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Adam R. Moore

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Connecticut and the Forefront of Forestry
Samuel W. Johnson Lecture 2005
Plant Science Day

By Adam R. Moore,
Executive Director and Secretary Forester of the Connecticut Forest and Park Association.
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Dr. Magnarelli, Members of the Board of Control, Ladies and Gentlemen, thank you for the opportunity to address you on "Connecticut and the forefront of forestry."

I am *honored* to deliver this year's Samuel W. Johnson Lecture. I began my career as a summer assistant at the Ag. Station. For Dr. Aylor, in the New Haven laboratory, I counted spores. For Dr. Victoria Smith, I measured dogwood anthracnose lesions. I helped Pete Thiel out here, on this farm, collecting samples of apple scab.

Let us acknowledge the beauty of this setting. Look at this beautiful, working, experimental Lockwood Farm, and Sleeping Giant in the background. I used to come here and think, "I can't believe this is Hamden, Connecticut – it feels like Vermont."

But now I don't say that. Now, I say, "Wait - this *is* Connecticut, this is *Hamden, Connecticut*!" Welcome to Hamden!

Forestry is not what comes to mind when we think of Connecticut. For that matter, forests are not what come to mind when we think of Connecticut, either.

Yet forests and forestry *were* in the minds of at least a few people who thought about Connecticut 110 years ago.

Those people may have climbed the rocky trail, over another traprock ridge, to the summit of Talcott Mountain in Simsbury, and looked at the land about them.

One hundred and ten years ago, they did not see forests. They saw abandoned farms, growing nothing but weeds and thorns. They saw hillsides stripped bare to feed the charcoal kilns. They saw no timber, and saw cities and towns and industries importing the wood they needed. They heard the whistle of the locomotive, saw the sparks flying off the rails, and saw spreading flames. They smelled the smoke, and choked on the ashes, of the thousands of acres of Connecticut forest that burned every year.

They went to the mountaintop, and did not like what they saw. They came down, and gathered at the home of the Rev. Horace Winslow in Simsbury, not far from the Pinchot sycamore, and founded something called the Connecticut Forestry Association.

They made Connecticut the first state in the nation to have a State Forester. They made Connecticut the first state in the nation to be able to set aside land for its Forests. They made Connecticut the first state in New England to have a State Forest. Gifford Pinchot, son of Simsbury, Yale graduate, and first chief of the U.S. Forest Service, came to Connecticut and founded the Yale School of Forestry. These citizen-conservationists placed Connecticut squarely in the forefront of the new field of forestry.

Yet these efforts in Connecticut, and the forestry effort in general, were just a part of something bigger. These efforts were just a part of the great American conservation movement.

And for American conservation, *this* was an era…of greatness.

It was an era that had its pollen in Henry David Thoreau's *Walden*, in 1854. It formed a seed with the landscape paintings of Albert Bierstadt, and Frederick Edwin Church; with Frederick Law Olmsted's design for Central Park; with the book *Man and Nature*, by George Perkins Marsh. And it germinated, and rooted itself on this continent, with President Abraham Lincoln. President Lincoln, in 1864, granted Yosemite Valley and the Mariposa Grove of Giant Sequoias to the State of California for the preservation of its scenic beauty and the enjoyment of the public.

The conservation movement sprouted with the establishment of Yellowstone National Park, the first national park in the world, in 1872. It grew with the founding of the Connecticut Agricultural Experiment Station, the first of its kind, in 1875. It branched out with citizen conservation groups, like the Connecticut Forestry Association, in 1895, and our older brethren, in Massachusetts and Pennsylvania, a few years earlier. It blossomed with Pinchot and naturalist John Muir. And American conservation bore fruit with our greatest conservationist President, Theodore Roosevelt, who himself created 5 National Parks, 4 National Game Preserves, 18 National Monuments, 24 Reclamation Projects, 51 Federal Bird Reservations, and 150 National Forests.

This was the age of Half Dome, of El Capitan, of Old Faithful. For National Forests, it was the time of the Olympic, the Umatilla, the Boise and the Bitterroot, the Medicine Bow and Monterey, the Tonto and the Tongass.

This was the dawn of scientific forest management. It was the dawn of wildlife management. And it was the day of reverence for the spectacular natural beauty that graces this continent.

This was the time when, in the minds of these national leaders, of these forestry leaders in Connecticut, the *public* interest was foremost. It was the time of "the greatest good for the greatest number." To Theodore Roosevelt, this number included the generations yet unborn; those, in his words, "within the womb of time, compared to which those now alive form but an insignificant fraction." Those unborn generations, to which Roosevelt referred and for which Pinchot and Muir did their conservation work, are we who sit here today.

Yet a schism grew in the conservation movement, a disagreement between Gifford Pinchot and John Muir over the Hetch Hetchy Valley in Yosemite. The schism persists, and today, American conservation is *riven* by a great continental divide. There is a great continental divide between those who value natural resources for their practical utility, and those who value natural resources for their scenic beauty. There was a divide between Interior and Agriculture. There is a divide between East and West, between the followers of Pinchot and those of Muir.

Today, we conservationists find ourselves divided; and we who are foresters find ourselves on the utilitarian side of

this divide.

Now, for the first time in over a century, Connecticut is losing its forest land. We are losing our farm land. And we have lost a seat in Congress. How can we claim anything that could possibly be called Smart Growth?

In the past few decades forestry has suffered from an image problem. The thing about forestry is that you cannot hide the aspects of the business that are unattractive. Agriculture does not have this problem. Cows look great in the field, and steak looks great in the supermarket. The public does not see what happens in the slaughterhouse. In forestry, trees look great in the woods, and lumber looks great at the lumberyard. Logging, however, looks pretty bad, for the most part, and it is right out there in the open, for everyone to see. There is no concealing it.

The unsightliness of logging has been a problem for forestry. I believe, however, that this is also an opportunity. It is an opportunity for openness, frankness and plain honesty – attributes that are needed in government, and in the corporate world, both nationwide and here in Connecticut. Here is an opportunity for this profession, for forestry, which is conducted in *both* the public and private sectors, to take a leading public stance for honesty and openness. We can show the public: this is where our lumber comes from, this is where our paper comes from, this is how we do it.

And while conservation stands divided, our forests stand threatened. Dale Bosworth, Chief of the U.S. Forest Service, has named four threats to the forests of our nation: fire, invasive species, unmanaged recreation, and the loss of open space. These forces threaten the forests of the United States, and they threaten the forests of Connecticut.

Fire, and the buildup of fuels, threaten forests everywhere, yet less so in Connecticut than in, say, Idaho, or Colorado, or Cape Cod. Our susceptibility to fire, though, depends a great deal upon the weather. Why, just this spring, things went from snowmelt, to the Connecticut River flooding, to fires breaking out, to flooding…all in about three weeks!

In Connecticut - the 13th most densely forested state, and the 4th most densely populated – the other threats of invasive species, unmanaged recreation and the loss of open space are focused like sunlight through a magnifying glass. Invasive plants creep in from the edges of our many roads and yards. We forest-dwellers are packed in tight, and we conflict and collide, and trample the plants and gully the trails, as we head to the woods to spend our leisure time. And we most certainly have the loss of open space. Land values are high and rising, we carve up forests for suburban house lots, and we are slicing the recreational trail system that we do have – the Blue-Blazed Hiking Trail System – with the cuts of a thousand lot lines.

Connecticut is on the front fire lines of these threats to America's forests.

And that is just where I want to be, because the forests of Connecticut have such promise.

Connecticut is a place that grows trees very well. Professor Tom Siccama at Yale said that, in Connecticut, all you need to do to grow a forest is to stop mowing your lawn.

Connecticut has a great diversity of trees. We have no geysers, we have no bison, but we do have sweet gum and tupelo. We do have red oak and tulip and basswood. We have hemlock and hophornbeam and striped maple.

Connecticut has opportunities. We have wood where wood is wanted, in the great world market that stretches from Portland, Maine to Washington, D.C.

As national timber production shifts from the public forests of the West, to the private forests of the East and South, we are well-poised to take advantage of this trend.

We have made forestry and logging more professional through licensing.

We have notable forestry educational institutions, both in Connecticut and nearby.

And we have - in the hundreds of local land trusts, garden clubs and Conservation Commissions - a growing, thriving, active movement of citizen-conservationists.

We have great reason for optimism.

I believe that wood will come to be seen as the green, renewable product that it is.

I believe that Connecticut sawtimber will grow in value.

I believe that wood and biomass will reemerge as a source of energy.

I believe that lands that are protected with conservation restrictions will also grow in value, as perpetual, living endowments.

I believe that lands that abut conservation land will grow in value, too.

I believe that technology will make forestry more cost-effective.

I believe that as pressure grows on the forest, and as its value rises, there will be a greater demand for foresters.

And I believe that scientific achievements, such as those that are occurring, and will occur, at this Experiment Station, will yield disease-resistant trees.

But for now, there are some specific things that we can do to begin placing Connecticut at the forefront of forestry.

We can call upon Congress to do a better job of regulating interstate commerce. Many of the 10,000 rhododendrons shipped to Connecticut last year, from an Oregon nursery, may have been infected with Sudden Oak Death. The prospect of Sudden Oak Death arriving in Connecticut through infected shipments is not only bad for our forests, it is bad for commerce. These infected plants were shipped not only to Connecticut, but to some 39 other states as well, despite quarantine. That kind of quarantine is no protection. No individual state can regulate interstate commerce, but the United States Congress can. We can recommend a bar code labeling system to more quickly track down infected shipments. I also thank Senator Lieberman and his staff for their attention to this issue.

We can continue the good work being done by the Invasive Plant Council. All of the Council's work is available on its website, but here is a brief, incomplete accounting of the initial results of the Council's work: Banned: common barberry, leafy spurge, mile-a-minute vine, giant hogweed, hairy jointgrass, and more.

And as of October 1 of this year, this will be the result: banned: purple loosestrife, parrotfeather, dwarf honeysuckle, goutweed and more.

I must say, though, that invasive plants care nothing for bans, they ignore them completely, they pay utterly no heed to laws passed by the General Assembly. And we can call them all the terrible names we want – spurge, strife, hogweed, goutweed, varmints – they don't care a bit. We should, therefore, encourage the Council to develop control and eradication methods for these scourges.

We can encourage foresters to educate the public about their work. Connecticut foresters, actually, are doing a good job of this. Perhaps the fact that we live so closely together makes for better communication. This schism is not as deep in Connecticut as elsewhere; we have not had the controversies that have engulfed other states.

We can encourage foresters, and their employers, to recognize that forestry is far broader than just timber sales and inventory. If a trail is to be established in the forest, that is the forester's domain. If warbler habitat is the goal, if scenic vistas are the goal, those, too, are the work of the forester.

If there is an endangered plant in the forest, it is the forester's duty – and privilege – to care for that plant. Truly,

what an honor - what an honor - that is: to be charged with the care and nursing of a species that teeters on the brink of extinction.

We can move ahead with the Connecticut Forest Resources Plan, and urge the new Connecticut Forestlands Committee onward. This Plan and this Committee will do much to address these threats as they face Connecticut. If you would like to read the plan, or join a subcommittee, or attend a meeting, call the Connecticut Forest and Park Association and we will help you.

The Committee can also review our state's open space goal of 21%, read the *Wildlands and Woodlands* document prepared for the forests of Massachusetts, and see if our goal ought to be adjusted.

We can bolster the staff of the Department of Environmental Protection Division of Forestry.

We can move ahead - carefully - with third party certification of forest practices. Certification is worthwhile, but I am concerned that it is too expensive for the average landowner and that the chain of custody for forest products must be certified as well. I fear that the costs of certification will shift the industry to only the largest of forest landowners and the largest of lumber companies. I believe that the American Tree Farm system is a good, model, certification program for small landowners, it has worked for 50 years, and it has recently been improved.

We can encourage our federal elected officials to think carefully about implementing the Roadless Rule for our National Forests. I do not believe that just because an area is roadless now, it should therefore remain so forever. It is important to have wilderness areas on our public lands, and it is also important to have reserves, that are not managed now, but can be in the future.

We can work with towns, and regional planning agencies, to improve town zoning. We should promote village centers, promote open space set asides, and discourage excessively large lots that waste land.

We can ensure that towns comply with Public Act 490. Some towns do not. They are adding a building lot valuation onto the assessment of land that is classified as forest land. This defeats the purpose of the law, which is to forestall development by lowering the tax burden on the farm and forest landowner.

The State Nursery. If we are to be a leader in forestry, we need our State Nursery. I believe that the State Nursery will be an ideal place to rear the blight-resistant American chestnuts that I believe the Experiment Station will soon develop.

We can expand the Blue-Blazed Hiking Trail System. Trails are the connection to the land for people that have no land. There was once a time when you could walk down your front stoop in New Haven, walk down Whalley Avenue to West Rock, get onto the Regicides Trail, hike to the Appalachian Trail at Mohawk Mountain, and from there, hike to Maine, or Georgia. That's remarkable. I want to renew this connection and expand the system.

We can encourage the prosperity of our cities. I agree with State Forester Don Smith, who wrote in *Connecticut Woodlands* that the best way to help our forests is to help our cities. Thriving cities, like New Haven, attract people who might otherwise settle in the forest. And thriving cities need thriving watershed forests.

And we can save the land.

We can employ every means, every private and public land conservation program, to set aside land for conservation.

If we do these things, we *can* place Connecticut at the forefront of forestry, we can share the lessons we learn, and we can serve our nation in meeting the challenge of these four threats.

And yet, even if we do these things, that will be insufficient. That will still leave us divided.

The greatest thing we can do, the *greatest thing*, is to cross that continental divide.

To cross it, we must recognize that this divide, between aesthetics and utility, is absolutely fundamental. This dual nature is the natural state of things. It is day and night, male and female, north pole and south, full moon and new, photosynthesis and respiration, life and death.

To accomplish this, we must strive to better connect our society with the land, and the sea. In this world of air-conditioning and modern technology, we must make a *point* to make this connection. We must make a *point* to see the sunset, or take a walk, or pick apples.

The divide is a conundrum. Thoreau and Muir write of the value of nature and wildness, and their eloquence is printed on the fibers of millions of spruces. The forester takes up forestry because he cherishes the woods, and his timber sales level the very forests he loves.

It would be a grievous error, to turn all of the American forest, private or public, into a nature preserve, and to get all the water, the wood, the fiber and all that the forest provides, from elsewhere.

It would be an equally grievous error, to tap the forest for all the resources it can produce. Should we quarry Half Dome for its granite? Should we tap Old Faithful for its geothermal power? Should we have felled the Charter Oak for its lumber?

For that matter, should we quarry Sleeping Giant for its trap rock? Clearly, Connecticut has answered: no.

And for that matter, should we have dammed, and flooded, the Hetch Hetchy Valley in Yosemite?

Should we?

The flooding of this great valley, the sister of the Yosemite Valley, is the source of this schism. I believe that it is worth considering whether the dam ought to be removed. This is a weighty, serious matter – the water and power needs of San Francisco, the sanctity of a National Park – and it is already being studied. Perhaps it should remain: its value is too great, its removal costs are too high. But perhaps it should not. I must say, the symbolism of a receding flood, of healing waters, of rebirth – is quite powerful.

To truly be in the forefront of forestry, we must be in the forefront of conservation. We must recognize that we must provide sustenance, but also preserve beauty.

Conservation is the balance of both sides of this divide. They are *both* right, they are *both* good.

"Beauty, as well as bread," wrote John Muir.

"Conservation means development as much as it does protection," wrote Theodore Roosevelt.

We should realize that such a divide is within each and every one of us. And we should realize that we Americans are really not as divided - as partisans on either side, or as those who would exploit a schism – would have us believe. We, as citizen-conservationists, must cross this continental divide, by recognizing, and communicating, the value of both sides of conservation. We must connect our society to the land and to the sea. In doing so, we will lead, once again, the great American conservation movement.

This morning, the first rays of the rising sun shone on the spruces on Cadillac Mountain in Acadia National Park. It shone on the Pilgrim Monument, and the cedars of Cape Cod. The sun shone on the pitch pines on Martha's Vineyard. It shone on mountain laurel in Union, on sugar maple in Durham, on Middlefield apples, on Sleeping Giant oaks, on Lockwood Farm chestnuts, on American elms in New Haven, on Christmas trees in Shelton, on 400 year-old hemlocks in Norfolk.

The sun rose higher, and shone upon Tidal Basin cherries and cypress swamps in Georgia. It shone on Indiana walnut and Mississippi cottonwood. It shines on an Arkansas ivory-billed woodpecker -on a pair of ivory-billed woodpeckers!

It shines on great, open plains, on Rocky Mountain aspen, and on the lodgepole pines of Yellowstone.

It shines on canyon juniper, on Sierra sequoias, and bristlecone pine thousands of years old. It shines on California redwoods and Cascade range Douglas-Fir .

It shines on Alaskan Sitka spruce, on the snow-capped peak of Mount McKinley, and on the Bering strait, where the first Americans crossed onto this continent, more than ten thousand years ago, and where in midsummer the sun will *never* set!

This is what those first Americans left to us. May the sun illuminate us, as we think of forestry, and conservation, and generations ten thousand years hence, on this farm, on this eastern edge, of this great, great land.

Mr. Adam R. Moore has been the Executive Director and Secretary-Forester of the Connecticut Forest & Park Association since 2001. He was awarded a Bachelor of Arts in Biology from Yale College and, as a Charles Wilson Scholar, also received a Master of Forestry from Yale School of Forestry and Environmental Studies. Prior to his position with CFPA, Adam worked as a land superintendent for Martha's Vineyard Land Bank Commission (Edgertown MA), as a forester and business manager for Connwood Foresters, Inc. (Rockfall, CT), and as a forest management crewmember for Yale Forests (Eastford, CT).

Role of Nectria-cankered Birch in the Future of Connecticut's Forests

By Dr. Francis J. Ferrandino[1], Dr. Jeffrey S. Ward[2], and Dr. Sandra L. Anagnostakis[1], *[1]Department of Plant Pathology and Ecology, [2]Head, Department of Forestry and Horticulture, The Connecticut Agricultural Experiment Station.*

The history of Connecticut's forest in the past 300 years is marked by responses to major disturbances. When European settlers first came to our state, they cleared the land to farm the soil. By the middle 1800's, only 30% of the original forest remained, and this forest remnant was repeatedly harvested for lumber, charcoal, and firewood. In the latter part of the 19th century, as less rocky, more arable land became available in the midwest, Connecticut's farms were abandoned one-by-one. By 1914, approximately 50% of the state had returned to forest. This trend of increasing forest cover had continued until the recent past, and now fully 60% of Connecticut is forested.

One quarter of the trees of the resurgent early 20th century hardwood forest was the fast growing American chestnut along with a mixture of oak, maple, birch, and minor species. In 1907, an exotic plant disease, Chestnut Blight, was introduced from eastern Asia. This pathogen girdles the trees and kills the above ground portions of the plant. By the early 1920's, the formerly dominant American chestnut was reduced to an understory shrub. Over a period of less than a decade, one-quarter of the canopy trees in the forest was removed. The forest rebounded from this disturbance - oak became the dominant tree with maple and birch filling in most of the gaps. In September of 1938, a major hurricane tracked across the center of Connecticut dropping 9 – 17 inches of rain, followed by winds in excess of 100 miles per hour. Twenty percent of the largest trees in the state were uprooted or broken. The removal of large canopy trees resulted in a flush of new growth.

During the next two decades (1940-1960) there was no major disturbance to Connecticut's forest. During this period, the forest matured and the intense competition for sunlight, water, and nutrients resulted in a natural thinning of the trees. However, in the past 40 years, there have been three major factors affecting Connecticut's forests:

1. The forest has come under increasing deer browse pressure as the total estimated deer population in Connecticut rose from 7,500 in 1963 to at least 75,000 in 2003.

2. Gypsy moth caused three major defoliation episodes (1961-64, 1973-74, and 1981-83) which drastically increased the mortality of oak.

3. A scale insect scale wiped out entire plantations of red pine (1976).

All of these factors favored black birch as an increasingly important forest tree and, indirectly, contribute to the spread of a disfiguring canker disease of black birch called Nectria canker.

Black Birch

Black birch, also called "sweet birch", "cherry birch", or "mahogany birch" is a major constituent of Connecticut forests. The wood is also unique. When exposed to air it darkens to a color resembling mahogany and, in times past, was used as an inexpensive substitute for the more valued tropical wood. The leaves and bark of the tree contain an aromatic oil (Methyl Salicylate) which makes them unpalatable to deer. This oil, chemically indistinguishable from Oil of Wintergreen, protects young birch seedlings from deer browse damage in the winter months and renders the foliage of this tree unpalatable to gypsy moth caterpillars. The tree reseeds prolifically and tends to dominate recently cleared forest sites. Seed production begins when trees are about 40 years old and large seed crops are produced every 1 or 2 years.

Due to the prolific reseeding properties of black birch and its inherent resistance to deer browsing and insect herbivory, this tree species has taken advantage of the changing forest conditions in recent times to increase its numbers. Consequently, there was an 18% increase in the number of birch trees in Connecticut greater than five inches in diameter between 1985 and 1998. During this same time period, the number of oak stems in the same category decreased by 22%, and the number of maple trees remained fairly constant. Thus, black birch trees are an increasingly important component of the Connecticut forest.

Nectria Canker

Increased populations of young black birch seedlings creates conditions that are conducive to the spread of Nectria canker. The first person in the United States to report Nectria canker on black birch (*Betula lenta*) was G. P. Clinton of The Connecticut Agricultural Experiment Station. He found cankered birch trees in New Haven in 1906 and called the disease "European Canker", since it had previously been reported only in Europe. Currently the disease is widespread throughout Connecticut, however, the severity of disease is highly variable among forest sites.

Nectria canker causes defects along the trunk effectively rendering the lumber valueless for anything but firewood. The disease is caused by a fungus closely related to *Nectria galligena* which causes apple twig blight. We have shown that the fungus can be isolated by inserting slivers of

infected wood into 'Granny Smith' apples. The fruit acidicity stifles the growth of bacterial contaminants. Presently, the taxonomy and population structure of this fungus is being studied by Dr. Robert Marra, a Station scientist.

The spores of this fungus become airborne and then are washed into open wounds in the bark during, or immediately, following rain. Wounds may be caused by burrowing insects, frost cracks, damage due to crossed branches or climbing vines, cracking, or the death of a side branch. Once the outer bark is breached, the fungus spreads in the cambium killing the living tissue underneath the bark. The outer covering of bark remains intact for a number of years. During this period, the only outward sign of infection is the flattening of the tree on the canker side where little or no new wood or bark is produced. The dead bark eventually sloughs off leaving an open-faced canker (Figure 1). In response, during the summer months, the tree produces profuse amounts of callous tissue (Figure 1: right panel) in an attempt to wall off the fungus. If a tree is less than 7 years old, slow-growing, or weak, then the fungus has the advantage and the tree is quickly girdled and dies. However, healthy fast-growing trees can often wall off the invader with callous tissue and attempt to close over the canker (Figure 1: right panel). When the canker is two or three years old, the fungus produces small red fruiting bodies, called perithecia, which form around the perimeter of the canker. These perithecia are produced continuously throughout the year except in mid-summer (July and August). Inside these perithecia are hundreds of spore-containing tubes called asci. When mature and moistened by rain or dew, these tubes swell and the enclosed ascospores are shot out into the air. The spores are then carried by wind, rain, or insects to a wound in the tree bark and a new canker develops.

Studies in Pennsylvania have shown that more than half of the Nectria cankers on black birch were initiated when the host tree was between 7 and 14 years of age and fully 95% of the cankers began on wood less than 20 years old. Young birch trees have very thin bark that is easily damaged. A fingernail can scratch the bark of a sapling and draw sap. However, by the time trees are 20 years-old and about 4-5 in. in diameter, the bark thickens and becomes resistant to infection. Nectria canker is caused by a well-evolved pathogen and does not usually kill its host. Nectria canker is analagous to a childhood disease, like chicken-pox. Most people are infected as children and carry the scars left behind the rest of their lives. Most Nectria cankers on birch are established when the tree is young but the cankered tree remains alive for many decades. The only difference is that Nectria cankers continue to produce infectious spores as long as the tree is alive. When the tree dies, our research has shown that the production of perithecia increases 8-fold over a period of two years. Therefore, simply cutting down infected trees is not an effective control unless the logs and infected branches are removed from the forest.

Black birch stand density and age distribution determine the epidemic

A sporulating canker on a birch is most likely to infect nearby susceptible trees. Thus, the density of young black birch trees in the forest is a very important factor governing the spread of this disease. In studying the history of the Connecticut forests we are fortunate that Henry W. Hicock and others from The Connecticut Agricultural Experiment Station had the wisdom and foresight to establish the Old-Series forest research plots in 1926. Three of the plots are located in the Meshomasic State Forest near Portland, CT. These unmanaged plots have been protected to the present time and represent one of the oldest and largest long-term forest experiments in the eastern hardwood forest. The tracts were first inventoried in 1926-27 and every decade thereafter (with the exception of 1947). During the 1997 assay of these plots, the incidence of Nectria canker on black birch (*B. lenta)* was recorded. Out of a sample of 2357 trees, only 141 (~6%) were cankered; 113 of these were greater than 60 years old. In fact, there was a great disparity between incidence of disease on old trees (22.7%) and young trees (1.5%) (Figure 2: filled). When we looked at the location of infected trees within the plot, we found that infection occurs in clumps of birch trees on the order of 100 ft across. We think that this is the length over which the pathogen can easily be spread. Therefore, susceptible (young) trees within 100 ft of an infected tree are likely to become infected. In an old undisturbed plot, such as the Old-Series plots, above, different species of trees of all ages are mixed. This spreads out the susceptible trees, and may explain why there was so little disease observed on younger trees in the Old-Series plots. You may ask - how did the older trees get infected? These older trees grew up in a very different forest.

Unfortunately, Nectria canker was not evaluated in the Old-Series plots when they were established. However, a 1934 survey of tree diseases in Connecticut forests conducted by Station scientists R. Kienholz and C. B. Bidwell indicated that more than 21% of 2400 black birch trees were cankered in Meshomasic State Forest, the same forest where the Old-Series plots are located. At this time the forest was young, the density of trees was much higher and the mean distance between susceptible black birch trees was less than 100 ft. So disease was high in all age categories (Figure 2: open).

To further test this idea that tree density has a strong influence on the level of Nectria canker, six younger stands with a high proportion of black birch were assayed for canker in 1997. Nectria should flourish in stands in which trees susceptible to nectria infection are in close proximity. Indeed, the incidence of cankers on these young plots ranged from 6%-18% (Figure 2: hatched), much higher than on trees of the same age growing in an unmanaged forest (Figure 2: filled < 60y).

What does all this mean for the future?

In epidemiology, the rapid spread of a disease among young susceptible hosts has a name. It is called the "Kindergarten Effect." Many people of all ages carry the scars left by chicken-pox which they contracted in kindergarten. In the same way, the birch trees of the forest carry the rememberances of the crowded forest of their youth in the form of Nectria cankers. Today the pressures of deer browse and past gypsy moth defoliation, as well as other disturbances, are increasing the density of young birch trees. This suggests a return of Nectria canker to epidemic proportions in some of our future forests.

Further Reading

Alerich, C. L. 2000. Forest Statistics for Connecticut: 1985 and 1998. U.S. Department of Agriculture Forest Service, Resource Bulletin NE-147, Newtown Square, PA.

Anagnostakis, S. L., and F. J. Ferrandino. 1998. Isolation of Nectria galligena from cankers on sweet birch. Plant Disease 82: 440-441.

Brinkman, Kenneth A. 1974. *Betula* L. Birch. In Seeds of woody plants in the United States. p. 252-257. C. S. Schopmeyer, tech. coord. U.S. Department of Agriculture, Agriculture Handbook 450. Washington, DC

Graves, A.H. 1919. Some diseases of trees in greater New York. *Mycologia* 11:111-124.

Hicock, H. W., M. F. Morgan, H. J. Lutz, H. Bull, and H. A. Lunt. 1931. The relation of forest composition and rate of growth to certain soil characteristics. The Conn. Agr. Expt. Sta., New Haven. Bull. 330. 73pp.

Kienholz, R., and C.B. Bidwell. 1938. A survey of diseases and defects in Connecticut forests. Ct. Agr. Expt. Sta. Bull. 412, 559pp.

Merrill, W., and R. J. Finley. 1981. Relationship of

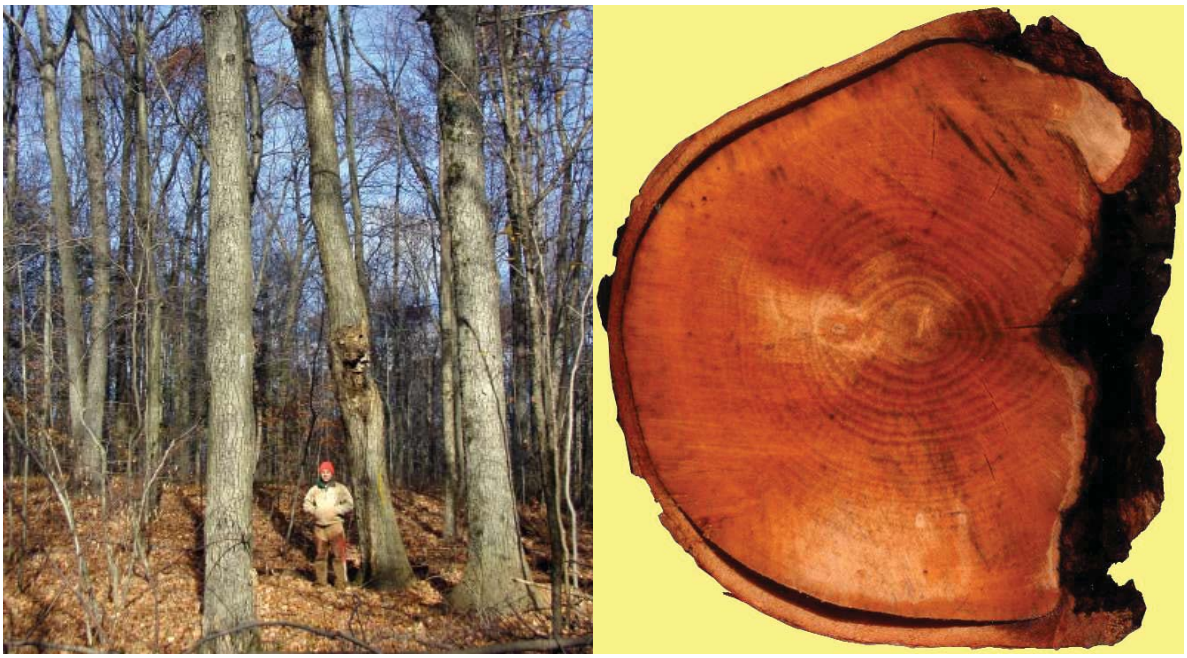

Figure 1. Left Panel: Nectria canker on black birch in the forest. Right Panel: Cross-section of cankered area.

stem tissue age to frequency of *Nectria galligena* canker of hardwoods, *Betula lenta*, *Betula papyrifera*, *Sassafras albidum*, *Juglans nigra*. Plant Dis. 65:66-67.

Dr. Francis J. Ferrandino was born in Brooklyn, New York and attended Elmira College in western New York, where he received Bachelor degrees in Mathematics and Physics (summa cum laude) in the spring of 1973. He completed his Masters and Doctoral degrees in Astrophysics in 1980 at the Rensselaer Polytechnic Institute in Troy, NY, where he taught as an Physics lecturer until the spring of 1981. Frank has been a visiting Assistant Professor of Astronomy at Williams College, Williamstown, MA (1981) and an Assistant Professor of Physics at the University of New Haven, West Haven, CT (1981-1982). He was hired as a fluid dynamicist in the summer of 1982 to study the spread of pollutants in Connecticut's rivers and the dispersal of airborne pathogens in farmer's fields.

Frank's research interests include: aerial dispersal of fungal spores, spatial and temporal epidemic models, yield loss prediction, stochastic simulation of dispersion processes, sorption-desorption processes, movement of pollutants in soil, powdery mildew on cucurbits, and septoria on tomato. He is, presently, an Associate Scientist in the Department of Plant Pathology and Ecology.

Dr. Jeffrey S. Ward was raised in Milan, Ohio, the birthplace of Thomas A. Edison. He received his BS (forest biology) and MS (silviculture) at The Ohio State University, and his PhD (forest ecology) at Purdue University. Both his PhD dissertation and early research at the Station focused on long-term population dynamics of woody plants in unmanaged forests. Both studies were begun in 1926 and have continued through the present. His work has shown that disturbances such as fire, affect the composition of our forests for at least sixty years.

His more recent work has examined alternative forest management practices, use of prescribed fire to maintain oak, methods of reducing deer damage in forest plantations, and controlling invasive species such as barberry. He is the Chief Scientist of the Department of Forestry and Horticulture.

Dr. Sandra L. Anagnostakis was born in Coffeyville, Kansas and attended college at the University of California at Riverside, where she received a Bachelor's degree in the spring of 1961. In graduate study at the University of Texas at Austin, she worked with C. J. Alexopoulos in mycology. After receiving a Master's degree in Botany, she joined the staff of The Connecticut Agricultural Experiment Station in the Department of Genetics (1966). She completed her Doctor of Agronomy degree at Justus-Liebig University in Giessen, West Germany in 1985, working with Professor J. Kranz.

Sandra has worked on the genetics of various fungi, including those that cause corn smut disease and Dutch elm disease. She has been working on chestnut blight disease (caused by *Cryphonectria parasitica*) since 1968. After completing basic studies with the fungus, she imported Hypovirulent (virus containing) strains from France (1972) and demonstrated that they could be used in the U.S. for biological control of the disease. She has worked on the ecology of the blight fungus and its control by hypovirulence, and studies of virulence in the fungus and resistance in the trees. She continues the Experiment Station project on chestnut tree breeding experiments to produce better timber and orchard trees. Current work has expanded to include canker diseases of butternut trees in Connecticut.

She is an Agricultural Scientist in the Department of Plant Pathology and Ecology.

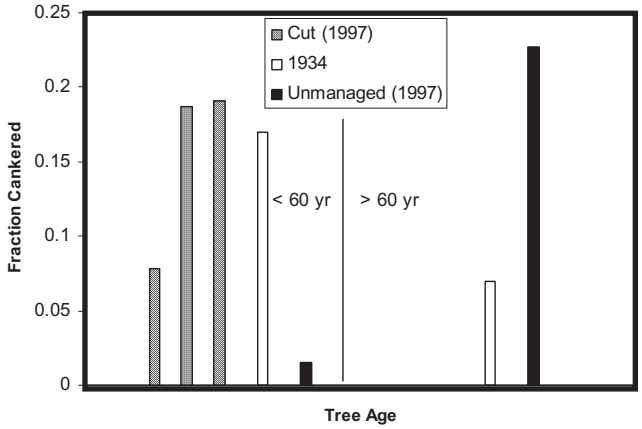

Figure 2. Nectria Canker incidence for trees older or younger than 60 years old for Keinholz and Bidwell's 1934 survey (open), the 1997 survey made in the unmanaged plots (filled), and 1997 clearcut measurements (hatched).

Alternative Forest Management Practices In Connecticut: The Good, The Bad, and the Ugly

By Dr. Jeffrey S. Ward
Department of Forestry and Horticulture, The Connecticut Agricultural Experiment Station.

Background

Sixty percent of the Nutmeg state is forested with a quilt of oaks and pines, maples and birches, and hemlocks and ashes. These forests filter drinking water, support diverse wildlife habitats, provide outdoor recreation opportunities, and supply wood for a vibrant forest products industry. Responsible stewardship of our forest by this generation will provide future generations with healthy, sustainable forests.

Three factors require development of innovative methods of forest management: increased parcelization of ownership (i.e., smaller forest ownerships), increased resistance to clearcutting, and obtaining a more diverse age-structure. This is not to say that woodlots and forests need active management. However, forest preserves are not dioramas. Change happens. Unmanaged forest preserves will gradually become dominated by late successional species such as sugar maple, birch, and beech as the larger oaks grow old, senesce, and die.

Family and farm woodlots account for most of the Connecticut forest. Most of the holdings are managed for privacy, wildlife, and recreation (non-commodity amenities), rather than timber production. Forest ownership incurs expenses including real estate taxes and insurance. Owners may be open to forest management practices that provide income while retaining the non-commodity amenities. Many woodlot owners will not accept the heavy cutting required to regenerate sun-demanding species such as oak and aspen, at least not on a large portion of their forest at one time. Some of the alternative forest practices that extend the period of intact high forest canopy while maintaining forest health will be discussed in **The Good**.

Public sentiment is often opposed to forest harvesting, especially clearcutting, on public lands. Thus, more stands are being managed through partial cuts over longer rotations. All too often, partial cuttings on private lands are high-grading operations in the guise of "selective" harvesting. The justification given for removing the largest diameter trees is that they have low growth rates and are unable to respond to release. The very real negative consequences of these practices to long-term forest health will be discussed in **The Bad**.

Most of our forests were established around 1900. There are very few old stands and increasingly fewer young stands that provide early successional habitat. The unbalanced age class distribution the Connecticut forest presents a challenge to both private and public forest landowners wishing to implement sustainable forest management with a wide range of age classes. A wide range of age classes (i.e., balanced age distribution) creates a diversity of habitats, which in turn supports a diversity of wildlife species. The short and long-term benefits of clearcutting will be discussed in **The Ugly**.

The good – The majestic presence of large trees is essential for many woodlot owners and for visitors to state forests. However, retaining mature trees increases the difficulty of regenerating some species, such as oak and pine that need abundant sunlight to develop. Our research has shown that crop-tree management (explained below) and shelterwood management (Figure 1) can extend the period when forests have large trees while maintaining forest health.

Figure 1. The Shelterwood System can increase oak regeneration.

Crop tree management focuses on improving growth individual trees to improve the stand, while more traditional thinning focuses on improving overall stand growth. Crop-tree management is similar to weeding in a garden. Weeding increases growth of flowers and vegetables by releasing moisture, nutrients, and light that had been utilized by weeds. Similarly, crop-tree management increases growth of selected trees by releasing moisture, nutrients, and light that had been utilized by less desirable trees. Crop-tree management differs from conventional thinning in two ways: fewer trees are usually removed, particularly in younger stands, and selected crop-trees are more thoroughly released.

Implementation of crop-tree management is straightforward and begins with a determination of the landowner's goals (esthetics, timber, wildlife) for the woodlot. Crop-trees are selected that best match the landowner's goals and competing trees are marked for cutting. Crop-tree release is riskier than traditional management because effort is concentrated on relatively few stems. Therefore, care should be taken in selecting healthy, high quality trees.

We found that over a 10-year period, crop-tree release increased diameter growth of sawtimber ($\geq$ 11 inch diameter) red oak by 42%. There is no sign that this growth increase is slowing. Formation of new defects on the valuable butt-log was largely limited to the slowest growing trees. Black birch also responds well to crop-tree release. After eight years, diameter and volume growth of crop-trees (10.6-13.5 inches diameter) was nearly forty percent greater than for unreleased trees. We are currently studying the possibility of crop-tree release of oaks with diameters larger than 20 inches and multi-aged crop tree release.

Another system that extends the period for large trees

is the shelterwood method. Shelterwood management regenerates a new forest under the shelter of older trees. Mimicking the results of a severe ground fire, in which only the healthiest dominant trees survive, the best growing, most desirable trees in the stand are left during the initial harvests. The resulting stand resembles an open park with a canopy of large well-spaced trees over a tableau of new regeneration and wildflowers. The residual overstory left after the early removal stage(s) provides the seed source and cover for the regenerating forest, which, though becoming established over a number of years, will essentially be another even-aged forest. All or part of the residual overstory is removed later to provide full sunlight for the now established seedlings and saplings.

Although the purpose of a shelterwood is to initiate regeneration, our research indicates that stand volume growth (i.e., the amount of new wood) following the initial shelterwood harvest was similar to unmanaged and thinned stands – slightly more than 200 board-feet/acre/year. Because this growth was concentrated on fewer trees, and because the lower quality trees were removed, the average grade of residual trees increased over time on the shelterwood plots. Interesting shrubs such as beaked hazelnut and sheep laurel thrive in shelterwood cuts, as do indigo buntings, red-tailed hawks, and white-tailed deer.

Figure 2. High-grading can damage a stand for decades.

The bad – All too often a high-grade harvest is disguised as a "selection" harvest where the most profitable trees are removed with little, or no consideration given for future generations (Figure 2). Both high-grade cutting and the closely related diameter limit cutting practice have negative long-term impacts on the landowner's pocketbook and on forest health. These practices may appear to be the most ecologically sound method of forest management – cutting the largest trees to release smaller, younger trees. Landowners are mistakenly persuaded that the largest trees are overmature and should be harvested before they die. However, our studies have followed growth and survival of trees since 1926. We found that large trees with healthy crowns will survive for decades and may survive for centuries. If the stand is thinned by removing the smaller, poorly-growing trees and trees with defects, then, as mentioned above, diameter growth of the remaining trees can be increased by forty percent or more.

Our studies revealed that several problems arise when high-grading or diameter limit practices are executed in a woodlot. First, to achieve economically viable harvests, it was necessary to lower the diameter limits for the second cutting cycle. This was because there were fewer and fewer large trees on these plots. Second, both practices reduced stand growth rates by altering the species composition. Slower growing red maple and shrubby species became more dominant. The replacement of oak with maple has a deleterious effect on wildlife species (turkey, deer, squirrels) that depend on acorns to fatten up before the arrival of our cold New England winters. Lastly, we found high-grading and diameter-limit practices reduced the quality of the remaining trees. Many of the trees had rot or poorly formed stems that made them susceptible to wind, ice, and snow damage.

In a word – beware! Responsible stewards of the land will shun the short-term profit of high-grading and diameter-limit cutting and favor management practices that encourage the long-term health of the forest. We should manage our woodlots and forests for sustainability to ensure that future generations will enjoy the same benefits of a healthy and diverse forest that we enjoy today. High-grading and diameter-limit cutting are not sustainable practices in southern New England oak forests.

The ugly – It comes as a surprise to some people that silvicultural clearcutting, when properly planned and executed, is an indispensable and legitimate method to enhance regeneration (Figure 3). Silvicultural clearcutting removes all stems with diameters greater than two inches. Removing trees that are the most valuable or trees larger than a certain size, and leaving the others behind, is not a silvicultural clearcut. Rather, this is a commercial clearcut (aka, diameter-limit) with all of the potentially negative impacts described above.

A clearcut mimics the conditions found following a catastrophic windstorm or fire. There are certain species of trees that are only successful when growing in full sunlight conditions created by clearing of all competing vegetation. This group of species includes tulip poplar, aspen, paper birch, most oaks, eastern red cedar, butternut, and others. Eastern bluebirds, ruffed grouse, eastern cottontails, and other wildlife species thrive on the shrubby stands created by clearcutting. The abundant insects, berries, and grass seeds found in clearcuts are a valuable food source for songbirds during both the nesting season and the fall migration. Without clearcutting, or final overstory removal following a shelterwood, these species will gradually decline and become rare in much of our region. Indeed, the Connecticut Department of Environmental Protection and others have recognized that the early successional habitat created by clearcutting is one of Connecticut's "imperiled communities."

Our research has found that clearcutting often results in young stands that include oak among the larger stems. More recent studies have shown that prescribed burning, when used in conjunction with clearcutting, can further increase the proportion of oak, as well as the proportion of hickory, sassafras, and aspen that will be the forest as it matures.

Future work – Starting in the early 1900's with the first studies of chestnut management and reforestation and through gypsy moth control in the 1960's, The Connecticut Agricultural Experiment Station has developed practical solutions for sustainable forest management. Our research on innovative alternative management practices will provide additional tools for maintaining forest health and diversity. In addition to the research noted above, we are currently investigating the impacts of and potential solutions for alien insects, diseases, invasive weeds, and browsing deer. This year, a new study was initiated to examine the composition

Figure 3. Clear cutting benefits sun loving species like aspen and cherry.

and health of trees within urban communities to assist local managers on the fastest growing component of our landscape – the urban forest.

Dr. Jeffrey S. Ward was raised in Milan, Ohio, the birthplace of Thomas A. Edison. He received his BS (forest biology) and MS (silviculture) at The Ohio State University, and his PhD (forest ecology) at Purdue University. Both his PhD dissertation and early research at the Station focused on long-term population dynamics of woody plants in unmanaged forests. Both studies were begun in 1926 and have continued through the present. His work has shown that disturbances such as fire, affect the composition of our forests for at least sixty years.

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FURTHER READING

Ward, J.S., S.L. Anagnostakis, and F.J. Ferrandino. 1999. Seventy years of stand dynamics in Connecticut hardwood forests - the Old-Series plots (1927-1997). The Connecticut Experiment Station Bulletin 959 68p.

Ward, J.S., P.H. Brose. 2004. Mortality, survival, and growth of individual stems after prescribed burning in recent hardwood clearcuts. P.193-199 *In* Proceedings 14th Central Hardwood Conference. USDA Forest Service General Technical Bulletin NE-316.

Ward, J.S, G.R. Stephens, F.J. Ferrandino. 2005. Influence of cutting methods on residual stand growth in sawtimber oak stands. Northern Journal of Applied Forestry 22(1): 59-67.

Ward, J.S., and G.R. Stephens. 1999. Influence of cutting methods on 12-year-old hardwood regeneration. P. 204-208. *in* 12th Central Hardwood Forest Conference. USDA Forest Service General Technical Report, Southern Research Station General Technical Report SRS-24.

Ward, J.S., and G.R. Stephens. 1993. Influence of crown class and shade tolerance on individual tree development during deciduous forest succession in Connecticut, USA. Forest Ecology and Management 60: 207-236.

Ward, J.S., T.E. Worthley, J.P. Smallidge, K. Bennett. 2006. Northeastern Forest Regeneration Handbook. USDA Forest Service, Northeastern Area State and Private Forestry. NA-TP-03-06. 59p.

Ward, J.S. 2007. Crop-tree release increase growth of black birch in southern New England. Northern Journal of Applied Forestry. (in press)

Ward, J.S. 2005. Stand dynamics in Connecticut forests: the New-Series plots (1959-2000). The Connecticut Agricultural Experiment Station Bulletin 995.35p.

Ward, J.S. 2002. Crop tree release increases growth of mature red oak sawtimber. Northern Journal of Applied Forestry 19(4): 149-154.

Ward, J.S. 1992. Response of woody regeneration to thinning mature upland oak stands in Connecticut, USA. Forest Ecology and Management. 49: 219-231.

Ward, J.S. 1991. Growth response of upland oak sawtimber stands to thinning in Connecticut. Northern Journal of Applied Forestry. 8: 104-107.

NOTES

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The Connecticut Agricultural
Experiment Station
Box 1106, New Haven, CT 06504-1106