



# After the Fire...Predicting Tree Survival



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The Georgia Wildfires in the spring 2007 have produced the largest fires in our state's history. Based upon previous fires (in Florida) and consequent research by State and Federal researchers, some information is available that is relevant to our situation.

*Once the smoke clears, stand evaluation begins...*



Wildfires produce intense, lethal temperatures where head fires occur. Trees killed directly by the fire are obvious in the aftermath.

*Wildfires Vary with intensity across the landscape...*



No wildfire kills everything in its path...Large fires burn at varying levels of intensity and corresponding levels of damage variation can be seen

## Mortality/Survival is somewhat predictable based upon previous fires



3 year old Longleaf

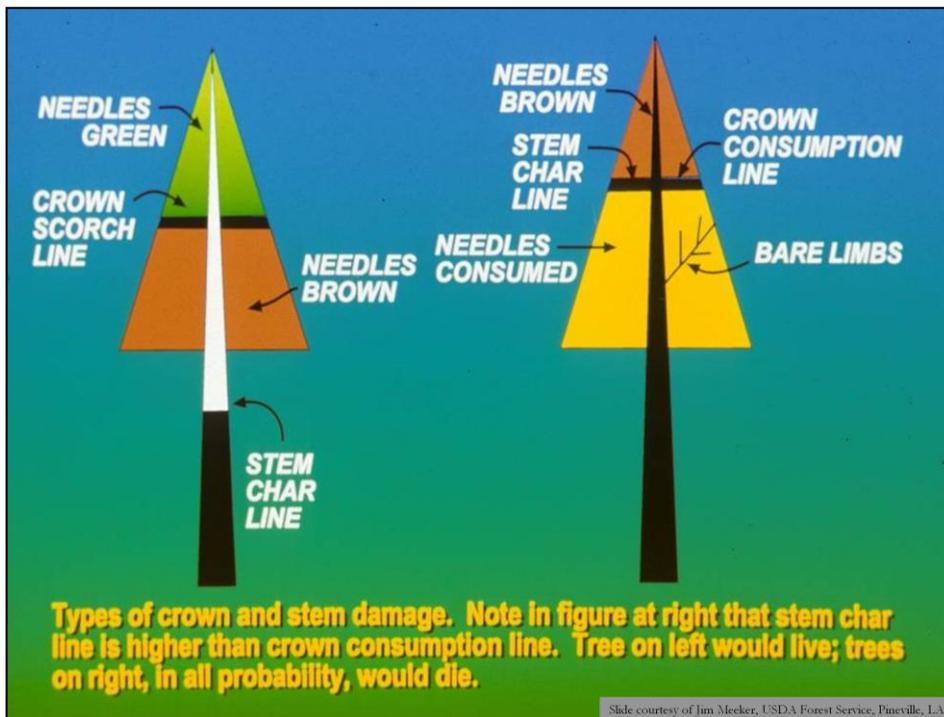
Survival likely



4 year old Slash

Survival unlikely

A fire has different levels of intensity based upon many factors including fuels, topography, time of year, drought, weather (relative humidity, wind direction and speed, and temperature). No fire destroys all trees, but the “head” of the fire (the part that pushes forward first) has greater heat than the rear or sides (flanks) of the fire. Almost every fire on the flanks and rear produce less intense heat and destruction, and our southern pine species have adapted to be able to withstand low or moderate burns. Note the “crown scorch” on the trees above – this refers to a fire that doesn’t physically burn the needles off, but produces sufficient heat to kill the living needles present on the tree. Note also that portions of the above trees still have green needles which indicates the heat produced by this fire wasn’t prolonged or as intense as a direct head fire.



Some terms that are used when evaluating fire damaged trees. Crown scorch refers to needles that weren't directly burned in the fire, but were exposed to lethal temperatures during the fire event. These needles will typically drop from the tree in about 30 days after they turn reddish – brown. Stem char line refers to the blackened portion of the stem that was obviously exposed to direct flame. After needles drop and crown scorch can't be effectively measured, stem char line remains as a permanent record on the tree indicating fire severity. Crown consumption indicates the portion of the crown/living needles that were directly burned off by the fire, and this indicates greater damage to the tree than scorch.

Fires during the growing season do greater harm to the tree than those during the dormant season. Temperatures are typically higher from March to September, and newly formed tissue is more prone to damage than older stems, twigs and branches.

## Crown Fire...



GFC Photo

The worst case is the crown fire which literally consumes part of all of the living foliage of the trees.

## Crown Consumption...



Trees in this aerial photo have lost all their needles and are effectively dead at this point. Salvage operations can utilize this material for a short window of time, but most of the weight that is lost (due to water) occurs in the first 90 days. Decay occurs rapidly after this during the growing season.

## Crown Consumption...



From the ground, crown consumption is apparent on the trees to the left. Note the stand change to a younger age class in the foreground – many of these smaller trees should survive despite the much larger trees being killed.

## Crown Scorch...

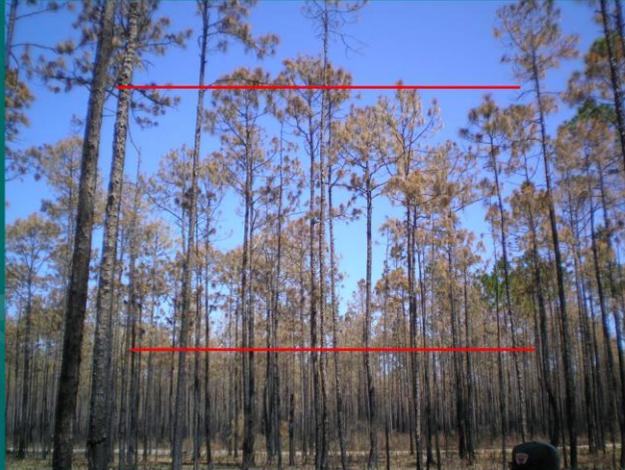


Heat, of varying levels, over 140 degrees for more than one minute is lethal to most plant tissues. Plant foliage has very little insulating ability so an understory burn can create this temperature and cause all needles to die. Southern Yellow pine species normally have 3 years worth of needles on the tree during the growing season – a best case scenario for trees with complete crown scorch is that the tree is able to put on this year's needles (provided the stems and buds aren't damaged). Fires during the dormant season tend to cause less bud and twig damage versus this fire that occurred after bud break...the first growth flush was lost.

## Stem Char remains as an indicator of fire severity after needles have dropped...



Photos by Chip Bates, GFC



Scorched needles will drop from the tree within about 30 days following the fire, and furthermore stem char has been found to be a better indicator of tree damage than the brown needles. About one-third of the trees above have stem char indicating a “moderate” level of damage.

## *Evaluating Stands*

- ✓ Salvage for severely burned/consumed stands
  - ✓ Highest Priority for immediate concern
  - ✓ Most of the tree's weight is lost within 90 days
- ✓ Trees with less than one-third crown scorch/stem char with minimal basal or root damage will likely survive
- ✓ Stands suffering moderate damage will require subjective evaluation to make management decisions
- ✓ Wildfire damage within the stand will likely vary – must determine “average” damage level for the stand
  - ✓ Will residual stand be fully stocked?
  - ✓ If not, does it make financial sense to leave an understocked stand rather than starting over?

When evaluating stands, severely burned or consumed stands should be salvaged immediately because fire killed trees will lose considerable weight in the first 3 months. Stands with light damage (one-third or less stem char) with minimal damage to the base will likely survive, but the stands that are “in-between” will require some careful evaluation tempered by some subjective prediction to determine their fate.

## Ips Attack



Photo by Chip Bates, GFC

Red boring dust is an indicator that this tree is likely already under attack from one of the ips engraver beetles.

‘Wagon-wheel’ symptom of severe basal/root damage from intense, residing fire



Slide courtesy of Jim Meeker, USDA Forest Service, Pineville, LA

Let's consider damage to the root system and base of the trees. Keep in mind, that wildfires occur as a direct result from extended drought, and these burns can consume all of the litter layer and the humus layer of soil. The upper layer will normally contain fine, feeder roots of the tree which are directly killed, and trees can be stressed from this damage and consequent reduction in water absorption capability of the tree. Deeply burned soils can expose the main lateral roots indicating the severity of the damage.

## “Deep” Burning of Duff layer causes severe damage



Fires that linger for extended periods of time at their base can severely damage the cambium layer and the food and water conductive tissue of the tree. Trees that burn completely around the circumference and are effectively “girdled”.

'Crater' symptom of severe basal damage from fire  
consumption of soil organic mater



Trees that have heavy duff accumulation at the base suffer lingering, smoldering fires that burn all of the organic material from the tree and is an obvious sign of severe damage to the tree.

'Circle of death' symptom indicative of severe basal/root damage



Slide courtesy of Jim Meeker, USDA Forest Service, Pineville, LA

Deep burning around the base of tree will kill smaller trees immediately and is another indication of severe damage.





Moderate crown scorch will result in the majority of needles lost from these trees. Good rainfall in the aftermath can help tree health and may allow recovery. Insect attacks for up to 2 years are a risk for these severely stressed stands.

## *Rating System Based Upon:*

### ➤ **Crown Scorch/Stem Char/Needle & Limb Consumption**

- Needles drop soon after the fire (about 30 days) but stem char remains
- Crown consumption more damaging than crown scorch...

➤ *Less than one-third - Survival likely*

➤ *One third to two thirds - ?????*

➤ *Greater than two-thirds - Death likely*

### ➤ **Other Observations:**

- Basal Stem Damage & Root Damage can kill pines
- Growing season fire worse than dormant season...
- Younger stands tend to be OK if they survive the first 3 months
- Older stands will suffer mortality into the second growing season

### ➤ **Future Risks:**

- Future insect attack – ips, black turpentine, pine sawyer
- Continued Drought and tree stress

We can rate stands (or groups of trees that are managed together) by stem char or limb consumption. Based upon previous studies following wildfires in Florida (Dixon et al, 1988; and Barnard, Hanula et al., 2000, and Meeker – Florida Department of Agriculture and Consumer Services, and the USDA Forest Service), these were studies in Slash Pine following wildfires – one in the fall and the other in the spring.

Stem char is a good indicator of tree damage, fire severity and likelihood of survival – one thirds is easy to measure in the field and can give reasonable results.

Other things to consider – crown consumption is more damaging than merely scorch, growing season fires tend to cause more insect problems and consequent mortality, basal damage (caused by smoldering fires) can also cause high mortality (even if stem char doesn't indicate this), younger stands that made it through the first 3 months tended to survive. Older stands with moderate to severe damage will suffer additional mortality the second growing season (possibly due to insects), and lastly ongoing drought can make the problem worse and conversely, plentiful rainfall following the fire can help minimize losses.

### Post-Fire Evaluation Guidelines for Forecasting Potential Insect & Disease Problems and Associated Tree Mortality

**I. Average Crown Damage/ (Probability of Tree Mortality)**

**A. Percent Crown Consumption**

0-25% (Low)       25-50% (Moderate)       >50% (High)

**B. Percent Crown Scorch**

1. **Dormant Season (October 1 – February 28)**

0-25% (Low)       25-75% (Moderate)       >75% (High)

2. **Growing Season (March 1 – July 30)**

0-25% (Low)       25-75% (Moderate)       >75% (High)

**II. Average Stem Damage**

**Relative Height of Stem Char/ (Probability of Tree Mortality)**

0-25% (Low)       25-75% (Moderate)       >75% (High)

**III. Average Basal Root Damage<sup>1</sup>(Probability of Tree Mortality)**

0-25% (Low)       25-75% (Moderate)       >75% (High)

<sup>1</sup>based on attached matrix

**IV. Signs and/or symptoms of insect attacks** (e.g., pitch tubes or boring dust from bark beetles, boring debris from ambrosia beetles, oviposition pits or excelsior from wood borers, etc.) on trees characteristic of the stand and post-burn fire effects

Absent (Uncertain)       Present (High)

**V. Note that the effects of multiple damages are somewhat additive.** For example: moderate crown scorch + moderate stem char + moderate basal/root injury, likely equals a high probability of insect infestation and tree mortality.

In summary, Meeker et al (USDA Forest Service) came up with a check list to help evaluate fire damaged stands which will give an indication of the degree of damage the fire has caused and the likelihood of survival and help with management decisions.

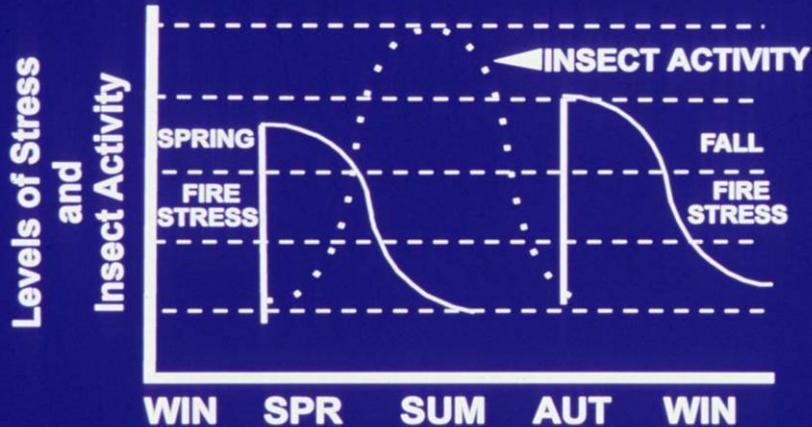
**FIRE DAMAGE RATING MATRIX FOR  
BASAL/ROOT PORTION OF  
SOUTHERN PINE TREES**

	<b>DAMAGE</b>		
<b>Indicator</b>	<b>Light</b>	<b>Moderate</b>	<b>Severe</b>
<b>Lower Bole</b>	Bark partially charred, ex. a side or plates only	Bark completely charred, all sides plates and fissures	Bark completely charred and noticeably consumed
<b>Ground Substrate</b>	Litter charred to partially consumed, remains recognizable; upper duff burned to partially consumed.	Litter mostly to entirely consumed; duff partially consumed, feeder roots burned in duff layer.	Litter and duff entirely consumed, leaving ash or exposed mineral soil, and crater effect around roots
<b>Roots</b>	Concealed, not evident	Slight exposure and charring, particularly on one side or at the tree base, feeder roots burned in duff layer	Abundant exposure and charring (in direction and distance) to partial or complete consumption

Remember to look at the basal damage on the trees as this can have long-term impacts on survival also.



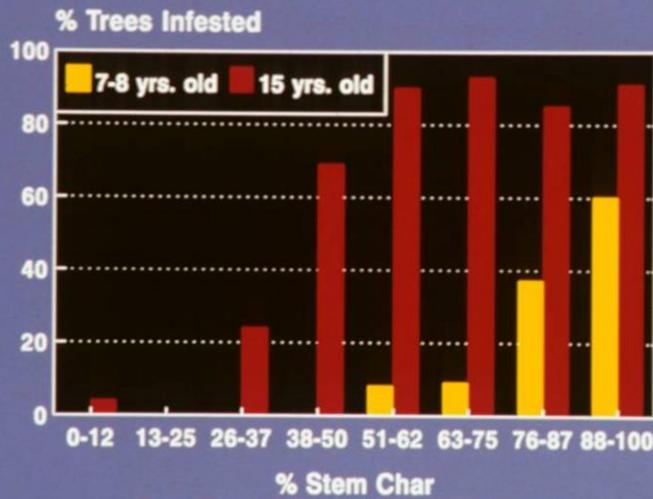
**Wildfires may cause insect outbreaks?????**  
**History hasn't proven this to be true...**



From: Martin, R. 1989. Proc. Soc. Am. For. pp 87-91.

One reason the mortality isn't immediate after a fire may be insect activity following a "growing season" fire. Ips and black turpentine beetles are more active during the warmer months and a fire during this period tends to coincide with this natural cycle when these species can attack, and build up populations to attack more trees.

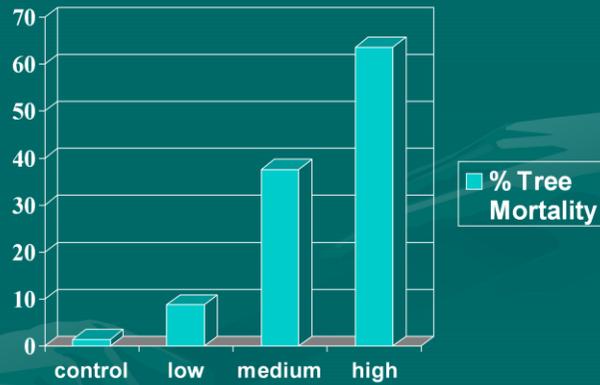
## Relationship of Ips Engraver Beetles to Fire-Damaged Slash Pine



From: Dixon, W. D. et al. 1984. SJAF. 8(2): 85-88.

The mortality in the moderately damaged stands was also correlated in another study which found that ips was directly attracted to older trees with this level of damage (and the severely damaged ones also).

## Initial Mortality July 1998 Wildfire

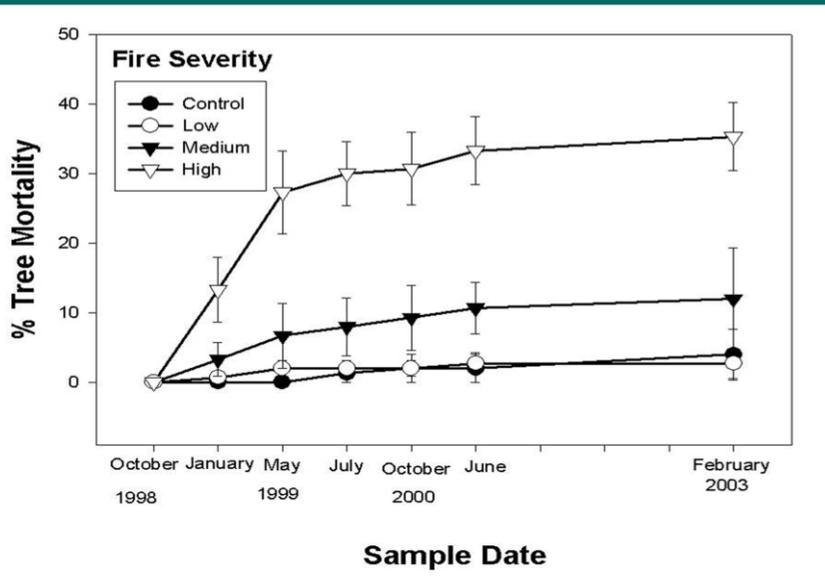


**Fire Severity**

J.L. Hanula et al. – USDA Forest Service, Athens, GA

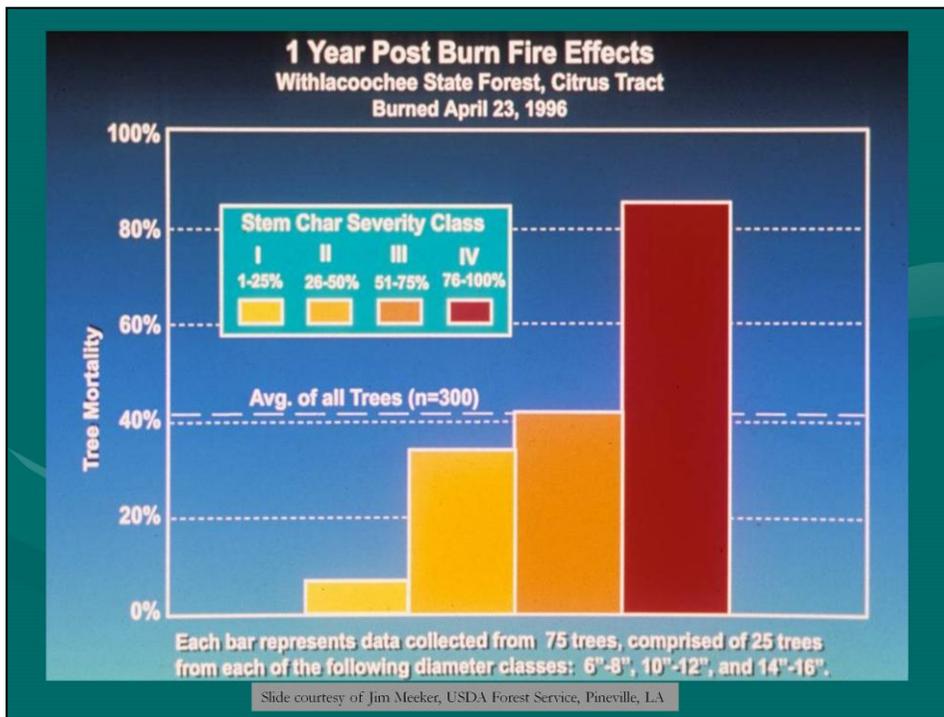
This is the same July, 1998 fire in the previous slide but shows initial mortality (formal study began in October of that year).

## % Mortality over time based upon Fire Severity - July Fire



J.L. Hanula et al. – USDA Forest Service, Athens, GA

The 1990's Florida study (Summer Fire) indicated that stands with High (or "severe" in the terminology of the previous study) were lost both immediately following the fire and into the stresses of the following growing season. Some losses also occurred with the stands that suffered Medium fire severity ("moderate" damage), and no significant (long term) losses occurred in the stands with little damage. This five year study coincided with an ongoing drought and did not reflect an increasing mortality as would be expected. Trees that survived initially tended to survive similarly to unburned stands.



In making the determination of these moderately damaged stands, here is some information that may help with these decisions. For a spring wildfire event in Slash Pine in Florida (similar our Georgia fires this year) in the mid 1990's, trees that had stem char ranging from 26-75% suffered losses in the 30-40% after one year following the fire event.