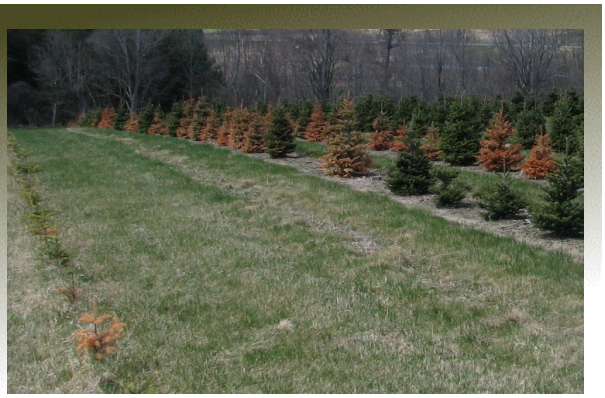
Vermont Forest Health



2012 Christmas Tree Losses:

The Role of Late Winter Desiccation

Department of Forests, Parks, & Recreation
June, 2012 vtforest.com

Christmas tree growers reported sudden damage to fir trees in late winter/early spring 2012. The foliage turned a pale beige color or, in some cases, a brighter red. Often the damage was severe enough to cause branches, upper crowns, or entire trees to dry out completely.

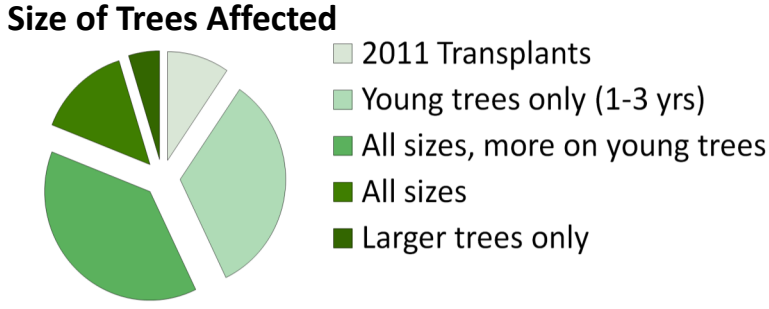
The NH-VT Christmas Tree Association surveyed growers to learn more about the unexplained tree loss. Thirty-one growers responded to the survey. Additional reports were received at a growers' meeting and through diagnostic requests to the VT Department of Forests, Parks, and Recreation.

Observations on Christmas Tree Mortality

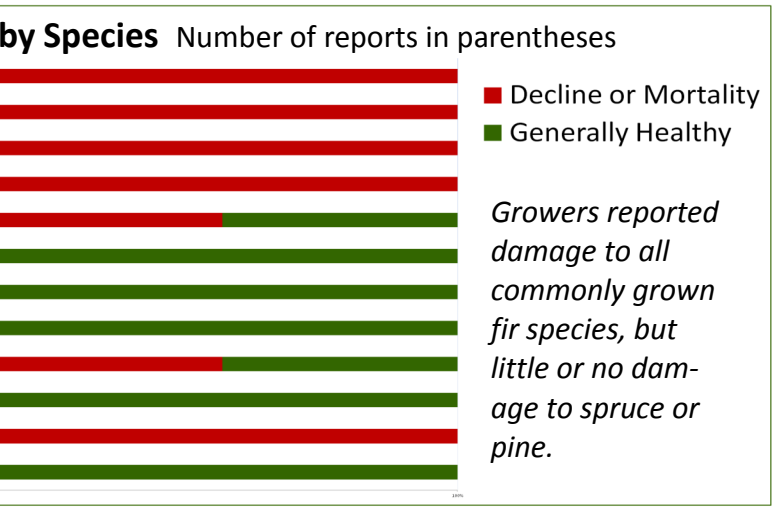
Losses were common in both New Hampshire and Vermont. However, few "unexplained losses" were reported from northeastern Vermont or northern New Hampshire. The extent of damage varied considerably from limited losses to over 2000 trees lost.

Although 80% percent of growers reported the worst damage on younger trees, 57% reported losses to larger ones. Some only lost 2011 transplants, and some only trees in the ground for three years or less.

Although 80% of growers reported the worst damage on younger trees, 57% reported some losses to larger trees.



Growers reported damage to all commonly grown fir species. It's not surprising that balsam fir led the list of damaged species, being the most common tree grown. Fraser fir continued to show its vulnerability to wet site conditions. Although based on just a few reports, there was little or no damage to spruce or pine. The only spruce damage mentioned was to blue spruce, which has recently been affected by needle-cast.



Growers reported damage to all commonly grown fir species, but little or no damage to spruce or pine.

Three-quarters of growers reporting mortality first saw symptoms in 2012. Some saw mortality as early as February. Of those who didn't see damage until April, some had not been in their plantations earlier in the season, and thought they might have missed the onset.

Nearly half of growers reported the worst damage on heavy or wet soils, and 15% reported limited root systems. 23% observed no contributing factor. However, in many plantations where losses were related to soils or root problems, growers reported losing some trees with no apparent limitations. Although snow on the ground was rare, trees under snow cover were okay.

Factors Associated with the Worst Damage

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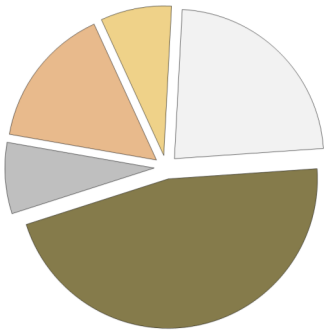


In addition, known disease problems were reported by some growers, including Armillaria and Phytophthora root rots. Several also observed scattered red branches appearing suddenly on otherwise healthy trees.

Speculation on Cause

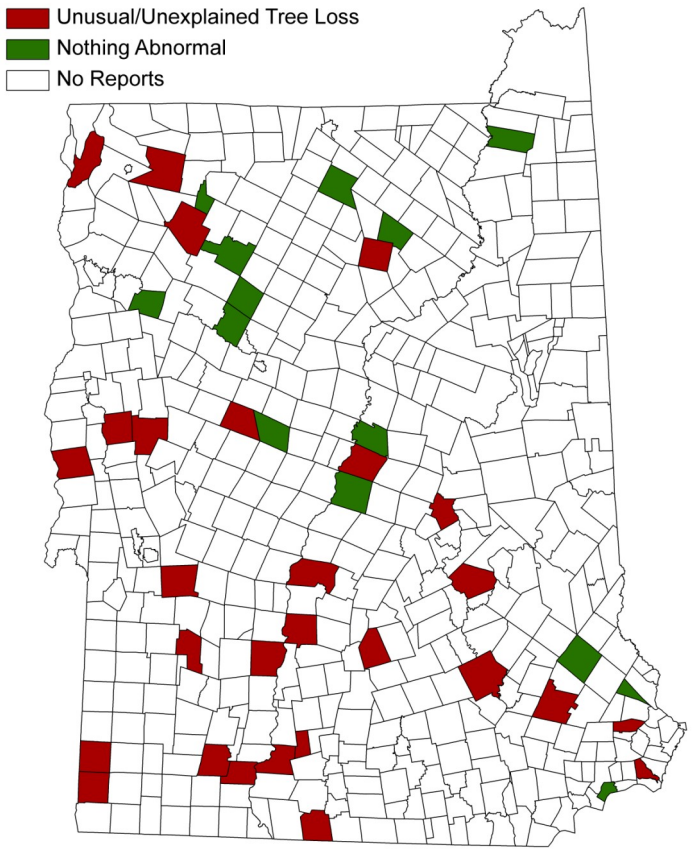
A working hypothesis is that desiccation was the cause of these symptoms. Trees were not able to take in water through their roots as fast as they were losing it through their needles.

The rapid onset of symptoms across a broad geographic area points to weather as an inciting factor for tree losses. As growers pointed out, there was no lack of unusual weather in the winter of 2011-12 or in the growing season of 2011 that preceded it. Across the region, soil was saturated for parts of 2011, the open winter allowed soil to freeze, and drought conditions developed in late winter. Then, March outstripped months of above average temperatures with heat topping 80 degrees.

The footprint of some of these weather patterns roughly coincides with the geographic pattern of damage reported by growers. Examples are March temperature and precipitation departure from normal, although other weather factors may have been more important.

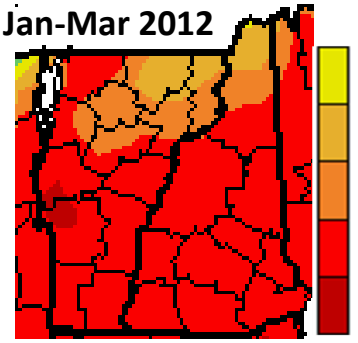
Christmas Tree Damage in Winter/Spring 2012

Reported by Growers to the VT NH Christmas Tree Association or the VT Dept of Forests, Parks, & Recreation

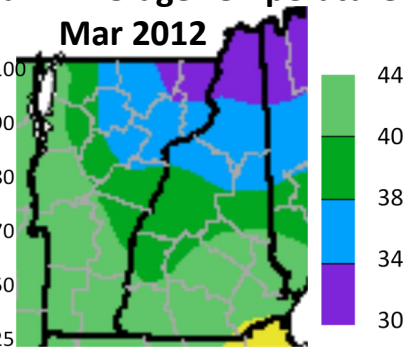


The footprint of unusual weather patterns in early 2012 (below) roughly coincides with the geographic pattern of damage reported by growers .

Precipitation % of Normal Jan-Mar 2012



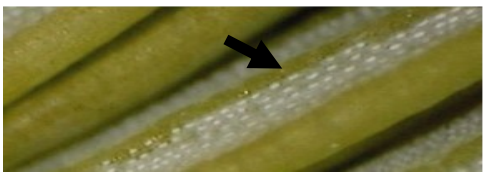
Average Temperature Mar 2012

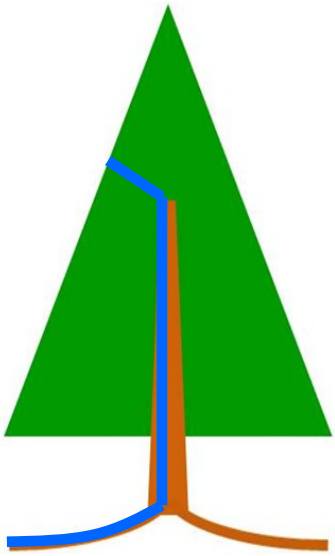


To understand what may have gone wrong, it helps to understand how water moves in trees, or "transpiration". A stream of water moves from the soil particles, through vessels in the roots, stem, and branches, to the surface of the needles, where it evaporates through holes called "stomates". Because water sticks to itself, water is pulled up from the soil to replace the water that evaporates from the needles, similar to a beverage moving up a straw. The engine that powers this anti-gravity machine is the dryness of the air, which determines the evaporation rate.

When water is evaporating from the needles faster than the soil water can replace it, the tension in the water column increases (think of a rubber band). When the tension increases too much, the stomates close to prevent further water loss. However, under extreme conditions, evaporation can be so rapid that the water column snaps. This results in cavitation, a pocket of air that interrupts transpiration until the continuous stream of water is restored. Under even more extreme conditions, trees die from dessication.

Water is pulled up from the soil to replace water that evaporates from the needles, through holes called "stomates" (arrow, below). When water is evaporating from leaves faster than the soil water can replace it, the stomates close to prevent further water loss. Under extreme conditions, evaporation can be so rapid that the water column snaps. The resulting pocket of air interrupts transpiration until the continuous stream of water is restored.





The factors growers reported as contributing to damage in early 2012 would all intensify desiccation by interfering with a tree's ability to replace transpired water. These included oxygen-deprived root systems caused by wet or saturated, heavy soils, or by planting too deep. They also included undersized root systems, including recent transplants. Sandy soils can't hold much water, so their supplies can be rapidly depleted.

Even where there were no tree losses, some growers reported that scattered dead branches showed up suddenly. These branches had prior wounds, caused, for example, by sawyer beetles or machinery. With the rapid evaporation in late winter, there weren't enough intact vessels to resupply water to their foliage.

Weather conditions alone might explain losses where other factors were not involved. Balsam fir is shallow-rooted. Where there was no snowpack, the entire root system could have been in frozen soil, with no liquid water available. Even where it was not actually frozen, there were days in March when the soil was fifty degrees colder than the air. The quick change in temperature as water moved from the soil to the air, along with the extreme negative pressure in the water column, could have taken gases in the water out of solution, creating cavitation.

Balsam fir is a shallow-rooted species. In 2012, soil froze more deeply than normal, in much of the region, because there was no snow cover. Many trees had roots only above the frost line.

Branches with old wounds reddened quickly in the spring. The wounds reduced the number of vessels able to transport water to the foliage.

While it's only speculation, there are possible explanations why fir in Christmas tree plantations were affected more than native balsam fir. In the unnaturally open environment of a plantation, the trees and the soil are more exposed to extreme weather conditions. With their shallow root systems, balsam fir depend on the soil humus layer more than other species, a layer lacking in Christmas tree plantations. Fertilization may also be a factor. Higher nitrogen decreases the cold tolerance of trees and results in earlier budbreak. Dissolved materials in the soil can affect the tensile strength of water, making the water column in the tree more likely to break.

In the open environment of a Christmas tree plantation, trees are more exposed to extreme weather than balsam fir in the wild.

Recommendations

While there are no quick remedies to the weather, some things might be helpful to keep in mind:

- Tree losses may not be from the weather alone. Check the root collar of dead or dying trees for pitch indicating the presence of root rot. Pull recent transplants to make sure they were planted correctly.
- Continue to evaluate the risk of planting trees on marginal sites given that they will need to survive many years of increasingly extreme weather.

Check dead and dying trees for other causes. Trees with root rot may have pitch at the root collar. Often the lower branches die first. If you suspect root rot, check under the bark for streaking (indicating Phytophthora, below left) or white fungal "fans" (Armillaria, below right).

For More Information

Water Movement in Trees http://warnell.forestry.uga.edu/service/library/index.php3?docID=162&docHistory%5B%5D=2

Climatic Profiles of Fir Species http://planthardiness.gc.ca/index.pl?lang=en&m=6&genusid=1000003

Recent Weather http://www.nrcc.cornell.edu/

Phytophthora Root Rot http://extension.psu.edu/ipm/program/christmas-tree/pest-fact-sheets/stem-and-root-injury/phytophthora.pdf/view

Armillaria Root Rot http://extension.psu.edu/ipm/program/christmas-tree/pest-fact-sheets/stem-and-root-injury/armillaria-root-rot.pdf

NH VT Christmas Tree Association http://www.nh-vtchristmastree.org/

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