Biennial Forest Health Report

North Dakota 2011-2012

NDSU

North Dakota Forest Service

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Introduction

This report summarizes forest pest conditions observed in 2011 and 2012 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.

This report attempts to characterize the current condition of North Dakota's forested resources. A brief summary depicts the overall condition and potential threats to each forest resource category. 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.

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 undifferentiated, 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. 2013).

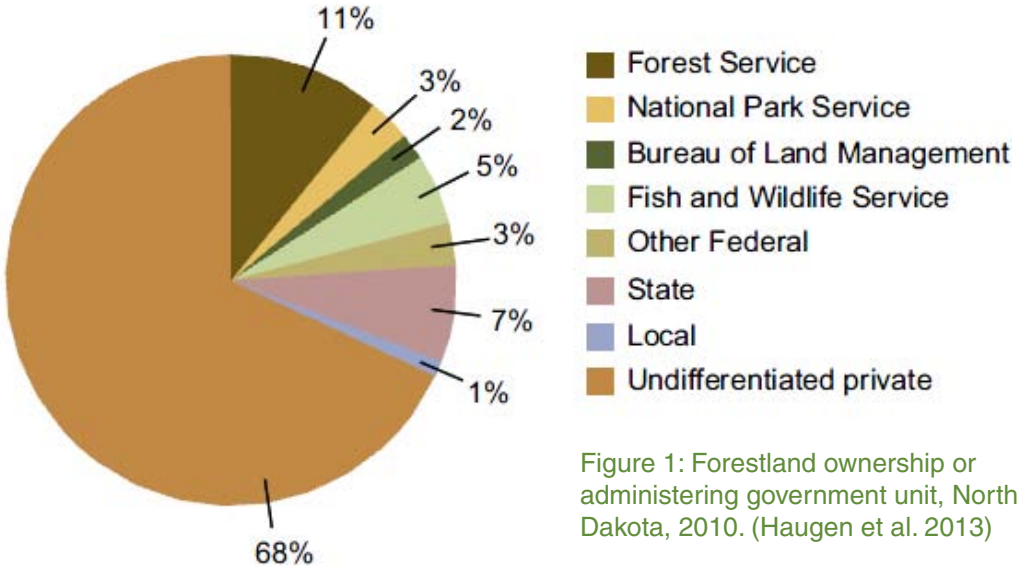

Figure 1: Forestland ownership or administering government unit, North Dakota, 2010. (Haugen et al. 2013)

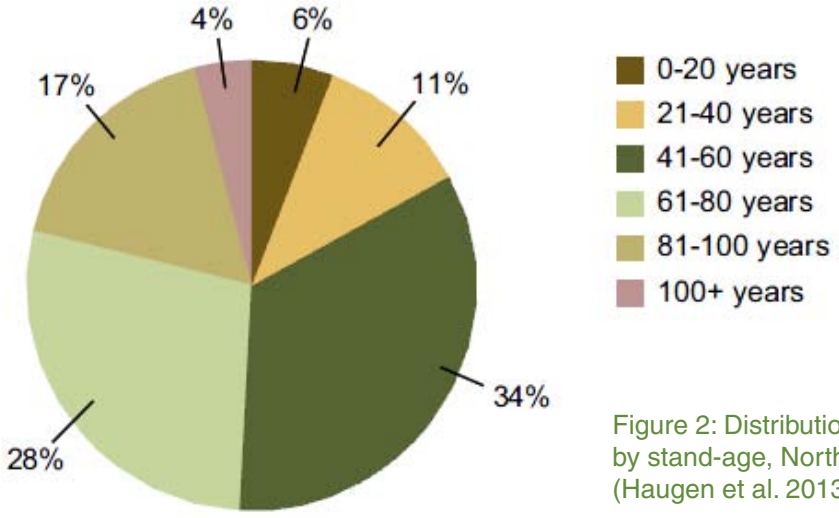

Figure 2: Distribution of forestland by stand-age, North Dakota. (Haugen et al. 2013)

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 (Appendix 2). 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.

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).

Despite their limited acreage, native forests are important resources in North Dakota. These forests provide wildlife habitat and 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:

- Reduced species diversity due to damage caused by non-native forest pests;
- Overmaturity of existing stands and suppression of natural disturbances essential to regenerate forests (Figure 2); and
- 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). 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 recreation opportunities.

The elm/ash forest type is the most abundant of all native riparian forestland in the state (Appendix 2). 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. More recently, higher than normal deer populations have put additional, significant pressure on the regeneration of the elm/ash forest type. The threat of the emerald ash borer is another significant issue affecting the elm/ash forest type along riparian areas due to the overall abundance of ash.

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 like that in 2011, sustainability of cottonwood regeneration on the Missouri River is not likely without direct management.

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 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 (*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. Rural tree plantings generally refer to field windbreaks, farmstead shelterbelts, 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.

Figure 3: Spruce windbreak as an example of a rural planting in Traill County. (A. Bergdahl, North Dakota Forest Service)

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. 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 are 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 field windbreaks due to herbicide exposure, marginal cold hardiness and canker diseases, and 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 greatly reduced had additional species been incorporated into these plantings.

Community Forests

Community forests include boulevard trees, trees planted within 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.

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.

Figure 4: New plantings at Riverside Park in Beulah. (North Dakota Forest Service)

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

Section 1

Weather-related Trends

Following the wet years of 2009 and 2010, 2011 was among the wettest years on record (12th wettest growing season since 1895) (Figure 5) (Akyüz and Mullins, 2011), causing lake levels to rise in many parts of North Dakota and prolonged summer flooding of many low-lying and riparian areas. This wet weather had a significant impact on trees in many areas of the state, especially the Missouri and Souris River basins, where historic, long-term flooding occurred in 2011.

In a remarkable contrast, 2012 was among the driest years on record (13th driest growing season since 1895) (Figure 6) (Akyüz and Mullins, 2012), leading to drought-related tree problems and the failure of a larger than usual percentage of new plantings. Whether too wet or too dry, 2011 and 2012 were stressful to trees, and the impacts of these extreme weather patterns likely will be seen in years to come.

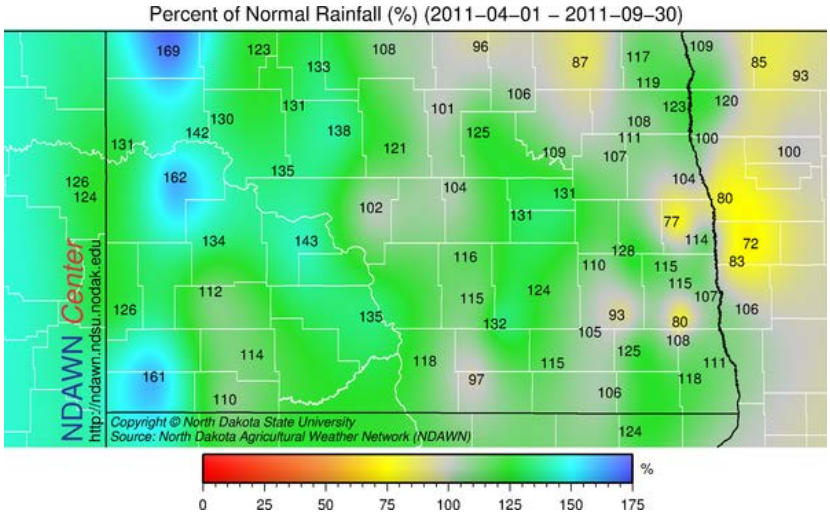

Figure 5: Percent of normal rainfall during the 2011 growing season.

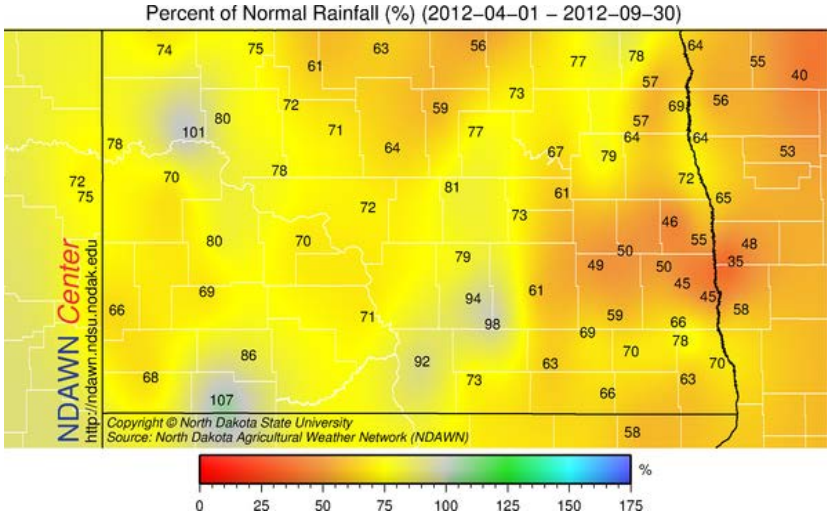

Figure 6: Percent of normal rainfall during the 2012 growing season.

Remote Sensing of Flooded Forestland In the Missouri and Souris River Basins as a Tool for Establishing Long-term Forest Health Plots for Assessing Flooding Impacts

The North Dakota State University Geosciences Department, with direction and support from the North Dakota Forest Service, utilized remote sensing technologies to create maps of inundated forestland during the crest of floodwaters for the entire Missouri and Souris River flood plains in 2011 (Figure 7, Figure 8). Using Geographic Information Systems (GIS) and tools for geospatial analysis, researchers were able to identify areas of flooded forest and quantify the acreage of inundated forestland along the Missouri and Souris Rivers (25,015 acres of inundated forestland along the Missouri River and 11,531 acres along the Souris River) (Kotchman et al., 2011).

This technology provides the state with accurate information that could be used for a number of purposes, including the establishment of long-term forest health monitoring plots in flooded forest areas.

In the summer of 2012, a group from the North Dakota State University Department of Plant Pathology, with financial support from the North Dakota Forest Service, established long-term survey plots and conducted a survey of flood areas to assess mortality and regeneration. Follow-up surveys will be carried out in years to come. This survey is particularly useful because very limited information is available on the effects of flooding on forest health in the northern plains.

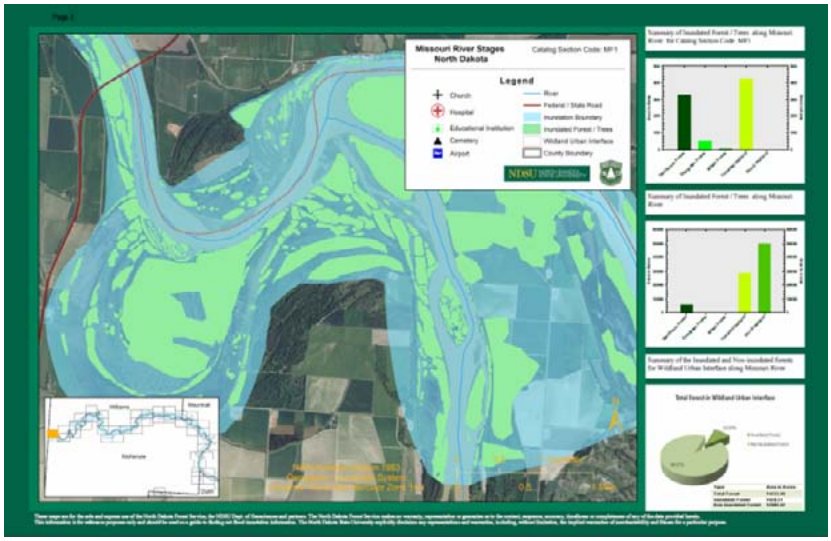

Figure 7: An example of a section of the Missouri River in 2011 highlighting inundated forestland created using satellite imagery and geographic information systems (GIS). (Kotchman et al., 2011, North Dakota Forest Service).

Figure 8: Large-scale flooding on the Oahe Wildlife Management Area. (North Dakota Game and Fish Department)

Turtle Mountains

Figure 9: High water levels leading to aspen mortality in the Turtle Mountains. (A. Bergdahl, North Dakota Forest Service)

Large areas of the Turtle Mountains experienced flooding throughout the growing season in 2011 (Figure 9). Many forested areas bordering bodies of water were impacted negatively. Since the flooding, evidence of root dieback, severe stress and some mortality has been noticed, especially in lower areas and forested lakeshores. The effects of 2011 flooding in the Turtle Mountains may be seen for years to come.

The dry period from August 2011 through the growing season of 2012 saw waters recede in many areas.

Red and Sheyenne Rivers

In earlier years, flooding of the Red and Sheyenne rivers mostly has occurred in early spring, before the onset of the growing season. Aside from the mechanical damage caused by floodwaters and the debris they carry, the impacts on the health of trees in these flooded areas have been moderate in previous years.

Figure 10: Flat, dark rhizomorphs indicating the presence of armillaria root disease by the Red River in Walsh County. (A. Bergdahl, North Dakota Forest Service)

In 2011, floodwaters were high and remained high well into the growing season, causing significant stress to trees in the flood plain. First-person observation and anecdotal evidence suggest that most of the larger trees withstood the flooding but suffered significant stress. In some cases, this stress has appeared to incite attack by wood boring insects, and armillaria root disease (*Armillaria spp.*) (Figure 10) has been observed on recently dead and declining trees in park areas that have experienced prolonged summer flooding.

Because the distribution of armillaria species is unknown in North Dakota, researchers are not sure whether the species commonly encountered in stressed forest areas is the more aggressive *Armillaria mellea* that can cause direct mortality of trees or one of many other primarily saprophytic and less aggressive armillaria species that may occur in North Dakota. Until more information is available about the occurrence of armillaria in North Dakota, clear control options cannot be offered to land managers.

Devils Lake

The water level of Devils Lake continued to rise in 2011 due to higher than normal precipitation, coupled with the absence of a natural outlet. While 2011 was wetter than normal, this was balanced by 2012 being drier than normal. Thus, the water level did not advance in 2012 and new forest land was not inundated.

Figure 11: Farmstead and windbreak flooded by increasing Devils Lake water levels in 2011. (A. Bergdahl, North Dakota Forest Service)

Figure 12: The same trees in a flooded area near Devils Lake in the summer of 2011 (above) and fall of 2012 (below). (A. Bergdahl, North Dakota Forest Service)

Section II

Cooperative Forest Pest Surveys

Emerald Ash Borer

In 2011 and 2012, a cooperative effort by the North Dakota Department of Agriculture (NDDA), U.S. Department of Agriculture Animal and Plant Health Inspection Service Plant Protection and Quarantine (APHIS PPQ) and North Dakota Forest Service (NDFS) placed “purple sticky prism traps” throughout North Dakota (Figure 13) to survey for emerald ash borer (EAB) (*Agrilus planipennis*). Traps placed numbered 243 in 2011 and 393 in 2012; no emerald EAB was detected either year.

As well as serving as a detection tool, the purple traps have proven to be a powerful tool for increasing public awareness of the potential threat of EAB. Cooperative trapping and outreach efforts are ongoing and focus on larger communities, parks, campgrounds and areas along major transportation routes. Due to the abundance of ash in North Dakota communities, natural forests and conservation plantings, continued cooperative efforts to monitor for EAB will be prioritized.

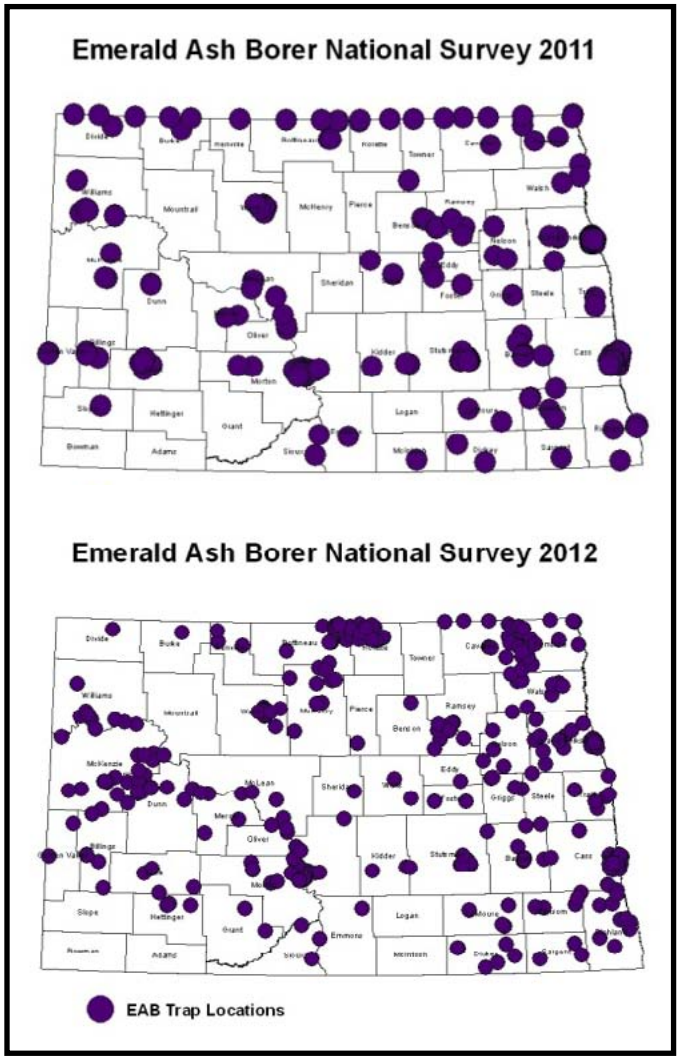

Figure 13: Emerald ash borer trapping locations in 2011 and 2012. (North Dakota Department of Agriculture)

Gypsy Moth

Cooperative trapping efforts involving the APHIS PPQ, NDDA and NDFS included devising and carrying out a trapping plan consisting of 341 traps surveying roughly 218,240 acres in 2011. In 2012, 355 traps were placed, effectively sampling 227,200 acres. No gypsy moths (*Lymantria dispar*) were detected in 2011 or 2012. No positive finds for gypsy moth have occurred in North Dakota since 2005.

Forest Tent Caterpillar

A 2011 winter egg mass survey of areas in the Turtle Mountains where heavy defoliation by forest tent caterpillar (FTC) (*Malacosoma disstria*) was reported yielded zero egg masses. This survey was carried out in accordance with previously described methods (Minnesota Department of Natural Resources).

The survey results, in addition to other physical evidence, such as firsthand reports from across the region of heavy webbing at the branch tips and numerous "rappelling" larvae, led to the inference that defoliation was caused by an agent other than FTC in north-central North Dakota. FTC was still present in the northern and eastern parts of North Dakota, and populations were expected to remain high in areas around Turtle River State Park, where defoliation was severe in 2011 and 2012.

Large Aspen Tortrix

An aerial survey on June 22, 2011, and further ground truthing efforts revealed that widespread defoliation observed in the Turtle Mountains was caused by the large aspen tortrix (LAT) (*Choristoneura conflictana*) (Figure 14). Approximately 20,500 acres of defoliation was recorded in the Turtle Mountains[1] (Figure 15). In retrospect, a major proportion of the reported defoliation in 2009 and 2010 likely was the result of LAT and not FTC.

Figure 14: From left to right: large aspen tortrix larva, cocoon, cocoon folded and webbed in a leaf, and adults. (A. Bergdahl, North Dakota Forest Service)

Communication with a North Dakota State University entomologist revealed that LAT had been collected in large amounts in the Turtle Mountains as far back as 2008 (Gerald Fauske, personal contact). This information raises questions about the actual extent of earlier reports citing defoliation caused by FTC. Concurrent defoliation by FTC and LAT was reported earlier in other areas of the U.S. and Canada; this kind of defoliation also may have been occurring in the Turtle Mountains to varying extents in past years.

In 2012, areas heavily defoliated by LAT were revisited. While LAT still was active and easily found in these areas, the population was lower and the defoliation less severe than in 2011. The reason for this is unclear and may indicate a decrease in population following a population boom in 2011. This trend would fit the boom-and-bust population cycle that often characterizes lepidopteran defoliators such as LAT.

Figure 15: Aerial view of LAT defoliation of aspen in the Turtle Mountains in 2011. (A. Bergdahl, North Dakota Forest Service)

[1] An aerial survey was conducted in June 2011 by the U.S. Forest Service, Region 1. Forest health-related GIS data collected during the flight was used by the North Dakota Forest Service to estimate defoliated acres.

Winter Dieback of Freeman Maple Cultivars: Assessment 2012

Figures 16 and 17: Typical pattern of dieback seen statewide on more recently planted Freeman maple cultivars. The photo on the top is from a new development in Bismarck and the photo on the bottom is a newer planting in Valley City. (A. Bergdahl, North Dakota Forest Service)

Maple cultivars have become very popular across the Northern Plains in recent years due to their fast growth rate and vibrant fall color. In recent years, the Freeman maple cultivars Autumn Blaze® Maple – Acer x freemannii 'Jeffersfred' and Sienna Glen® Maple – Acer x freemannii 'Sienna' have been planted very commonly in newer housing areas. These cultivars are selections from hybridizations of red maple, (*Acer rubrum*) and silver maple (*Acer saccharinum*) and have become highly favored in the urban setting.

In the spring of 2012, tree resource managers across North Dakota voiced concern regarding large-scale dieback and mortality of Freeman maple cultivars. Especially the newest plantings installed in the past few years showed various levels of dieback from the top down (Figures 16 and 17) and in many cases 100 percent mortality.

This dieback and mortality was not accompanied by any signs of insect or pathogen attack. The cause of this dieback was determined to be weather-related: unusually warm weather in the fall that may have interfered with the process of hardening off, or unusual early warming events in the spring that may have activated growth, followed by cold snaps that could have resulted in frost injury to vulnerable tissues.

Although the cause of dieback may never be known exactly, questions began to arise about the suitability of Freeman maple cultivars for our region. The primary question was: Which of the two most commonly planted maple cultivars performed better in the challenging conditions of the previous year?

Rather than providing a clear answer to this question, the results of this assessment instead simply reinforced the fact that principles of sound cultural practices need to be followed when installing and establishing new plantings.

This assessment found that trees of smaller diameter that were not mulched were far more likely to have sustained weed-whip/mower damage; weed-whip and mower-damaged trees had much higher levels of dieback ratings (Figure 18). A properly mulched zone around new plantings eliminates the need to use a weed-whip or mower close to the main stem of a tree, thus limiting the occurrence of damage to the main stem. The survey suggested that uninjured (mulched) trees were apparently better able to mediate environemtal stress, and this seemed especially true for Sienna Glen® Maple (Figure 19).

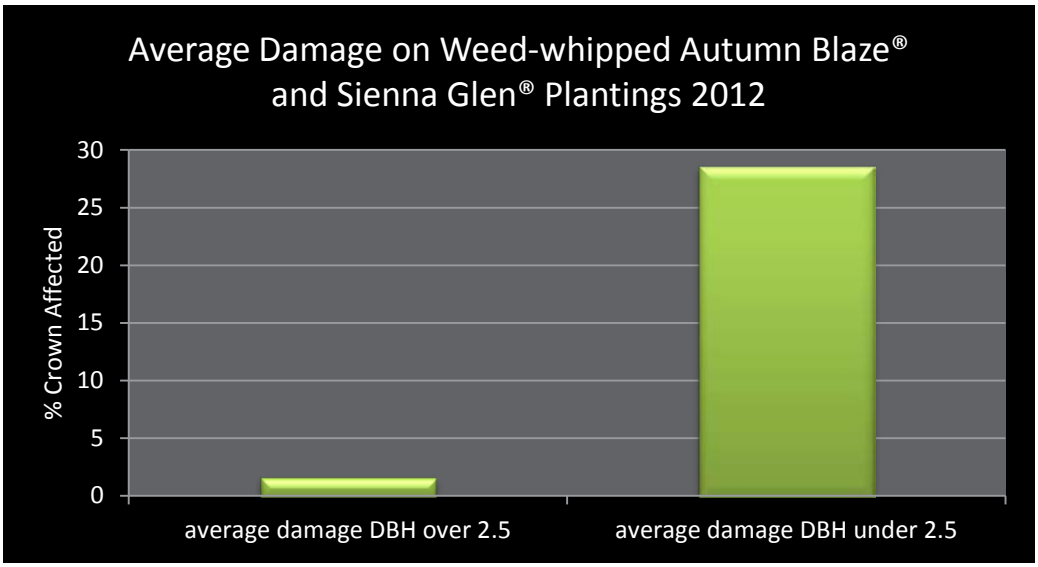

Figure 18: Average crown damage ratings for all trees above or below 2.5 diameter at breast height showing weed-whip damage. (2012 Maple Cultivar Winter Damage Assessment (2013), North Dakota Forest Service, NDSU)

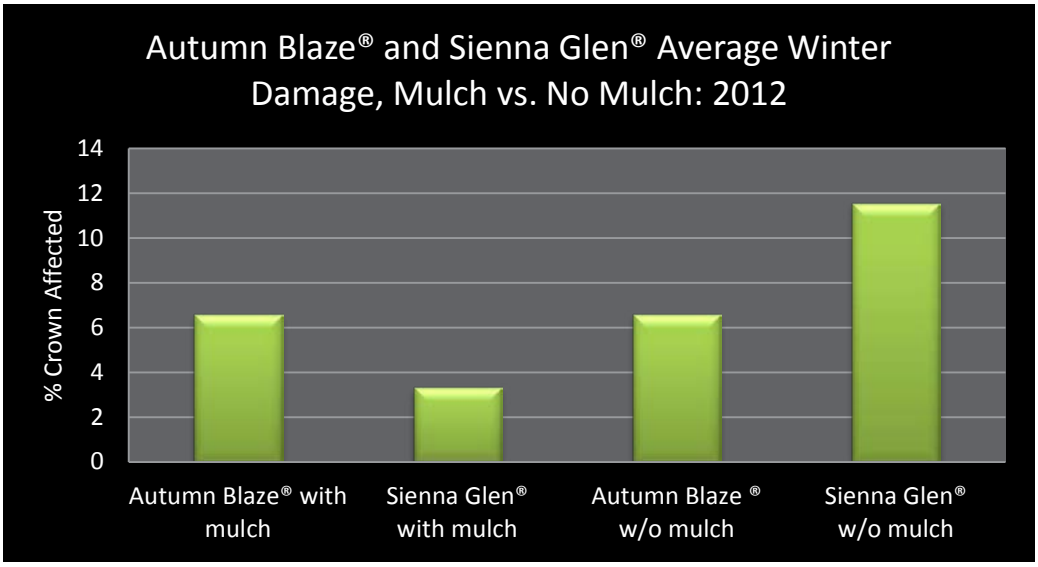

Figure 19: Effect of mulch on Autumn Blaze® and Sienna Glen® maple cultivar average crown damage ratings. (2012 Maple Cultivar Winter Damage Assessment (2013), North Dakota Forest Service, NDSU)

Section III

Recent Insect Trends of Concern

Japanese Beetle

The Japanese beetle (*Popillia japonica*) (Figure 20) was detected in a number of locations in North Dakota in 2012: Grand Forks, Bismarck, Fargo, Minot, Oakes, Taylor, West Fargo and rural Foster County. This is a tree pest of concern due to its strong feeding preference for the foliage of American basswood (*Tilia americana*) and little-leaf linden (*Tilia cordata*). It also is a serious pest of many woody horticultural plants.

Figure 20: Japanese beetle adult on a linden leaf. (C. Elhard, North Dakota Department of Agriculture)

In areas where Japanese beetle is established, lindens annually suffer from intense defoliation from these insects. Lindens are a popular tree in urban plantings and are an important component of our natural forests, especially in riparian areas.

Two-lined Chestnut Borer

Several visual surveys for two-lined chestnut borer (TLCB) (*Agrilus bilineatus*) damage to bur oak were carried out in Fargo at multiple locations by the Red River, and sites in the Sullys Hill National Game Preserve and Sheyenne State Forest. This was done mostly as a baseline survey to establish a point of reference for future conditions of TLCB in these areas.

In the Red River corridor through Fargo, TLCB damage was apparent and was found frequently in association with armillaria root disease. Which pest came first was not immediately clear; however, both pests are indicators of primary stressors that could include chronic stress via prolonged inundation of the root horizon. Further, the drought conditions between September 2011 and the entire growing season of 2012 (Figure 3) likely will cause further stress to oak trees, possibly leading to an increase in TLCB mortality.

TLCB was not readily apparent at Sullys Hill and in the Devils Lake Hills region in general. This area has experienced heavy outbreaks of two-lined chestnut borer in the past (Bill Hodus, personal contact), which has raised some concern that the extreme weather conditions during the past five years could be a predisposing factor for another such outbreak. These areas will be monitored in the coming years.

A severe wind event in the Sheyenne State Forest in 2009 caused severe branch breakage in many bur oaks in the area, according to a 2010 ice damage survey of the area. Following this stress event, populations of two-lined chestnut borer, already commonly found in the area, were predicted to increase rapidly in the following years. This outbreak has not been seen, but the area will continue to be monitored.

Section IV

Recent Diseases of Concern

Dothistroma Needle Blight

Dothistroma needle blight (*Dothistroma pini*) first was found in North Dakota in 2010 in a ponderosa pine (*Pinus ponderosa*) planting in Pembina County. In 2011, the disease was discovered in three more counties in North Dakota: Cass, Cavalier and Stutsman. At the Absaraka Horticultural Research Farm, the disease was found on *P. albicaulis, P. ayacahuite, P. cembra, P. contorta var. latifolia, P. flexilis, P. mugo, P. nigra, P. ponderosa and P. uncinata*. Outside of the research farm, the disease was able to be confirmed only on P. ponderosa. No new finds of the disease were made in North Dakota in 2012.

Figure 21: Dothistroma needle blight in Jay Wessels Wildlife Management area, Pembina County. (A. Bergdahl, North Dakota Forest Service)

Brown Spot Needle Blight

Brown spot needle blight (*Scirrhia acicola*), a needle disease, was detected for the first time in North Dakota in 2011. A small-scale disease outbreak occurred in a Christmas tree plantation outside of Enderlin in Ransom County. The infected Scots pine (*Pinus sylvestris*) trees were six to eight years old. The source of the outbreak has not been determined.

The Christmas tree producer no longer is producing and selling trees, and the trees in the most heavily infected area have been destroyed. The assumption is that the disease is still present on the site, existing in lower levels on other Scots pine trees.

Figure 22: Left: Brown spot needle blight found in Ransom County in 2011. (A. Bergdahl, North Dakota Forest Service) Right: Brown spot needle blight fruiting bodies on Scots pine needles. (University of Illinois Extension)

Lirula Needle Blight

Reports of lirula needle blight (*Lirula macrospora*) on spruce (*Picea spp.*), which have been rare during the past five years or so, increased in 2011 (Figures 23 and 24). This may indicate that the prevalence of this disease is on the rise in the eastern half of North Dakota. The future development of this disease complex will be monitored.

Figures 23 and 24: Lirula needle blight. Notice the orange color of second-year needles and ash gray color of third-year needles that can persist on the tree for multiple years. Notice the long, black fruiting bodies on the underside of needles in the photo on the right. (Rainbow Tree Care and L. Haugen, U.S. Forest Service, respectively)

Linden Leaf Blotch

Linden leaf blotch (*Didymosphaeria petrakiana*) was encountered in North Dakota for the first time in 2012 (Figure 25). This is significant because it is one of the few leaf diseases affecting American basswood and little-leaf linden (*Tilia americana* and *Tilia cordata,* respectively), commonly planted in community settings in our region.

This disease is not considered significant to tree health because the effects are mostly aesthetic; the blotches develop on leaves later in the year (mid-July in North Dakota in 2012) and it is thought to only mildly inhibit overall photosynthesis. The disease has been observed in only one location on American basswood in a riparian area in Cass County and has not been found in other areas of the state.

Figure 25: Fungal blotches typical of the linden leaf blotch pathogen on American basswood in Cass County. (A. Bergdahl, North Dakota Forest Service)

Section IV

Other General Tree Health Trends of 2011-2012

Insects

- Reports of heavy **aphid** infestations were very common statewide. The ash leafcurl aphid (*Prociphilus franxinifolii*) was especially abundant, causing leaf curl on entire trees and excretion of massive amounts of sugary waste, prompting landowner calls (Figure 26).
- **Pine sawfly** (*Diprion similis*) incidence, according to a number of reports, seems to be on the rise in parts of the state. Pine sawfly was encountered on white pine (*Pinus strobus*) and Scots pine (*P. sylvestris*). It also may occur on jack pine (*P. banksiana*).
- **Pine tip moths** (*Retinia sp., Ryacionia sp.*) continue to be encountered regularly across North Dakota (Figure 27). Reports of **cone worm** (*Dioryctria spp.*) in the Bismarck area have been common. The causal agents of the tip damage have not been identified to species, although the type of damage and the host and pest distributions suggest the listed genera.
- **Native borers of ash trees**, especially ash bark beetles (*Hylesinus spp.*), redheaded ash borer (*Neoclytus acuminatus*) and ash-lilac borer (*Podosesia syringae*), continue to contribute to the decline of ash trees in urban and rural environments. Carpenterworm (*Prionoxystus robiniae*) also is encountered commonly in green ash (*Fraxinus pennsylvanica*) in our region. These pests often are found in home plantings and windbreaks stressed by herbicide drift from adjacent agricultural areas. The stressed condition of these trees makes them favored targets of these secondary pests.

Figure 26: Ash leafcurl aphid damage in Richland County. (A. Bergdahl, North Dakota Forest Service)

Figure 27: Tip moth larva in an opened pitch mass at the tip of a ponderosa pine twig in Barnes County. (A. Bergdahl, North Dakota Forest Service)

- **Bronze birch borer (BBB)** (*Agrilus anxius*) damage was seen commonly in Jamestown, Valley City and Washburn in 2012 (Figure 28). European weeping birch was particularly targeted by this flat-headed, phloem-feeding borer. Mature trees, as well as newer plantings, were seen succumbing to infestation. Drought stress is commonly thought of as a predisposing factor leading to BBB infestation. The reason for the increase in the occurrence of this insect in certain areas, despite the wetter years leading up to 2012, is unknown.

- **Fall webworm** (*Hyphantria cunea*) defoliation was seen commonly in 2011 and 2012, especially in Schubert (Canada Red) chokecherry (*Prunus virginiana var. Schubert*) plantings in urban and rural areas in the eastern half of the state.

- **Eriophyid mites** were prevalent across the state, especially the bladder-type gall in Figure 29, below.

Figure 28: Bronze birch borer damage to European weeping birch in McLean County. (A. Bergdahl, North Dakota Forest Service)

Figure 29: Damage to maple leaves caused by a species of eriophyid mite in McLean County. (A. Bergdahl, North Dakota Forest Service)

Diseases

- **Ash anthracnose** (*Gnomoniella fraxini*) on green ash (*Fraxinus pennsylvanica*) and **oak anthracnose** (*Apiognomonia quercina*) on *Quercus macrocarpa* continued to be a significant problem during the unusually wet summer of 2011. **Oak leaf blister** reports also were very common in 2011. Disease levels of these pathogens were reduced in 2012 due to the unusually dry weather during the initial infection period in the spring and throughout the growing season.

- **Stigmina needle cast** (*Stigmina lautii*) continues to be the most prevalent disease of spruce (*Picea sp.*) trees in conservation and homeowner plantings. Prevalence of stigmina needle cast is quite high in relation to rhizosphaera needle cast, which was reflected in the proportion of reports from the eastern half of North Dakota in 2011 and 2012. Needle cast fungi still were encountered commonly in 2012, although the dry weather may have contributed to a lower overall amount of disease. Future efforts regarding this disease will be aimed at widespread sampling of needle diseases to determine the prevalence of stigmina in relation to rhizosphaera needle cast in North Dakota.

- **Dutch elm disease (DED)** (*Ophiostoma ulmi*) (Figure 30), which is present in all 53 North Dakota counties, continues to be a disease of significance. This is especially the case in communities in the western half of the state. DED first was reported in the west in the 1990s, so the disease cycle is at a point where new infections of mature trees are very common and the devastation of this disease is very prevalent. This poses significant challenges for urban tree managers, especially in small towns where funds are not available for prompt removal and proper disposal of infected trees.

Figure 30: The crown of an American elm tree showing symptoms of infection by the Dutch elm disease wilt fungus in Williams County. (A. Bergdahl, North Dakota Forest Service)

- **Armillaria root disease** (*Armillaria spp.*) is expected to increase in the coming years. It is linked to the various statewide flooding events that occurred (or continued to occur) during the 2011 growing season. No information is available on the species occurrence and distribution of armillaria root rot species in North Dakota. In 2012, armillaria was found associated with areas flooded during the growing season of 2011.

Figure 31: Ash heart rot decay conks on green ash. (M. Kangas, NDSU)

Figure 32: Black rot canker on an apple tree in Emmons County. Note the black rot canker, fruit lesion and frog-eye leaf spot are all the result of infection of different plant parts by the same species of fungus. (S. Gerhardt, NDSU Extension Service)

Figure 33 : Lesions caused by apple scab (blotches with undefined margins) and frog-eye leaf spot (rounder spots with defined margins and light centers). (J. Zeleznik, NDSU Extension Service)

- **Ash heart rot** (*Perenniporia fraxinophila*) (Figure 31) is found extensively in association with mature green ash trees statewide. This seems to be more of a natural phenomenon linked to increasing tree age. While green ash trees with extensive heart rot provide crucial habitat for avian and mammalian cavity nesters in forest settings, ash heart rot represents a risk to life and property in inhabited rural areas and especially in more urban settings. Due to the high percentage of ash in North Dakota communities, steps to mitigate risk associated with ash heart rot should be a priority in small cities and towns.
- **Stem decay of aspen** (*Phellinus tremulae*) is very common in the Turtle Mountains region and other areas where aspen is found commonly. The higher prevalence of decay is a natural process associated with overmature stands of aspen. In the absence of periodic disturbances such as fire and harvesting, stem decay and high wind events constitute the mode of forest succession.
- **Fire blight** (*Erwinia amylovora*) continues to be a problem encountered commonly on apple trees and cotoneaster in North Dakota. Despite the dry weather during the growing season of 2012, other common diseases of apple such as **black rot** (*Botryosphaeria obtusa*) and **apple scab** (*Venturia inaequalis*) (Figure 32 and 33) remained significant. Foresters suspect that these diseases have benefitted from homeowner irrigation practices. Homeowners who do not take measures to avoid spraying water directly on the crown of trees unknowingly create conditions for development of these diseases.

Abiotic

- **Herbicide damage** continues to be an agent of damage to trees and shrubs commonly encountered in urban and rural environments. Improper or careless selection and/or application of herbicides and pesticides constitute a substantial percentage of homeowner inquiries regarding tree and shrub health in North Dakota (Figure 34 and 35).

Figure 34: Spruce tree (middle) suffering from herbicide exposure. Notice the spiral pattern of damage winding around the tree indicated in the duplicate picture. (A. Bergdahl, North Dakota Forest Service)

- **Iron chlorosis** is a major tree and shrub health issue resulting from high pH soil conditions. Various species of trees and shrubs commonly experience significant health problems due to the high alkalinity of many North Dakota soils. In recent years, and especially in the spring/early summer of 2011, moist, below-average soil temperatures led to an increase in iron chlorosis incidence and severity.

- **Cultural practices**, such as improper planting, mulching, pruning, watering and fertilization, mostly by private home owners, constitute a major proportion of tree health issues responded to by the forest health specialist in North Dakota. Efforts to educate the public about proper tree care continues to be a priority of the North Dakota Forest Service, North Dakota State University, and state and municipal entities involved in the care of tree resources.

Figure 35: Oak seedling exposed to an unknown formulation of herbicide near Coleharbor. (A. Bergdahl, North Dakota Forest Service)

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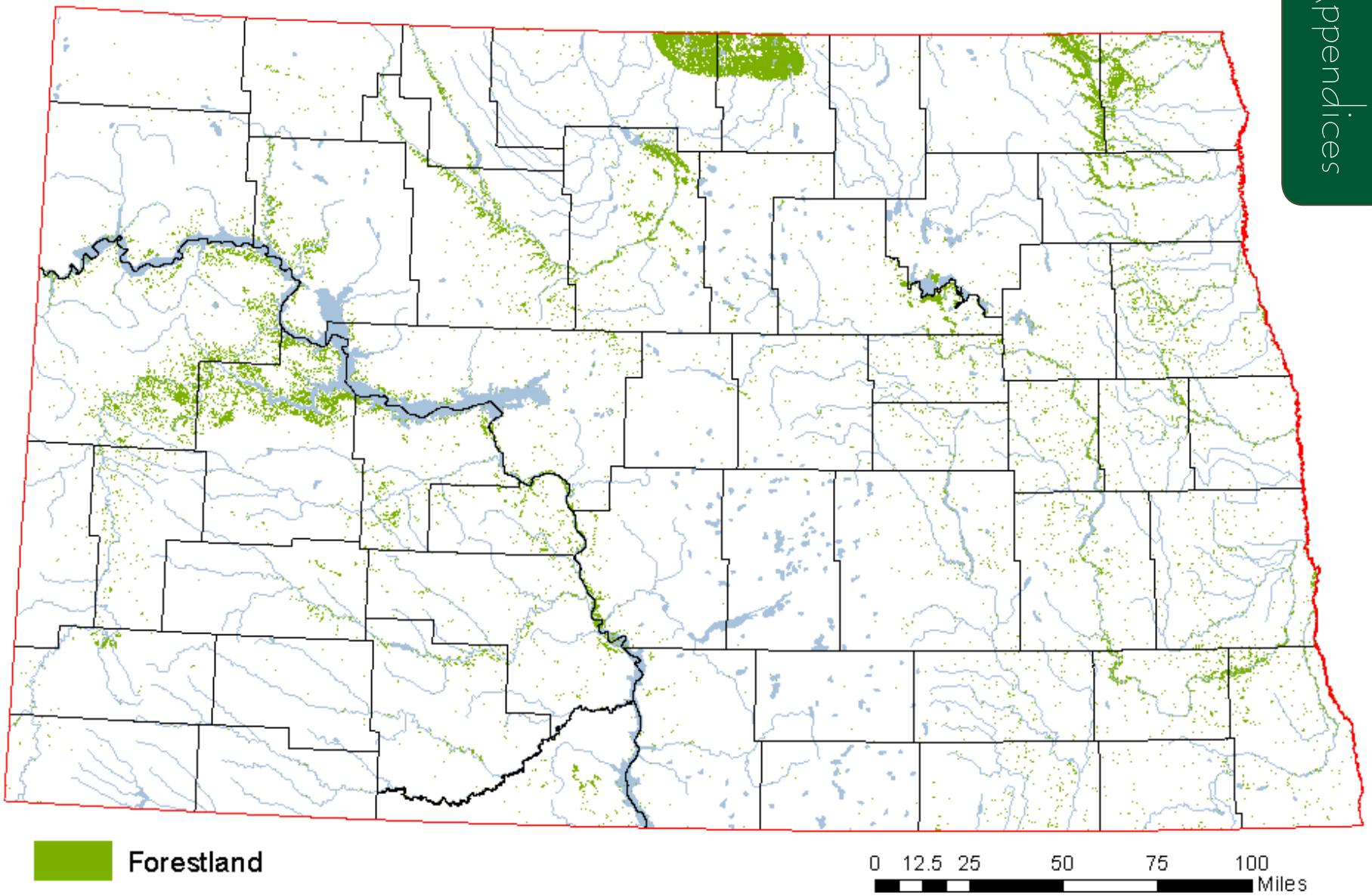
Appendix 1: Forestland in North Dakota digitized in ArcGIS (North Dakota Forest Service).



Appendix 2: North Dakota, 2012, area of forestland, in thousand acres, by forest-type group, forest type and owner category. (D.E. Haugen et al., U.S. Forest Service)

Forest-type Group/ Forest Type	Owner category			
	All Owners	Public	Private	Unidentified Owner
Softwood type groups				
Pinyon / juniper group				
Rocky Mountain Juniper	87.7	73.9	13.8	--
All forest types	87.7	73.9	13.8	--
Ponderosa pine group				
Ponderosa Pine	5.9	--	5.9	--
All forest types	5.9	--	5.9	--
All softwood groups	93.7	73.9	19.7	--
Hardwood type groups				
Oak / hickory group				
White oak / red oak / hickory	12.4	7.9	4.5	--
Bur oak	136.5	26.0	110.5	--
Elm / ash / black locust	133.3	31.6	101.7	--
Mixed upland hardwoods	25.9	--	25.9	--
All forest types	308.1	65.5	242.6	--
Elm / ash / cottonwood group				
Cottonwood	58.2	23.3	34.9	--
Willow	2.2	--	2.2	--
Sugarberry / hackberry / elm / green ash	105.6	34.9	70.7	--
Cottonwood / willow	0.8	--	0.8	--
All forest types	166.9	58.2	108.6	--
Aspen / birch group				
Aspen	106.6	28.0	78.7	--
Balsam poplar	4.5	--	4.5	--
All forest types	111.1	28.0	83.1	--
Other hardwoods group				
Other hardwoods	67.9	12.8	55.1	--
All forest types	67.9	12.8	55.1	--
Exotic hardwoods group				
Other exotic hardwoods	4.2	--	4.2	--
All forest types	4.2	--	4.2	--
All hardwood groups	658.1	164.4	493.7	--
Nonstocked	1.7	--	1.7	--
All forest groups	**753.6**	**238.4**	**515.2**	**--**

All table cells without observations in the inventory sample are indicated by --. Table value of 0.0 indicates the acres round to less than 0.1 thousand acres. Columns and rows may not add to their totals due to rounding.

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