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ASSESSING STORM DAMAGED FOREST STANDS

Drs. E. David Dickens, Forest Productivity Professor; David Clabo, Silviculture Assistant Professor; and David J. Moorhead, Emeritus Silviculture Professor,
Warnell School of Forestry and Natural Resources
Mr. Chip Bates, Forest Health Coordinator, and Scott Griffin, Forest Management Chief,
Georgia Forestry Commission

INTRODUCTION

Major weather events such as hurricanes, tornadoes, and ice storms impact portions of the Southeastern United States annually. These events can inflict damage on both urban trees and rural forests. Severe storms often have major impacts on forests and can cause widespread tree breakage and uprooting. Less severe storms may leave trees damaged, leaning, or partially uprooted, where the stems may live for a period after the event. Landowners are strongly encouraged to utilize professional foresters and arborists to help with decisions about timber management or potentially hazardous trees around homes and in urban environments. Seeking independent advice is a sound way to reduce hasty judgments and ensure all available options are considered. Storm damage within a given area can vary greatly, so careful evaluation of each damaged area should be the first step to recovery following a severe weather event. Management decisions are often based on the most damaged stands evaluated. However, damage across a storm path can vary greatly, and different areas should be considered independently. This publication presents critical points to be considered when evaluating and managing storm damaged areas. It is recommended that a local, reputable professional forester be engaged to assist with timber stand evaluation.

In general, trees severely damaged in storms that cause tree breakage must be salvaged immediately. Stands with less damage, such as limb or top breakage and leaning trees with partial uprooting or fallen trees with some roots still in the soil, allow for longer salvage windows. Opportunistic insects and tree diseases should be considered when evaluating storm damaged stands as they will often find weakened and stressed trees and hasten mortality.

STAND TYPES

The general rules of thumb after hurricane, tornado, and ice storm events are as follows for stands in varying circumstances:

1. Unthinned, well stocked young pine stands less than five to eight years old and hardwood stands less than 15 years old, with heights less than 15 - 20 feet generally have the least damage. Damage may include some stem breakage, lean, or uprooting, but typically the number of trees damaged per acre is less compared to older, taller stands. The lean, uprooting and stem damage in these young, unthinned stands tend to be on the edges of the stands, where the winds were the strongest. The age, heights, crown and stand density, and species composition of neighboring stands can also affect damage levels, especially along stand edges.
2. Recently thinned (within the last two years) pine stands tend to have the most damage, with leaning and uprooted trees and greater stem breakage (usually at the eight -20 feet stem height range).

3. Pines with heights greater than 15-20 feet and lean greater than 30 to 45 degrees (from vertical) do not typically straighten and recover.
4. Older, larger pines and hardwoods (diameters greater than 12-14 inches and greater than 60-80 feet in height) that are leaning less than 30-45 degrees will usually not return to a straight position, but tend to live for a number of years (at least two to three years from observations) as long as the root system is intact with little to no evidence of mounding, uprooting, or exposed roots.
5. Partially uprooted pines that have most of their root system intact in the ground can survive for some time, but may not be a viable part of the stand. Uprooted pines with exposed roots and leaning more than 60 degrees or crowns laying on the ground tend to present brown needles in spring of the following year. (Photo 1).
6. Pine and hardwood stumpage prices after these storm events can be significantly lower than prior to the event, due to the sudden increased supply of wood on the market.
7. Logging operations in storm damaged stands are generally much slower and more hazardous.

The central question that needs to be addressed after a major storm in each pine, mixed pine-hardwood or hardwood stand is: Does the landowner have enough trees/acre in visibly good condition to carry forward?

The three following stand damage levels: *light, moderate,* and *catastrophic-severe* are assessment categories where *light* is "yes" there are enough trees/acre, *moderate* is usually "yes" there are enough tree/acre but there may be a need for a thinning or clearcut 1-2 years after the storm event when stumpage prices have improved and the major salvage operations are over, or *catastrophic-severe* is "no" there are not enough trees/acre in visibly good condition to carry forward and a salvage operation is usually the best option for these stands.

ASSESSING STAND DAMAGE CATEGORIES AND TREATMENT OPTION(S)

1. Light damage: A range of 0 to 10% of trees are damaged throughout the stand. Typically, only branches are broken from trees, with minor damage to tree stems across the stand. Most lean or bent trees are bent less than 45 degrees from vertical. No salvage operation will be necessary and the stand may recover with no additional immediate treatments. Photos 2 through 6 are examples of light damaged stands.

   Option: Typically there is not enough damage in these stands to warrant any salvage operation.

2. Moderate damage: An average of 35% damage (approximately one tree of three damaged) with a range of 11%-50% damage in the stand. Branches are broken from trees with visible damage to tree stems across the stand. Eleven to 50% of the stems in the stand have visible damage to tree stems. Up to half the trees in the stand may be snapped, noticeably uprooted, or have severe lean greater than 45 degrees from vertical. Moderate damage stands may require a sanitation thinning to minimize losses and remove trees that will likely not survive. The key question in moderate damaged stands is "are there enough trees per acre in visibly good condition, with less than 30 degree lean to carry on to rotation?" If a sanitation thinning is warranted, then in many cases it may occur after the major clearcut salvage operations have been completed in more severely damaged stands. Photos 7 is an example of moderate damage. Photo 8 is an example of a moderately damaged stand that was salvaged thinned within a month of a May 2008 tornado. Photo 9 is a moderate to catastrophic-severely damaged stand depending on if the landowner thinks he or she has enough trees in visibly good condition standing close to vertical to continue managing the stand.

   Options: When visibly undamaged trees per acre (standing at or close to vertical with <20-30 degree lean) totals are sufficiently high to carry the stand for at least two years (in some cases five to 10+ years), a sanitation thinning can be conducted, leaving standing trees in good condition to grow to rotation. In most cases, thinning operations can be done a one year to several years after the major salvage operations have been completed on catastrophic-severely damaged stands.

3. **Catastrophic-Severe damage:** An average of 75% damage (three trees of four damaged) with a range of 50% - 100% damage in the stand. Fifty to 100% of the stems are broken, tops broken out across the stand, limbs stripped, and trees bent more than 45 degrees from vertical. A salvage operation must be considered and a clearcut in most cases will be the prudent management decision. In many cases, a salvage operation may not occur and the stand would be considered a total loss. After Hurricane Hugo hit South Carolina in September 1989, approximately 16% of the pine stands that were catastrophically-severely damaged were salvaged, leaving essentially 5 of 6 acres in the most severe damage category not being salvaged. Photos 1, 9 and 10 are examples of catastrophic-severely damaged stands and Photo 11 provides an example of a catastrophic-severely damaged stand having been clearcut within a month of a May 2008 tornado.

Catastrophic: severely damaged stands do not have an adequate number of trees per acre to maintain a viable stand. Table 3 illustrates a minimum basal area (a function of trees/acre and diameters) of living pines by species for a landowner to retain, with their specific goals and objectives in mind.

Options: Where feasible, perform a salvage operation (clearcut) as soon as possible to remove standing trees, along with storm damaged wood. Post-salvage options for reforestation will depend on debris level per acre, costs and whether natural regeneration is an option if debris level and costs are too high:

(1) For high debris levels per acre, strip clearing approximately every 100 feet with a D8 or bigger bulldozer, then running two D8's with a large ship chain (each link 60+ pounds) hooked to both bulldozers can be used to knock debris down to a more manageable level. Then, based on the need to bed the site or not, strip V-blade then bed on poorly drained sites or strip V-blade and hand or machine plant. It should be noted that anchor-chaining is most suited to large, contiguous tracts as movement and use of this heavy equipment is costly.

(2) Heavy duty mulching machines are another mechanical option to clean the site for access and make the site relatively easy to plant. This activity does not move debris so site productivity is not reduced. There may be limits to the amount, size (tree diameters and stem lengths), and orientation of the debris load on each site for mulching. Mulching, like option 1 above will NOT provide long-term woody or herbaceous control, therefore a herbicide treatment is needed to give the planted seedlings a competitive advantage. The herbicide treatment can be done pre-plant after woody vegetation has 2-5 ft of re-growth or as a 1st or 2nd year post-plant over-the-top application with a herbicide labeled to do so.

(3) On sites with moderate debris levels per acre, saw-head fell, pile or windrow debris, limbs, and tops, and, if possible, burn piles after obtaining a burn permit under appropriate weather conditions. Hand or machine plant depending on site. Ideally an herbicide treatment should be done prior to planting, but ideally there should be 2-3 feet of new vegetation growth for the herbicides to best control unwanted vegetation after completing options 1 or 2.

(4) For moderate debris levels, apply a pre-plant site preparation herbicide treatment in late summer or fall. If possible, conduct a prescribed burn to reduce debris amounts (with fire breaks in place) two or more months after the herbicide site preparation treatment. For all site preparation burning, obtain a burn permit before burning.

(5) Chemically treat or mechanically prepare the site for planting without burning (or burn two to three months after the chemical or mechanical treatment). Plant quality seedlings from December through February. If salvage operations are conducted after June, site preparation will likely have to be delayed until the following growing season to allow sufficient resprouting of vegetation (2-3 feet tall or taller) to ensure herbicide uptake and translocation to roots for most effective competition control. Regeneration weevils may present problems following planting after mid- to late-season harvests (after June 30) if planting loblolly or slash pine seedlings.

MAJOR TYPES OF DAMAGE: (pine and hardwood trees are sold by weight; water loss is an important economic factor and may also be important from an insect and disease perspective):

1. Snapped, broken stem pine and hardwood trees: These trees can lose weight relatively quickly (approximately 50% of a tree's weight is water) if broken below the live crown. They should be salvaged sooner than pines and hardwoods that have been uprooted, especially high valued trees, assuming there is enough intact stem length to salvage at a high value.
2. Uprooted pine and hardwood trees: If the root systems have been mostly uprooted, but some of the root system is still in contact with soil, these trees can lose their weight more slowly than snapped stem trees, and salvage operations may be conducted weeks to months after the uprooting has occurred. For example, in October 2016, Hurricane Matthew caused many pines and hardwoods to be uprooted in the coastal counties of Georgia. Moderate to severe stand damage continued about 70 miles inland due to heavy rainfall (10 inches of rain was common across Coastal Georgia and South Carolina over two days) before, during, and after the hurricane. Many of these similarly damaged trees could have been salvaged between the months of October and February (prior to the next growing season) without much weight loss and degradation. Following Matthew, Irma and Michael, many pines that were noticeably uprooted bore brown needles into the first spring following these hurricanes (April into May being the most common time, based on observations after these three hurricanes).

Merchantable pine stands (greater than 15 - 20 years old) levels of damage

Pine stands that occupy moderately well, well, and excessively well-drained soils (upland sites) tend to have stem breakage and "leaners" as the common damage issues. In lower lying areas (somewhat poorly to very poorly drained soils) and with excessive rain (Hurricane Matthew, October 2016), pines and hardwoods can be uprooted or will lean excessively. Valuable snapped pine and hardwood trees should be salvaged sooner than uprooted hardwoods, due to quicker water (weight) loss and potential wood degradation. Snapped pines and hardwoods, regardless of pre-storm event product class (pulpwood, chip-n-saw, sawtimber or pole class), are generally considered pulpwood. Exceptions include very tall, older pines that may have one, two or three logs of good wood eight feet above the snapped part of the stem. These high value, visibly undamaged logs should be salvaged as soon as possible due to weight loss and wood degradation issues, which reduces their value over time (Tables 1 and 2).

Pre-merchantable pine stands (age one to 15 years) Levels of damage

Generally, stands with heights less than 15 - 20 feet and lean less than 45 degrees from vertical with no visible uprooting will recover. Assess level of lean and stem breakage. If there are > 300-350 stems in good condition (lean < 45 degrees with no visible stem breakage and no visible uprooting), the stand can be carried out to thinning age (Photos 4 and 5).

▶ Table 1 lists a timeline for salvaging timber.
▶ In all damaged stand cases, inspect the site every two to three weeks for beetle outbreaks (southern pine, black turpentine, and Ips beetles especially) or disease (root rot, pitch canker, etc.). Table 2 lists a timeline for insect and disease infestations.

Hardwood and mixed pine-hardwood stands

Hardwood and mixed pine-hardwood stands tend to occupy lower slope positions with soils ranging from somewhat poorly to very poorly drained classes. In these cases, most damage is from tree top, stem, and branch breakage and uprooting. Assess these stands using the same criteria as pine stands, from severe (Photo 10), moderate to low damage classes and prioritize which stands need to be salvaged first, and which can wait. In many cases, due to excessive rain prior to, during and after major hurricanes, these sites may not be dry enough to log for many months.

Follow-up visits to storm damaged stands

Damaged stands that have been left unthinned due to low amounts of damage or salvage thinned should be visited every two to three weeks to inspect for insect (i.e., pine beetles) and/or disease (i.e., pitch canker) damage that can arise in damaged stands for the following couple of years. If evidence of insect or disease is present, contact a local, reputable forester for assistance in determining the need for further salvage thinnings. Photos 12, 13 and 14 illustrate pine stem damage (forking or broken tops) years after a strong wind or ice storm event. Photo 15 is a cross-sectional loblolly pine wood disk illustrating basal area (0.20 0.44 and 0.85 ft2/tree) based on dbh for 6-, 9- and 12.5-inch trees, respectively and the product classes based on dbh (for chip-n-saw and sawtimber with no visible defect)

Table 1. Timeline for timber to be salvaged to prevent degradation

Product	Harvest window*	Comments
Pine and hardwood veneers	4 - 6 weeks	Blue Stain prohibits use if left longer
Pine dimension lumber	3- 4 months	Should be kiln dried to prevent emergence of secondary pests
Pine posts	4 - 6 weeks	Blue Stain will affect wood toughness and preservative treatment
Pine and hardwood pulp, fiberboard, particleboard and OSB	6 - 8 months with a few cases up to 1 year	As wood begins to decay, pulping process will be affected. Storm damaged wood should be mixed with sound wood

*The harvest window can vary due to several factors including but not limited to: time of year of the storm event, temperatures, rainfall, humidity and winds after the storm event. Once the bark starts to fall off the trees, the window to salvage and get some value is usually considered past.

Table 2. Timeline for invasion of damaging insects and diseases

Species	Year one	Year two
Pine	Bark beetles, ambrosia beetles, sawyers, blue stain fungi, soft rot fungi	Decay fungi
Oak and Hickory	Wood borers, ambrosia beetles, sawyers, soft rot fungi	Sapwood decay fungi
Other hardwoods	Wood borers, ambrosia beetles, sawyers, soft rot fungi	Sapwood and heartwood decay fungi

DOES THE STAND QUALIFY AS A "CASUALTY LOSS" FOR TAX PURPOSES?

A casualty loss is defined as a sudden loss, so tornado and hurricane damaged stands can qualify as casualty losses. Casualty losses are deductible the year of the casualty on IRS Form 4684, Casualty and Thefts (Gaddis and Dicke 2006). The wind damaged stand qualifies as a casualty loss as the lesser of the fair market value (FMV) loss in timber or the loss in timber basis. Timberland owned for more than one rotation will often have a zero basis whereas timberland recently purchased (i.e., $1,800 per acre for 100 acres of loblolly in 2000 with $500 in a land basis and $1,300 in the timber basis) may have some timber basis. Recently purchased timberland zoned for residential or commercial development will usually have a timber basis above FMV. If the landowner has a timber basis, then a registered forester will need to (1) estimate the fair market value (FMV) of the timber pre-casualty, (2) the FMV following the casualty (#s 1 and 2 by timber cruise) with the FMV loss = FMV before – FMV after (often the salvage value). The FMV loss is deductible up to the timber basis, and (3) the basis in timber.

Table 3. Southern pine basal area per tree, target minimum per acre (BA/ac) based on average dbh (diameter at 4.5 feet above groundline), and target minimum trees per acre (TPA) in good condition and well-spaced.

Average dbh (inches)	Basal area/tree (square feet)	TPA for 60 sq ft BA/ac (timber production)	TPA for 30 sq ft BA/ac (wildlife)	TPA for longleaf natural regeneration	TPA for loblolly/slash natural regeneration
6	0.1765	340	170	--	--
7	0.2673	224	112	--	--
8	0.3491	172	86	--	--
9	0.4418	136	68	--	--
10	0.5454	110	55	55	12
11	0.6600	91	45	47	10
12	0.7854	76	38	38	9
13	0.9218	65	32	33	8
14	1.070	56	28	28	6

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Photo 1: *Example of a catastrophic-severe damaged pine stand; less than 30 trees per acre standing upright and in good condition.*

Photo 2: *Light damage pine stand; many trees per acre standing are in reasonable visible condition.*

Photo 3: *Light damaged pine stand with 150 to 200+ trees per acre standing in reasonable visible condition.*

Photo 4: *Young, pre-merchantable longleaf pine stand with mostly moderate damage. The stand contains a sufficient number of trees per acre to carry to rotation with some clean-up.*

Photos 5 and 6: *Young old-field planted longleaf stands with varying levels of lean. The left photo longleaf trees with lean greater than 45 degrees will most likely not fully straighten to vertical. The right photo is a 16-year old longleaf stand 4 days after Hurricane Matthew came through Bulloch County, Georgia, with portions of the stand having uprooted trees due to high rainfall and lower hurricane force winds. Overall, both stands should have enough good, healthy trees to carry the stands to rotation with some clean-up.*

Photo 7: *A mixed pine-hardwood stand with moderate damage.*

Photo 8: *A moderate damage loblolly stand thinned 30 days after a May 2008 tornado.*

Photo 9 and 10: *Examples of a moderate to catastrophic-severely damaged pine stand (left) with a marginal number of crop trees left per acre and (right photo) a catastrophic-severely damaged pine stand with no good crop trees per acre.*

Photo 11: *A severely damaged stand (foreground) clearcut 10 days post a May 2008 tornado with moderately damaged stand thinned in background (Photo 8)*

Photos 12 and 13: *A fork (12, left) where storm damage broke the terminal growth and photo 13 (right) with a broken top from the same storm. If the fork or broken top is at least 17 feet above the ground, then the tree may have chip-n-saw or sawtimber value to that height.*

Photos 14 and 15: *A living loblolly pine (14, left) with a broken top with four live limbs, six years after a storm event. At right (15), a 32-year-old loblolly pine wood disk (cut @ dbh; 4.5 feet above groundline) showing examples of a 6-, 9-, and 12.5-inch dbh tree and basal area per tree (Table 3) and dbh for pulpwood, chip-n-saw, and sawtimber categories.*

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