NDSU Extension Service
North Dakota State University

Tree Talk

June 2006
Volume 2 Issue 2

*"Good timber does not grow with ease;
the stronger the wind, the stronger the trees."*
- J. Willard Marriott

This article first appeared in the Winter 2006 issue of the Minnesota Shade Tree Advocate newsletter, and is reprinted here, minus the original photos, with permission of the authors. Not all of the tree species highlighted in Table 2 are hardy in North Dakota, but the table points out the differences between species in their tolerance to fill soil.
-Joe Zeleznik

Will Fill Kill?

The truth about adding soil over the roots of existing landscape trees.
By Rebecca Koetter and Gary R. Johnson

No, the title "Will Fill Kill?" has nothing to do with people's propensity to stuff digestive systems during Thanksgiving! Instead, it directs attention to the common questions of homeowners' about relandscaping and construction activities around their trees:

- What is fill soil?
- What are the potentially harmful effects on tree roots and tree health?
- Are there options available to avoid harming trees?

Fill is a term commonly used by building contractors, landscape architects and designers that refers to the addition of soil or other materials (e.g., sand, gravel, debris) to raise the level of a landscape. Fill is strictly a physical change and is not normally a method to improve soil nutrition, aeration or moisture movement. Fill is used to level out irregular landscapes. It's used to fill up larger depressions that may be the results of settling soils or previous excavations. Or, fill may be used to create a foundation for sidewalks, patios or driveways.

Fill (sometimes referred to as misplaced soil) can be any sort or mixture of mineral materials (from large rocks to sand), soil (from clay to silt) or debris (bricks, concrete, or other artifacts). Often, it's a random concoction of these elements: mixes of soils, clay and gravel, chunks of concrete mixed with clay and sand. Organic matter that does add nutrition to inert soils is generally not part of fill soils. The point is, fill soil is an unreliable part of the landscape and in areas where it's part of newly constructed areas it quite often alters soft water movement and contributes to unacceptable compaction levels (Day, 1999).

When a significant amount of fill is added to a landscape, soil conditions will change as will the root growth potential of existing trees. It has been estimated that 80 to 90% of all tree problems are related to soil and its effects on root growth potential and health of the trees' entire root systems (Smiley, et al, 1998).

A primer on tree roots.
Overall, tree root systems are often misunderstood. Many believe that tree roots extend tens or scores of feet deep into the ground, and those trees have one moisture-seeking tap root that reaches the water table. However, most trees have a short tap root stage of life and most roots are within the top three feet of the soil. In addition, fine roots (those that absorb most of the water and nutrients from the soil) are found within the top 12 inches of the soil (VanDerZanden, et al, 2001). Research has revealed that as little as 4 to 6 inches of fill places over the roots of some tree species have caused serious life-damaging conditions (University of Rhode Island, 2005), yet seven FEET of fill placed over the roots of one tree caused no apparent damage (Costello, et al, 2004). How can this be?

Fill alters air, nutrient and moisture situations. However, research has shown that these situations may or may not be solely responsible for tree damage. Table 1 shows the variability of effects on tree root health based on fill texture and depth. Other factors that are at least as important as the quality and depth of fill include the tolerance of the existing trees: *tree species, tree age and overall tree health*.

In general, these factors moderate or aggravate the effects of fill:

- Species with a vigorous growth habit (e.g., red maple, green ash) and those that survive in wetter environments may grow rapidly enough to recover from the fill event (Table 2).
- Younger trees recover from damage quicker than older trees of the same species. Trees in good health respond better to injury than trees in poor health of the same species (Costello, et al, 2004)

Table 1: Soil fill by texture class that can be added with varying degrees of effects on root health. From: Coder, Kim D. 1996. Construction Damage Assessments: Trees and Sites. University of Georgia.

Soil Texture Class	Initiation of root damage	Massive root damage
	Amount of fill (inches)	
Sand	8	24
Fine sand	6	18
Sandy loam	4	12
Fine sandy loam	3	9
Loam	2	6
Silt loam	1.5	4.5
Clay loam	1.5	4.5
Clay	1	3

Table 2: A partial listing of trees that are more likely to survive the addition of fill over their root systems. From: Johnson, Gary R., 1999. Protecting Trees from Construction Damage. University of Minnesota Extension Service.

Tree Species	Relative Tolerance
Northern White Cedar (Thuja)	Good
Tamarack (Larix)	Good
Green Ash (Fraxinus)	Fair to Good
River Birch (Betula)	Good
Catalpa (Catalpa)	Fair to Good
Eastern Cottonwood (Populus)	Good
Red and Silver Maple, Boxelder (Acer)	Good
Bicolor Oak (Quercus)	Fair to Good
Black and White Willow	Good
Black Spruce (Picea)	Fair to Good

More than the Fill, more than the Trees.
In addition to the obvious factors, namely, the fill and the trees, there are still more factors to consider. The soil composition (i.e., the texture as well as the structure) of the original landscape – also called the base soil − is very influential on a tree's tolerance, and the amount of the tree's root area that will be directly impacted by the fill (Tusler et al, 1998). Base soils that are more prone to compaction can aggravate the detrimental effects of fill because the existing tree roots are growing in the base soil.

Finer textured base soils – such as silts and clay soil – are more vulnerable to compaction by the equipment that brought in and spread the fill soil (e.g., trucks and tractors). The mere weight of 6 inches of fill is often enough to significantly compact a vulnerable base soil.

The texture and structure of the fill soil compared to the texture and structure of the base soil can determine the amount of water that will reach existing tree roots. A coarse textured fill over a compacted, fine textured base soil (or vice versa) can result in a situation that makes it very difficult for both oxygen and moisture to uniformly penetrate the soils where the tree roots currently exist and where they need to grow.

Is it a tree worth saving, a battle worth fighting?
With this information on the effects of varying depths and textures of fill soil, varying textures and structures of base soils, and a tree's relative tolerance to changes, the next step should be a determination of whether the tree or trees in question are worthy of preservation and protection tactics. Diseased or dying trees should be removed simply because the chances of a tree in that condition surviving are slight. Removing those trees would open up space for new trees after the filling operation is over. However, if the tree is relatively healthy and is a key element in the looks and function of the landscape and if money is not an issue, then all necessary stops to save the tree may be taken.

As a general rule, it is cheaper and more effective in the long run to prevent damage from taking place. Research has shown that little success can be expected by removing fill that has been present around the tree for more than two years (Cue et al, 2002). The initial costs may be high, but time, energy and money will be saved if proactive actions are taken.

Preventing damage from fill.
The decisions have been made: fill will be added, but fill must not kill! Nothing is absolute, but the following tactics have successfully accomplished both and are most effective when all tactics are used.

Minimize the amount of roots covered. Tree "wells" can very effectively protect existing tree roots from being smothered by fill…IF they are constructed in the right place. At a minimum, locate the wells as near as possible to the dripline (the edge of the branch spread) of the tree. As research has shown with tree wells, the larger the well, the better (Costello et al, 2004). A tree well constructed directly around a tree trunk or within a few feet isn't much more than a very attractive brick coffin. Often, tree wells will need drainage holes or pipes if the fill is very deep and/or if standing water problems are to be avoided.

Choose fill wisely. Tree health will be determined by the amount of fill used and the ability of the tree roots to grow into the newly added fill. Use the least amount of fill that is absolutely necessary. Choose fill that is less damaging to roots (Table 1). Select fill that has a similar texture to the base soil. Better conditions for tree health are achieved when only a small portion of the roots are affected and the fill soil is similar in texture to the base soil (Costello et al, 2004).

Take care of the base soil. Avoid driving heavy equipment over the base soil, especially during the times of the year when the base soil is thawed and moist. This is the period when soils are most vulnerable to compaction, and finer textured soils such as clays can be irreversibly compacted. If you must use heavy equipment, do the grading when the base soil is frozen or very dry. If you can't do the filling during those times of the year, apply the fill with the long arms of a backhoe and then grade it.

Aeration systems and layers of coarse gravel under the fill may not help at all. There is little research-based evidence that aeration systems under fill soils are consistently effective, and they are very expensive. Likewise, coarsely ground rock layers that separate base soils from fine textured fill soils may restrict water movement by creating a layered stratum that does not allow normal water percolation. The above tactics would be expensive with good intentions; however the benefits would be marginal and the chances that more damage could result are high

In Summary

Many existing trees are unwittingly lost due to filling operations associated with new landscapes and construction activities. This doesn't always need to happen if a few simple steps are followed:

1. If the tree is priceless, irreplaceable . . . don't fill.
2. If the tree is worth saving and has a chance of making it (i.e., good genes, younger, healthier), then continue with the following steps. KEEP that tree healthy during and after the fill operation.
3. Choose a fill that will be less restrictive to water and oxygen from Table 1 (e.g., a sandy loam is better than clay).
4. Choose a fill that has a similar texture to the base soil.
5. Apply the least amount of fill necessary.
6. Affect the least amount of the root system as necessary. If possible, construct a well that will keep fill away from the roots of the tree.
7. Do not compact the base soil during the fill operation. Avoid heavy equipment use, especially during times of the year when the base soil is wet.
8. Finally, because so many considerations and assessments must be done in order to save and keep trees healthy, it may be worth your time and money to have a professional who is a specialist in tree preservation assess and monitor the entire fill project.

References Cited:

Coder, Kim D. 1996. Construction Damage Assessments: Trees and Sites. University of Georgia.

Costello, L.R. and Susan D. Day. 2004. A New Look at the Impact and Management of Fill Soil around Trees, pp. 25-29. Arborist News. August 2004.

Cue, K.P., S. Josiah. 2002. Landscaping around established trees. Retrieved June 15, 2005 from NebGuide Web site: http://ianrpubs.unl.edu/forestry/g1452.htm.

Day, Susan. 1999. Growth and Physiology of Several Urban Tree Species in Soils Disturbed by Construction Fill or Compaction. Dissertation submitted to the faculty of Virginia Polytechnic Institute and State University.

Johnson, Gary R., 1999. Protecting Trees from Construction Damage: A Homeowner's Guide. University of Minnesota Extension Service, FO-6135.

Smiley, E.T., T.R. Martin and Bruce R. Fraedrich. 1998. Tree root failures. Landscape Below Ground II: Proceedings of an International Workshop on Tree Root Development in Urban Soils. D. Neely and G. Watson, Eds. International Society of Arboriculture, Champaign, IL.

Tusler, P.E., J.D. MacDonald and L.R. Costello. 1998. Fill soil effects on soil aeration. Landscape Below Ground II: Proceedings of an International Workshop on Tree Root Development in Urban Soils. D. Neely and G. Watson, Eds.

University of Rhode Island, (n.d.). Maple Tree Decline. Retrieved June 16, 2005, from Greenshare Factsheets Web site: www.uri.edu/ce/factsheets/sheets/mapletreedecline.html

VanDerZanden, A.M. and J. McNeilan. 2001. Conserving Water in the Garden: Landscape and Lawn Care. Retrieved June 16, 2005 from Orgeon State University Extension Service Web site: http://eesc.orst.edu/agcomwebfile/EdMat/html/EC/EC1531/EC1531.html.

Rebecca Koetter is a Graduate Research Assistant in the Department of Forest Resources, and Gary Johnson is a Professor of Urban and Community Forestry in the Department of Forest Resources, University of Minnesota.

Emerald Ash Borer

By Justin Knott, N.D. Department of Agriculture

In 2002, the emerald ash borer (EAB), *Agrilus planipennis,* was determined to be the cause of widespread ash tree mortality in and around Detroit, Michigan. It is now believed the metallic green beetle (Figure 1) was introduced at least 10 years ago. The insect probably arrived on solid wood packing material in cargo shipments from eastern Asia (Cappaert et al. 2005), the native range of emerald ash borer (Figure 2). EAB already has killed an estimated 15 million ash trees.

Figure 1. Adult emerald ash borer. Photo by David Cappaert, http://www.forestryimages.org

Biology

The life cycle of the emerald ash borer usually takes one year to complete. Adult beetles emerge from ash trees in June and early July, leaving a D-shaped exit hole (Figure 3). The adults feed on leaves for a week then mate and lay eggs on the bark. The eggs hatch within two weeks. Larvae bore through the tree's phloem, just under the bark in a serpentine pattern (Figure 4), which restricts the tree's ability to move sugar to the roots of the tree. The larvae overwinter under the bark and pupate in the spring just before they emerge.

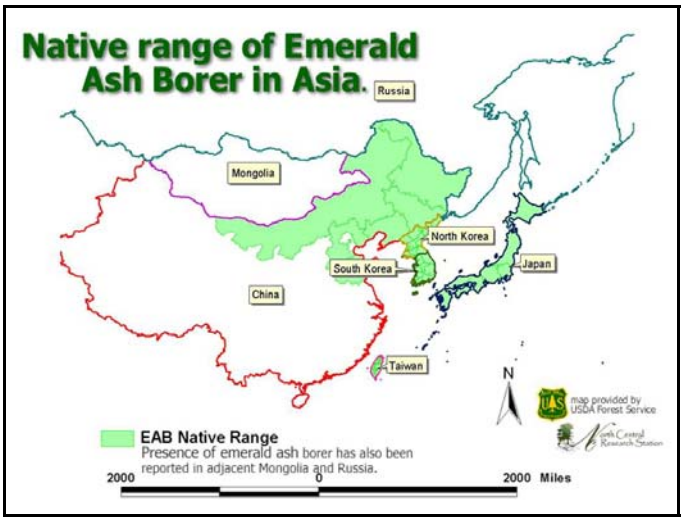


Figure 2. Native range of emerald ash borer. Map from the USDA Forest Service.

Figure 3. D-shaped exit hole of the emerald ash borer. Photo by David R. McKay, USDA APHIS PPQ, http://www.forestryimages.org.

The beetles initially colonize the tops of the trees and then subsequent generations infest the lower portions. This progression of infestation eventually girdles the tree. Once a tree is girdled, it will die in one to three years (Poland and McCullough 2006). It may take thousands of beetles and several years to kill a tree depending on the tree's size and health. Symptoms of infestation include: dieback, generally from the top down; D-shaped exit holes about 1/8 inch long; serpentine galleries underneath the bark; woodpecker activity; and suckers growing from the base of a tree.

Figure 4. Emerald ash borer larva and serpentine larval galleries. Photo by David Cappaert, http://www.forestryimages.org.

The adult beetles do not naturally disperse over long distances. Investigations of infested sites indicate that the majority of beetles move less than a half mile. Lab experiments have shown that EABs are capable of flying three miles (Taylor et al. 2005). The beetle actually has spread much farther than

it could naturally, due to the movement of infested trees and wood. Movement of firewood from the Detroit area to lake homes in northern Michigan is believed to have been the cause of many of the outlier infestations.

Detection and Known Distribution

This insect has proven to be very difficult to detect and it is hard to delimit the extent of infestations. Detections are occurring years after the introductions, usually when an area of dead ash trees is noticed or when an adult beetle is found on a trap tree, which is a labor intensive, expensive and destructive survey method. Our knowledge of the insect's distribution has greatly expanded since the initial Detroit detection. The insect has been found at sites in Indiana, Ohio and Ontario, Canada. Due to the lag time between infestation and detection, it is exceptionally difficult to regulate emerald ash borer. Areas have been quarantined as new infestations have been found. The quarantines prohibit the movement of ash trees and wood unless steps have been taken to remove the risk of transporting EAB, such as removing bark or heat treatment. Currently, only one introduction of the outlier infestations is known to have occurred after quarantines were put into effect (Fort Brimley State Park in the Upper Peninsula of Michigan). In short, we don't know how effective quarantines and regulations are to stop or slow the spread of EAB because it's too early to tell.

Eradication Efforts

Through 2005, state and federal dollars were spent in efforts to eradicate EAB, especially from outlier sites (outside of southeast Michigan). In this effort, all ash trees within a half mile radius of an EAB find were destroyed. The average cost of these eradication efforts is $500,000 per site (Poland and McCullough 2006).

The situation is changing quickly. In 2005, limited funding caused officials to concentrate on outlying infestations in "gateway" areas, which lead to uninfested areas, such as the Mackinac Bridge that links the upper and lower peninsulas of Michigan. In 2006, federal funding for EAB has been cut and states do not have the money to continue eradication efforts. Therefore, this year's efforts will be directed at delimitation and regulation.

Latest Research

Researchers are concentrating on developing an effective trap to enhance survey efforts. They are developing an attractant based on volatiles, which are given off by trees that are stressed (Crook et al. 2005). Potential biological control agents have been found and are being evaluated for effectiveness and nontarget effects (Gould et al. 2005).

The USDA-NRCS is collecting and storing seed from ash trees across the nation in an effort to preserve the genetic diversity of ash trees in case EAB continues to spread and kill ash trees. Go to www.mi.nrcs.usda.gov/programs/pmc.html for more information on this program. The online clearinghouse for information on EAB is at www.emeraldashborer.info.

Potential Impacts to North Dakota and Response Efforts

Ash trees are a major component of riparian forests, rural tree plantings and urban settings across North Dakota (Figure 5). Ash trees provide immense benefits in each of these roles, the value of which is impossible to fully quantify. It is difficult to predict the effect a species will have in a new area. However, all indications are that if (when) EAB arrives in North Dakota, all ash trees will be at risk.

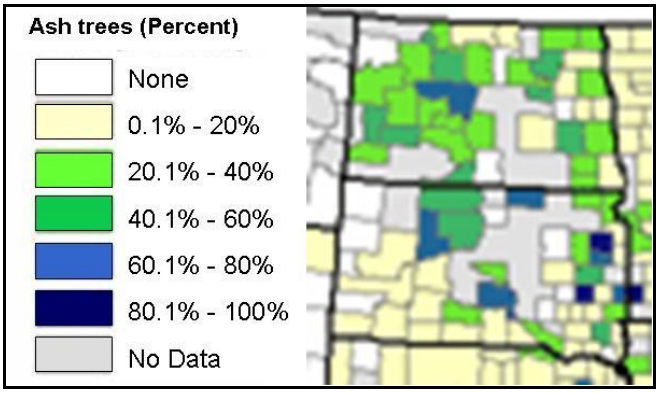


Figure 5. The susceptibility of North and South Dakota's forests to emerald ash borer is high because of the very large amount of green ash found in the state. This map only includes timberlands and does not take into account the amount of green ash found in cities and towns. Map adapted from the USDA Forest Service: http://www.fs.fed.us/ne/syracuse/Data/Nation/data_eab_kh_trepc.htm.

Actions in North Dakota (and all other states with ash trees) need to focus on keeping EAB out of the state and taking steps to lessen the impact

when it does arrive. Regulation and inspection of nursery stock is the responsibility of the N.D. Department of Agriculture. The department will continue to monitor and inspect nursery dealers and growers, including out of state nursery stock. The North Dakota Invasive Tree Pest Committee is cooperating with state agencies, tree care professionals, campsite owner/operators and other groups who have contacts and influence to people coming to North Dakota. The central message is to leave firewood at home. The department is targeting out-of-state campers, RVers, anglers and hunters. Firewood is a pathway that could move EAB as well as other insects and diseases. A firewood alert poster is available at www.ag.ndsu.nodak.edu/diaglab/firewood_alert_2006.pdf

An important proactive step is to diversify the species composition of tree plantings as much as possible. This will lessen the impact of EAB, native pests and any future exotic pests.

Literature Cited

Cappaert, D, D.G. McCullough, T.M. Poland, and N.W. Siegert. 2005. Emerald Ash Borer in North America: A Research and Regulatory Challenge. American Entomologist. 51: 152-165.

Crook, D.J., I. Fraser, J.A. Francese, and V.C. Mastro. 2005. Chemical ecology of the emerald ash borer *Agrilus planipennis* Fairmaire (Coleoptera: Buprestidae) in relation to tree volatiles. Available online at: http://esa.confex.com/esa/responses/2005/80.pdf

Gould, J., L. Bauer, H. Liu, D. Williams, P. Schaefer and D. Reardon. 2005. Potential for biological control of the emerald ash borer. Available online at: http://www.emeraldashborer.info/files/Annapolis2005.pdf

Poland, T.M. and D.G. McCullough. 2006. Emerald ash borer: Invasion of the urban forest and the threat to North America's ash resource. Journal of Forestry. 104: 118-124.

Taylor, R.A., T.M. Poland, L.S. Bauer and R.A. Haack. 2005. Is Emerald Ash Borer an Obligate Migrate?, p. 14. *In* Proceedings of the 2005 Emerald Ash Borer Research and Technology Development Meeting Pittsburgh, Pennsylvania. USDA Forest Service FHTET-2005-16. 84 p. http://ncrs.fs.fed.us/4501/eab/downloads/eab2005.pdf

NOTE: Emerald ash borer presents an enormous threat to the forest resources of North Dakota because our heavy reliance on green ash has made us vulnerable. However, the nearest infestation is more than 600 miles away in the upper peninsula of Michigan. Should we be concerned? What is North Dakota doing, and what should we be doing to protect our ash resource? The following opinion piece is Jim Walla's (NDSU plant pathologist) assessment of what we should be doing in response to the EAB threat.

My assessment − North Dakota's approach to the EAB threat.

Jim Walla, Department of Plant Pathology, NDSU

Based on the current, grim EAB situation, the planting and management of ash trees should cease. It appears that a strong program could delimit and eventually eradicate EAB infestations if effective action is taken before more infestations develop. Work to provide EAB funding and actions to currently infested states should be a very high priority of our forestry community. If those states are able to begin delimiting infestations, it will be critical to restrict and manage imported firewood. Without better methods of detection and a realistic scenario for dealing with infestations in North Dakota, detection efforts here would not be beneficial. Ash trees will be in our future only if we and others commit to using all available means of dealing with EAB, even if the process results in funds and glory going to other states.

EAB is prolific, difficult to detect, easily spread and very damaging.

What is the threat? Emerald ash borer is a monster, a goliath, a pestilence of historic proportion. There is no evidence that left unchecked, it will not eliminate ash from North America. This is comparable with the effects of chestnut blight, the worst forest catastrophe ever recorded. No useful resistance to EAB has been found among native ash. Pesticides can protect individual trees, but their application will threaten any EAB eradication efforts by keeping live trees that can prolong the presence of an infestation. No, I don't believe

I have overstated the case. If EAB gets to our area within 20 years, we will have lost the war.

There have been multiple threats from insects and diseases introduced to forests in North America since the 1800s. These introductions have been met with various levels of reaction ranging from none to extreme. Some major mistakes have been made by acting too late or taking minimal action. Taking minimal action tends to fail and simply to be a waste of resources. Lessons from past introductions should be used to determine our reaction to new pests. The reactions should be based on the importance of the threatened resource, on the biological potential for successful actions and on the expertise and funding available to carry out those actions. In this case, ash is the most valuable tree species in North Dakota. There are limited biological weak links currently known in EAB, and the only place that adequate expertise and funding can come together to provide any hope for success is in the currently infested states.

Some will say that North Dakota would be able to respond adequately to EAB infestations. I don't think so. The only way to settle the issue is through an exercise that identifies specifically what it would take to fully carry out eradication of an established EAB infestation in North Dakota I understand that USDA Animal and Plant Health Inspection Service (APHIS) officials in North Dakota are working to arrange a mock EAB eradication exercise. That would be extremely valuable. Such an exercise should include identification of all the costs, including administration, infestation delimitation, tree removal and destruction for all the years it would take to eradicate an established infestation. Where would the millions of dollars for such a multiyear effort come from? APHIS doesn't have the funds to do the needed work in states already infested. North Dakota has an emergency response fund, but how much of that, if any, would be available for an EAB eradication effort? Would those funds then be available for additional EAB eradication efforts?

What can we do?

Currently, there are nondelimited infestations in at least three states and there is inadequate funding to properly carry out detection, delimitation, eradication and quarantine. Given this situation, the only approach that we in North Dakota can reasonably take is to completely stop managing for ash in native stands and stop using ash in plantings. That is a hard choice, given that ash is our most valuable species in native stands and in planted landscape and resource conservation settings. There is no comparable replacement species. Anyone that plants trees should be searching for other species and start using them now. Toward that end, the North Dakota Forest Service and NDSU recently teamed to obtain funds to evaluate some of the woody plant germplasm maintained at the Northern Great Plain Research Lab in Mandan. Some additional species and selections within species will almost certainly be identified that can add to our choices of woody plant materials used in North Dakota. We critically need more such work.

The only other reasonable option that we have is to try to change the current EAB situation. We need our state officials to do everything in their power to increase federal funding and quarantines to fight the EAB battles before the infested area expands. This is where ALL of our current EAB efforts must focus to give us any chance of saving our ash trees.

1. Funding. The bottom line for any chance of success is that congress must appropriate funding to APHIS for EAB detection, delimitation and eradication work in the infested states. That approach already has been successful against Asian long-horned beetle (ALB) infestations that are being mopped up in Chicago, New York City and in New Jersey. For several years, the funds were available for ALB eradication. More than $30 million was spent on ALB efforts in 2005, compared with approximately $10 million for EAB. Emergency funds from APHIS were used for EAB efforts. However, these emergency funds cannot be used for more than three years and 2005 was the third year. Funding has drastically decreased in 2006. How, with a success story in the very similar ALB situation, can EAB not be dealt with properly? The answer is that EAB has not reached a high priority among forestry professionals as stated by an Indiana Department of Agriculture employee leading that state's EAB efforts.

Even if everything that should be done is accomplished, EAB may not be eradicated.

Thus, increased federal funding needs to be allocated to the USDA Forest Service specifically for research into methods to improve detection and management of EAB. Such research would likely identify vulnerabilities in EAB that would allow more efficient or less expensive detection, delimitation or eradication of infestations. In the long run, such research would provide tools that could be used in North Dakota to reduce damage if EAB gets here. That's why avoidance or prevention of EAB into the state for the next 20 or so years is very important. With more tools available by then, we might then have some chance of managing or reducing EAB damage.

2. Properly established and enforced quarantines. There already are vulnerabilities known in EAB that could be used to our benefit. The adult beetle is not a strong flyer, so infestations can be delimited given adequate funding and persistence. The primary threat for long-distance dispersal (i.e., to other states) is in infested wood, so adequate quarantines could protect those of us outside the infested areas. The word "adequate" is the key. Quarantines are in place to stop all ash movement from known infested areas, but the quarantines are not being enforced strongly enough to stop the transporting of all infested firewood. Further, the quarantines are not inclusive enough. For instance, quarantines in Indiana are only in force in the township that contains known infestations. There are certainly unknown infestations outside the quarantined areas. There needs to be a zone in front of any discovered infested sites from which no firewood or nursery materials can be exported. Based on distances that new infestations have been found from previously known infestations, that zone should be at least 150 miles. We need APHIS to establish and enforce adequate quarantines to protect our resources from EAB.

We need our state's elected and appointed officials to step forward in raising the priority of EAB funding and actions. Officials of the N.D. Forest Service and N.D. Department of Agriculture recently met to discuss actions that they can take, both individually and through their respective national associations. This also should be done by state parks, tourism and natural resource agency officials. The forestry community in North Dakota need to let these officials know that this is a critical situation. In addition, letters and other contacts by individuals, organizations and appointed and elected officials to our highly-ranked congressional delegation, APHIS and the USDA Forest Service are urgently needed to quickly raise the priority of EAB containment.

What next?

If adequate funding and quarantines are provided to infested areas, then some action within our state would be appropriate. The main action should be stopping or destroying all out-of-state firewood. This should be through N.D. Department of Agriculture regulations and through education of owners and managers of campgrounds where firewood might bypass restrictions. Some say regulating the importation of firewood would be too difficult to enforce, so a voluntary effort should be tried, such as the Smokey Bear program. The main problems with that approach are: (1) much reduced effectiveness in an age of media overload; and (2) that fires still happen even after Smokey tells us that only we can prevent fires. Further, such media campaigns are backed up by regulations. If EAB enters North Dakota, how are we going to stop it? If every ash tree within 1 mile of an infestation in Fargo must be removed to begin an eradication effort, where will the tens of millions of dollars come from to do that? Maybe from the regulatory agencies that thought a voluntary effort was all we could justify? No, this threat is too serious to play chicken. The question is how many of our pest management tools should be used to deal with the EAB threat. I say empty the toolbox! Doing less threatens North Dakota with BILLIONS of dollars in ecological, environmental and economic damage.

If firewood importation restrictions are imposed, local sources will be needed. Indeed, local or certified sources of firewood could reduce the desire of some to import firewood. Our natural resource management agencies, especially the N.D. Forest Service, would be naturals in facilitating the availability of local firewood sources.

Finally, if funding and quarantines become adequate in the infested states and if adequate firewood import restrictions and campground

monitoring are established in North Dakota, then we should consider planting ash trees again.

What should we not do?

We should not use our time and funding on EAB detection, at least not until detection is more efficient and states closer to the known infestations find EAB. Any actions toward detection within North Dakota will just be feel-good exercises. Watching for dying ash trees essentially is as effective as the most intensive detection efforts in the infested states. Even if 90 percent of the infestations were found early, the remaining infestations would become well-established. In reality, based on what is going on in the known infested states, the chances of early detection here are probably less than 10 percent. Early detection of some EAB sites is like stopping a few nuclear warheads in an all-out war. If one goes off, we lost. What would we do if infestations were found? Delimitation of EAB infestations, let alone their eradication, has been less than successful in Michigan, Ohio and Indiana, where there is a lot more expertise and funding. Detection efforts at this time would make it look like we are doing something, but it would provide no meaningful results.

Similarly, we should not try to tap into federal EAB funds to support actions outside the infested areas. Until they are able to begin delimiting infestations, siphoning EAB funds will place us at greater risk.

Finally, we should not look for the next best tree species and overplant it the way we overplanted American elm and then green ash. Doing so will lead to this same situation. Diversity is needed to buffer the effects of threats to individual species.

Cytospora canker of spruce

Joe Zeleznik, Forester, NDSU Extension Service

Introduction

Cytospora canker (Figure 1) is a common problem associated with spruce trees in North Dakota. While the pathogen may be benign, having latent infections in the branch bark, it often kills individual branches and spreads to other branches. Cytospora is usually not fatal (Proffer and Hart 1988), but the loss of branches because of this disease may impair windbreak function or reduce the aesthetic value of an individual tree. Cytospora canker should not be confused with Rhizosphaera needlecast. The patterns of symptoms of the two fungi are very different. Rhizosphaera occurs mainly in the north and eastern parts of North Dakota. The western parts of the state usually are too dry for Rhizosphaera to develop. Mike Kangas of the N.D. Forest Service has developed a nice two-page flier (2004) that describes the differences between these diseases.

Biology of the disease

The naming of fungi can be very confusing. Cytospora canker of spruce is no exception. *Cytospora kunzei* is the asexual stage of fungus' life cycle. In some literature, it goes by the name *Leucocytospora kunzei*. The sexual stage of *C. kunzei* is called *Valsa kunzei*, but also is known as *Leucostoma kunzei*. Furthermore, there are many other Cytospora species that commonly affect other trees. For example, *Cytospora chrysosperma* attacks various poplar and willow trees in the Great Plains.

In this article, the term "Cytospora" will specifically refer to Cytospora canker of spruce (*Cytospora kunzei*).

In North Dakota, Cytospora is most often found on Colorado blue spruce trees. Other hosts include Black Hills spruce (and other varieties of white spruce), Norway spruce and Douglas-fir. Norway spruce and Douglas-fir are not common in the state, but occasionally grow on protected sites in urban areas. Several other conifer species that don't grow in North Dakota also can be infected by *Cytospora kunzei* (Proffer and Hart 1988, Kavak 2005). Cytospora canker is rare within the native range of blue spruce (Sinclair and Lyon 2005).

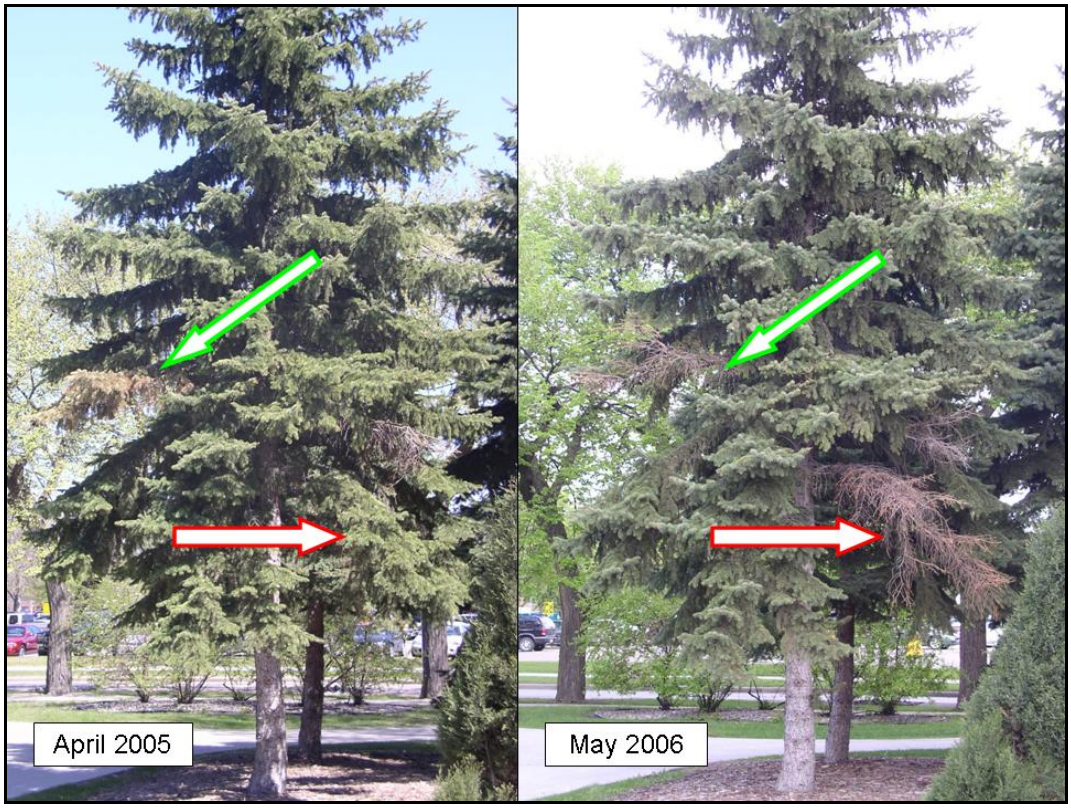


Figure 1. Blue spruce tree with Cytospora canker. The photo on the left was taken one year before the photo on the right. In the first photo, the branch on the left (green arrow) is just beginning to show needle dieback. The red arrow points to a branch that is showing no symptoms. Within one year (second photo), both branches were dead. Photos by Joe Zeleznik.

Trees become infected with Cytospora through wounds (Kamiri and Laemmlen 1981a, Schoeneweiss 1983, Proffer and Hart 1994). This usually occurs on branches via cracks in the bark because of mechanical stress caused by heavy snow loads or by wounds from hail damage. Old branches are more susceptible than young ones and old trees are more susceptible than young trees. Once the disease gets established, it grows, kills the bark and eventually circles and kills the entire branch. Lesions expand more rapidly along the branch than around it (Sinclair and Lyon 2005). Therefore, the process of infection, canker development and branch death may take several years. However, it usually is less than a year from the start of visible symptoms to the complete death of the branch (Figure 1). Cankers can develop around the main stem, but these are not common (Sinclair and Lyon 2005).

The disease often starts near the bottom of a tree. Eventually, higher branches become infected. However, it also can be initiated in a branch midway along the stem (Figure 1). As a branch is dying, the needles will discolor. The needles turn a dull green and then purple or brown before falling off. The other main symptom (after dead branches) is the accumulation of sticky resin around cankers and on the stem and branches below the infected areas (Proffer and Hart 1994) (Figure 2).

The different stages of fungal growth (sexual and asexual) produce spores that can infect spruce trees. The asexual stage produces spores throughout the growing season, with the highest production in spring (Kamiri and Laemmlen 1981b). These spores can withstand freezing and begin germination at 68 degrees, with maximum growth around 81 degrees. The spores of the sexual stage are only produced in spring and early summer. Both spore types spread to new branches via rain splash or simply are found in the air (Kamiri and Laemmlen 1981b). These authors also found that the amount of spore dispersal is directly correlated to relative humidity, rainfall and leaf wetness. Some authors

(e.g., Sinclair and Lyon 2005) suggest that insects also may vector spores to spruce trees, though this has not been proven. Pruning tools are another means
of spreading the spores from branch to branch.

Figure 2. Resin has oozed from a higher branch infected with Cytospora canker and collected and crystallized on these branches. Accumulation of resin, by itself, does not necessarily indicate Cytospora canker, since resin flow is a normal response to wounding in spruce trees. Resin does not cause infection and can accumulate on non-infected branches. Photo by Joe Zeleznik.

The fruiting bodies that hold the spores are located beneath the outer bark (Figure 3) with only small openings protruding to the bark surface. The asexual spores (conidia) are held in structures called pycnidia, while the spores of the sexual stage (ascospores) are found inside structures called perithecia. Perithecia are not often observed on blue spruce in the northern Great Plains (Walla 2006) and in Michigan (Kamiri and Laemmlen 1981b, Proffer and Hart 1988).

As stated, the fungus can remain as a latent infection in the bark without producing branch-girdling cankers (Schoeneweiss 1983). It only will enter the branch through a wound. Even if a tree is wounded and infection begins, the tree may be able to compartmentalize around the wound, cutting off fungal growth. Compartmentalization is more likely if the tree is in good health and watered well. Stressed trees, especially those under water stress, are more likely to allow infections to become established (Kamiri and Laemmlen 1981a, Schoenewiss 1983). Schoeneweiss (1983) also found that exposing trees to freezing stress (minus 4 to minus 20 degrees) did not predispose them to infection. Conversely, Cytospora will grow in bark killed by other agents, so the presence of Cytospora doesn't necessarily mean that it caused the death of the branch (Walla and Crowe 1986).

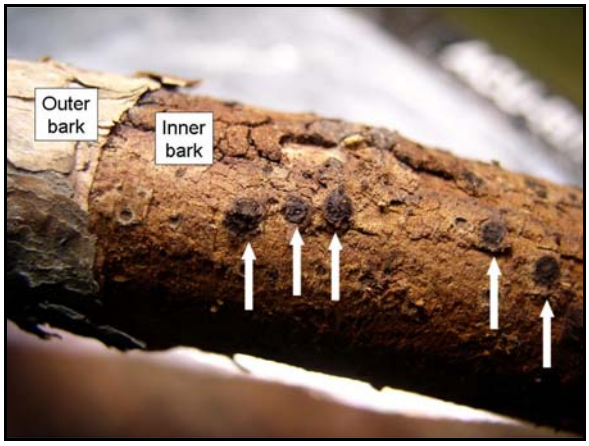


Figure 3. Pycnidia (white arrows) of Cytospora canker on the inner bark of a branch of Colorado blue spruce. Photo by Joe Zeleznik.

Control

Chemical control has not been proven effective, so cultural techniques are the only methods available. Even after a branch has been killed, the fungus will continue to produce tree-infecting spores in the dead bark. Therefore, the most important method of control is removal and destruction of infected branches. Pruning can be done in winter or during dry weather through the growing season. Pruning should be completed as soon as possible after the infection is detected. Because rainy, wet weather increases spore dispersal (Kamiri and Laemmlen 1981b), winter pruning is preferred. Disinfect pruning tools between cuts by using rubbing alcohol or a 10 percent bleach solution. Clean and oil the pruning tools after use because the disinfectants may be corrosive. If infected branches are pruned without being destroyed, they will continue to be a source of infection as they release more spores into the air. Two consecutive years of thorough sanitation will substantially reduce future infections.

Minimizing drought stress is another important factor in fighting Cytospora canker of spruce. If possible, water the trees every seven to 10 days if moisture is limiting, allowing the water to slowly soak deep into the ground. Light, frequent watering

(every two to three days) is not recommended because it promotes a shallower-than-normal root system. Also, spruce trees do not tolerate flooding very well, so overwatering may cause more harm than good. Of course, watering is much easier with shade or ornamental trees than in shelterbelts. However, minimizing competition from weeds and other trees will minimize moisture stress even in windbreak trees. If weeds are removed by cultivation, depth must be carefully controlled because tree roots also may be destroyed during the tillage process.

Another factor in preventing infection is planting the "right tree in the right place." For example, spruce trees should not be planted on extremely dry, sandy soils. Planting also is not recommended near older spruce trees, even if they are not infected because they will probably become infected in the future and serve as a source of inoculum for many years. Also, "frost pockets," which are low areas where cold air collects, may result in higher infection rates of Cytospora (Reich and Van der Kamp 1993). Where Black Hills spruce and Colorado blue spruce are site adapted, consider planting the Black Hills spruce because it is more resistant to fungal infection. Cytospora also seems to be more prevalent where spruce trees are crowded together. Keeping trees farther apart, so that their crowns do not touch each other, seems to minimize infection.

Literature cited

Kavak, H. 2005. *Cytospora kunzei* on plantation-grown *Pinus elderica* in Turkey. Australasian Plant Path. 34: 151-156.

Kamiri, L.K., and F.F. Laemmlen. 1981a. Effects of drought-stress and wounding on Cytospora canker development on Colorado blue spruce. J. Arbor. 7(5): 113-116.

Kamiri, L.K., and F.F. Laemmlen. 1981b. Epidemiology of Cytospora canker caused in Colorado blue spruce by *Valsa kunzei.* Phytopathology. 941-947.

Kangas, M. 2004. Spruce diseases in North Dakota. NDSU Extension Service publication PP-1276. 2p.

Proffer, T.J., and J.H. Hart. 1988. Vegetative compatibility groups in *Leucocytospora kunzei*. Phytopathology. 78:256-260.

Proffer, T.J., and J.H. Hart. 1994. Wound inoculations of Colorado blue spruce with isolates of *Leucostoma* (*Cytospora) kunzei* and other Cytospora species. J. Arbor. 20: 215-221.

Reich, R.W., and B.J. Van der Kamp. 1993. Frost, canker, and dieback of Douglas-fir in the central interior of British Columbia. Can. J. For. Res. 23: 373-379.

Schoeneweiss, D.F. 1983. Drought predisposition to Cytospora canker in blue spruce. Plant Disease. 67: 383-385.

Sinclair, W.A., and H.H. Lyon. 2005. Diseases of trees and shrubs. Second Ed. Cornell University Press. 660p.

Walla, J.A. 2006. Personal communication.

Walla, J.A., and F.J. Crowe. 1986. Cytospora canker of spruce. pp. 132-133 *in* Diseases of Trees in the Great Plains. J.W. Riffle and G.W. Peterson, *Tech. Coordinators*. USDA For. Serv. Gen. Tech. Rep. RM-129. 149p.

Freeman maples … to plant or not to plant.

By Allen Lee, Fargo Forestry Department

It seems that it is nearly impossible to visit a nursery in the area, mention the word maple, and promptly be told that one of the Freeman maples is the best thing since sliced bread. "It's guaranteed to grow and turn a brilliant red fall color every year" is a saying I frequently hear. However, we should temper our enthusiasm a little when selecting this type of tree.

Freeman maples (Acer x freemanii) are naturally occurring hybrids between red maple (*Acer rubrum*) and silver maple (*Acer saccharinum*). This hybrid cross has been around for quite some time. It was made popular in the late 1960s by the late Glenn Jeffers of Jeffers Nursery in north- central Ohio with the discovery of the cultivar 'Jeffersred', sold under the trademark name Autumn Blaze®

(Figure 1). Originally, Autumn Blaze® hit the nursery trade in the early 1980s. In all, there have been at least 12 cultivars of the hybrid identified, named and sold (Table 1). Autumn Blaze® maple easily is the most popular in the nursery trade. Additionally, Autumn Blaze® was selected as the Urban Tree of the Year in 2004 by the Society of Municipal Arborists.

Figure 1. An establishing Autumn Blaze® maple. Photo by Allen Lee.

Since its parents are red maple (not fully adapted in North Dakota) and silver maple (iron chlorosis and branching problems), it would seem difficult to recommend this type of tree. However, the hybrid is supposed to take the good characteristics from each parent and leave behind the bad ones. This should result in a cross that is hardy, grows fairly fast, is tolerant of clay soils, and will produce nice, red colored fall foliage. The jury still is out whether that will hold true in the long run for our North Dakota climate. Freeman maples have been sold in the Fargo area for nearly ten years, mostly in the past five.

Differentiating a Freeman maple from a silver maple is nearly impossible with only a quick glance. Like most maples, Freemans have opposite, simple leaves, with five lobes on each leaf, but the lobes are not as deep as those in *A. saccharinum* (Figure 2). Freeman maples also have a silvery colored lower leaf surface and a light gray bark when young. Freeman maples set themselves apart from *A. saccharinum* when they show their fall colors (Figure 3). Freeman maples have more brilliant red and orange coloration when growing on acid soils. Growth appears to be at quite a high rate when young, up to 2 feet a year in Fargo (through six growing seasons so far). When nearing maturity, the trees easily should be 50 feet tall by 40 feet wide. Time will tell how large they actually will grow in North Dakota.

Figure 2. Leaf of an Autumn Blaze® maple. Photo by Allen Lee.

Propagation of this type of tree commonly is done through rooted cuttings (own rootstock). Originally, propagators were grafting a bud of the Freeman maple onto *A. rubrum* rootstock, but reports were surfacing of delayed root graft incompatibility. Most nursery stock wholesalers will identify their trees as being grown from their own rootstock or grafted onto a different rootstock.

Figure 3. An Autumn Blaze® maple in full fall coloration. Photo by Dale Herman.

Taking care of Freeman maples is riddled with uncertainty. Sources still recommend that this hybrid will grow best in slightly acidic soil, which is a scarce resource in North Dakota. Iron chlorosis symptoms have not appeared on any of the cultivars

planted in North Dakota, though the long-term prospects are still unknown. As with most trees, watering during drought periods, performing structural pruning at a young age, planting to a proper depth and using good mulching practices will help ensure that these trees will get a good start.

Perhaps the most practical cultivar to try in North Dakota climates is 'Sienna,' sold under the trademark name Sienna Glen®. Originally found near Lake Elmo, Minnesota, by Dennis Heins, it shows less frost cracks and sunscald injury than Autumn Blaze®. Additionally, when grown in sod, mulched with woodchips and receiving adequate irrigation, it performs quite well. In Fargo, the Fargo Forestry Department has planted nearly 200 Sienna Glen® maples the last three years as replacements for lost American elm trees. To date, they are looking fantastic and show decent red to orange fall coloration. Additionally, transplant success of bare root plants has been quite high.

In western North Dakota, these hybrids have shown mixed results. Craig Armstrong, the city forester in Dickinson, said that the Autumn Blaze and Sienna Glen maples have done well in sheltered sites in town, but there has been some dieback on trees planted in exposed areas. Rebecca Haag of the Bismarck Forestry Department has seen similar results. However, Paul Beck of Lowe's Nursery in Minot, has both of these cultivars planted on exposed sites near his home and both are doing well.

Our harsh northern climate, high pH soils and limited rain make the growth and sustainability of maple trees somewhat difficult to attain. However, with all the recent introductions of Freeman maple hybrids, there is hope on the horizon that one or more of these will prove to be a winner.

Sources

Dirr, M.A. 1990. Manual of woody landscape plants: Their identification, ornamental characteristics, culture, propagation, and uses. Fourth edition. Stipes Publishing Company, Champaign, IL. 1007p.

Sternberg, G., and J. Wilson. 1995. Landscaping with native trees, The Northeast, Midwest, Midsouth & Southeast Edition. Chapters Publishing Ltd., Shelburne, VT. 288p.

Jefferies Nurseries. http://www.jeffriesnurseries.com/hunt.htm

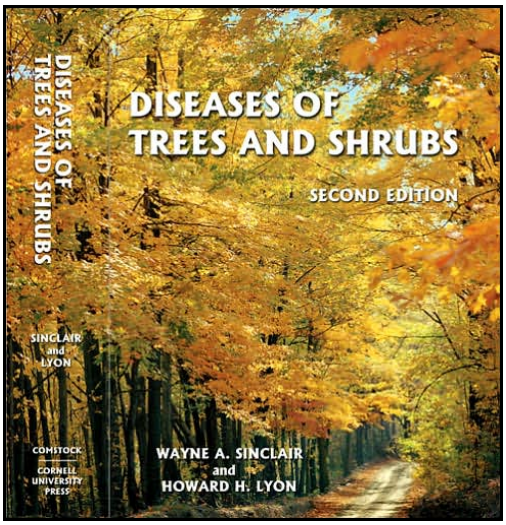
Table 1. Freeman maple cultivars.

Cultivar name	Trademark name	Mature size in feet (height x width)	Comments
'Armstrong'	none	60 x 15	Fastigiate growth, not hardy in N.D.
'Armstrong Two'	none	60 x 15	Better red fall color than Armstrong, not hardy in N.D.
'Jeffersred'	Autumn Blaze®	50 x 40	Oval, rounded form, Zone 4
'DTR 102'	Autumn Fantasy®	50 x 40	Upright, broadly oval form, Zone 4
'Celzam'	Celebration®	45 x 25	Red to gold fall color, Zone 4
'Lee's Red'	none		Brilliant red fall color, not hardy in N.D.
'Marmo'	none	70 x 35	Red to yellow fall color, Zone 4
'Morgan' (syn. 'Indian Summer'	none	70 x 35	Hardier than some cultivars, Zone 4
'Scarsen'	Scarlet Sentinel®	45 x 25	Oval, rounded form, orange red fall color, Zone 4
'Sienna'	Sienna Glen®	50 x 40	Supposedly pyramidal/rounded form, Zone 3

Small Talk – June 06

New edition of Diseases of Trees and Shrubs book

A second edition of the incredibly useful book "Diseases of Trees and Shrubs," by Sinclair and Lyon, came out at the end of last year. This new edition is fully updated and illustrated with more than 2,200 digitally optimized color images in 261 full-color plates and more than 350 black-and-white photographs and drawings. Symptoms, signs and cycles of hundreds of diseases are described and microscopic features of many pathogens are depicted in photos and line drawings. A searchable CD-ROM included with the book contains bibliographic entries for more than 4,500 works that readers can consult for additional information or images. The book retails for about $85.



North Dakota Forest Service Centennial celebration

The North Dakota Forest Service is celebrating its 100th birthday this year. The centennial theme, "rooted in the past – growing towards the future," honors past forestry accomplishments and highlights the agency's future direction for the next century. The N.D. Forest Service is a unit of North Dakota State University and is headquartered on the campus of Minot State University-Bottineau (formerly NDSU-Bottineau). The Forest Service and MSU-Bottineau are celebrating their centennials together, on July 14-16, 2006. Events include a Smithsonian traveling exhibit entitled, "Inspirations from the Forest" and a N.D. Museum of Art traveling exhibit, "Shelterbelts." On Saturday, July 15, events include a forestry tour with stops at the State Forests and the Towner State Nursery, tree climbing exhibitions and a ceremonial tree planting. The forestry tour is free to the public, but space is limited. Registration is required.
A poster containing more information is available on-line, or you may contact Glenda Fauske of the N.D. Forest Service at (701) 228-5446.