North Dakota Forest Health Highlights 2021

NORTH DAKOTA STATE FOREST SERVICE

NDSU NORTH DAKOTA STATE UNIVERSITY

Overview

This report summarizes forest health observations and program activities in North Dakota for 2021 and includes an overview of notable forest health issues. Forest health surveys and reports, sick tree assistance requests, and personal communication with natural resource and community forestry professionals form the basis of the information presented in this report.

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Cover image: Over looking the Little Missouri River, Little Missouri National Grassland, ND.

North Dakota's Forests

North Dakota's tree-covered landscape is made up of native forests, conservation plantings, and community forests, producing a myriad of environmental and economic benefits to its residents. With an estimate of 1,556,184 acres, this landscape is divided into 796,878 acres of forestland and 759,306 acres of trees outside of forest (Figure 1). The definition of forest, according to the USDA Forest Service, requires "a treed area to be at least one acre in size with a minimum dimension of 120 feet by 363 feet and 10% canopy cover." This definition excludes two important forest components in the plains states: conservation plantings and many of the riparian forests. These two components are frequently found to be too small to satisfy the USDA definition.

Trees outside of forest (TOF), which can be argued to have made living and farming on the plains possible, contain 29,000 miles of windbreaks found in North Dakota. Preventing soil erosion, increasing crop yields, and protecting homesteads and roadways; 470,766 acres of windbreaks, as determined through the Great Plains Initiative 2 (GPI2) project, perform innumerable benefits. Until the publication of these project findings in 2021, little had been quantified regarding their distribution and current state of health (Figure 1). GPI2 raised the importance of tree health in these landscape components, motivating management to improve their condition.

Figure 1. Green represents the acres of forest distributed across the state in North Dakota's categories of forest (natural, community, and conservation plantings).

In both forestland and TOF, green ash is the dominant species. In natural forests this is often due to the lack of natural disturbance disrupting a slow transition towards the more shade tolerant ash. In TOF situations, this was an effort to perpetuate a common native species in a planted context. The other prominent species on the North Dakota landscape are, by volume, cottonwood, bur oak, quaking aspen, and Rocky Mountain juniper. Maintaining the health and sustainability of our forest resources is fundamental to the social and economic health of North Dakota. Programs like GPI2, the annual measurements done through Forest Inventory and Analysis, and community inventories help guide approaches and designations that address our resource needs.

Fifty-three communities in ND have Tree City USA designation, which recognizes them as communities with a plan to maintain the growth and health of their tree cover. Two college campuses have similar designations, recently achieving Tree Campus USA recognition.

Sick Tree Assistance Requests

The North Dakota Forest Service Forest Health program aids those experiencing health issues with their forest, landscape, or windbreak trees. During 2021 the Forest Health program consulted with private and public owners regarding an assortment of biotic and abiotic issues that range from animal and insect damage to the consequences of severe drought. Figure 2 shows the breakdown of seven general categories that represent the proportion of issues found to be responsible for all tree health request. Table 1 shows a list of the general tree health categories and some of the particular issues that would constitute each.

Table 1. Common agents associated with the categories of sick tree issues.

General Category	Particular Issue
Drought	Foliar browning, Dieback, thin foliage
Insect	Pine moth, sapfeeders, endemic beetles
Veg. Mgmt.	Assistance with general vegetation management
Planting	depth, watering, sod competition, poor site
Disease	Needle casts, blights, stem cankers
Herbicide	Off-label applications
Animal	Beaver and sapsucker damage

The predominant tree health issues evaluated during the 2021 growing season were driven by long-term drought conditions, that started during March of 2020, in large portions of the state and continued through the fall of 2021. Most tree health issues during this recent growing season could very frequently be tied to a lack of water causing a loss of tree vigor. This loss of vigor leads to reduced resistance to other health threats, often causing the presence of complicating insect and disease issues. In a general sense, tree decline is often caused by multiple stressors, having additive impacts that yield greater consequences. As such, trees experiencing a loss in vigor from most stressors can recover, should the future growth conditions permit adequate productivity. If there is no opportunity for recovery, then there is a steady state of decline with eventual tree death.

With the weather conditions we have experienced in North Dakota during the past two growing seasons, there is a good chance we may see a steady state of decline in tree health in the next growing season. Many trees have simply had to cope with the cumulative consequences of reduced growth from drought and the lowered resistance to any additional stressors. The condition of next year's growth will be dependent primarily upon the available moisture for spring and early summer growth during 2022.

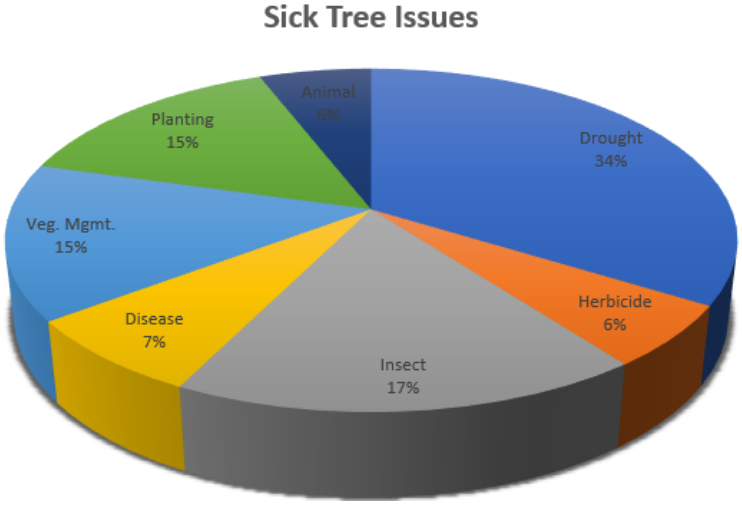

Figure 2. A breakdown of the general sick tree categories experienced during the 2021 growing season.

Abiotic Tree Health Issues

Weather trends

2021 was dominated by drought, including above average temperatures and below average precipitation. The period from December 2020 through August of 2021 was the sixth-driest nine-month period since records began in 1895 (North Dakota State Climate Office Bulletin) (Figure3). Since March of 2020, there has been no area of the state that has not satisfied one of the five drought categories. This translated to the growing season for 2021 starting with approximately 85% of the state satisfying the Extreme drought category, a level prone to major crop losses and widespread water shortages.

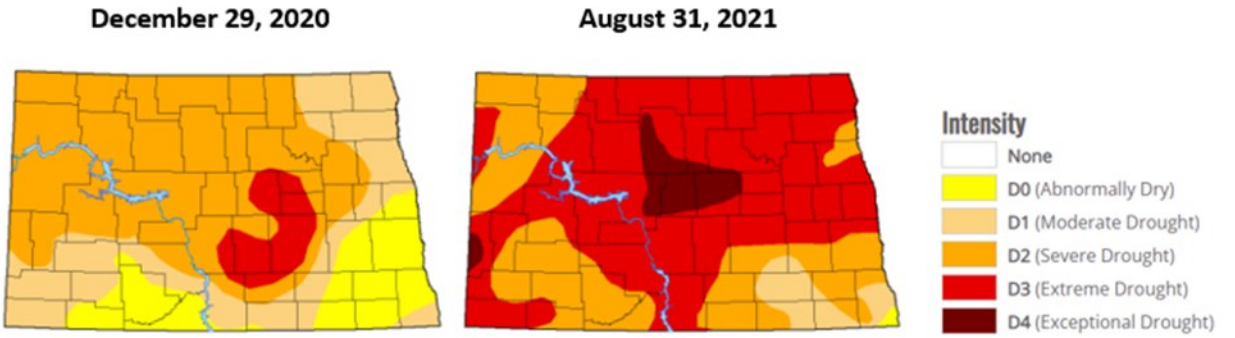

Figure 3. Drought conditions from early winter 2020 through the end of the 2021 growing season.

Exacerbating the 2.47.inches below average rainfall during the growing season (Figure 4), the overall average summer temperature (June through August) was 3.9 degrees above normal. Increased temperatures lead to greater atmospheric demand for moisture, causing trees to limit water loss through their leaf surfaces. During a period of drought, this stress becomes far more challenging when water is not available to the root system. By closing stomates, trees decrease gas exchange, which slows photosynthesis, limiting carbohydrate production and growth. Under the drought conditions of 2021, most trees likely experienced low levels of photosynthesis, making them less resistant to additional health challenges, such as insects and disease, or difficult growing conditions in the future.

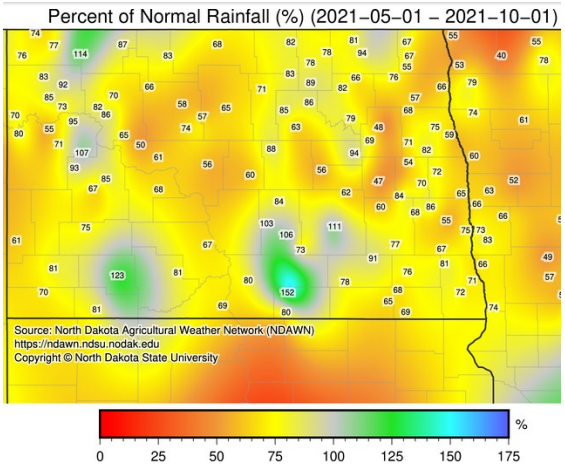

Figure 4. Total 2021 growing season precipitation as compared to the average over the same period for the timeframe 1991-2010.

Abiotic Tree Health Issues

Drought and landscaped trees

Landscaped species that are not growing in moist soil and under preferential site conditions have a harder time dealing with drought stress. This stress often leads to wilting and dieback in the upper branches, early browning or discoloration of foliage, and reduced leaf area. This occurs when the lack of soil moisture and/or the atmospheric demand for moisture puts stress on tree structures thereby limiting water movement. This situation was visible in many trees that are not native to this landscape, often having evolved under cool, moist growing conditions, but are now planted in much drier locations. Some good examples of this are birch and some maple species, which have shown many of these symptoms (Figure 5).

Figure 5. Four commonly observed tree health symptoms associated with a lack of moisture. From left to right, wilting in birch, scorch in deciduous leaves, leaf discoloration, and the production of reduced leaf area.

Drought and conservation plantings

Many conservation plantings throughout the state are in decline based on their age, lack of maintenance, and related planting density. As trees grow and fill a space, they have an increasing need for resources (light, water, and nutrients) to assure adequate growth. A natural forest generally experiences a varied set of disturbances (storm damage, fire, insects, and disease, etc.) through time to influence the density of vegetation, redistributing resources. Without influencing tree density in plantings, the growing demand for resources leads to steady overall decline. Because the precipitation level in the Plains is low compared to the majority of forested landscapes, water availability challenges conservation plantings.

Drought-caused mortality in young trees

Newly planted seedlings and saplings require a consistent level of tending to become established. A primary requirement is supplying adequate water to establish the root system and support growth. The 2021 drought conditions led to high levels of mortality for recently planted seedlings and saplings. The limited establishment of the root system meant many of these trees simply could not acquire the necessary resources for adequate growth. This consequence went beyond 2020 planting, since the cumulative consequences of two dry seasons continued to challenge establishment.

Abiotic Tree Health Issues

Drought and irrigation

Many landscaped trees during the 2021 growing season declined despite being planted in an otherwise irrigated setting. In many circumstances the amount of water applied through irrigation (10 to 20 minutes daily) supported grass growth but was inadequate to recharge soil moisture accessible for tree root systems. It is important to recognize that applying enough irrigation to recharging the soil moisture below a sod layer is significantly more than that which supports grass growth. Trees require far more water than grass to support their leaf area, so effort should be taken to thoroughly irrigate the soil below the tree crown. In most cases it is best to remove the competition from the sod below a tree by replacing the sod with mulch, which will not actively remove moisture.

Drought symptoms in pine trees

Drought conditions caused many conifer species to have browning needles as the season progressed. The lack of moisture caused senescence in the needle starting from the outer tip moving inward towards the stem, a symptom frequently referred to as "scorch." A lack of soil moisture and a high atmospheric demand limited the trees' ability to support the path of water from root to foliage, causing a loss of function and dehydration of leaves (Figure 6). Some senescence in needles was also a consequence of *Diplodia pinea,* a shoot blight, and *Dothistroma septosporum*, needle blight of Pines. As mentioned previously, these foliar diseases are persistent in our landscape, but likely experienced limited spread in 2021 due to a lack of moisture which is necessary for spore dispersal.

Figure 6. Symptoms of drought stress in pine. Scorch of needle tips, loss of water conductance to limbs and the whole tree, occasionally leading to beetle infestations.

What can you do to protect your trees from drought?

The 2021 growing season conditions were difficult for trees, raising the question of whether the 2022 growing season will see an increase in all health issues because trees will start from a compromised state. Depending on the precipitation between November of 2021 and the spring of 2022, there may be a continued decline in many trees. If we do not get the necessary precipitation, it will be important to assure adequate watering once the ground thaws to support the leaf development period. Likewise, continued dry conditions will require watering through the growing season to support adequate growth.

Abiotic Tree Health Issues

Herbicide issues

Annually, herbicides play a role in a large portion of the tree health issues evaluated in urban and rural environments in North Dakota. Improper or careless selection and/or application of pesticides constitute a substantial percentage of homeowner inquiries regarding tree and shrub health. In most circumstances, herbicide injury to urban and rural trees is a consequence of indirect application targeted at neighboring vegetation. Instances of chemical volatilization, drift, and overspray should be thoroughly considered in accordance with herbicide labeling and no herbicide intended for agricultural use should ever be used otherwise. It is vital that the application of herbicides strictly follows the manufacturers labeled recommendations.

Biotic Tree Health Issues

Spruce disorders

Disorders of spruce trees are a consistent issue in North Dakota. Spruce are not a native North Dakota species, generally having evolved in a cool climate with wet summers and a more porous soil structure. Blue spruce, the most widely planted of the spruce species in North Dakota, is the most drought tolerant species with the minimum annual precipitation in its native range being equivalent to the highest average rainfall for North Dakota. Planting spruce in fine textured soils that experience lower annual precipitation creates a scenario that frequently causes enough stress to lead to the persistence of several insect and disease issues.

Insect and disease related issues on spruce during 2021 were no more prevalent than most years. During a growing season that experiences drought, the loss of tree productivity generally reduces resistance to insect presence and changes the concentration of metabolic constituents to favor their feeding. There was a presence of *Pikonema alaskensis* (Yellow-headed spruce sawfly) and *Oligonychus ununguis* (Spruce spider mite) in spruce throughout the state, but never at a level that raised concern.

The three most common disease that garner attention on spruce are *Stimina lautii* and *Rhizosphaera kalkhoffii* needle casts and *Cytospera kunzei*, a canker disease. Caused by fungi, these diseases spread through spores that develop and disperse when the appropriate moisture and temperature conditions converage. These diseases remained present during 2021, but to a lesser extent, potentially due to the overall lack of moisture.

Dieback in native species

The presence of dying crowns and overall decline of green ash and cottonwood trees is a slow process that can be seen in many natural and urban environments throughout North Dakota. Many of these trees are large, old, and growing at high densities which means they have lower productivity and often limited growing space and available resources. These two species in particular are experiencing a high presence of endemic insect disturbance, as would be expected with low overall vigor. These endemic insects are a natural mechanism of disturbance that will decrease the density and increase new growing space and available resources.

Biotic Tree Health Issues

Insect issues

Tree health related issues are tied to a loss of vigor that starts with the conditions in which the tree is growing, whether site or weather related. The conditions of the site will depict the available light, nutrients, and water that will maintain a rate of adequate growth to the vegetation present. If these variables are not available in adequate amounts, either through increasing demand or a lack of presence, trees become stressed and consequently vulnerable to secondary causes of decline, such as insects and disease. During the 2021 growing season, drought was the fundamental driver of the loss of tree vigor statewide, which led to the minor presence of secondary insect issues. Insect issues made up 18% of the overall investigated tree health issues throughout the state.

The elm leaf miner, *Fenusa ulmi*, is a small sawfly that is native to Eurasia. During its larval stage, it tunnels through the mesophyll inside the leaf between the upper and lower epidermis. This activity hollows out paths through the leaf, reducing the photosynthetic capacity of individual leaves (Figure 7). This damage agent is only found on elm and its feeding is generally not considered to be detrimental to the tree. Successive years of leaf miner presence can reduce tree vigor, but it generally does not cause mortality in a tree with previous infestations. Approximately 8% of secondary insect related tree health issues during 2021 were associated with leaf miners.

Figure 7. Elm leaf miner on elm.

Scales are tiny sucking insects that feed on the bark, fruits, and leaves of trees and shrubs. Scales are one of the sapfeeding insects that produce honeydew, a sticky clear excrement that is often found on the surfaces beneath a tree crown. Not all sapfeeding leads to the production of honeydew, but the presence of it frequently causes the formation of sooty-mold, which makes the surfaces on the tree appear blackened. There are several species of lecanium scale, *Parthenolecanium spp.*, which are commonly found throughout North Dakota, using a variety of deciduous trees species as a host (Figure 8). Another scale insect, the European elm scale, *Eriococcus spurius*, has been found in western North Dakota, with a pronounced presence in Bismarck. Approximately 16% of secondary insect issues during 2021 were associated with scale insects.

Figure 8. Lecanium scale on green ash.

Biotic Tree Health Issues

Pine moths, *Diocryctria spp*, are wood boring insects whose larval stage bores into the trunks, branches, and shoots of ponderosa, Austrian, and scotch pines in North Dakota. There are several species of pine moths that cause similar damage, more often to younger trees with a less-developed, thin bark. Common injuries from this insect are a dead terminal leader and pitch masses that form near an entrance tunnel, often at branch whorls. This is a common and perpetual insect pest of planted pines in North Dakota. It often causes wind breakage in previously damaged trees, where boring creates a weakened stem. It is common to find a small degree of past damage and is only a serious issue when a more pronounced presence occurs. Recently assessed damage has mostly amounted to only a few dead branch leaders on a small percentage of planted trees, which is rarely a serious concern. Approximately 25% of secondary insect issues during 2021 were associated with one of the pine moth species.

Eriophyid mites are a microscopic mite from the family *Eriophyidae* that live on the surface of leaves of many species of vegetation. They are sapfeeders with piercing mouthparts that remove sugar and nutrient rich phloem sap from the leaves. Many of these mites cause damage during their feeding process, such as stippling of leaf tissues or growth distortions that form galls. There are many galls that can be formed on the leaf surface that can reduce tree vigor through repeated occurrence, but are generally not a serious issue in acute scenarios. Eriophyid mites and the galls they form are frequently seen in many landscape and community forest trees throughout the state. It is estimated that gall related tree health issues made up approximately 15% of secondary insect issues during 2021.

Spring and fall cankerworm, *Paleacrita vernata* and *Alsophila pometeria*, are native moths and pests of numerous deciduous trees (Figure 9). The larval stage of this species feeds on and defoliates trees during periodic outbreaks. In North Dakota, the periodicity of outbreaks has never been clearly determined, but is approximately 13 years in neighboring Minnesota. Following three consecutive years of significant cankerworm defoliation in eastern North Dakota, the 2021 growing seasons saw very little activity. There were scattered small populations in Fargo, but no determined cankerworm activity occurred in any other location throughout the state. The pockets of defoliation in Fargo were found in periodic tree crowns, rarely progressing from individual trees into the larger canopy. Cankerworm was associated with approximately 2% of tree health related issues.

Figure 9. Defoliation in a single crown of American elm in Fargo, ND. The culprit was a fall cankerworm, as identified by three sets of prolegs on the back half of the larvae abdomen.

Biotic Tree Health Issues

Disease issues

Diplodia pinea and *Dothistroma septosporum* are foliar diseases of pine that cause reduced growth and can lead to excessive defoliation in chronic circumstances (Figure 10). These diseases maintain a presence in our landscape due to the number of weakened pine trees found in poorly-suited off-site plantings. Like the majority of others, these diseases become established in stressed trees, eventually causing chronic infection and in some cases, tree mortality. With consecutive 2020 and 2021 growing season drought conditions, there is a potential for these diseases to influence a larger number of trees in the future, should additional stresses continue. One or both of these foliar diseases was found at low occurrence and causing minimal issue on approximately 35% of pine plantings visited during 2021.

Figure 10. The loss of vigor from an assortment of issues can be seen through short distorted growth. This ponderosa pine is also experiencing Diplodia needle blight.

Tree issues on the horizon

Thousand cankers disease (TCD) complex is a symbiotic relationship between the walnut twig beetle, *Pityophthorus juglandis*, and the fungus, *Geosmithia morbida*, that primarily affects black walnut, *Juglans nigra*. The fungus from this complex has not yet been detected in North Dakota, but during 2021, the walnut twig beetle was trapped in Ransom county. The beetle's lifecycle is likely to be limited by the cold climatic conditions experienced in North Dakota, but the consequence of this complex is yet to be understood in our landscape.

A more concerning health issue for landscaped pine in North Dakota in the near future is pine wilt. A disease that disrupts the flow of water in the tree's conducting tissues, pine wilt causes a relatively rapid browning of foliage in the crowns of non-native pine species, commonly scotch pine, *Pinus sylvestris*. This wilt disease is caused by the pinewood nematode, *Bursaphelenchus xylophilus*, which reproduces rapidly, clogging the xylem tissue. The nematode is a microscopic worm that is transferred from tree to tree by feeding pine sawyer beetles, *Monochamus spp*. This wilt has yet to be found in North Dakota, but it has been identified in northern South Dakota.

Forest Health Surveys

Beetle trapping

In a collaborative effort with the North Dakota Department of Agriculture (NDDA), the North Dakota Forest Service (NDFS) assists in monitoring for the presence of exotic and non-native wood borer and bark beetles in North Dakota using multi-funnel Lindgren traps. This trapping effort is funded through the USDA Animal and Plant Health Inspection Service's (APHIS) Cooperative Agricultural Pest Survey (CAPS) Program. The objective is targeted on four economically important exotic wood boring insects that have become established in the United States and Canada, but is effective for an assortment of tree pests.

Figure 11. Three of the "natural" forest Lindgren funnel trap sets deployed in 2021.

The CAPS Program trapping has been focused on areas of high traffic, commerce, or ports-of-entry, sampling within ten counties statewide using a series of insect lures. For 2021, the North Dakota Forest Service implemented an additional set of Lindgren trapping locations (Figure 11). The NDFS trapping was focused on expanding the surveying to include sites that were considered closer to "natural" than the other CAPS locations; in this context defined as sites in natural forest or planted stands of trees with more natural growing circumstances.

During the 2021 sampling season, none of the economically important species were trapped in the Lindgren traps deployed state-wide through the multi-agency effort. Despite not finding these species, there were a dozen new records of other wood and bark boring species from three families or subfamilies of interest that do pose potential health challenges for trees and shrubs. The twelve species, associated with *Scolytinae*, *Cerambycidae*, and *Buprestidae* all have their own life cycle preferences focused on the bark and wood of trees, playing into varied states of tree and forest health. Monitoring these species is of particular interest as North Dakota continues to experience repeated drought circumstances, which will likely continue to reduce tree resistance to insect disturbances.

Forest Health Surveys

The sub-family *Scolytinae* contains the largest number of insects that tend to cause the greatest amount of damage to trees and shrubs by completing a portion of their life cycle in the vascular tissues of the bark that conduct metabolic products throughout the tree. This is important because disrupting these tissues causes senescence of the connected distal components of the plant. Of the twelve new state records, eight are from the *Scolytinae* sub-family (Table 2). Most are relatively innocuous, but *Pityophthorus juglandis* (walnut twig beetle) has a symbiotic relationship with the *Geosmithia morbidia* fungus that causes TCD in black walnut. Walnut twig beetle was detected in Ransom county in 2021, but the fungus that completes this disease complex has yet to be found.

Table 2. A list of the 12 new species and the North Dakota counties they were trapped in during 2021.

Family or sub-family		Counties found
Scolytinae		
	Pityophthorus juglandis	Ransom
	Cyclorhipidion bodoanum	Slope
	Ips borealis	Bottineau, Burke, Pembina
	Pseudothysanoes lecontei	Grand Forks
	Anisandrus obesus	Pembina
	Hylastes longicollis	Slope
	Hylastes macer	Slope
	Pityokteines ornatus	Slope
Cerambycidae		
	Acanthocinus pusillus	McHenry
	Rhagium inquisitor	Slope
	Phymatodes varius	Ransom
Buprestidae		
	Chrysobothris cf rotundicollis	Slope

Forest Health Surveys

2021 Aerial Detection Survey (ADS) and Ground Assessment

ADS flown by USFS July 7th, 2021 and ground assessed August 24th-26th, 2021

The 2021 ADS was flown during the first week of July in 2021 (Figure 12). Aerial Detection Surveys assess forest stands for visible damage to individual tree crowns or the forest canopy. Under most circumstances, the damage consists of defoliation or discoloration of the foliage in the upper portions of the crowns and canopy. These surveys are primarily focused on native forests, which in North Dakota, are frequently found along river corridors or in locations with a significant elevational gradient, such as many of the gullies in the Badlands and Pembina gorge, or the plateaus of the Turtle and Killdeer Mountains.

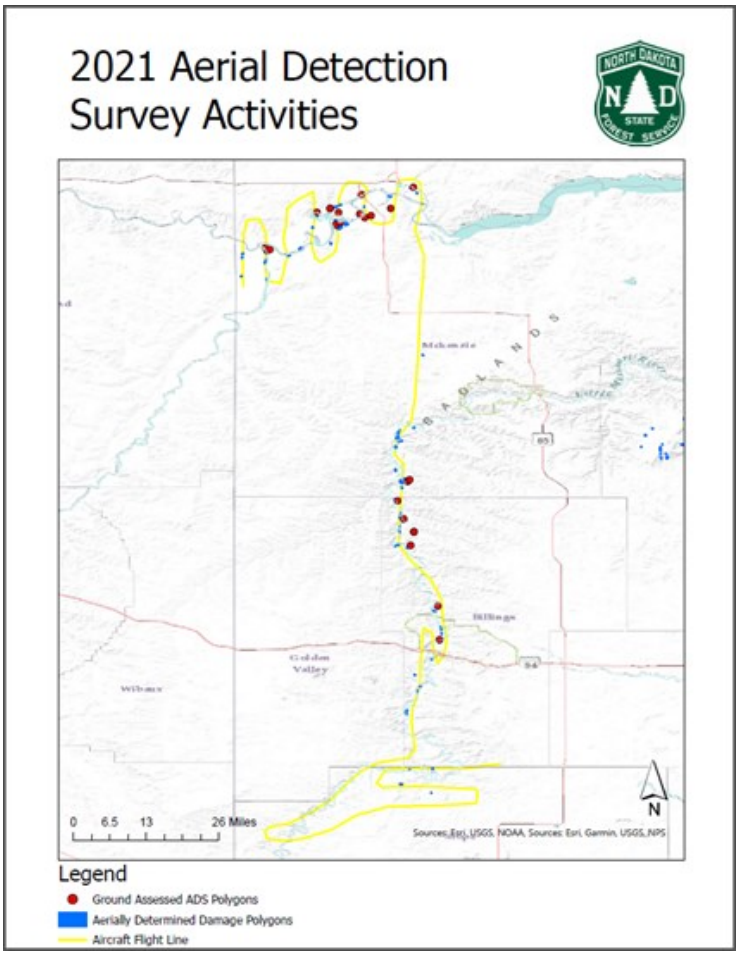

Figure 12. Map of the July 7th ADS flight line with the associated disturbance polygons (blue) and ground assessment points (red).

ADS in North Dakota are conducted with the assistance of out-of-state agencies. The eastern half on ND has historically been contracted with the Minnesota DNR, while the western half has been with the US Forest Service. Following the 2020 season, where covid-19 prevented most surveying, there was a backlog across all states. Since North Dakota's forests are a small, fragmented portion of our landscape, it is sometimes difficult to have an ADS accomplished in a timely manner. Despite its small landscape component and its limited capacity as a financial resource, our forests do play an ecologically important role, serving as a bridge for the spread of many forest insect and disease issues between the more densely forested eastern and western US landscapes.

In 2021, the ADS was acquired for only a portion of western North Dakota. On August 7th, 2021 the USFS crew was able to charter a flight along the Little Missouri River from the native pine stands of Slope County, north to the Northern Unit of Theodore Roosevelt National Park. The flight then went overland to the Missouri River, working from the mouth of Lake Sacagawea, southwest to the Montana border. The entire survey flight line was approximately 300 miles, generating 86 disturbance polygons with a size ranging from 1 to 264 acres.

Forest Health Surveys

Ground assessments of 31% of the polygons generated form the ADS were conducted for a total of 866 acres. It was determined that the damage for 83% of these acres, was caused by abiotic issues, while the other 17% was biotic. In these two river systems, which drain from very different watersheds, the abiotic issues create contrasting water availability circumstances. Forest canopy damage along the Missouri River, is more frequently caused by flooding events, like that during 2011, which killed forest stands throughout the river floodplain (Figure 13). The canopy damage along the Little Missouri River is more frequently caused by a declining rate of cumulative discharge in this smaller watershed with smaller annual flow. Since 1994, the Little Missouri River has continued to dry, limiting alluvial water availability to deep-rooted cottonwood, *Populus deltoides*, trees. The defoliation, which was determined to be mortality, in both of these systems is made up of forest stands consisting mostly of declining low vigor older cottonwood trees.

Figure 13. The defoliation in the image to the right shows drought stressed old age declining cottonwood trees along the Little Missouri River. The image below is dead cottonwood trees from a flooding event along the Missouri River.

The assessment of polygons that were generated around defoliated canopies in the upland areas containing Ponderosa pine stands in slope county were contributable to drought stress induced scorch and some needle blight. The low vigor induced by limited water availability has allowed, a slight, but persistent presence of *Diplodia* and *Dothistroma* diseases in these forests. In this context, these diseases do not require management and only in rare circumstances of many repeated years of infection will they cause mortality. Given the extent and longevity of the drought conditions in this region, there will likely remain a consistent presence of this disease that may lead to intermittent mortality of individual and small groups of trees.

Outreach and Education

Education and outreach efforts during 2021 were complicated by the continued covid-19 pandemic. Several events did occur as scheduled, but were conducted in virtual context rather than face-to-face. NDFS Forest Health continued to be involved in a few annual trainings intended to train professionals to recognize and deal with commonly encountered forest health issues to North Dakota. NDFS Forest Health also conducted trainings for two different home owners association groups regarding the process and benefits of planting trees in our communities. The opportunity also arose to teach forestry practices and forest health topics to high school students during a regional outdoor Envirothon event.

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