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Managing Storm Damage to Southern Yellow Pines

Bill Pickens
Conifer Silviculturist

Sustained high winds and heavy rain generated by hurricanes cause extensive damage to forests. Ice and snow storms cause similar widespread damage. Damage includes tree uprooting, main stems snapping, broken limbs and crowns, trees that are bent or leaning, and injury from flooding. Some of the damage is so severe that tree mortality is inevitable. With other damage, the tree may be stressed but will recover. However, often the damage is worse looking than it actually is. Trees are extremely resilient. Take time to first assess the damage and base your actions accordingly.

The purpose of the this paper is to provide guidelines to help the land manager access the extent of damage, and decide whether damaged trees will recover and thus can be managed, or will not recover and should be harvested following storms.

Silvicultural considerations

⇒ Southern yellow pines exhibit strong apical dominance. This means that when wind breaks the top of a tree, a new top or leader emerges from the break allowing the tree to continue height growth. With some trees, two or more leaders may fight for dominance resulting in the classic lyre or forked top. Others form below the break producing a distinct crook. Typically trees produce a single leader.

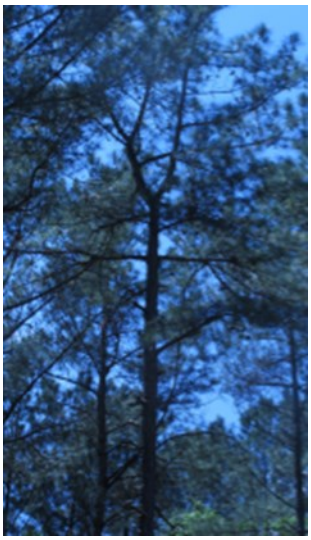

Figure 1. The crook formed at the top of this tree is a result of storm

⇒ Juvenile wood found in younger trees is flexible so usually will bend but not break at the stem. Young trees that are bent or leaning will usually straighten within the first growing season.

⇒ Trees on the edge of openings suffer the most damage. Interior trees are buffered and support each other. For this reason, newly thinned stands are susceptible to windthrow.

⇒ Pines with fusiform rust are susceptible to stem breakage.

⇒ Pines exhibit strong phototropic responses that allow a bent tree to straighten up. Young stands will recover quickly, usually during the first growing season.

⇒ Compression wood develops quickly in response to leaning forms, and has a negative impact on wood quality.

⇒ Longleaf pine, with its deeper rooting characteristics, less taper, and higher specific gravity, is less susceptible to storm wind damage. In a survey following Hurricane Katrina, only 16% of loblolly pines were undamaged while 64% of the longleaf pines were undamaged. Most of the loblolly trees were broken, which quickly lose value, while the longleaf where leaning with intact root systems, and able to retain value. However, longleaf seedlings and saplings have a low tolerance to extended flooding.

⇒ Loblolly pines are more tolerant to short duration flooding and salt intrusion. Minimal damage occurs to young plantations inundated for 1-2 days.

⇒ Because of pines rapid growth rates, understocked stands recover quickly to acceptable stocking levels and can be managed profitably.

Survey the Damage
Since trees at the stand edges are more heavily damaged than those in the interior, storm damage often looks worse than it really is. A survey is an important first step to assess the extent, degree, and type of storm damage. The survey should include an evaluation of the condition of the trees, as well as an estimate on the volume of timber damaged.

A quick walk-through exam may be enough to evaluate the extent of the storm damage. However, if the severity of the damage is not visually obvious, an intensive survey is required. A grid survey method is recommended using at least 30 circular plots, which are measured on a two chain by four chain grid (a chain equals 66 feet). This method is the same as recommended for natural regeneration determination or seedling survival count. The plot tallies damage and provides an estimation of recovery potential. A forester may be needed to help with the survey.

From the survey, the amount, its distribution, and the type of damage is determined. Based on this information, logger availability, and the wood product market, an economically based management decision is made on whether to harvest or let the stand recover through a normal rotation length.

Types of Damage
Extensive damage can cover a wide area in the form of uprooting, stem breaking, leaning, bending, twisting, crown loss, wounding, and flooding. The type and severity of damage impacts the trees growth rate, makes it susceptible to insects or disease, reduces wood quality, and causes mortality. Heavily damaged trees are best removed as soon as possible.

Figure 2. Small trees are very flexible and are likely to straighten up within a few weeks.

Recovery Potential
The information gathered from a field survey allows us to evaluate the recovery potential of the stand. Recovery potential is dependent on the type of damage and the age of the pine. Will the tree survive? Will it grow vigorously or become suppressed? Is it susceptible to insect or disease? Will it have good form? Consider the following points to answer these important questions.

Immature Pine Stands
The damage to young pine stands is usually from broken tops or bent trees, due to the flexibility of juvenile wood, higher stocking density, lower tree height, and less foliage.

Young stands (less than 15 years) have an amazing ability to completely straighten even from severe bending or leans. The younger the stand is the better chance it has to recover. The less the lean or bend the better chance a young tree will completely straighten (Figure 2. illustrates this concept). The angle of the lean is determined by measuring from the base of the stem to the top of the crown (Fig 3). Table 1 provides guidelines for management decisions for young pine trees less than 15 years old.

Table 1. Recovery potential of leaning immature pines

If the bend or lean is……	Likely recovery is…….
> 40 degrees	No Recovery – poor crop tree
30 – 40 degrees	Poor recovery – will likely become suppressed
15 – 30 degrees	Partial recovery – 60-80 %
< 15 degrees	Full recovery – good crop tree

Mature Stands
Damage to mature stands (greater than 15 years) is likely to be from stem breakage, leaning, and uprooting. Expect mortality of trees with visible root damage, especially if associated with lean greater than 45 degrees. While trees with less severe lean will live, their growth is slowed and they will likely become overtopped by more vigorous competitors. Significant crown loss results in mortality or slows growth. Bole

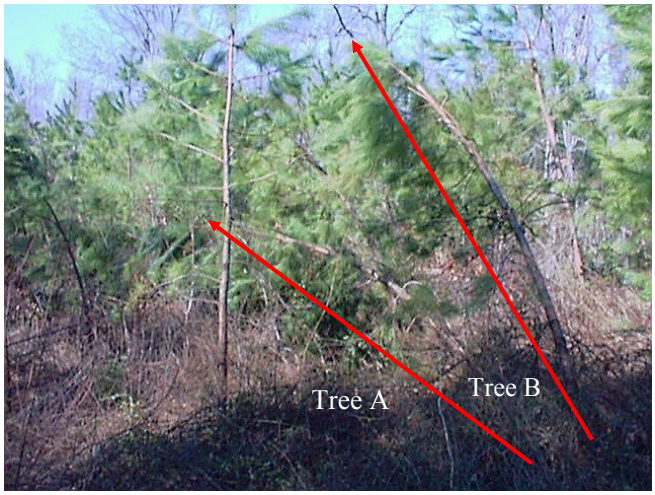

Figure 3. The amount of lean from vertical is measured from the ground to the top of the stem. Tree A has a 60 degree lean and is not likely to straighten. Tree B with a 30 degree lean is more likely to recover.

damage from twisting or shake that separate internal fibers is often not easily seen. Look for pitch flow to identify internal bole damage. Because they support each other, mature stands often have less trees with severe leans. Table 2 summarizes potential recovery in a mature stand.

Management Options – Stand Level

Table 2. Recovery potential for mature pine stands (age 15 or greater) based on degree of damage

If the tree is…….	Recovery potential is ……..
Root Sprung	No Recovery
Cracked or Twisted Stem	No Recovery
Broken Stem	No Recovery
Top Broken	Lateral branches will assume terminal growth, slight crook is likely.
Lean > 45 Degrees	No Recovery
Lean 15 to 45 degrees	Partial Recovery, Likely will to become suppressed, crook will develop, susceptible to next storm
Lean > 15 degrees	Full Recovery

Recommendations for management of storm damaged forest areas must consider the following factors.

- Amount and distribution of the damage
- Extent of the damage
- Recovery potential
- Landowners objectives
- Economics
- Local wood products market

Management options are limited to two basic choices, 1) to start over or 2) to manage what is not damaged or will recover. Management priorities depend on the risk of a pest outbreak that may result from the weakening of the tree defenses. Remove or salvage the most severely damaged trees first. Consider salvage of damaged trees in the following priority based on damage type; root sprung, broken tops, and lean greater than 30 degrees.

When considering whether to start over or to manage what you got, keep in mind that the damage is never as bad as it looks. Often a thinning is all that is needed to improve the health and look of a pine plantation. Economically it is likely that the return on investment will be higher if you manage what is left even if it is considered understocked.

Table 3. Recovery potential for immature and mature pines based on amount of crown present

Flood Tolerance

If the amount of crown present is ……	
> ¾ ……	Full recovery.
½ to ¾ ….	Slower growth likely; susceptible to insect damage.
< ¾……	Likely to become suppressed.

Loblolly pine is moderately tolerant to saturated soils and flooded conditions Mature stands can survive periods of root flooding for up to 3 weeks without any adverse impact. Young seedlings are more susceptible and will die if completely covered with floodwaters for more than a week. Loblolly is less tolerant to salt water. Mortality is likely for areas that are flooded for more than 3 days particularly if the salt is not flushed out of the soil by fresh water.

Manage to reduce the risk

While it is impossible to eliminate the risk of damage from the powerful winds and large amount of rains associated with hurricanes, the following management activities may help to reduce losses.

1. Species vary in wind resistance, but live oak, pondcypress, and baldcypress are the most resistant. These trees deep rooting habit makes them fairly wind-firm. Longleaf is a good choice for sandy and sandy loam soils. Resistance of tree species to common hurricane damages is shown in Table 4.

2. Vary the age and size class of your stands. Young trees are usually not damaged or recover complete while older trees are prone to being uprooted or break.
3. Conduct frequent light thinning to reduce taper and increase DBH. Maintain a low basal area. Stagger thinnings to limit exposure of recently thinned areas.
4. Use wider spacing for establishing loblolly and longleaf pine plantations.
5. Avoid planting loblolly in areas subject to frequent flooding. Bottomland species are a better choice

References:

Barry, Patrick J., R.L. Anderson, and K.M. Swain. 1982. How to evaluate and manage storm-damaged forest areas. USDA Forest Service Forestry Report SA-FR 20.

Barry, P.J; Doggett, C. 1993. How to evaluate and manage storm damaged forest areas. USDA-SRS. Mgmt. Bulletin R8-MB 63

Bragg, D.C., M.G. Shelton, and E Heitzman. 2002 Silvicultural lessons from the December 2000 ice storms In Proc.of 2002 Arkansas Forestry Symposium, Walkingstick, T.R editor. Univ. of Arkansas Coop. Exten. Serv. , Little Rock, AR.

Brewer, C.W. and N.E. Linnartz. 1973 The recovery of hurricane-bent loblolly pine. LSU Forestry Note # 104. Louisiana State Univ., Baton Rogue, LA. 2 pp1973.

Burton, James D. 1961 Thinning and pruning influence glaze damage in a loblolly pine plantation. USFS. Southern Res. Stn. Res. Note SO 264 .

Dunham, P. H. and D. M. Bourgeois. 1996. Long-term recovery of plantation-grown loblolly pine from hurricane damage. In Proc.: Hurricane Hugo: South Carolina Forest Land Research and Management Related to the Storm. Eds. Haymond, Jacqueline L.; Harms, William R., Gen. Tech. Rep. SRS-5. USDA Forest Service, Southern Research Station, Asheville, NC: 552 p

Johnsen, Kurt H.. 2009. Hurricane Katrina winds damaged longleaf less than loblolly pine., South. J. Appl. For. 33(4) 178-181.

Shultz, Robert P. 1997. Loblolly pine, the ecology and culture of loblolly pine (Pinus taeda L.). USDA Forest Service Ag. Handbook 713.

Touliatos, Plato and E. Roth. 1971 Hurricanes and trees, ten lessons learned from Camillle. Journal of Forestry Vol 69, 5: 285 -289.

Williston, H. L. 1974. Managing Pines in the Ice-Storm Belt. Journal of Forestry Sept: 580-582.

Wind Wood Utilization. the hub for information specifically relating to the preparation for, response to, recovery from major wind events and the utilization of *downed & damaged timber* and *woody debris* that can be generated. Website: http://windwoodutilization.org/

Figure 4. Mature tees that are bent, snapped are up-rooted are not likely to recover and should be salvaged before insects and fungi degrade wood quality

Table 4. Tree species resistance to hurricane related damage (in descending order from most resistant)

Flood tolerant	**Breakage**	**Uprooting**	**Salt**	**Deterioration by insect and disease**
baldcypress	live oak	live oak	live oak	live oak
pondcypress	palm	palm	palm	palm
tupelo-gum	baldcypress	baldcypress	slash pine	sweetgum
sweetbay	pondcypress	pondcypress	longleaf pine	water oak
willow	sweetgurn	tupelo-gum	pondcypress	sycamore
sweetgum	tupelo-gum	redcedar	loblolly pine	baldcypress
sycamore	dogwood	sweetgum	redcedar	pondcypress
river	magnolia	sycamore	tupelo-gum	southern red oak
birch	sweetbay	longleaf pine	baldcypress	magnolia
cottonwood	southern red oak	southern red oak	sweetgum	tupelo-gum
green ash	water oak	magnolia	water oak	sweetbay
red maple	sycamore	slash pine	sycamore	hickory
pecan	longleaf pine	loblolly pine	sweetbay	pecan
mulberry	slash pine	sweetbay	southern red oak	redcedar
american elm	loblolly pine	water oak	hickory	red maple
persimmon	redcedar	red maple	pecan	dogwood
water oak	hickory	dogwood	magnolia	longleaf pine
swamp chestnut oak	red maple	hickory	red maple	slash pine
magnolia	pecan	pecan	dogwood	loblolly pine
hickory				

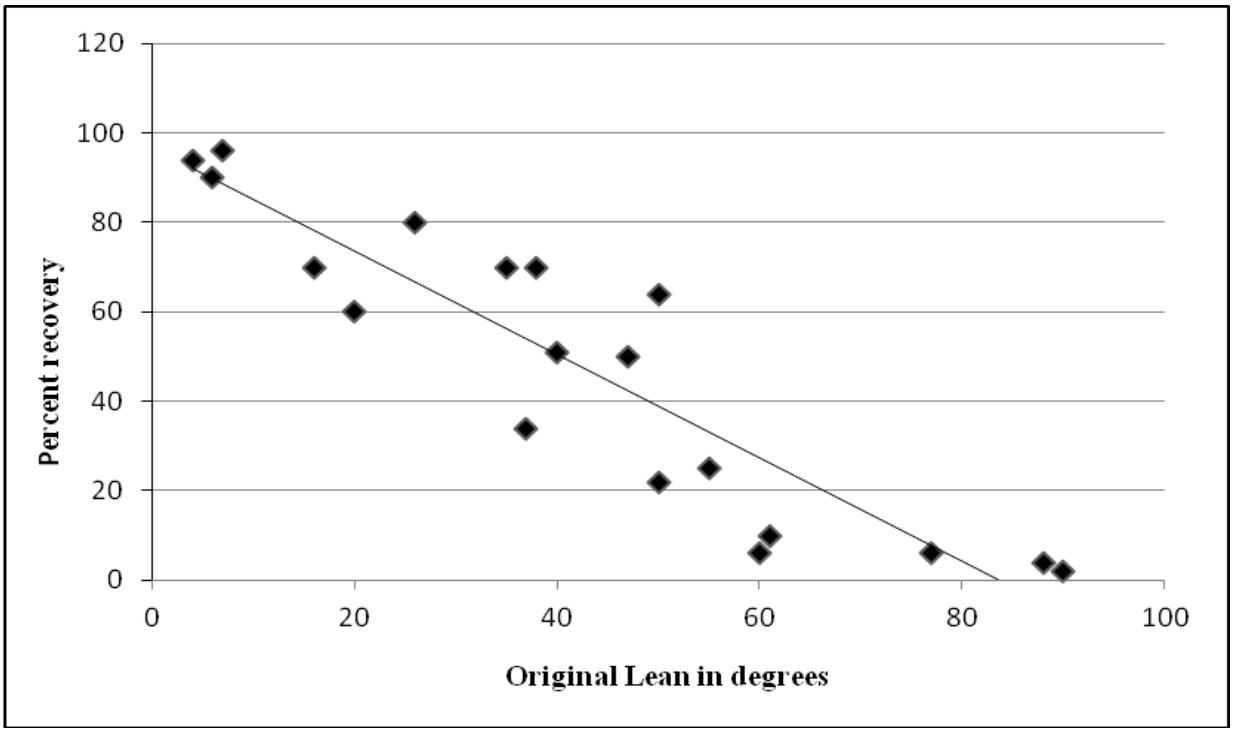

Figure 5 . Potential recovery of an 11-year-old loblolly pine from storm damage. Adapted from a study by Brewer & Linnartz, LSU Forestry Notes, 1973.

Table 5. Key to assist with management decisions for storm damaged trees.

IMMATURE Stands (Less than 15 years old)				MATURE Stands (Greater than 15 years old)			
Broken Tops with ...		Bent or Leaning ….		Broken…….		Bent or leaning…..	
Less than 1/2 the crown remains……. And if …greater than 15 feet OR greater than 7 years old	No Recovery –Salvage trees	Less than 1/2 the crown remains And if ...less 12 feet tall and 5 years old	Recovery uncertain—may recover	Top only	Select recovery- Keep dominant and codominant if more than half the crown remains	Bole	No Recovery —Salvage trees
1/2 to 3/4 of crown remains	Recovery is likely– keep as needed	Less than 20 degrees	Recovery likely—Best choice for cro trees**	15 degrees 0r less	Recovery likely—Best choice for crop trees	Less than 15 degrees, but greater tan 30 degrees	Select recovery—some trees may be retained
Less than 3/4 of crown remains	Recover is likely—keep for crop trees**	Greater than , but less than 30 degrees	Select Recovery—Some trees may be retained as needed **	Less than 15 degrees	Select recovery—Use trees that are less than 15 feet tall	Greater than 30 degrees	No recovery—Salvage trees
		Greater than 30 , but less than 40 degrees	Select recovery—Use trees that are less than 15 feet tall				

** Only if trees have a good live crown ration > 25% and they are not cracked, broken , or root sprung.