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Weather Resiliency of Shortleaf Pine

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Introduction

Weather events are a natural process affecting all forest types and exert a strong influence on forest growth, structure, composition, and dynamics.[32] These weather events include severe wind, ice and snow, flooding, drought, and lightning.

Shortleaf pine, the most widespread pine species in the Eastern United States, occurring in 22 states, with a range of over 440,000 square miles (Fig. 1),[13] inhabits many climatic conditions. It grows on a wide variety of site types, from the coastal regions of the southern United States to the pine barrens of New Jersey, oak woodlands of the central Midwest, and the dry ridges of Arkansas and Oklahoma.

This fact sheet summarizes what is known about the resiliency of shortleaf pine to the weather events of severe wind, ice and snow, drought, and lightning and fire. Overall, there is little empirical evidence on the effects of these weather events, with most information being observational or hypothetical. The fact sheet does not cover the management or silvicultural responses to weather events.

SEVERE WIND

Winds strong enough to damage tree species arise from several sources: frontal systems, thunderstorms, tornadoes, and along and near coastal areas, tropical cyclones (tropical storms and hurricanes). Each of these sources produces wind with differences in maximum speed, direction, and duration. The damage from these different severe wind events occurs in complex patterns at a range of spatial scales, from individual trees to the landscape.[27]

Damage to trees includes abrasion, lost needles, lost branches, and tipping or breaking of the main stem.[27] Damage from wind events is unpredictable and is dependent on the position of the stand in relation to the center of the storm, the wind speed, the direction, and duration of the gusts, differences in crown architecture, root system configuration, stem and branch density, and site characteristics such as topography and soils.[27]

Shortleaf pine is considered to be resistant to wind events,[13] with the exception of trees with shallow root systems on sites such as ridgetops and highly eroded soils. The gentle taper of the trunk probably reduces the risk of stem breakage[27] and the higher modulus of rupture (MOR; a measure of maximum bending load before wood fails) and elastic modulus (EM; the ratio of force to the degree of deformation), may make the species more resistant to damage than other southern yellow pines.[3]

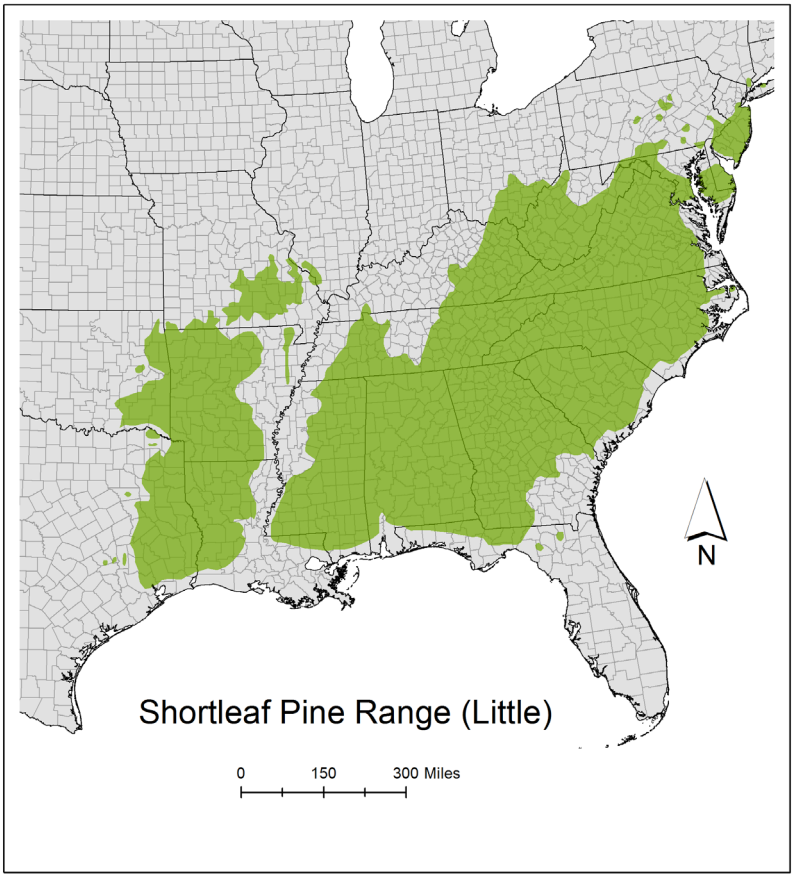

Figure 1. Historic range of shortleaf pine published by E.L. Little, 1971, USDA Forest Service.

ICE AND SNOWSTORMS

Ice and snow accumulation are a frequent and extremely damaging weather event in temperate regions.[11] It results from the movement of a strong frontal system when warm moist air moves above a layer of cold air.[3] Ice and snow storms usually occur at large scales, affecting millions of acres of forest.[3] Snowfall averages less than 16 inches annually over most of the range of shortleaf pine but can have greater accumulations in the mountains of the Ozarks, Cumberland Plateau, Southern Blue Ridge and in the range north to New Jersey.[13]

Damage to trees can range from loss of limbs to mortality from extensive crown loss or the falling of the whole tree.[3] Damage is unpredictable and is related to variation in ice accumulation, wind conditions, topography, vegetation, stand density, and management practices.[3] A study in the Appalachian Mountains found that ice damage was most extensive on east-, southeast- and south-facing slopes, at middle elevations, and on slopes of moderate steepness,[28] topographic locations where shortleaf pine often naturally occurs. The frequency of severe ice and snowstorms in most of the southeastern U.S has a >5 year return interval.[11]

Shortleaf pine can be damaged by extensive ice and snow accumulation. An ice storm in northern Arkansas resulted in the loss of almost one-third of the volume in a heavily stocked stand.[14] Another ice storm in Arkansas in December 2000 resulted in moderate damage to branches less than 2 inches in diameter.[25] While susceptible to ice and snow damage, shortleaf pine is more tolerant than other southern yellow pines,[7] perhaps because of the shorter needles and flexible branches.[24] A determining biomechanical factor may be the MOR.[3] The MOR is sensitive to the specific gravity and moisture content of the wood and to defects or variability in the wood.[3] Among the southern yellow pine species, shortleaf pine's MOR is higher than loblolly, but less that longleaf and slash.[29]

DROUGHT

Mean precipitation varies across the range of shortleaf pine, from 40 inches along the western and northern reaches and 48 inches in the northeast to over 56 inches along the southern range and Gulf Coast.[7,13] Drought within this region is common and the region has experienced many short severe droughts as well as several long multi-year droughts.[26]

Shortleaf pine is considered relatively drought resistant, but there are few studies that have tested this. This includes its tolerance of a wide range of soil and site conditions, ability to withstand drought, and adaptation to fire.[9]

LIGHTNING AND FIRE

Lightning is a common phenomenon in the southeastern United States, with the south Atlantic and Gulf coastal plain and north to the Ouachita Mountains having some of the highest density of lightning strikes in the country.[21,22,30] A similar pattern exists in estimates of historic mean fire intervals,[10] reflecting the relationship between lightning strikes and fire events. Whether lightning results in a ground fire depends on many factors, including slope, aspect, fuels, fuel moisture, humidity, temperatures, and wind.[2,22]

Lightning is a common damaging agent to trees, especially older, emergent trees or trees growing in isolation. Losses of shortleaf pine to lightning is not mentioned in the literature and is probably minor, although this is most likely variable across the range of site conditions. Lightning-struck trees are thought to be more susceptible to insect damage, particularly southern pine beetle.[5]

Lightning is the primary natural cause of fire in southeastern forests, including forests with shortleaf pine. Shortleaf pine is classified as fire-resistant and is not susceptible to crown fires because of a high and open crown and the self-pruning of lower branches.[4] Shortleaf pine has several fire-adapted traits allowing it to survive fire and colonize burned areas. Seedlings and saplings have the capacity to re-sprout when top-killed by fire due to axillary buds located in a basal J-shaped crook near the ground surface, a unique feature of the species.[17] A thick platy bark and minimal quantities of resin production protect older trees from fire.[7,17]

Fire plays a critical role in the regeneration, establishment, maintenance, composition, and structure of shortleaf pine ecosystems.[16] Historically, the source of fire was from both lightning and Native Americans, while currently prescribed fire is used to emulate this ecological process. Fire prepares bare soil for regeneration and reduces competition. Windstorms and human disturbances also provide conditions for shortleaf pine regeneration. In the absence of fire or other disturbances at the landscape scale, shortleaf pine communities succeed into hardwood-dominated forests.[4,20]

FUTURE CHANGES IN CLIMATE AND WEATHER-RELATED DISTURBANCES

The climate of the Southeastern and Mid-South sections of the United States will change in future decades. While there are many sources of uncertainty in the climate projections for the region, all predict that temperatures will be warmer, precipitation will be more variable and intense, droughts will be more frequent, and that wildfire events—with potential extreme drought conditions and increased ignition sources—will be more common.[15,18] Models predict that fire hazards are likely to increase by 10 percent with some predicting an even greater increase with extended drought stress and increased fuel levels.[15]

Shortleaf pine has many characteristics that will allow it to thrive in these changing conditions.[12,18,19] This includes its tolerance of a wide range of soil and site conditions, ability to withstand drought,

and adaptation to fire.[9,23] Modeling potential suitable habitat for shortleaf pine under several global climate models and two emissions scenarios suggest that the species has the potential to increase its abundance in much of its current range and expand northward in Missouri, Kentucky, and West Virginia[12] with the appropriate ecological and silvicultural management. The abundance of shortleaf pine has already shown a significant western shift.[6]

The characteristics of the species will allow management for ecosystem resilience. Resilient sites are those with a high capacity to adapt to stress while still maintaining species diversity and ecological function.[8] In shortleaf pine systems, fuels, vegetation structure, and landscape patterning can be managed through fire and thinning, to increase resilience.[2,31] An emphasis on restoring areas with well-connected sites and a high geophysical diversity will provide a range of ecological conditions for associated wildlife.[1]

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