

Loblolly Pine Health in the Southeastern U.S.

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Importance of Southern Pines

Southern pine species such as loblolly, longleaf, shortleaf, and slash cover much of the southeastern U.S., and are a critical component of the region's economy¹. Loblolly pine is the most widely planted species in the southeastern region, is commercially managed in plantations and natural stands, and accounts for nearly half of the pine growing stock². These pine stands are ecologically and economically critical to the region as they improve soil and water quality, create habitat for various wildlife species, and provide timber and pulpwood products worth tens of billions of dollars each year with many benefits to local communities^{3,4}. As demands on our pine resources increase, forest threats such as urbanization, climate change, and invasion by non-native species are also expected to increase¹. Implementing specific management practices can minimize these threats and assist managers and landowners with maintaining the sustainability of pine forests.

Abiotic Factors Affecting Loblolly Pines

Southeastern forests are historically maintained and disturbed by abiotic and biotic factors. Amongst abiotic factors, frequent understory fires are important in maintaining and regenerating pine forests, however fires are used less frequently in loblolly pine plantations⁵. In the late 19th and early 20th centuries, many southeastern forests were clearcut and harvested, then converted into farms, which resulted in major soil erosion issues (especially in the Piedmont region)⁵ (Fig. 1A). When these farmlands were abandoned in the 1930s and 1940s, they naturally regenerated to forests, however the original cover-type and many associated native species were largely lost from these systems^{1,5}.

Adverse weather conditions such as drought and wind/ice-storms can increase pine susceptibility to insects and diseases⁶ (Fig. 1B). The frequency, duration, and unpredictability of drought and storms are expected to increase under climatic changes with ensuing impacts to pine sustainability⁷. For example, catastrophic and severe fires due to drought in 2016-2017 heavily impacted forests especially in Georgia, North Carolina, and Tennessee (Fig. 1C).

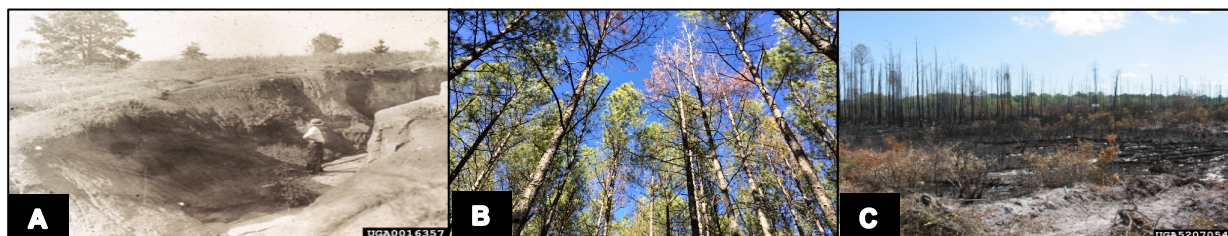


Fig. 1. Examples of abiotic factors such as (A) soil-erosion after farming; (B) drought; and (C) severe wildfires that have historically and are currently negatively impacting pine productivity.

Biotic Factors Affecting Loblolly Pines

Insect Pests

Biotic agents such as bark and woodboring beetles are major factors affecting pine plantations and natural forests^{8,9}. These beetles create tunnels under the bark and in wood of the tree, thus girdling and killing it. A number of bark beetles are also associated with pathogenic fungal species that further contribute to tree mortality. Southern pine beetle (*Dendroctonus frontalis*) is considered the most damaging insect affecting loblolly pines¹⁰ (Fig. 2A). Southern

pine beetle outbreaks can kill hundreds of thousands of pine trees within a region in a given year. Tree stress and damage that result from drought, poor soil conditions, lightning strikes, fungal infections or mechanical damage increase activities of other damaging species including pine engraver beetles (*Ips*), black turpentine beetle (*Dendroctonus terebrans*), and deodar weevil (*Pissodes nemorensis*)¹¹ (Fig. 2B-C). Many woodboring insects such as pine sawyer (*Monochamus*), and other longhorn and jewel beetles also show increased activity on stressed

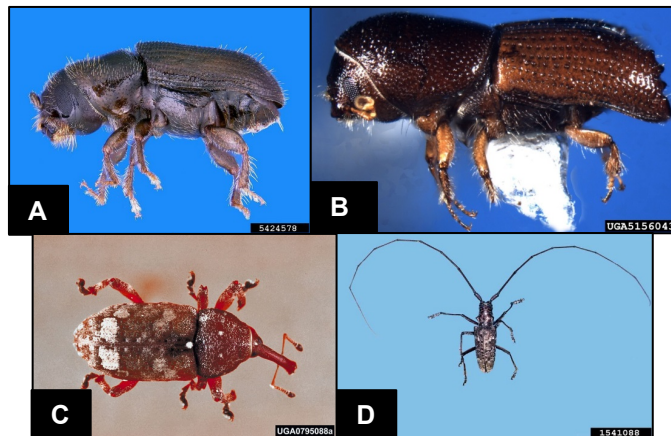


Fig. 2. Examples of economically important adult bark and woodboring beetle species in loblolly pine plantations: (A) *Dendroctonus frontalis*; (B) *Ips avulsus*; (C) *Pissodes nemorensis*; and (D) *Monochamus* species (not to scale).

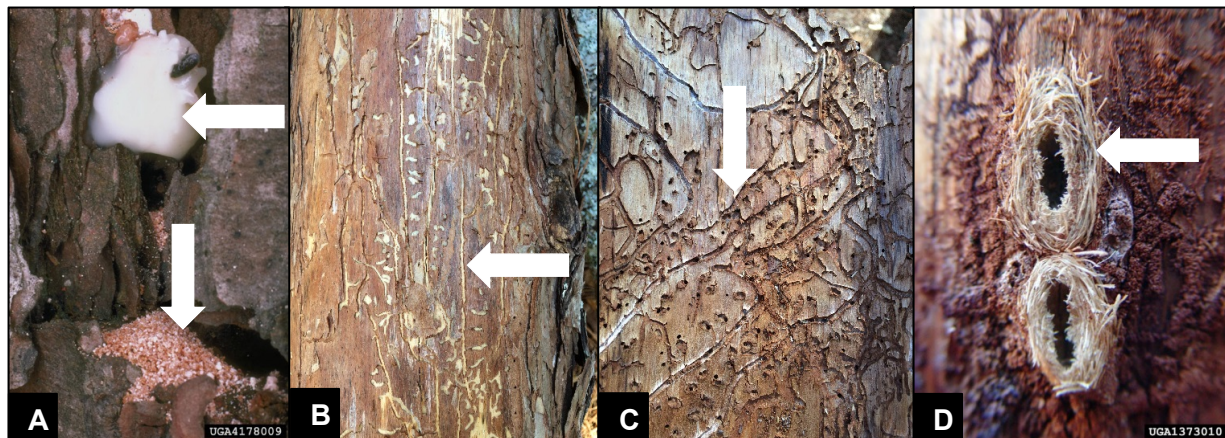


Fig. 3. Examples of signs of bark and woodboring beetle activity on loblolly pine trees: (A) pitch tubes and boring dust; (B) *Ips* beetle galleries under bark; (C) *Dendroctonus frontalis* galleries under bark; and (D) chip cocoons of *Pissodes nemorensis*.

trees, further contributing to damage and death⁹ (Fig. 2D). General signs and symptoms of bark and woodboring beetles are round or oval exit/entrance holes (<0.5 inch) on the bark, sawdust (fine to coarse), pitch tubes, beetle galleries under bark, branch dieback ("flagging"), and growth reduction (Fig. 3, Table 1)¹¹.

Table 1. Common signs of insects on stressed, dying, and dead loblolly pine trees.

Species	Common Signs (Fig. 3)
Black Turpentine Beetle	Large (quarter-sized) pitch tubes along root flare up to about 5 feet, reddish brown boring dust, larger entrance/exit holes, J-shaped feeding galleries under the bark
Deodar Weevil	Chip cocoons under the bark
Ips Beetles	Smaller (dime-sized) pitch tubes throughout the bole, reddish brown boring dust, small entrance/exit holes, H, Y or X-shaped galleries under the bark
Southern Pine Beetle	Smaller (dime-sized) pitch tubes throughout the bole, reddish brown boring dust, small entrance/exit holes, S-shaped galleries under the bark
Woodborers	Coarse or fine white boring dust or chips, round or D-shaped exit holes

Fungal Pests

Fungal pathogens are common in loblolly pine stands, and their activity varies with soil types and land-use history. In most stands, activity of these organisms has minimal impact on tree health; however under some conditions they can have major impacts. Heterobasidion (i.e., Fomes/Annosus/Annosum) root disease (caused by *Heterobasidion irregulare*) is most active in stands with well-drained, coarse-textured surface soils (sand and sandy loam A horizons) after thinning in wintertime when spore production is the highest¹². Fungal spores infect stumps and move into tree roots and surrounding trees generally through root contact causing tree death (Fig. 4). Infection centers of dead and dying trees occur around infected stumps that continue to expand for up to 10 years. Stump treatments or summer thinning (below 34° latitude only) can significantly reduce infection.



Fig. 4. Heterobasidion root disease with (A) stringy roots showing sap stain; and (B) fruiting bodies at the base of the tree.

Littleleaf disease is a major problem on older trees (>40 years old) growing on soils that have high subsoil clay content, poor internal soil drainage (either naturally or due to soil compaction), and low nutrient availability, especially phosphorus levels¹³. *Phytophthora cinnamomi* is the pathogen that is most commonly associated with littleleaf disease¹⁴. Symptoms of littleleaf disease include shortening of needles, abundant sterile cone production, and root death. Since this disease affects older trees that are not very responsive to fertilizer or other treatments, harvesting followed by site preparation that includes soil tillage (such as a

combination plow), fertilization, and replanting may be the only option available to the landowner.

Loblolly Pine Dieback and Mortality

During the last several decades, there have been reports of dieback and mortality of loblolly pines in the Piedmont, Sandhills, and Upper Coastal Plain physiographic regions. Counties in west-central Georgia and east-central Alabama are reported to have the highest levels of tree dieback and death. This phenomenon has been referred to as "loblolly pine decline" or "southern pine decline" (SPD) by some researchers and forest managers, and symptoms include crown thinning, yellowing of needles, reductions in growth, and root and branch death¹⁵. Analysis of FIA data and field visits to sites previously characterized as having SPD had a variety of abiotic (e.g., soil types and climate) and biotic (e.g., insects, pathogens, and genetics) factors that were causing individual stands to show symptoms of decline¹⁶. From this research it appears that a number of unrelated problems are being lumped under the name SPD, which leads to misdiagnosis of causal factors of damaged stands. Further controversy has also arisen due to the focus of research on common contributing fungi and insects. Southern *Leptographium* fungi and their vectors (*Hylastes*, *Hylurgops*, and *Pachylobius* species) are ubiquitous in damaged pine stands^{15, 17}. There are many unknowns about the ecological and economic impacts of these southern root-feeding weevils and *Leptographium* species in healthy and stressed loblolly pine stands. However, none have proven to be primary pathogens^{16, 18}. Recent studies show root-feeding weevils mainly attack stumps and stressed/dying trees instead of healthy ones, which suggests that silvicultural activities that optimize tree health will minimize their activities¹⁸.

Maintaining Loblolly Pine Health

Loblolly pine tree health can be maintained by corrective treatments at stand establishment combined with appropriate intermediate stand treatments. Site preparation tillage that breaks up restrictive subsoil layers can improve growth and tree vigor in most sites and may be particularly valuable on sites where littleleaf disease is expected to occur¹⁹. At establishment, fertilization with phosphorus or phosphorus plus nitrogen should also be considered for these sites as well as other sites where soils tests indicate low phosphorus availability²⁰. Herbaceous weed control during the first growing season is generally recommended and is always recommended when fertilization at establishment includes nitrogen. Hardwood control may or may not be needed. On sites with low hardwood competition (<1,800 hardwood rootstock/acre), herbaceous weed control is sufficient²⁰. Post-planting, regular low-intensity prescribe burning or herbicide treatments will also reduce hardwood plant competition (Fig. 5A). If trees were planted at high density, then thinning is recommended to 80-100 ft²/ac (often this will be timed to coincide with nitrogen and phosphorus fertilization)²¹ (Fig. 5B). During thinning, damage to tree bole and roots should be avoided otherwise pest problems can be exacerbated. Selection of quality contractors coupled with on-site inspection during the operation and contractual provisions to cease operations during wet weather will help minimize damage. Healthy loblolly stands may have a few dead trees, but widespread dieback should not be present.

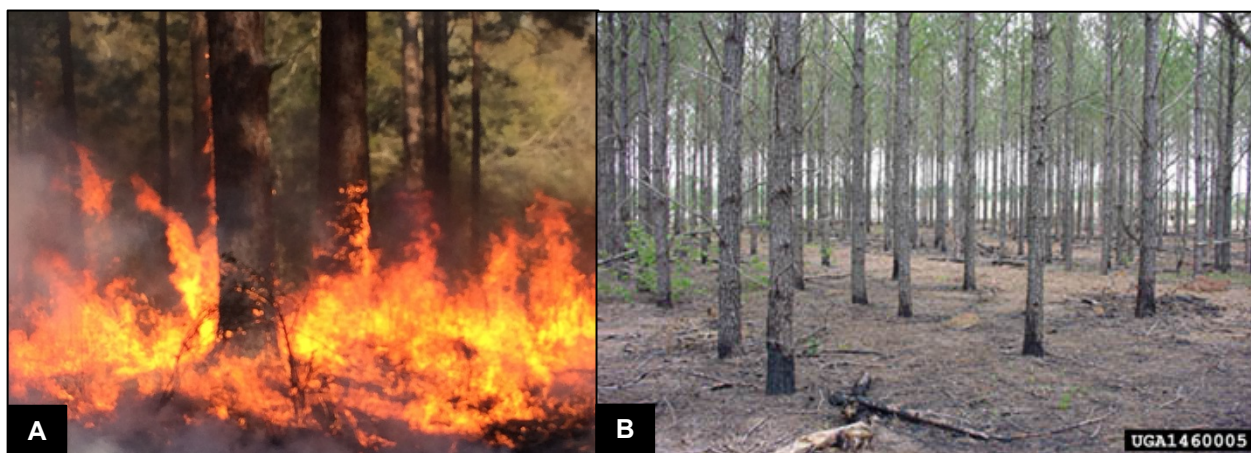


Fig. 5. Stands undergoing (A) prescribed burning and (B) thinning activities that assist with forest health.

Contact an extension agent, state forestry agent, or a consulting forester for further assistance with pine tree health issues and management options. Always use a licensed pesticide applicator and use label directions when applying pesticides. More information on pesticide application is available from the USDA Forest Service (<http://www.fs.fed.us/foresthealth/pesticide/>), or from your state's cooperative extension service.

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