

Evaluating Crown Canopy Changes In Vermont Ice-Damaged Forests by Image Analysis: 1999-2003

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Introduction

Current forest health monitoring crown measurements may not be the best way to describe ice-damaged tree crowns and how they change over time. Vertical images of crown canopies can be used as visual records of change and be analyzed for changes in canopy cover. Oblique images of individual tree crowns also serve as visual records of change and can be analyzed for crown density as well as compared to standard crown ratings.

In 1999, photo points (20 per site) for stand level changes were established in two light to moderately damaged Vermont Monitoring Cooperative plots in Ranch Valley (Mt. Mansfield), one heavily damaged site in Roxbury, one severely damaged site in Stratford (Podunk) and one severely damaged salvaged site in Orange (Butterfield). Three control plots were established - one in a very lightly damaged site in Ranch Valley, one in a very lightly damaged site in Stratford and one in a lightly damaged site in Orange. The Mt. Mansfield sites were all on shallow upland soils with fairly poor fertility while all other sites were excellent for growth of northern hardwoods. Vertical images obtained during July to August were analyzed for percent canopy cover. New images were taken from the same points in 2000, 2001, 2002 and 2003 to follow changes in canopy cover and crown condition.

An additional 72 photo points were established for oblique photography of individual dominant or codominant tree crowns in various crown loss categories. Most of the trees selected had severe damage, with 70 to 80 percent crown loss due to the 1998 ice storm. Trees selected included 44 sugar maple, 6 white ash, 15 yellow birch, 3 beech, 2 paper birch and 2 black cherry. These were photographed again in 2000, 2001 and 2003 to follow crown recovery or demise.

Methods

Four 1/24th acre plots were established in each stand following Forest Health Monitoring standards for plot layout. The two VMC plots were pre-existing. One 4-foot fiberglass rod was driven to 31.5 inches above ground at each plot center and at the 24-foot radius in each of the four cardinal compass directions to establish 20 points per stand for vertical canopy cover images. Vertical crown cover images were taken with a digital camcorder equipped with a super wide angle lens (16mm equivalent), set onto each fiberglass rod (via drilled wood adapter screwed into tripod socket) and leveled (Figure 1). Images were downloaded into a computer and percent canopy cover was determined using MultiSpec, a freeware program developed at Purdue University for analysis of landsat images.

Individual trees in and adjacent to the plots were selected for oblique photography if their crowns had heavy damage and were totally visible from some ground point. The ground point was marked with a fiberglass rod and distance and azimuth from here to the tree was recorded.

Crown pictures were initially taken with a 35mm camera equipped with a 28mm lens, using color transparency film and scanning the slides into the computer. Beginning in 2001, a digital camera with a wide angle lens was substituted for the 35mm camera.



Figure 1. Camcorder setup for vertical canopy photography.

Results

Percent canopy cover for all ice-damaged stands averaged 69 percent in 1999 but increased to 77 percent in 2001 and 80 percent in 2003. Crown canopy increases in the most heavily damaged plots were often impressive (Figure 2). Percent canopy cover for control stands averaged 83 percent in 1999, increased to 89 percent in 2001 and dropped slightly to 88 percent in 2003. All stands, including controls, except the three stands at high elevations (Mt. Mansfield plots at 2200 ft.), had a significant increase in crown canopy cover over the four-year period as well as between 1999 and 2001 (Figure 3). The largest one-year increase for most stands was between 1999 and 2000. Greater canopy cover growth in 1999 is thought to be due to abundant moisture in that year compared to severe drought conditions in 2001 and moderate drought in 2002. The Butterfield stand had its largest increase in canopy cover between 2000 and 2001. A salvage thinning here in 1998 further reduced the canopy cover and disturbed the site. This appears to have delayed the canopy growth response by one year in comparison to similar undisturbed stands. Canopy cover in two of the three control plots decreased between 2001 and 2003. This was a significant decrease for the Podunk control plot. The decrease may be related to the drought conditions in 2001 and 2002 or may indicate that these stands are reaching their maximum canopy cover level. In comparison, all the ice-damaged plots on good sites increased in canopy cover between 2001 and 2003. This was a significant increase for one of the three locations. The slow-down is likely related to the recent drought.

Table 1. Crown condition change between 1999 and 2003 by species and median crown loss due to the 1998 ice storm.

Tree Species	Number of Trees	Median Crown Loss	Number of Trees that:			
			Improved	Worsened	No Change	Died
White Ash	6	75%	6	0	0	0
Sugar Maple	44	85%	40	0	2	2
Yellow Birch	15	70%	7	1	2	5
Paper Birch	2	35%	0	0	0	2
Beech	3	70%	2	1	0	0
Black Cherry	2	65%	1	0	1	0

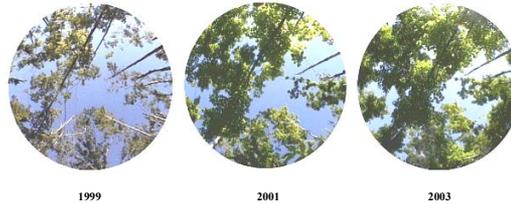


Figure 2. Crown canopy improvement for one point in a heavily damaged northern hardwood forest

Most crowns of individual trees used for oblique photography improved in foliage color during the first two years and in crown area and density over the five years (Figure 4). Of the 72 trees photographed, most (79%) improved in crown condition over the five years. Four trees remained the same by 2003, two worsened in crown condition and nine had died. White ash showed the best recovery. All of these trees improved even though they had the highest median crown loss (85%) due to the ice storm of any species group (Table 1). Sugar maple also fared very well, with 40 of 44 trees improving despite a median crown loss of 75%. Of the two trees that died, one had 90% crown loss and was dead in 2000. The other had 80% crown loss and a severe logging wound on the lower bole inflicted in 1998. It was dead in 2002. Of the two sugar maples showing no improvement, one had a severe logging wound on the lower bole and the other had a large Nectria canker. Yellow birch had poorer response, with only 7 of 15 trees improving. Three of the trees that died had 70% crown loss while the other two had 80 and 95% crown loss. Two were dead in 2001, one was dead in 2002 and two were dead in 2003. There were only two paper birch trees in the plots but both were dead by 2001, despite only 30-40% crown loss. There were 3 beech trees and two black cherries. None of these trees died but one in each group stayed the same or worsened in crown condition. Shortle, Smith and Dudzik also found poorer survival rates for ice storm-damaged birch, especially paper birch, compared to white ash and sugar maple (2003).

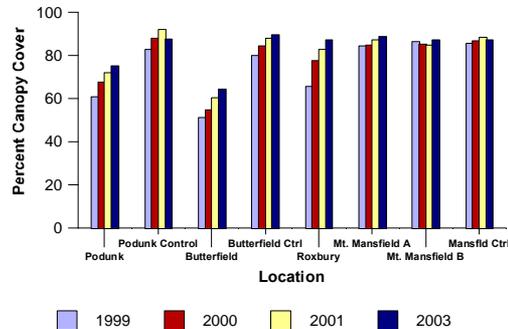


Figure 3. Canopy cover from 1999 to 2003 for hardwood stands damaged by the 1998 ice storm.

Conclusions

Crown canopy cover in heavily damaged hardwood stands on good sites increased significantly over the five years. The most dramatic increase occurred between 1999 and 2000 except for a stand that was further disturbed by a salvage thinning in 1998. Here, response appeared to be delayed by one year. Rate of canopy growth increased somewhat following drought conditions in 2001 and 2002 but not as much as in the lightly damaged control plots. Crown area and density of individual trees with severe crown loss improved for most trees, especially white ash and sugar maple. Birches showed poorer response.



A. A 10" white ash in Roxbury with 80% crown loss



B. A 13" diameter sugar maple in Orange with 80% crown loss



C. An 8" diameter sugar maple in Stratford with 80% crown loss



D. A 16" diameter yellow birch in Roxbury with 60% crown loss

Figure 4. Some examples of trees whose crowns improved over the five years.

Literature Cited
Shortle, W.C., Smith, K.T., and Dudzik, K.P.
2003. Tree survival and growth following ice storm injury. Research paper NE-723. U.S. Department of Agriculture, Forest Service, Northeastern Research Station. 4 p.