ICESTORMINJURY OA

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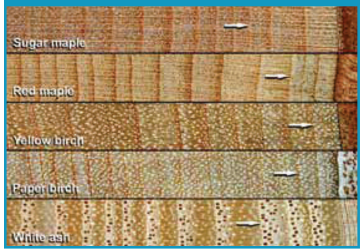
TREE RECOVERY FROM Ice Storm Injury

Dr. Smith will be speaking at the ISAO Conference from 1 - 2 pm on Wednesday, February 18!

Ice storms are part of nature, particularly in northeastern North America. The combination of air and surface temperatures, precipitation, and wind that result in damaging layers of ice is very specific, occurring infrequently at any given location. Across the region however, damaging ice is formed in fragmented areas every year. Occasionally as in December 2013 and January 1998, a closely-spaced series of ice storms severely damaged large rural and urban areas in Ontario and adjacent provinces and states.

Ice storms immediately affect people's lives through damage to buildings and to the infrastructure for transportation and energy. By necessity, governments and news media focus on public safety and human effects of infrastructure damage. With major storm events, aerial and ground surveys assess the impact of tree injury on infrastructure over large areas of the landscape or along stretch of roadway or utility corridors. After the immediate safety and cleanup needs are met, public attention moves on to other topics. But what contributes to the severity of tree injury and eventual recovery? Some of the lessons learned from the tracking of individual trees in rural forests since the northeastern ice storm of 1998 (Shortle and others 2014) are summarized in this article.

Fig. 4. Patterns of growth suppression and recovery in trees injured in the 1998 regional storm. Increment cores (bark to the right) were collected after the 2000 growing season and the onset of the 1998 growing season is marked (arrows). PHOTO CREDIT: Kenneth R. Dudzik, USDA Forest Service, Durham, New Hampshire, USA



Crown injury that occurs over a time span of minutes to hours induces a cascade of changes that affects trees for years to decades to come. The force of accumulated ice aggravated by wind (Fig. 1) can exceed the strength of the stem and branch system in tree crowns (Kraemer and Nyland 2010). Breakage and tree crown loss result from stem snaps, branch breaks and pullouts, and ripped forks. The strength limits may be due to inherent wood properties such as compression or bending properties as measured in a wood testing lab. Under sufficiently extreme conditions, any size of branch or stem of any tree species is vulnerable to breakage. Under less extreme loading, branches or stems may bend and become supported by neighbor trees or by the ground without breaking. Crown architecture contributes greatly to the degree of stress loading with the upright decurrent shape of pine and hemlock being less vulnerable than the spreading excurrent shape of elm and ash. At the level of tree biology, crown breakage affects tree budgets through: (1) reduced income from photosynthesis and (2) increased expenses for defense and recovery.

Less obvious than broken branches but still a consequence of breaks is the sudden blockage of potential water flow from air bubbles or emboli introduced into the water-conducting sapwood cells or pores. Living xylem parenchyma cells quickly die from desiccation following introduction of air into sapwood. Into the growing season, metabolic shifts form compartmentalization boundaries at the margin of healthy and killed sapwood (Shortle and Dudzik 2012). These boundaries consist of plugging, waterproofing, and anti-microbial materials that resist the spread of lost function and infection. The sapwood killed by desiccation and subsequent infection discolors, usually becoming darker than healthy sapwood. This wound-initiated discoloration generally occurs within compartmentalization boundaries. Eventually, wood-destroying fungi can spread within the discolored wood.

Crown breakage and wounding contribute to tree infection through (1) providing an entry pathway for new infections of killed sapwood and (2) the release of previously compartmentalized infections in the stem and root system. Intact bark provides good protection from invasive wood decay fungi. The high moisture content and low oxygen levels in healthy sapwood limits the growth of most aerobic organisms responsible for decay. Mechanical injury, sapwood cell death, and wood aeration favors initial infection and spread. However, the production of compartmentalization boundaries both in wood present at the time of injury and in wood formed after injury resists the loss of healthy sapwood function (Shortle and Dudzik 2012). Compartmentalization boundaries are expensive as organic compounds are diverted from normal energy-yielding to defensive processes. Tree species vary to the extent to which they commit resources to compartmentalization boundaries and individual trees vary in the availability of metabolic resources for defense at the time of injury and during recovery.

Fig. 1. Ice deposition and tree injury are a natural part of northeastern forests

Systematic dissection of storm-injured trees show that discoloration and decay moves slowly from broken branches and may take years to reach the main stem. Dissection also revealed that trees that initially survived canopy loss were at risk from the release of previously compartmentalized infections, particularly infections introduced by earlier wounds of the lower stem or woody root system. Infections can be released by mechanical breaching of compartmentalization boundaries, low availability of energy to maintain those boundaries, or increased aeration of infected and adjacent wood.

Following crown breakage, the key to long-term survival and restoration of growth rates is the building of a new crown to replace the lost photosynthetic capacity. New branches can form from sprouts that arise from pre-formed latent buds and from new meristematic points, frequently at the wound margin (Smith 2014). Sprouting is sometimes viewed negatively as a source of timber defects in rural forests or as a source of unsightly and weak branch attachments in urban trees. However, the ability to reiteratively sprout and build a new crown is fundamental for tree survival. Frequently, the character of high-value veteran trees is the result of sprouting and crown recovery after storm injury of long ago.

Initial surveys of severity and extent of ice storms document the footprint of human disruption. Such "snapshots" usually do not provide a measure of net economic or ecosystem loss. The tracking of individual trees showed that damage was strongly related to: 1) Tree health before the storm, particularly with respect to root disease, 2) Ability to sprout and rebuild crowns, and 3) Closure of open wounds. Accurate prediction of recovery requires looking for signs of infection in the roots and butt of trees and assessing the capacity for crown restoration. *(More images cont'd on next page).*

References:

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Fig. 3. Tree recovery depends on rebuilding tree crowns. Three years after storm injury for examples of paper birch, sugar maple, and white ash (left to right).

Fig. 2. Wound-initiated discoloration in paper birch about three years after storm injury