Photo courtesy: Jeff Stringer

Many woodland owners and those who work in Kentucky's forests have noticed the continuing loss of oak trees. These losses are widespread and many woodland owners who have large oaks have seen a number of these trees die. Often these losses occur without any outward signs or symptoms. While outward signs might not easily explain these losses, the majority of oak mortality is understood and expected.

All of the oaks typically do not die in one area. Instead, the mortality is scattered throughout the woodlands. Sometimes sporadic tree death occurs at a high rate for a couple of years and then the losses decline. This sporadic mortality occurs across all common oak species, with some locations showing more red oak losses, others showing more white oak losses, and some showing losses of red and white together.

Dying Oaks

by Jeff Stringer and Jody Thompson

Regardless of the level of mortality or the species of oak involved, the loss of large canopy oak trees is noticeable. However, the decline and death of larger oak trees is part of the natural progression and aging of oak woodlands. While from time to time a single insect or disease causes widespread mortality, insects and diseases do not usually work alone to kill oaks. Typically they work in concert with other factors. Understanding the underlying science and causes of this mortality is important and can be useful in developing appropriate management of our woodlands. For those not owning or managing woodlands, understanding that this mortality is often natural can help dissuade fears associated with the loss of these trees. This article is designed to provide an understanding of the underlying causes of mortality in large oak trees and provide examples of how this manifests itself in different woodlands throughout the Commonwealth.

Defoliations from naturally occurring insects can entirely defoliate trees reducing their energy reserves. Such was the case in 2003, as pictured above when regional defoliations of oak trees were common.

Tree-to-Tree Competition

First, it is important to remember that an individual oak tree is growing in a competitive environment. Every tree, including large canopy trees, is in competition with the surrounding trees for moisture, nutrients, and light. This competition occurs above ground and below ground. Each species of oak has a different tolerance for this type of competition.

Age and Vigor

Many Kentucky woodlands have large canopy trees that are 70 to 80 years old, and we can sometimes find oaks more than 100 years old. As a tree reaches the end of its natural life span, it tends to lose vigor, much like animals. Some oak species, such as scarlet oak and black oak, are short lived. They often do not live past 100 to 120 years old. Even white oaks that can live to 450 years old under the proper conditions can have much shorter natural life spans. Regardless, our woods and the large oaks they contain are aging and a loss of vigor associated with age is expected.

Native Insects and Diseases

In typical woodlands, a host of native insects, fungi, and other disease-causing organisms prey upon oaks. These organisms, however, are as much a part of the natural environment as the oak trees. One way to look at this issue is that the ecological job of some insects and disease-causing organisms is to remove the weak, dying, and dead trees so there is less competition for the healthier ones. Typically, healthy trees growing in good conditions can ward off attacks from these insects and other organisms much like a healthy human body fights off a common cold. For example, one way a tree fights off organisms that destroy their roots is by growing a large number of roots to overcome these losses. Simultaneously, physiological processes going on inside a tree act much like our immune system and help ward off the onset of disease or help to repel attacks by insects.

Insect damage such as the dead branch tips (flagging) caused by cicadas or other insects that occur annually may not kill trees but produce constant low level stress to our woodland trees.

Photo courtesy: Jeff Stringer

The insects and diseases affecting trees often go undetected. We occasionally notice insect defoliations in our oaks when the insect populations explode and you can see large scale leaf losses, and these infrequent episodes are important. However, so is the unnoticed defoliation from insects that typically results in the loss of 5 to 20 percent of the leaves over the course of a growing season. This type of low-level leaf loss that occurs across the whole growing season does affect the vigor and health of oak trees. Two common groups of diseases — *Armillaria*, which causes shoestring root rot, and *Phytophora*, which causes root rot in a wide variety of plants — have species that affect oaks and are present in every woods. However, they are inconspicuous organisms that sometimes have to be found through close examination. Regardless, healthy trees can typically withstand insect defoliations and attacks from disease-causing organisms such as root rot fungi. However, it is important to understand that our oaks are under constant attack from both insects and disease organisms.

Photo courtesy: W. Henry McNab

Root rot fungi constantly attack the roots of woodland trees. When the tree no longer has the ability to replenish roots their loss can lead to tree death. Sometimes this can happen through wind throw even when the tree is still alive.

Stress

The last concept that must be understood is stress. Stress is a part of life in the woods for the trees that grow there. While we don't often think of trees as being stressed, stress is a physiological condition not unique to animals. Like animals, stress lowers a tree's ability to fight things that can ultimately kill them. The older and less vigorous a tree, the more susceptible it becomes to things that cause stress.

Generally, trees under stress are not able to balance the amount of food they produce in their leaves from photosynthesis with the amount needed to maintain growth and development of their branches, stems, and roots. Trees must maintain a reserve food supply to refoliate each spring. They must also be able to maintain root growth in the winter and produce new wood in the spring, in some instances before the leaves are fully formed. In oaks, this reserve supply of food is in the form of starch deposited in the sapwood (the outer section of the wood in large branches and main stems) in a tree's large branches, main stem, and large lateral roots. This imbalance is stress. It can be a large imbalance leading to death over the course of just

a few years or a small imbalance that cumulatively leads to tree death over decades. Examples include:

1. Droughts that lead to a reduction in food production by the leaves and, ultimately, to a loss of starch reserves
2. Droughts or flooding, which both cause root death that hinders the uptake of water, oxygen, and nutrients necessary to make food, turn food into energy, and put on new growth
3. Late spring frosts and freezes that remove newly formed leaves and shoots, causing the tree to use up food reserves needed to refoliate
4. Defoliation by insects, particularly outbreaks that occur early in the growing season that reduce leaf area and thus food production
5. Storm damage resulting in a loss of leaves
6. Overstocking of trees, resulting in crowding and an increase in tree-to-tree competition
7. Man-made disturbances such as fires, incorrect logging, construction, using the woods for grazing, and other activities that wound above-ground portions of the tree or increase soil compaction, leading to root loss

Photo courtesy: Jeff Stringer

Uncontrolled grazing can be harmful to woodlands. It can lead to heart rot in large canopy trees and can stifle natural regeneration.

Putting It All Together

Tree death, especially the death of larger or older trees, is a combination of several of the factors that are discussed above. Trees that have been stressed by one or more of the factors listed above start to lose vigor. This loss of vigor is greatly exacerbated if the tree is already low in vigor due to its age. Combining naturally low vigor with stressors makes a tree less able to outgrow the organisms causing root rots or the insects preying upon it. The tree slowly loses the war and eventually dies. You can often see this process as the tree loses large canopy branches and top dieback occurs. Other times, the battle is occurring internally or below ground, and you never know it until the tree dies. Most often however, you can see symptoms of decline before the tree is dead. The following are examples seen in Kentucky over the last several years.

Combinations of Droughts and Freezing

Both late spring freezes and summer droughts have occurred throughout Kentucky over the last 10 to 15 years. Late freezing causes trees to refoliate and use up starch reserves in the root system. Couple this with one or more drought years, and the tree loses more food reserves. Understand also that the drought doesn't have to last the entire year. It takes only couple of weeks of dry soil conditions in combination with other stressors to start a cycle of decline. The tree then generates fewer new roots and root rot organisms take their toll. The loss of root further reduces a tree's ability to take up valuable moisture and nutrients, leading to more reductions in food production by the leaves. This negative feedback loop results in a tree that is unable to produce enough food to generate roots and refoliate and, ultimately, to the death of the tree in some cases several years later.

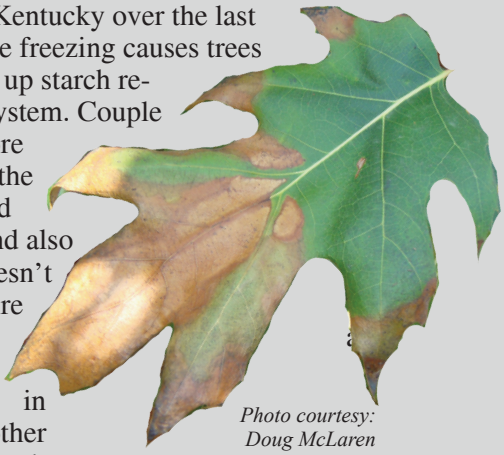


Photo courtesy: Doug McLaren

Tree stressors such as a drought can cause leaves to prematurely dry up, typically from the outer edges, leading to early leaf drop.

Defoliations and Droughts

In the last six years, native insect populations, such as forest tent caterpillars, have increased and led to large amounts of lost leaf area. These trees then have to refoliate, and if a drought occurs in the next year or two, the trees cannot replenish their root starch reserves. The result could be a loss of root regeneration and death in a similar manner as described for droughts and freezing.

Overcrowding and Age

Many oak forests are even-aged or close to it, meaning the majority of the canopy trees are about the same age. As some or all of these trees start to approach 70 to 100 years old, they are losing natural vigor. As they increase in size, each tree needs more and more growing space. This growth leads to crowding, both for canopy growing space, leaf area production, and underground, where roots compete for available soil moisture and nutrients. If these woods are crowded, there is limited room for crown expansion and, thus, leaf production for an individual tree. The limited leaf area leads to a reduction in the amount of food produced from the leaves and, thus, a reduction in the amount of food supplied to the roots. This further increases the trees' susceptibility to the effects of insects and disease organisms. The conditions described lead to the death of large canopy trees. This slow decline and mortality in oak stands is often referred to as oak decline and can easily occur. Couple this with other stressors such as droughts, freezes, or defoliation, and mortality rates will increase in these woods.

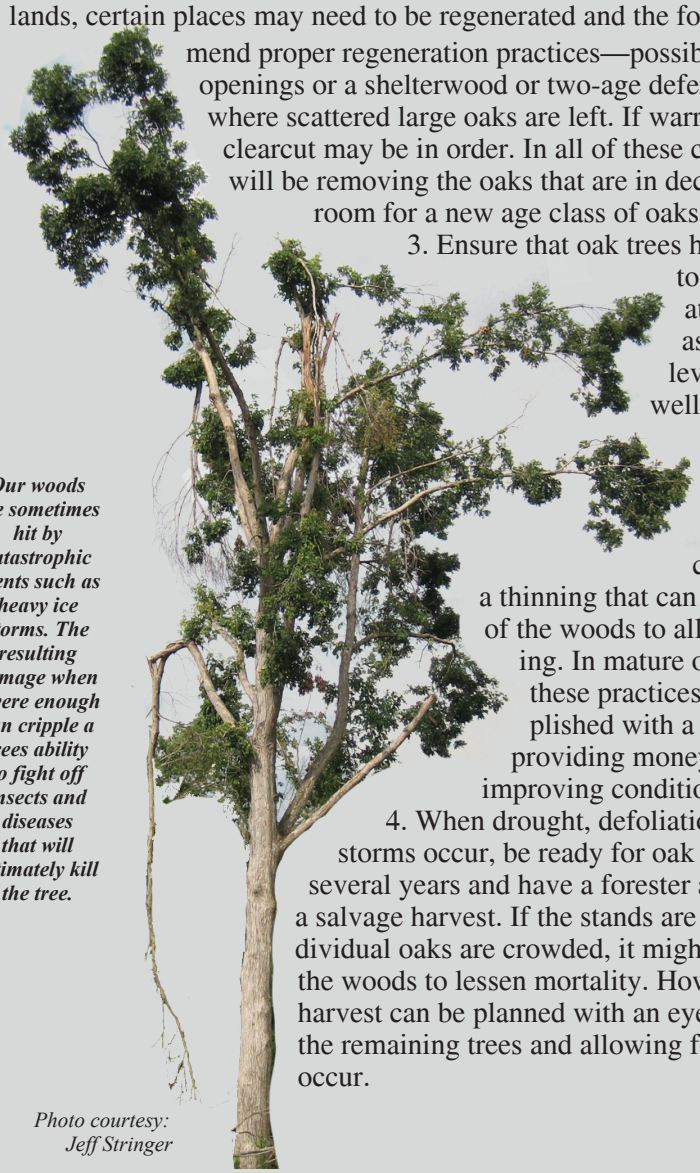
Storm Damage

Storm damage, particularly ice and tornadoes, have recently been common in Kentucky. When the damage is severe, resulting in a significant loss of leaf area (greater than 50 percent), the trees cannot quickly rebuild leaf area—storm damage removes the buds necessary to refoliate. Some die in the first growing season after severe damage, but it often takes several growing seasons. When trees are not damaged or significantly defoliated, they can usually recover. However, throw in another stressor, such as drought, and it can easily increase the number of dying trees even years after the storm.

Managing Oak Forests

While many factors associated with oak mortality are uncontrollable, as a woodland owner, certain practices can help with some of these losses. The following principles or techniques are important to incorporate into your woodland planning.

1. Determine the risk for loss in your mature woodlands by determining the species, age, and crowding condition of your woodlands. A forester can help assess your woodlands for each of these factors and determine if it is at risk for high rates of oak loss if there is drought or another stressor.
2. If you have short-lived oak species, such as scarlet or black oak, realize their longevity and remove them if they are economically mature. Also realize that you will have losses occurring sporadically or significant losses if droughts or other stressors occur. If there are a large number of these trees in your woodlands, certain places may need to be regenerated and the forester can recommend proper regeneration practices—possibly small group openings or a shelterwood or two-age deferment treatment where scattered large oaks are left. If warranted, a small clearcut may be in order. In all of these cases, the forester will be removing the oaks that are in decline, allowing room for a new age class of oaks to establish.
3. Ensure that oak trees have enough room to grow appropriately. A forester can assess the stocking level of the woods as well as the crowding of individual oak trees. Foresters can recommend practices, such as a crop tree release or a thinning that can adjust the density of the woods to alleviate overcrowding. In mature oak woodlands, these practices can be accomplished with a timber harvest, providing money for you as well as improving conditions in the woods.
4. When drought, defoliation, freezes, or storms occur, be ready for oak loss over the next several years and have a forester assess the need for a salvage harvest. If the stands are overstocked and individual oaks are crowded, it might be too late to thin the woods to lessen mortality. However, a salvage harvest can be planned with an eye toward improving the remaining trees and allowing for regeneration to occur.



Our woods are sometimes hit by catastrophic events such as heavy ice storms. The resulting damage when severe enough can cripple a trees ability to fight off insects and diseases that will ultimately kill the tree.

Photo courtesy: Jeff Stringer

Many woodland owners also have oaks in their yards and, unlike woodland oaks, there are practices that can help reduce their stress. Thoroughly water them during dry summer months or when droughts are starting. A few thorough waterings are much more beneficial than a number of light waterings. Also, get a soil test through your local Cooperative Extension Service county agent office for more accurate fertilization recommendations. These practices are two of the most important for individual care of established trees.

In summary, the loss of mature oak trees is a natural process in the woods. Once an individual oak tree loses vigor and becomes stressed, it is difficult for it to recover. Proper evaluation and management is critical to ensure you are taking proactive steps that can lessen problems associated with aging oak woodlands. Contact your local Kentucky Division of Forestry forester or consulting forester to assist with evaluating your woods. A forester can help make sure you have the proper recommendations for maintaining the health and vigor of your oak woodlands.

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