years.

Stigmina needlecast (*Stigmina lautii*) spores are present when daily highs are above 50 F (Walla), historically from mid-May to mid-October. Stigmina infections may be possible during these extended warm periods.

Between 1993 and 2011, rising water levels at Devils Lake flooded adjacent land, killing 8,225 acres of trees (Figure 19). Water levels dropped slightly in 2015 and remained steady throughout 2016 (Figure 8) because inflows balanced discharges on East Devils Lake and West Bay. The lake level depends on inflows, evaporation and pumping until it reaches 1,457 feet, when it will flow over a structure into Tolna Coulee.

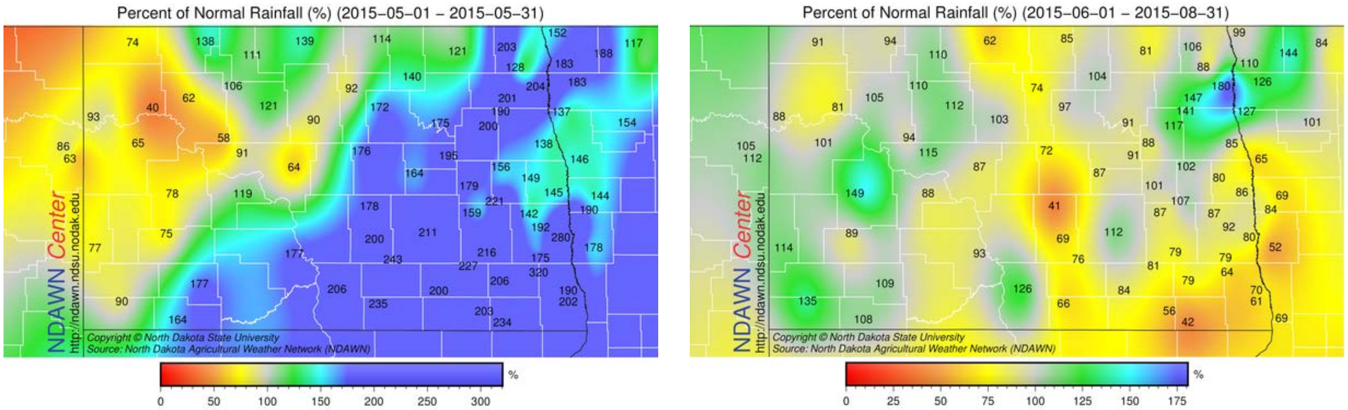


Figure 6: (left) Percent of normal rainfall maps in 2015 highlight a wet May followed by (right) near normal, dryer weather conditions.

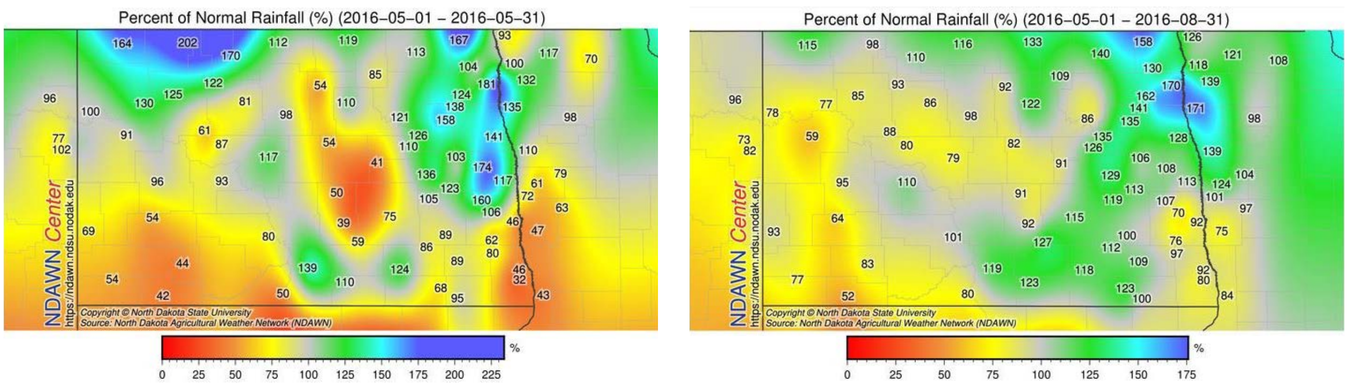


Figure 7: (left) Percent of normal rainfall for May 2016 and (right) percent of normal precipitation for 2016 growing season.

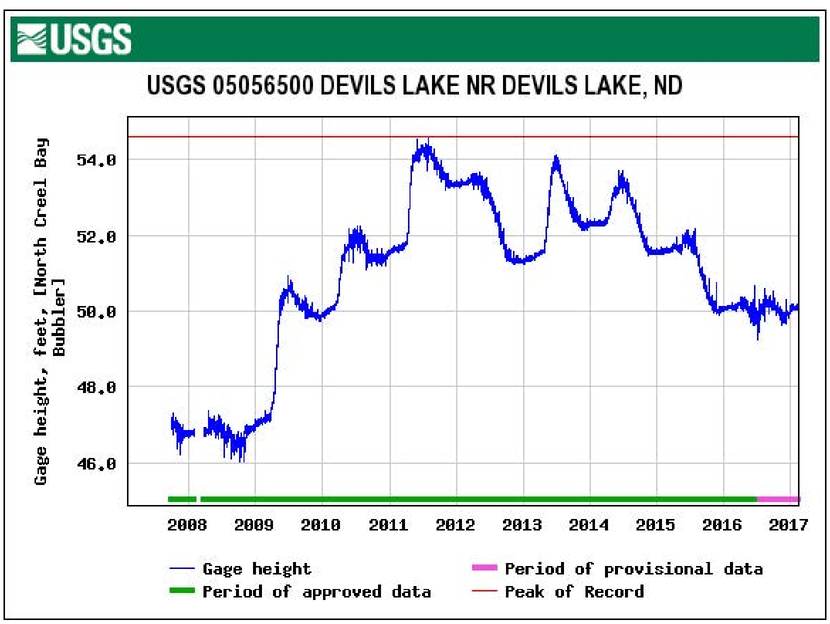


Figure 8: Devils Lake level 2008-2016.

Section II

Forest Health Surveys

Invasive Insect Trapping – Cooperative Surveys

- The North Dakota Department of Agriculture (NDDA) conducts Japanese beetle (*Popillia japonica*) surveying, and conducts exotic wood borer surveying in the state through the CAPS (Cooperative Agricultural Pest Survey) program. The U.S. Forest Service conducts gypsy moth trapping, setting out 350 traps in 2016. The APHIS (Animal and Plant Health Inspection Service), through a national program, contracts out trapping for emerald ash borer. No emerald ash borers (*Agrilus planipennis*) were detected. No gypsy moths were detected, either. The last known gypsy moth detection was in 2004 (Kangas).
- Japanese beetles have appeared every year since 2012 in decreasing numbers but in more counties and more varied land cover types (Elhard). With Japanese beetle spread appearing imminent, the NDDA will continue surveying in 2017 and will focus on public awareness and outreach. Japanese beetle has a strong feeding preference for basswood (*Tilia Americana*) and little-leaf linden (*Tilia cordata*), important components of community forests. Basswood also is a component of native forests and of conservation plantings.
- The 2016 Exotic Wood Borer survey trapped none of the 11 species of state/national concern from its 12 trapping locations in cities and potential entry sites. NDSU entomologist Gerald Fauske identified and recorded all specimens collected from the families *Scolytidae, Cerambicidae* and *Curculionidae*. Of the three Dutch elm disease vectors, the banded elm bark beetle (*Scolytus shevyrewi*) overwhelmingly outnumbered the European elm bark beetle (*Scolytus multistriatus*) and the native elm bark beetle (*Hylurgopinus rufipes*). Two years ago, all three appeared in samples in relatively equal numbers.

General Health of Spruce Plantings Across North Dakota

The following text was selected from a formal report prepared by Jim Walla of Northern Tree Specialties in Fargo, N.D. NDFS Forest Health contracted with Walla to do an in-depth survey of spruce tree health in North Dakota.

At least 10 spruce plantings in each of 10 counties distributed across North Dakota were examined in July and August 2014 (Figure 9). The purpose primarily was to determine incidence and severity of spruce needle diseases, and also to document other spruce health problems.

Stigmina needlecast (*Stigmina lautii*) or Rhizosphaera needlecast (*Rhizosphaera kalkhoffii*) (hereafter simply referred to as Stigmina and Rhizosphaera) were found in seven of the 10 counties, 55 percent of plantings and 38 percent of trees. Needlecast was prevalent in eastern counties, less common in central counties and not found in western counties.

Average disease severity ratings of Stigmina and Rhizosphaera were 2.1 and 1.8, respectively, on a scale of 3 (severe infection) to 0 (no damage) (Figure 10). Blue spruce and white spruce (Black Hills spruce) had similar incidence and severity of Stigmina. White spruce had much less Rhizosphaera than blue spruce. Stigmina was severe on one red spruce, a previously unknown host.

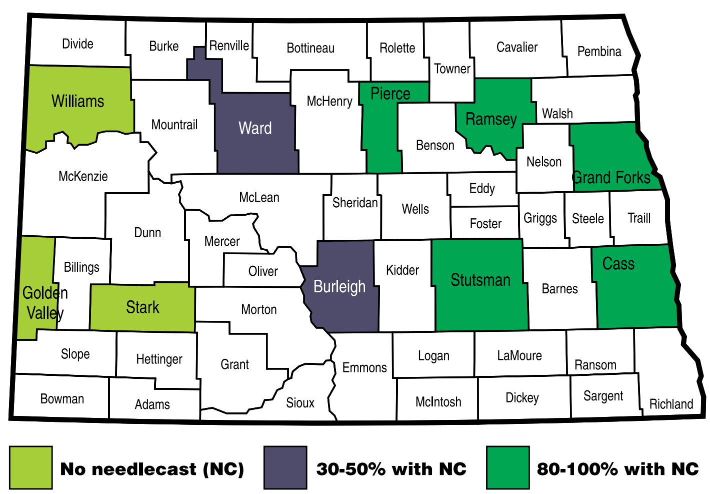


Figure 9. Incidence of needlecast in 10 counties surveyed in 2014. (NDSU)

Average natural and problem-associated crown porosity (area of openings visible through the crown) was 38 percent. The portion of crown porosity of trees with needlecast that was attributed to needlecast averaged 21 percent. Needlecast also damaged trees by decreasing vigor and killing weakened branches.

Stigmina was present on most trees (94 percent) with needlecast and usually appeared to be the predominant pathogen when present. Rhizosphaera was present on 52 percent of trees with needlecast.

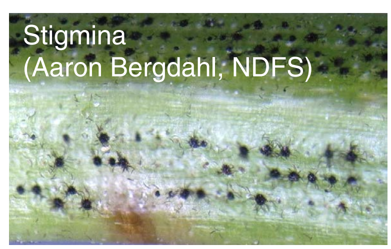
Because Stigmina is more damaging than Rhizosphaera, and fungicide management for Stigmina would be effective for Rhizosphaera but not vice versa, field or laboratory diagnosis of Stigmina needlecast at a site would make the presence of Rhizosphaera of little consequence in disease management decisions.

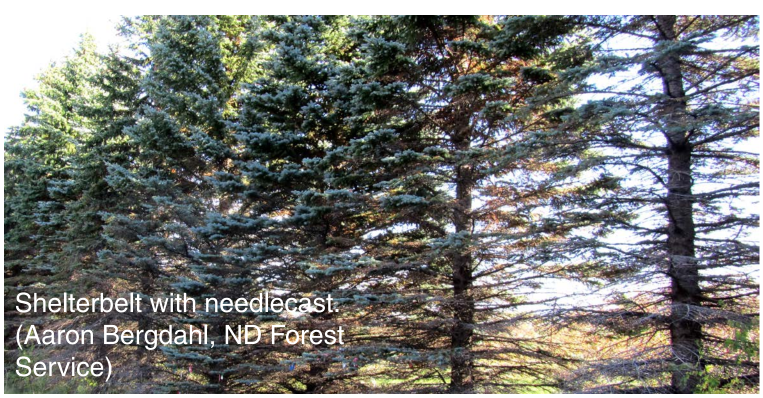
Incidence of Stigmina was about 1.5 times greater than Rhizosphaera on blue spruce (37 percent and 24 percent, respectively), and was four times greater than Rhizosphaera on white spruce (32 percent and 8 percent, respectively) (Figure 10).

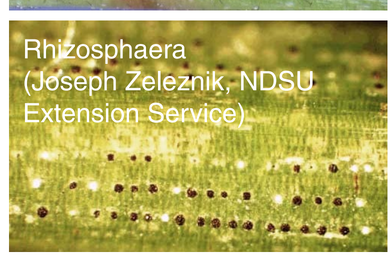
Figure 10. Incidence of Stigmina and Rhizosphaera.

		Stigmina				Rhizosphaera			
County	**Number of sites**	**% sites**	**% trees**	**ANSR**	**INSR**	**% sites**	**% trees**	**ANSR**	**INSR**
*Grand Forks	10	100	72	1.5	2.3	90	34	0.1	1.3
*Ramsey	10	100	69	1.4	2.0	70	21	0.1	2.0
*Pierce	10	100	83	1.3	2.3	100	52	0.4	1.9
Ward	13	42	19	0.5	2.2	42	14	0.1	1.0
Williams	10	0	0	0	x	0	0	0	x
*Cass	10	80	59	1.2	2.2	70	25	0.3	1.8
*Stutsman	10	100	65	1.3	2.1	100	54	0.9	2.0
Burleigh	10	30	11	0.1	1.0	20	3	0.02	1.0
Stark	11	0	0	0	x	0	0	0	x
Golden Valley	10	0	0	0	x	0	0	0	x
Average	Total 104	54	35	0.7	2.1	49	20	0.2	1.8

*Core needlecast counties.
ANSR = Average Needlecast Severity Rating (over all surveyed trees);
INSR = Infected-tree Needlecast Severity Rating (over needlecast-infected trees).
Rating scale:
3 = Severe (≥50% of foliage or crown affected);
2 = Moderate (10-49%);
1 = Light (1-9%); 0: No damage.


Stigmina (Aaron Bergdahl, NDFS)


Shelterbelt with needlecast. (Aaron Bergdahl, ND Forest Service)


Rhizosphaera (Joseph Zeleznik, NDSU Extension Service)

Underbark Temperatures of Green Ash Trees Across North Dakota

The underbark temperature of ash trees at five sites in North Dakota was monitored during the winter of 2014-2015 to gain information about patterns of temperature fluctuations of the ambient environment and how these influence the inner temperature of trees. This was done primarily to better understand the potential temperatures experienced by underbark-inhabiting insects, primarily wood-boring beetles.

With the potential threat of the emerald ash borer, NDFS forest health staff thought this information could be very useful when cross-referenced with field studies on the cold hardiness of the emerald ash borer.

In December 2014, temperature sensors were installed (Figure 11) at the following locations statewide (a reason for each site's selection is provided):

- Fargo, Trefoil Park: This area represents a typical riparian forest environment in North Dakota with a high number of ash trees. The area also is close to North Dakota State University, so it can be monitored easily. This area is representative of the climate of eastern North Dakota.
- Fargo, downtown: This area represents a typical urban environment surrounded by mostly asphalt and concrete. This area provides an excellent contrast to rural and natural environments (Figure 11).
- Bottineau and Walhalla: The locations were chosen as areas that experience cold temperature extremes - some of the coldest temperatures in the U.S. Also, these areas contain our largest contiguous native forest resources.
- Mandan, Agricultural Research Station: This was a convenient location just outside the Bismarck/Mandan metropolitan area, and due to the high population of Bismarck and Mandan, this is an area with greater potential for the introduction of emerald ash borer by unintentional human transport. This area also is representative of the climate of western North Dakota.

The ambient temperatures and the inner-bark temperatures on the south side (warmest side) of ash trees in a park setting and an urban setting were recorded throughout the

Figure 11. (top) The typical setup of the underbark temperature sensors pictured at the NDFS Field Station in Walhalla, ND. (bottom) A Temperature sensor installed at a NDSU campus location downtown Fargo. (Aaron Bergdahl, ND Forest Service)

winter of 2014. The temperature data during a one-day period when temperatures in eastern North Dakota dropped drastically are presented as a line graph in Figure 12.

One point of interest to note is the approximately 12-degree difference between the ambient temperatures and the temperature on the south side of the trees. Also interesting is the warmer southside inner-bark temperature measured in the urban setting, compared with the same measurement in the park.

The coldest temperature registered in 2014 was an ambient temperature of minus 30.4 F at the Walhalla site. The inner-bark temperature on the south side of the tree on that day was a full 10 degrees warmer.

In a study by Venette and Abrahamson (2010), the following information about EAB cold hardiness was published: When larvae reach minus 17.8 C (0 F), 5 percent will die; at minus 23 C (minus 10 F), 34 percent will die; at minus 29 C (minus 20 F), 79 percent will die; and at minus 34 C (minus 30 F), 98 percent will die. This would indicate that just less than 30 percent of EAB larvae, which tend to be found in greater density on the south side of trees, would have survived this temperature extreme.

Questions that still require investigation relate to the time period during which EAB larvae are exposed to low temperatures and the accumulative effects of cold stress during a prolonged winter. However, based on the most current information available, we reasonably can expect that EAB will be able to survive North Dakota winters.

With the same sensors installed at the same locations to monitor temperatures during the 2015-2016 winter, more information is expected to provide an even clearer picture of EAB's ability to survive North Dakota winters.

Because the invasive pest is not found in North Dakota, the message of the North Dakota Forest Service to not move firewood or unprocessed wood products into North Dakota or within North Dakota remains consistent. Citizens must remain informed and vigilant of EAB and continue to report situations where symptoms and signs of EAB are suspected.

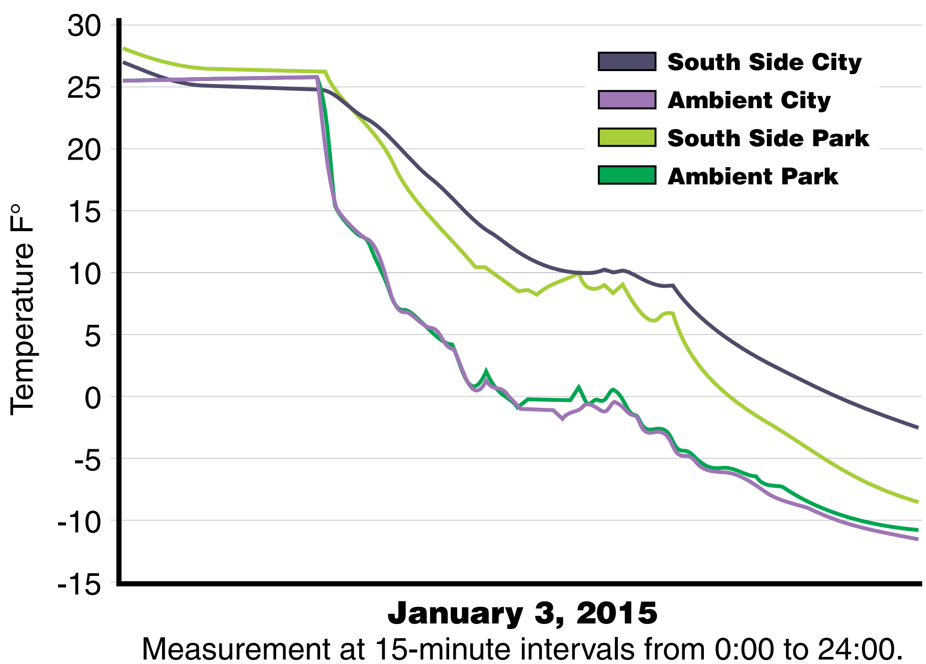


Figure 12. Graphic representation of the ambient air temperature and the under-bark temperature of the south side of a green ash tree in Trefoil Park and downtown Fargo on Jan. 3, a day that experiences a drastic temperature drop during a 24-hour period. Temperature was recorded every 15 minutes. (ND Forest Service)

Health Assessment in Limber Pine Research Natural Area, Slope County, N.D., 2015-2016

The southwestern corner of the state has an outlier limber pine stand. Jim Walla, a forest pathologist from Northern Tree Specialties, guided visits to the stand in 2015 and 2016. He provided formal reports following the health assessment of the stand. Here is a synopsis of his written reports.

The trees were observed to have substantial needle blight in 2015. The symptoms were like Dothistroma needle blight, but the spores were Diplodia-like.

The stand was revisited in 2016 for collection of samples and an assessment of incidence and severity of the blight. The identity of the fungus is unknown, so samples were sent to a geneticist at the Forestry and Agricultural Institute in South Africa for characterization. A preliminary report also identified a Dothistroma species on the needles that is similar to a new Dothistroma in the southern U.S.

A portion of the limber pines appeared to have Dothistroma needle blight; however, this later was disproved by microscopic analysis in the lab, and efforts continue to identify this needle fungus that appeared to be pathogenic in the stand (Figure 13).

A rough estimation of the trees affected by this needle blight was 10 to 20 percent of the trees distributed throughout the observed areas. Some trees with notable defoliation had very short, new-shoot growth and appeared to be at risk of dying within the next two years if such defoliation continues.

A *Pityophthorus* species (twig beetle) that had been observed in a previous trip with U.S. Forest Service staff was seen on some shoots of some trees in 2015. After collection, the twig beetle was confirmed as *Pityophthorus pinguis* by NDSU entomologist Gerald Fauske, who also visited the limber pine area.

Although the twig beetle was said to be less prevalent than observed during the previous visit, approximately 3 to 5 percent of the trees distributed throughout the observed areas had notable twig boring. A few trees had nearly all twigs affected, top to bottom.

Figure 13. Top: Unknown limber pine needle blight. Bottom: Limber pines in the Limber Pine Research Natural Area. (Aaron Bergdahl, ND Forest Service)

A perennial canker of unknown cause was observed in 2007 on limber pine. In 2015, photos of these cankers were taken and the cankers were searched for fruiting bodies of a possible causal agent. No fruiting bodies were found, so the cause remains unknown.

As in the past, white pine blister rust was not found in this stand. A witches'-broom that was seen in a past trip is now known possibly to have been caused by *Candidatus Phytoplasma pini*, a pathogen that was found in North Dakota in 2014 in spruce for the first time in North America. No witches'-brooms were seen on limber pine during observations in 2015.

Woodpecker/Wasp Interaction Shreds Bur Oak Bark

Oak shredding first was reported in North Dakota in 2006 and the causal agent was undetermined. Severe symptoms again were noted and reported widely in 2010-2011. In 2014, regional reports of similar injuries came from North Dakota, Iowa, Minnesota, Wisconsin and Montana.

In the winter of 2013-2014, an assessment was conducted of 200 oak trees in eight neighborhoods in Fargo. Samples of gall wasps emerging from wood collected in North Dakota, Montana, Colorado and Calgary, Alberta, in the spring of 2014 were confirmed as *Callirhytis flavipes*.

The damage is caused as woodpeckers (downy woodpecker, *Picoides pubescens*) forage on the bark- infesting stages of this insect during winter (Figure 14, bottom). The damage results in branch desiccation and death; often the leader is affected (Figure 14, top and middle).

After looking at the gathered data, the following analysis was made: *Callirhytis flavipes* have a preference for older age class, more corky-barked branches, resulting in greater damage ratings for oak trees in the 2- to 11-inch diameter class (Figures 15 and 16).

Observers noted in 2015 that many of the trees had been pruned or removed. The assessment will continue in 2017.

Figure 14. Top: Typical downy woodpecker foraging damage to a young bur oak planting. Middle: Desiccated upper portion of a young bur oak planting, making the tree unsalvageable. Bottom: Overlapping generations of Callirhytis flavipes overwintering as prepupae (black) and larvae (white) in small pockets underneath the corky bark of a young bur oak planting. (Aaron Bergdahl, ND Forest Service)

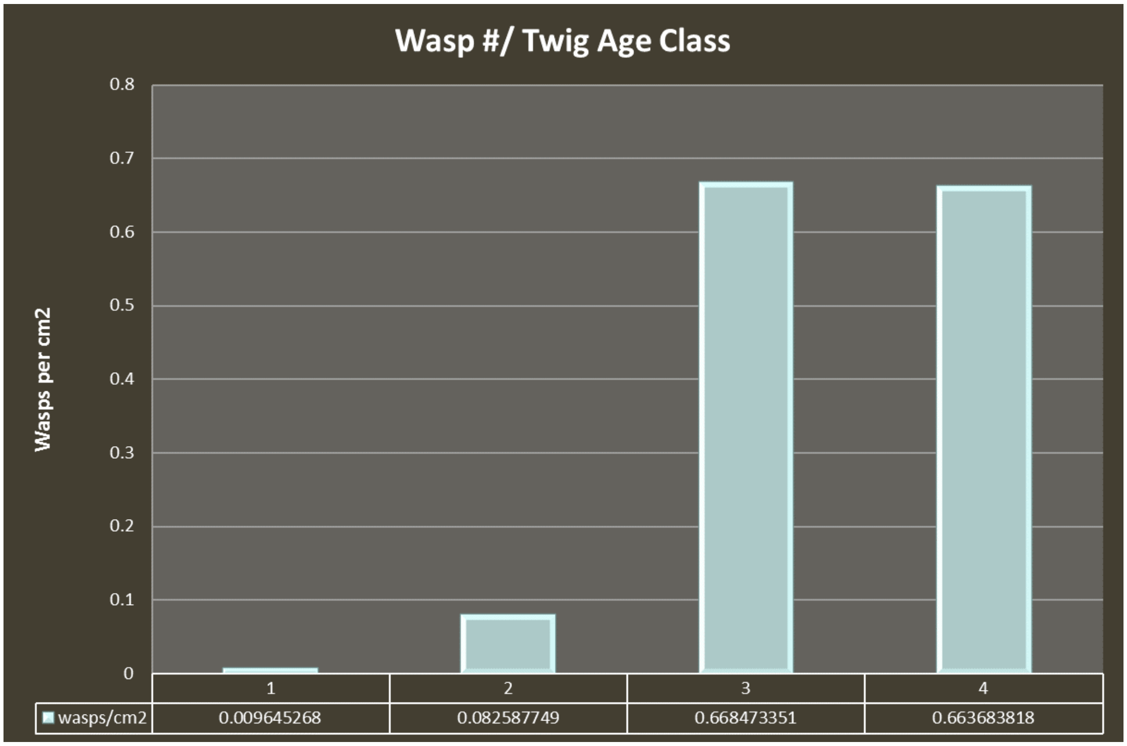


Figure 15. Infestation severity of *Callirhytis flavipes* per twig age class showing a preference for older, more corky wood (1 = current year's growth, 2 = last year's growth, 3 = growth from three years earlier, 4 = growth from four years earlier).

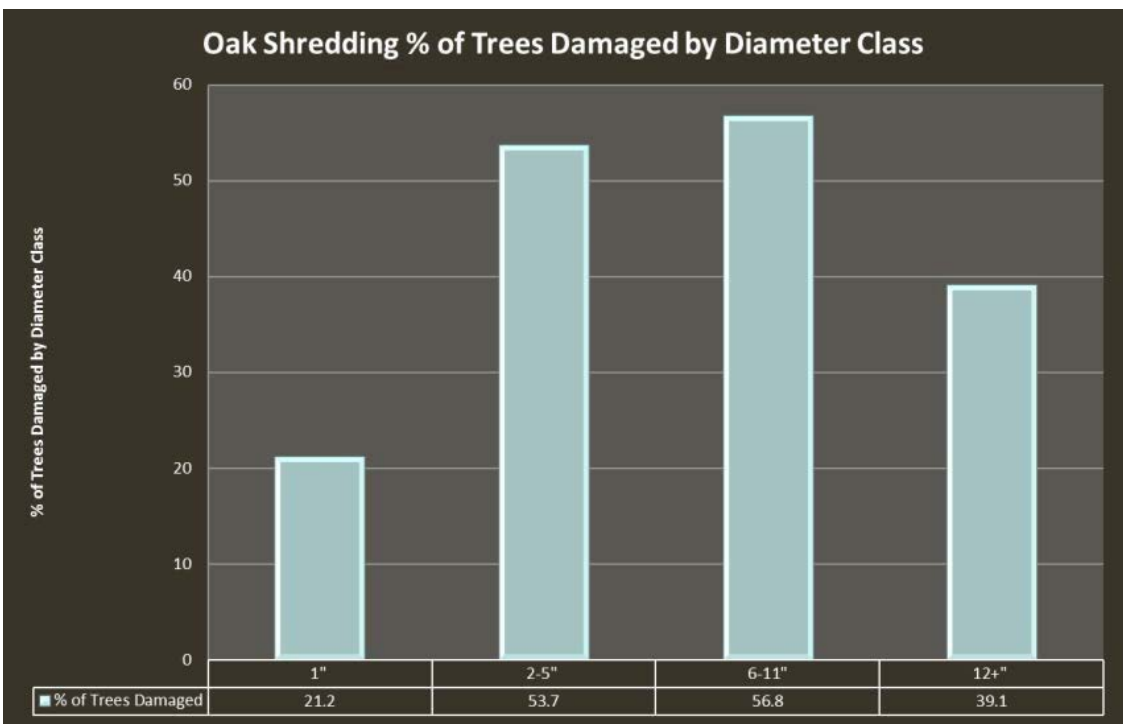


Figure 16. Percent of trees damaged trees by diameter class showing higher damage in the 2- to 11-inch size classes.

Section III

Recent and Common Insects, Diseases and Abiotic Issues

Defoliators

- Forest tent caterpillar (*Malacosoma disstria*) and large aspen tortrix (*Choristoneura conflictana*) continue to maintain populations in aspen resources where they are found in North Dakota, impacting forest resources. Other defoliators such as fall webworm (*Hyphantria cunea*) and yellow-headed spruce sawfly (*Pikonema alaskensis*) continue to have negative impacts on the effectiveness of shelterbelts and other conservation plantings.

Other Forest Insects

- Other commonly encountered insects and their associated problems include various aphids and scale species. Ips beetles (*Ips spp.*) also have been found, primarily in stressed ponderosa pine windbreaks.

Fruit Tree Diseases

- Several fruit tree diseases have been encouraged by spring moisture. These include the fungal diseases black rot (*Botyrosphaeria obtusa*), apple scab (*Venturia inaequalis*) and plum pockets (*Taphrina communis*), and the bacterial disease fire blight.
- Black knot of cherry is a challenge for homeowners and municipal forests. Black knot is present wherever chokecherry has been planted in windbreaks, for fruit production and for conservation, as well as in native forests.

Figure 17: Severe chemical injury to the leaves of a hackberry in Bottineau County, N.D. (Aaron Bergdahl, NDFS)

Other Diseases

- North Dakota trees are susceptible to canker diseases due to environmental and human-caused stressors. Commonly encountered canker diseases include Valsa canker of spruce (*Cytospora kunzei*), black rot, and cytospora canker of hardwoods (*Cytospora spp.*).
- Western areas of North Dakota continue to deal with the severe impacts of the first wave of Dutch elm disease in American elm (*Ophiostoma ulmi*). Communities with strong sanitation and enforcement programs are able to keep American elm as part of their community forest canopy. Communities with lax or unfunded programs fall behind in removals and suffer increasing canopy losses as a result.

Figure 18: Chlorosis of maple. (Aaron Bergdahl, NDFS)

Abiotic Issues

- The most common abiotic agents and associated problems include herbicide exposure (Figure 17) via drift or misapplication, effects of flooding events during past growing seasons, and the effects of planting municipal and conservation trees too deeply.
- Chlorosis is a common problem in North Dakota. Maple and birch trees are not well suited to the alkaline soils into which they often are planted (Figure 18).

Section IV

Aerial Survey 2015

Overview of 2015 Aerial Survey Results -

Sheyenne River, Red River, Pembina Gorge and Devils Lake Forested Areas

The North Dakota Forest Service (NDFS) Forest Health Program contracted with the Minnesota Department of Natural Resources' Resource Assessment group from Grand Rapids, Minnesota, to conduct an aerial survey of forest resources in selected areas in June 2015.

The areas surveyed in 2015 were the Sheyenne River, Red River, Pembina Gorge and forested areas around Devils Lake.

The following results of interest were obtained from aerial survey and GIS analysis:

- Devils Lake: 8,225 acres of dead trees due to past rising of water levels (Figure 19)
- Pembina Gorge: 6,953 acres of a mix of defoliation by insects and injury from the late freeze in May 2015 (Figure 20)
- Red River: 1,326 acres of forest tent caterpillar (FTC) defoliation (see aerial photo in appendix)
- Sheyenne River: 607 acres of FTC defoliation, mostly to the east of Lisbon (see aerial photo in appendix)

Figure 19. Top: Geographic information system (GIS) image of aerial survey results showing tree mortality (yellow areas) along the shores of Devils Lake. Bottom: Photo of an area on the GIS map. (Aaron Bergdahl, ND Forest Service)

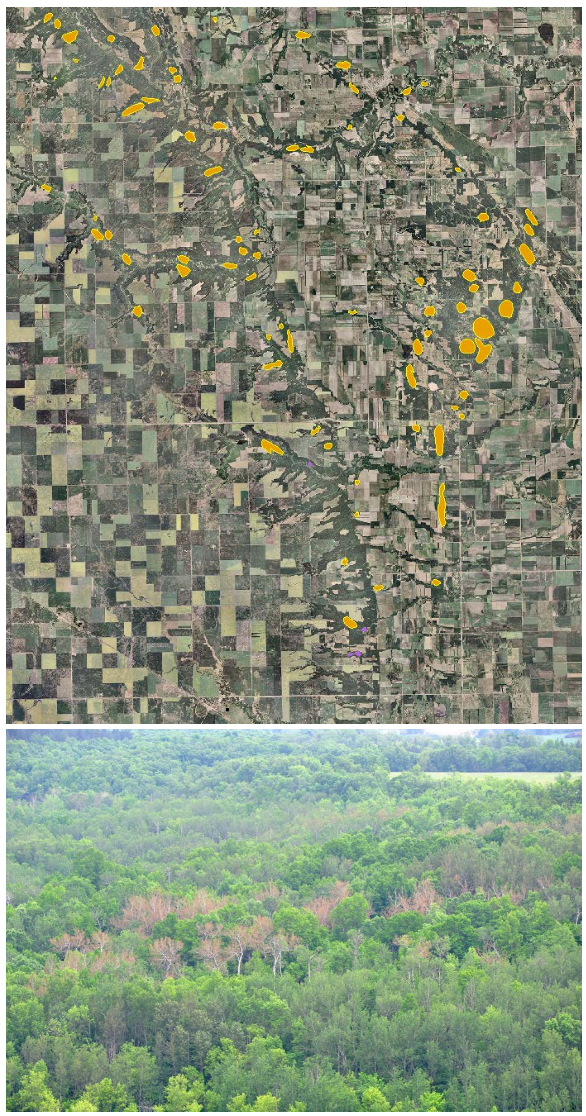
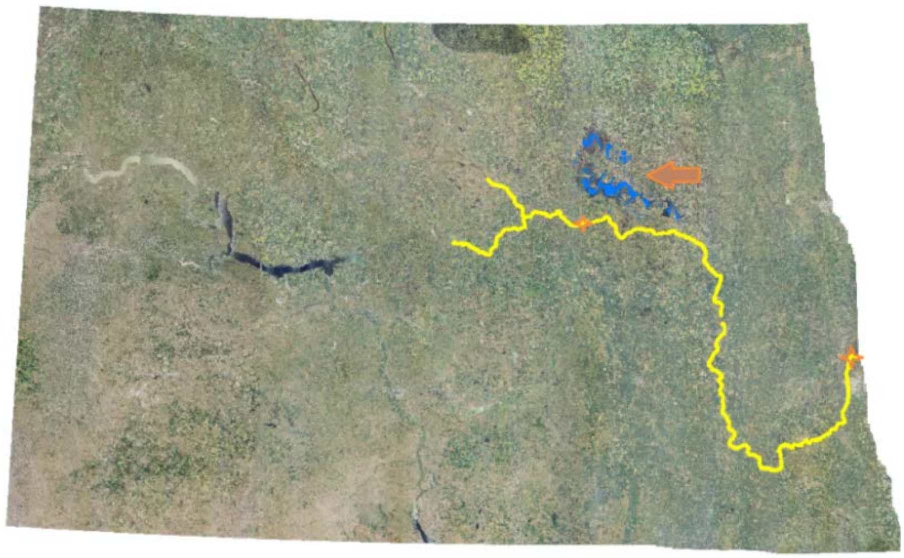


Figure 20. Top: Areas in the Pembina Gorge affected by insect defoliators or a late-season frost event highlighted on a GIS map (orange areas). Bottom: Photo of affected trees. (Aaron Bergdahl, ND Forest Service)



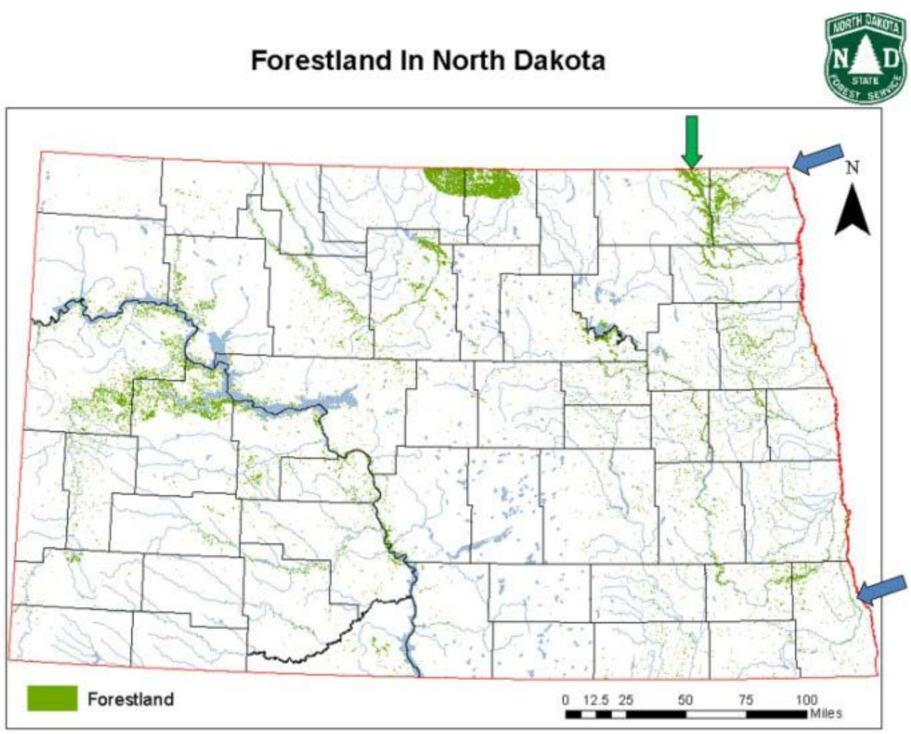


Figure 21: Aerial survey locations from 2015. Above: Sheyenne River start and stop points in orange, and Devils Lake in blue with orange pointer. Below: Green arrow indicates Pembina Gorge and blue arrows indicate the start and end point of the Red River survey area (NDFS).

Section V

Forest Health Program Activities

Emerald Ash Borer Awareness Week

EAB Awareness Week is a cooperative event among the North Dakota Forest Service, North Dakota Department of Agriculture, North Dakota State University Extension Forestry, and local urban and community forestry programs.

EAB Awareness Week 2015 was observed during May 17-23. Activities included a governor's proclamation of the event and cooperation with 40 communities and several state parks. Participants placed weatherproof fliers on ash trees to highlight information about EAB, its potential to change local tree resources and other messages, such as "Don't Move Firewood" and increase tree diversity in tree resources (Figure 22).

EAB Awareness Week 2016 was preceded by a governor's proclamation declaring May 22-28 a week to increase awareness of the potential threat of EAB to North Dakota's tree resources. At least 25 communities participated by placing updated posters on ash trees in their communities.

Each year, in addition to the laminated fliers, participants receive a copy of the statewide news release, a set of talking points to aid in answering questions, EAB fact sheets, and an informative PowerPoint presentation on a flash drive for use at meetings.

Future Awareness Week efforts will evolve based on feedback from city foresters and nationwide surveys of the effectiveness of The Nature Conservancy's "Don't Move Firewood" campaign.

Figure 22: EAB Awareness Week fliers at a Bottineau, N.D., park; flash drives used to provide communities with EAB Awareness Week information. (*Aaron Bergdahl, NDFS*)

Forest Health Internship Program

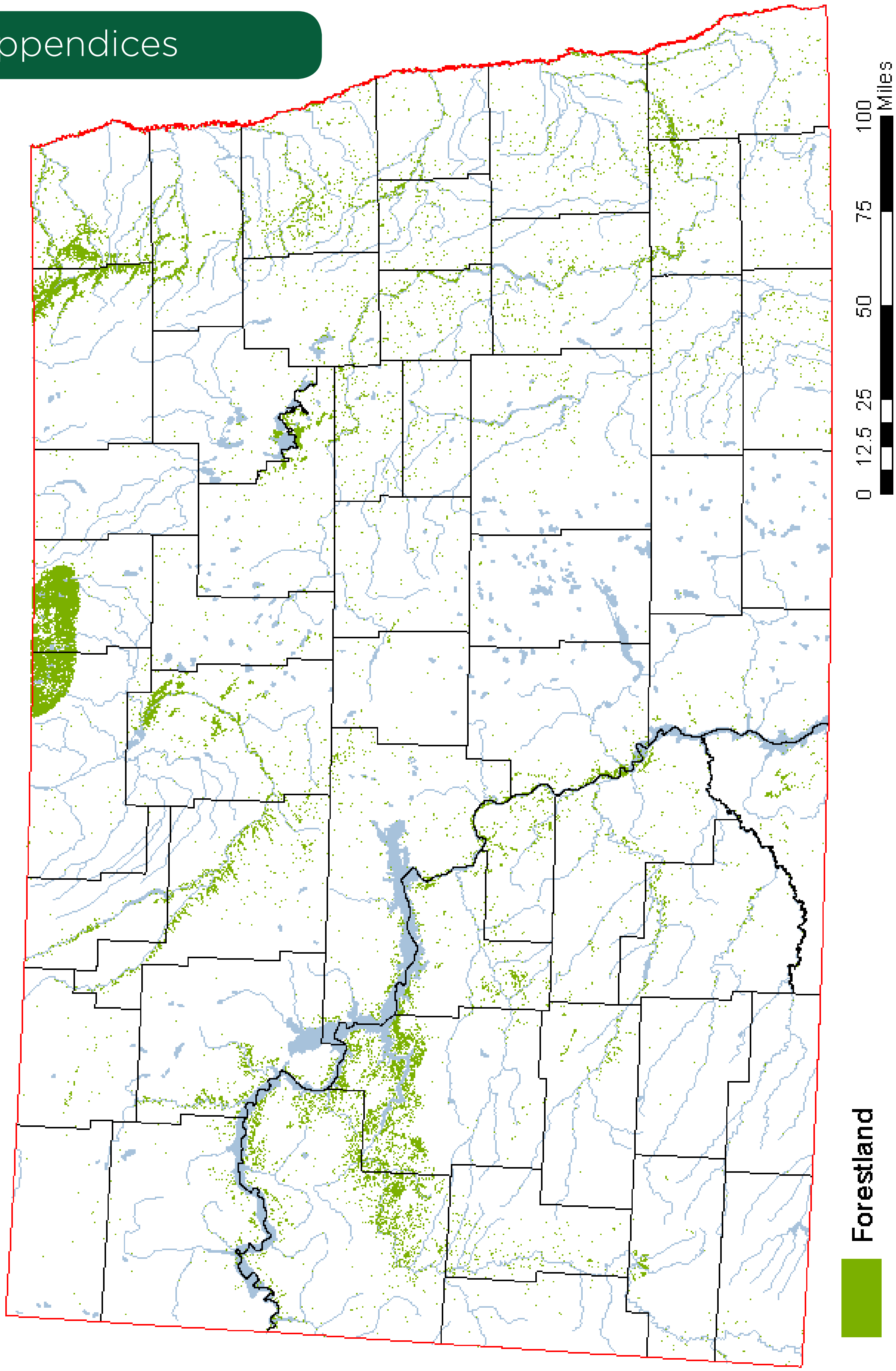
The forest health internship program continued in 2016, marking the fifth year of the program. The interns, Garrett Lynnes from Dakota College at Bottineau and Laura Grant from the State University of New York, inventoried state forestland to identify aspen stands suitable for regeneration.

One of North Dakota's forest health concerns is that overmaturity of aspen stands, accompanied by increasingly severe forest health issues, threatens the sustainability of aspen forests in the absence of stand-replacing disturbance. Their work addressed this issue by identifying suitable sites for treatment scheduled for 2017.

Figure 23: Forest health intern Garrett Lynnes in the heavy understory of an aspen stand in the Turtle Mountains. (NDFS)

Figure 24: Forest health intern Laura Grant collecting tree health data. (NDFS)

Appendix 1: Forestland coverage in North Dakota (NDFS).



Appendix 2: Riparian forest along Devils Lake in North Dakota from the 2015 aerial survey. (Aaron Bergdahl, NDFS)

Appendix 3: Sheyenne River forest resources in North Dakota from the 2015 aerial survey. (Dylan Roberts, NDFS)

Appendix 4: Red River forest resources, along with windbreaks and conservation plantings, from the 2015 aerial survey. (Garrett Masloski, NDFS).

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Any inquiries about the North Dakota Forest Service insect trapping or the Forest Health Program in general can be directed to Lezlee.Johnson@ndsu.edu or 701-231-5138. This publication is available in alternative formats by calling 701-231-5138.