READING THE FORESTED LANDSCAPE

A Natural History of New England

TOM WESSELS

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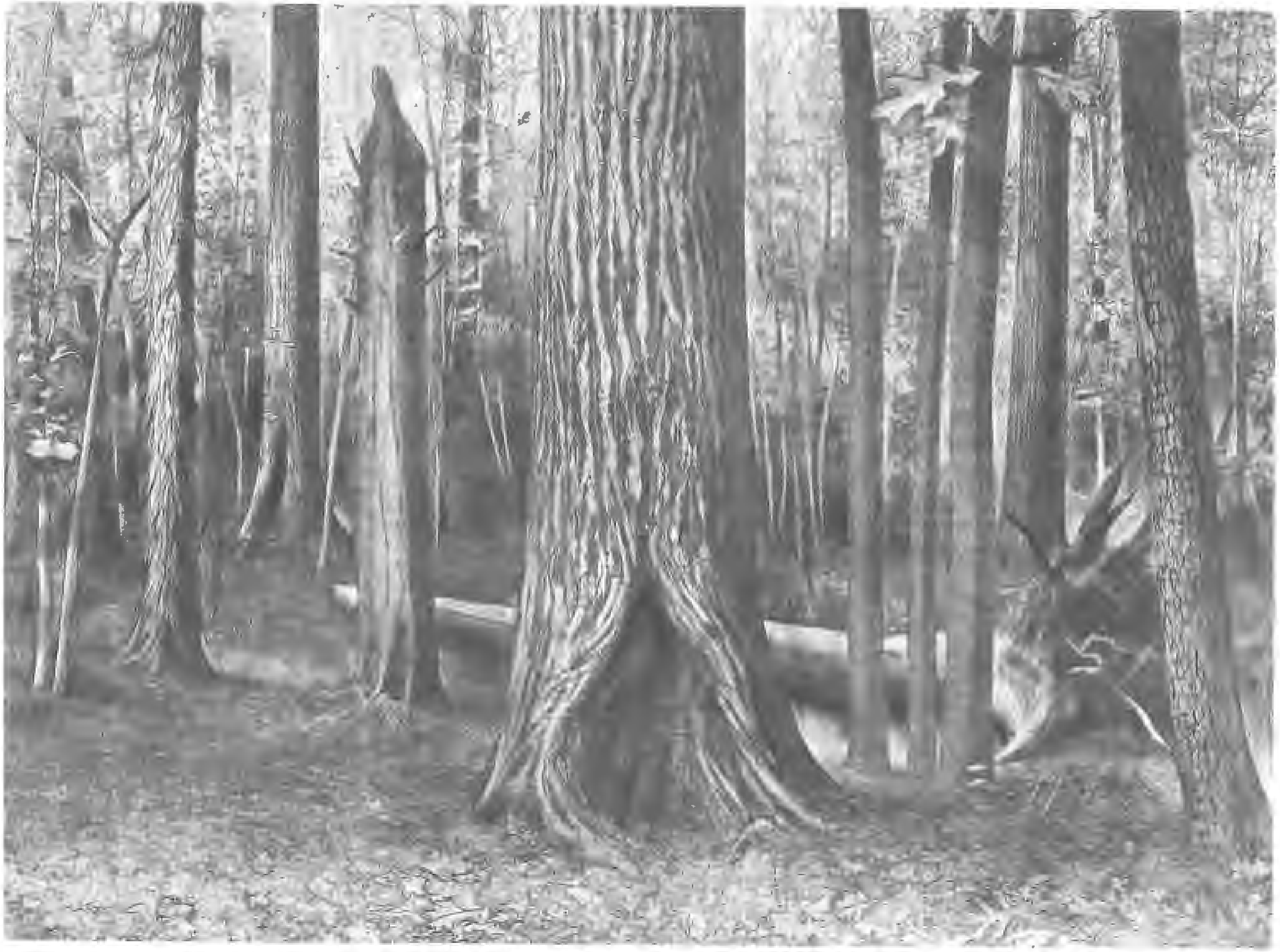


chapter one

THE AGE DISCONTINUITY

New England is blessed with a diverse array of forests. Whether they are young, dense stands of hemlock or older groves of beech and maple, each has a specific story to tell about its origins and development. Sometimes these stories are difficult to read; through time, nature's editing becomes bolder, and important parts of the tale are lost. In other forests, like the one depicted in the preceding etching, the stories remain intact and are easy to follow, once you have learned how to read forested landscapes. To develop this ability, you need to observe forests in new ways, paying particular attention to patterns of *forest structure,* the spacing and sizes of trees, and *forest composition,* the species of trees present. By the end of this book, you may be surprised by your new understanding of forested landscapes.

Let's begin by examining the forest in this first etching. What is most striking to you about its structure? There are some very large trees in this stand. The tree in the center is a red oak about three feet in diameter. At this size it is probably more than a hundred years of age. Small trees are also present, such as the triple-trunked red maple directly to the right of the oak and the majority of the trees that fill the background.

But medium-sized trees are missing. This is called an *age discontinuity*—a somewhat formal term for a forest that is missing trees of a certain age group. In this case it is the medium-sized trees that are poorly represented. Only two conditions can create an age discontinuity: the growth and development of a young forest or a disturbance to an older forest.

A young forest typically develops a gap in age classes when its canopy first closes. A closed canopy restricts shafts of sunlight from reaching the forest floor, and because the canopy in a young forest is so close to the ground, it creates dense shade that allows little vegetation to grow. It may take a couple of decades, as lower branches die off and the canopy moves skyward, before tree seedlings begin to show their presence. Even though the maturing and elevated canopy allows more light to reach the forest floor, light levels remain low and seedlings grow slowly. As the canopy trees continue their competitive race toward the sun, slower-growing individuals don't have the stamina to keep up. Their death creates gaps. The increased light through the openings allows seedlings to become saplings, which grow into young pole-sized trees. New seedlings continue to invade the woodland, but an age discontinuity between canopy trees and the younger poles standing beneath them becomes clearly visible. It will remain so until large, slower-growing individuals die off, creating big gaps in the canopy that become filled by the faster-growing former poles. It may take a century before the visible evidence of an age discontinuity is erased by younger trees filling the canopy gaps.

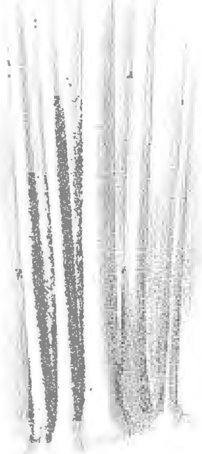
Because the largest trees depicted in this scene are probably more than a hundred years old, we can discount forest youth as the cause of the age discontinuity. Instead, we can look to some form of disturbance as being the progenitor of this forest's missing age class. What was the disturbance? Was it logging, fire, a blowdown, or some form of defoliation that removed the middle-aged understory trees?

Further evidence allows us to eliminate some of these possibilities and provides us with clues to solve the mystery. For example, there is a downed tree in this forest. It could be the result of a *blowdown*—a wind event strong enough to uproot and topple live trees. Certain clues make this possibility questionable. If we look closer, the downed tree appears to be more likely the result of *deadfall*. The standing dead snag to the left of the large red oak, you will notice, looks similar to the downed tree, as both are devoid of bark and display the same degree of weathering. Lacking any other evidence of downed trees, it would be a sound conclusion that this tree died before falling. Its roots rotted to the point where they couldn't support the upright trunk, and it fell. We can also throw out the blowdown hypothesis because the trees most susceptible to windthrow are the largest canopy trees, not the more wind-protected, middle-aged, subcanopy trees, and it is the latter that are missing from this landscape.

DOWNED TREE

Possibly the medium-sized trees were killed by defoliating diseases or insects, such as the oak-loving gypsy moth or maple-munching saddled-prominent caterpillar. But there are two problems with this scenario. Although insects and disease organisms discriminate among species of trees, they usually don't discriminate among trees of different sizes. Also, trees stripped of their leaves often die because their roots become starved of carbohydrate energy following defoliation. There is evidence to suggest that whatever removed the middle-sized trees left their root systems intact and alive.

DEAD SNAG



MULTIPLE-TRUNKED TREE

BASAL SCAR

The disturbance left behind trees that grew up to be *coppiced,* a fancy term for trees that have more than one trunk growing from their root system. The red maple to the right of the central oak is a classic example, as is the small double-trunked tree at the far left of the etching. *Multiple trunked* is another, possibly more descriptive, term for trees with this growth form. With the exception of gray birch and speckled alder (species that normally display coppiced growth), the only way for a tree to become multiple trunked is for the trunk to be killed while the root system is left alive. When this happens, the roots quickly respond by throwing up a number of stump-sprouts, a few of which eventually grow to tree size.

So, what could kill the aboveground portion of a tree and leave its root system vital? Both the cutting and the burning of a hardwood's trunk leave an intact root system that can stump-sprout. The cutting and burning of coniferous trees—pines (with the exception of pitch pine, which will be discussed later in this chapter), hemlock, and spruce—kill the root system. Having eliminated the possibility of a blowdown or a defoliation event, we can now consider either logging or fire as the cause of this forest's most recent disturbance.

Basal scars

At the start of this chapter I asked you to identify the most striking aspect of this forest's structure. I should now admit that I was a little disingenuous in my response, for the very first thing I noticed in the etching was not the age discontinuity, but the dramatic scar at the base of the large, central red oak. This *basal scar,* along with another on a big tree behind and to the left of the red oak, supports the idea of disturbance by either logging or fire. However, in order to play the game of elimination by looking for evidence of defoliation or a blowdown as the cause of the age discontinuity, I wanted to delay discussion of these slow-to-heal tree wounds.

Basal scars are created when the tree's bark is removed, either by fire damage or by some form of collision. Trees that line roadways often display triangular-shaped scars received from automobile impacts. In the forest, basal scars not due to fire are either the result of log skidding—the dragging of logs out of the woods—or of a falling tree hitting the base of a neighbor. This is a rare event in forests, as canopy branches either catch falling trees or deflect them away from their bases. The placement of the basal scars is the critical clue in determining whether logging or fire was responsible for their origin.

Suppose a fire burned up a moderately steep, forested hillside. On which side of the trees would most basal scarring occur? This is a question that often confounds my students. The most common response is the downhill side. Intuitively, this seems correct because a fire burning upslope directly confronts this side of the trees. Yet most basal scars are found on the uphill side. How could that be? The answer lies in the presence of *fuel pockets*—dead leaves and sticks that have accumulated at the base of the tree's uphill side due to the pull of gravity, which slowly tugs at forest litter and results in its slow, downslope migration. Any large, upright object, such as a boulder or tree trunk, impedes this flow much as a dam obstructs the flow of a river. When fire reaches a fuel pocket, it burns far longer than it does on the litter-free, downhill side of the tree. And if the fuel pocket is big enough, the fire destroys the tree's bark, creating an uphill basal scar.

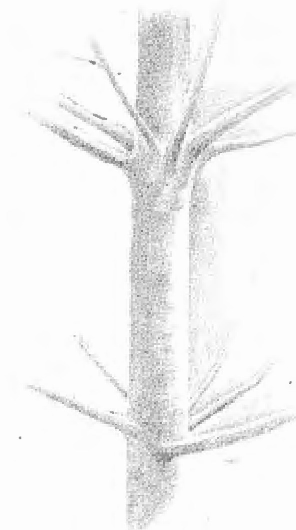
When a forest fire occurs on relatively level terrain, the fire scars are random in their placement, occurring wherever fuel, usually in the form of downed limbs, lies close to the base of a tree. The same random pattern is also created by falling trees hitting their neighbors. However, basal scars resulting from skidding do not show a random pattern—they often face one another from the opposite sides of logging roads, giving rise to the term *opposing basal scars.* As logs are dragged through the forest on these roads, they hit the base of trees, removing the bark and providing a clear testament to the forest's logging legacy.

BASAL SCAR

Not only does the etching's central red oak display a basal scar, but also another can be seen in the background, on a tree to the left of the oak. The topography of this landscape is fairly level, so what are we to make of the placement of these scars? On their own, the two basal scars do not provide enough information for us to state with certainty whether it was logging or fire that created them. To decide which disturbance impacted this forest, we need to return to the first observation I made about this forest—its age discontinuity—but this time from the perspective of a logger.

Place yourself in the role of a logger. What kinds of trees would you cut? What kinds of trees would you leave? Many of the large trees in the etching are oaks, highly valued for timber. The majority of the multiple-trunked specimens are red maple, a species of lower timber value. Would a logger remove the smaller, lower-valued trees while leaving the larger, higher-valued trees? Probably not. The age discontinuity depicted in the etching does not support logging, but it does support disturbance by fire. The trees most likely to survive a burn are the largest individuals with the thickest bark, while small and medium-sized trees run a higher risk of death. Following the fire, small multiple-trunked specimens will replace those that were killed, filling the understory, but an age discontinuity between these smaller trees and the large, surviving, canopy trees will be clearly visible. Having now eliminated forest youth, blowdown, defoliation, and logging, we are left with the conclusion that sometime in its past this forest experienced a fire hot enough to kill a number of trees.

Two more pieces of evidence support this theory. To the left of the central oak is a standing dead snag. Its *whorled limbs*—branches arranged in an encircling pattern—reveal it as a conifer, most likely a white pine. Both white pine and hemlock are the region's most common needle-bearing trees, but hemlock doesn't display distinct limb whorls. The snag's weathered look also suggests it has been dead for some time, yet it does not seem to support any visible fungal growth. The same is true for its downed companion. Trees killed by defoliation or competition for canopy space often develop significant fungal growth within a decade. Yet pines, spruce, and oaks, if killed by fire or lightning, become extremely rot resistant and can remain as fungal-free, standing dead snags for over fifty years. Other species of trees heat-killed by fire decay relatively quickly. Because the snags in the etching are whorled-limbed conifers and highly rot resistant, the best guess is that they were white pines, heat-killed by a very hot fire—along with the red maples, whose original trunks have since rotted away and been replaced by coppiced specimens. Only a hot fire could kill large white pines—trees that have thick, heat-protecting bark.



WHORLED LIMBS

Forest composition

Further evidence lending support to the fire theory is the species composition of this forest. Two types of trees in this stand serve as eco-indicators of warm, dry sites in central New England: white oak (the scaly-barked tree at the far right of the etching) and shagbark hickory (toward the far left). Not only do these trees grow in warm, dry sites, but also their barks are adapted to survive hot fires.

WHITE OAK

The bulk of a tree is simply dead wood. The only living part of a tree, other than its leaves, is a thin layer of tissue just underneath the bark. This layer, only a few millimeters thick, is the cambium. The best way for a tree to protect this cambial tissue from being damaged by fire is to surround it with thick, protective bark. Similarly, we protect ourselves from the cold by putting on layers of clothing to capture the insulating qualities of dead air space. This strategy could also shield us from excess heat. Fire-adapted trees have a comparable strategy, only they use layers of bark in the form of shag or scales. Thin, tight-barked trees like birch, maple, hemlock, and beech are easily heat-killed by a fire. Red oak, which has thicker bark, does somewhat better. But the most fire-adapted hardwood trees in our region are the white oak, chestnut oak, shagbark hickory, and the once common American chestnut.

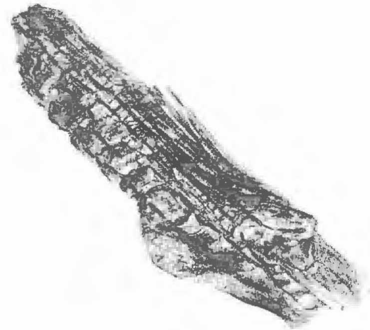
Even more fire-adapted than these hardwood trees are certain species of pine. Large white pines develop a thick layer of bark that has insulating properties slightly better than those of red oak. Red pine has loose, many-layered, flaky bark making it more fire-adapted than white pine. But the most fire-adapted tree in the region is the pitch pine. It has dramatically thick, layered bark and is the only conifer in central New England that can stump-sprout following fire or logging. The trunk of a pitch pine, from the ground up, is covered with needle tufts that surround *adventitious buds*—buds found in unusual places such as on the trunks of trees. Each bud is capable of giving rise to new growth in the event that portions of the tree are killed. If all of a pitch pine's needles are burned off, these buds will allow the tree to refoliate. Such adaptations, along with the ability of pitch pine seeds to aggressively colonize burned areas, make this species of tree the most fire tolerant in central New England.

Stands of pitch pine are found in only two kinds of sites in our region: very well-drained sands and hot, dry, rocky exposures. Both sites are prone to the highest frequency of fires in central New England. Often associated with the pitch pine on these sites is the region's smallest oak, the very fire-tolerant bear oak. Stands of pitch pine and bear oak, in fact, owe their existence to frequent fires. These trees grow slowly, need full sunlight, and require bare soil for their seeds to become established. Frequent fires eliminate the faster-growing species of pines and oaks that would eventually overtop and kill them. They also create exposed soil, which is a perfect seedbed for pitch pine regeneration. If fires are suppressed on these sites, the pitch pine and bear oak will be replaced by white pine and red and white oak.

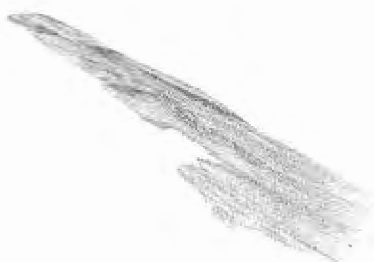
SHAGBARK HICKORY

The next most fire-prone forests are stands of red pine growing on dry, rocky slopes, which are the only sites in central New England where stands of native red pine are found. All other red-pine forests are plantations, the majority of which were planted between 1930 and 1960 in response to a fungal epidemic that affected white pine (discussed in chapter 4). Following red pine, fires most often affect dry-sited forests, like the one in the etching, composed of white oak and shagbark hickory.

All of these fire-adapted communities share another prominent feature: The ground cover is usually dominated by either lowbush blueberry or, on the warmest sites, black huckleberry. These two species of shrubs thrive in areas with frequent fires, which



CHARCOAL



BLACK FUNGUS

boost their berry-producing capabilities by allowing new branches rich in flower buds to replace older, burned branches. This capability explains why the blueberry barrens of Maine are burned every few years to ensure a good crop. Whenever a forest dominated by either pitch pine, native red pine, white oak, or shagbark hickory, with an understory of blueberry or huckleberry, is encountered in central New England, it is a safe bet that evidence of fire will be close at hand.

Although fire is most common in forests dominated by the above species, it also frequents forests dominated by either white pine, red oak, or beech. All of these species deposit leaf litter that is resistant to decay, and this litter bed greatly restricts herbaceous plant growth. Moist, green plants on the forest floor dramatically dampen fire activity, and forests lacking herbaceous ground cover become fire-prone. As all the tree species listed in this paragraph grow well in dry, warm sites and produce rot-resistant leaf litter, forests dominated by these species are also good places to look for past fire activity.

There remains one bit of evidence of fire that has not yet been discussed: the presence of charcoal. Charcoal is a problematic clue for fire in New England for a couple of reasons. The first is that after a few years it may not be visible. Ground charcoal becomes buried by leaf litter, and charring on trees is uncommon except in blazes hot enough to set living trees on fire. These very hot fires are rare in northeastern forests, where moisture levels in the litter, ground vegetation, and trees keep conflagrations from occurring. Even more problematic than the lack of visible charcoal is the possibility of being misled by a black fungus, a species of *Ascomycetes,* that usually coats the surface of decaying beech and maple. The fungus looks very much like charred wood but is simply part of the normal decay process. Unlike charred wood, whose surface is covered with rectangular blocks of charcoal, the fungal coating is smooth and will not leave black marks on the fingers. Until you learn to identify this fungal species, it is best not to look for charcoal as evidence of fire.

The landscape depicted in this etching has all the signs of a fire-prone ecosystem. It is dominated by oaks and shagbark hickory, displays basal fire scars, has rot-resistant standing dead snags, multiple-trunked fire-sensitive hardwoods, and an age discontinuity in which the middle-aged trees are missing.

Although forest fires are not often encountered in central New England (during the past twenty years, I have witnessed only three active fires), it does not mean that fire is unusual, nor does it mean that it has not played a significant role in shaping the region's landscape. The numerous hilltop fire towers that dot the countryside attest to the frequency of fire. Most of the region's fires burn limited acreages and are quickly extinguished, explaining their lack of visibility. Yet they are far more common than most people realize, particularly on dry slopes with a southern exposure. Logging, blowdowns, and pasturing may have limned our landscape with broad, bold strokes, but fire has left its mark in a more selective, discriminating manner.

A LOOK BACK

Today, more than 95 percent of the wildfires in central New England are the unintentional result of human activity. The rest are caused by lightning strikes. This is a dramatic change from precolonial times, when the majority of forest fires were intentionally set