Forests return to the Finger Lakes, then we lose some

Introduction

The forests of Central New York provide some of life's great pleasures, such as watching the greening of the North American continent after a long winter as spring advances from more southern latitudes. Or, six months later, experiencing the fiery forests as the trees breakdown the green-reflecting chlorophyll and withdraw it from their leaves, exposing the blazing red, orange and yellow carotenoid, anthocyanin and xanthophyll pigments for a few weeks until the leaves finally fall to litter the forest floor. The forests and woodlots of our region cycle through spectacular annual shows, but it wasn't always like this. About 15,000 years ago, most of Central New York, including the Finger Lakes Region, was buried under at least a mile of glacial ice. At our longitude, the farthest southward latitudinal advance of the so-called Wisconsin episode of the Laurentide glacial ice sheet extended across the New York State border into north central Pennsylvania. The north polar ice cap had been advancing, retreating, and advancing further and further southward for roughly 2.5 million years. Only a small area in southwestern New York, south of Salamanca in Cattaraugus Co. about 150 miles southwest of Ithaca, was spared from the maximum glacial advance. That area has a slightly higher elevation and represents the northernmost extent of the Alleghany upland. Thus, it was able to remain above the ice sheet. The relict forests there are now preserved as the Alleghany State Park.

But that was not the fate of forests in the Finger Lakes Region. Such forests as had developed, were scoured by the glaciers. If the advancing and retreating of the ice front was able to gouge the valleys of the Finger Lakes themselves down to 390 million year old bedrock, surely no plants survived. All the current plants have arrived in the past 15,000 years or so, since the final retreat of the glacial ice sheet. They came first as seeds borne on southerly winds and germinated in the mineral rich, but organically poor, glacial till soil. The heavier seeds were defecated by frugivorous birds and mammals exploring the edge of the newly exposed terrain. Subsequently, more plants came with the arrival of Paleoindian colonists, who travelled eastward across the North American continent from Eurasia, and their plants took root in the richer organic soil that had developed in the several millennia before their arrival in our area around 13,000 y.b.p. In the past four hundred years, northern European plants came from across the Atlantic with colonists, who also brought our "native" earthworms, which had been scoured away, if any had inhabited New York before the ice. Finally, most recently, plants from many other parts of the world have "escaped" from our gardens and yards to become "naturalized" in habitats more natural than the suburban landscape. This is especially true in Tompkins County. The cumulative result is that looking out now over the plateaus and valleys of the Finger Lakes Region, it is difficult to know how to define a plant as native or introduced. Native since when? Introduced by what agent? And from how far away?

Return of forests after the glacial retreat

Before providing a key for identification of the woody plants of forests in the Finger Lakes Region, we will dig in (literally) to what is known about reforestation of the land that was newly exposed by the retreat of the glaciers. How do we know the timing and sequence of forest development after the final glacial retreat ? No humans likely observed the early succession. If they did, there are no detailed oral or written histories of the first plants to take root in the newly accumulating soil. Thus, we need another source of information. The best information we have comes from carbon isotope dating of pollen contained in sediments dug from the bottom of lake beds, bogs, and swamps in our region.

As still happens today, during certain times in spring and fall copious amounts of pollen are borne on the wind and strewn across the landscape. I empathize with my friends who recognize this time of year with the weepy eyes and runny nose symptoms of "hay fever". That is not the plant's "intent". Evolutionarily, a plant intends for pollen, its male gametes, to land on a female flower of the same species and fertilize an egg there. But the wind is fickle and is ignorant of the plant's intention. Thus, plants whose pollen is moved by wind produce vast amounts of tiny, light-weight pollen, only a small percentage of which achieves fertilization. Some of the other grains stick to the webs of orb-weaving spiders, where they provide a critical source of nutrition for young spiders. But the bulk of pollen that is released simply blankets the landscape. Where it falls on standing water, such as a lake or pond or bog or swamp, it first tends to form a pale, yellowish mat on the surface because the pollen grains are hydrophobic, i.e., they do not get wet easily. But eventually they do, and then sink to the bottom of the body of water, spring after spring after spring after spring, forming layers in the sediment, called varves, at the bottom of the bog, etc., along with other organic matter that may comprise the sediment. As the millennia pass, the sediment accumulates and keeps a temporal record of what pollen was blowing in the wind at that location. If the body of water still exists today, modern palynologists (scientists who study pollen) can drill a core into the sediment and then identify the pollen grains in various layers to determine occurrence and abundance of the different species of pollen through time.

To put a date on some stratum in the core containing organic material, researchers use a technique called radiocarbon dating. At this point in our story, skipping two paragraphs ahead will not hurt your understanding of natural history, but in case you want to know how we know what we think we know about the age of pollen in the sediment cores, here is a very brief treatment of the radiocarbon dating method. Elemental atoms are composed of nuclei containing protons and neutrons surrounded by a cloud of electrons. The numbers of these units determine the properties of an atom of that element, e.g., its mass and elemental identity (determined by the number of protons), what other atoms it is likely to bond with, if any (determined by the arrangement of electrons), and whether it is stable or radioactive (determined by the number of neutrons). When the number of neutrons is the same as the number of protons, the atom is stable. Thus, common elemental carbon has six protons and six neutrons, for an atomic number of 12. We refer to this element as carbon 12 in speaking, although it is formally written as ^{12}C. Carbon, and many other elements, can have different numbers of neutrons in addition to their typical numbers of protons. Such variants are called isotopes. Some are stable, for instance about 1% of the carbon in the world has seven neutrons instead of six and is thus carbon 13. It is a stable isotope. However, when a carbon nucleus gains an eighth neutron, i.e., carbon 14 or ^{14}C, it becomes unstable and is radioactive. One of the neutrons emits a smaller packet of energy called a beta particle and that neutron becomes a proton in a process called radioactive decay. Thus, unstable carbon 14 with six protons and eight neutrons emits a beta particle from its nucleus transforming one of its neutrons into a proton, thus becoming a different element, nitrogen, with the seven remaining neutrons and seven protons for an atomic weight of 14. Like many properties of an atomic nucleus, the process of emitting a beta particle is probabilistic rather than deterministic. We cannot state for certain when an individual neutron in an atom of carbon 14 will emit a beta particle, but we can state that half the atoms in a sample of carbon 14 will have emitted their beta particles and transformed into stable nitrogen in 5730 years. That is called the half-life of this radioactive isotope of carbon. The radioactive isotopes of other elements have may have shorter or longer half-lives. The half-life of radon 222 that you may detect in your basement is about three days, whereas the half-life of radioactive uranium 238 decaying through a series of isotopes to stable lead 206 is 4.46 billion years. The half-life of potassium 40 decaying to argon 40 is about 1.39 billion years. Those long half-lives are in the range of the age of the Earth, 4.543 billion years, thus the uranium-lead and potassium-argon methods are more appropriate for dating older rocky aspects of Earth's history than is the ^{14}C/^{12}C method used for dating organic objects less than 50,000 years old.

Carbon 14 was created in the laboratory in 1940. Subsequently it was found in the atmosphere where it comprises about 0.0001 % of the carbon. It gets incorporated into carbon dioxide, CO_2, and taken in by plants. Animals have it too, and breathe it out. It is also part of the carbon that is in the bodies of all creatures. The atoms in our bodies continuously turn over and are replaced. Thus, the percent of carbon 14 in our bodies should be similar to what is present in the atmosphere. Until we die. Then we stop replacing the carbon atoms, and, obviously, the other elements as well. Carbon 12 and 13 are stable and they should remain in the same proportion in the tissues that are not attacked by decomposing organisms, e.g., teeth, bone, wood. But carbon 14 being an unstable isotope undergoes radioactive decay whether it is in a living organism or not. After 5730 years half of it will be gone, turned into nitrogen. After another 5730 years, half of the remaining amount will be gone, so only a quarter of the original amount is left. After 11,460 years. And so it continues until there is none of the original ^{14}C left. Thus, if we know the proportion of carbon 14 among the carbon isotopes comprising something organic that died, we can determine how long it has been undergoing radioactive decay by measuring the proportion that is left relative to the amount of carbon 12, which will not have changed. Thus, we can determine when a pollen grain was deposited, or how old a piece of mastodon bone might be, or when a tree was cut that was used to construct a support for a chamber in a Pharaoh's tomb. Shortly after the discovery of the carbon 14 isotope, Willard Libby at the University of Chicago developed the radiocarbon dating method in 1946, for which he received the Nobel Prize in Chemistry in 1960. The method is not very useful for samples older than about 50,000 years because too much of the original carbon 14 has decayed, but for dating much of human history this is the method of choice. The accuracy is contingent on knowing how much carbon 14 was present in the atmosphere at the time the organism died. Libby initially assumed that it had remained the same as it is now, but cautioned that such might not be the case. It was another 20 years until a calibration curve compared adjusted carbon 14 dates with precise dates from a series of annual growth rings in one of the three species of bristlecone pine trees, *Pinus aristata*, dating back to 4100 B.C.E. The calibration curve is continually being extended and refined, and the $^{14}C/^{12}C$ radiocarbon dating method is the workhorse method for archaeology and Pleistocene ecology.

Ok, now we're back from nuclear physics to natural history. Radiocarbon dating of pollen in the sediment cores sounds like it could answer our questions about the pace and composition of reforestation of the Finger Lakes Region after the retreat of the glaciers. It is currently the best source of information we have, but there are at least four caveats regarding how definitive this record can be for documenting the timing of the occurrence and abundance of a given plant species at the location of the sediment core.

First, pollen grains are not unambiguously identifiable to species, *per se*. They are often identifiable to family, and in many cases to the level of genus, based on size, shape, sculpturing, porosity, etc. Studies in which species identifications are definitively assigned, e.g., pollen from the legs of foraging honeybees, have typically compared the unknown pollen grain collected by the bee with a regional reference collection of possible identified pollen types in that genus. This is reasonable for present day unknown pollen, because we can know the identity of pollen from all flowers in the region. But with historical unknown samples from regions where the possible pool of pollens is also unknown, the determination of species is just a rough estimate.

The second caveat about data from pollen in the sediment cores is that even if we could associate each pollen grain with a specific plant species, our pollen record grossly underrepresents the flora of the Finger Lakes Region as a whole. Only about 10% of plant species send their tiny pollen, typically 17 – 80 μm in diameter, on the wind. Most plants, however, have coevolved with insects or other animals, such as bats or birds, to transport their larger pollen, typically 17 – 200 μm in diameter, specifically from one plant to another of the same species. Pollen of the common milkweed, *Asclepias syriaca* [Asclepiadaceae] is even bundled up into a pair of pollinia each about 1.5 mm long that clamp like saddle bags on to the legs of unsuspecting visitors to the flowers. Many of these flowering plants grow relatively low to the ground, so insects may be the only way to move their pollen very far. Having a relatively smart pollinator that can recognize a showy, smelly flower and take its pollen to the next flower of that species, especially if there is a rich nectar reward awaiting them, means that the plant can afford to produce much less pollen. Why waste gametes? Trees, on the other hand, have stature. Some are indeed majestic. The tallest trees currently in the Finger Lakes Region, are species of ash, hickory, pine, fir, oak, maple, etc., that are 30 – 45 meters (100' - 150') tall. From their crown heights such trees can simply shed their pollen onto the wind to float out over the landscape. Yes, in our temperate zone there are some trees that have showy flowers that attract insect pollinators, e.g., legumes [Fabaceae], such as Black Locust, *Robinia pseudoacacia*, and redbud, *Cercis canadensis*, and bignones [Bignoniaceae], such as *Catalpa speciosa* that is pollinated by large bumble and carpenter bees diurnally and by moths at night. Other insect pollinated trees are members of the soapberry family [Sapindaceae], such as horse chestnut, *Aesculus hippocastaneum*, which has spikes of white flowers with a yellow splotch around the entrance to the corolla that guides pollinators to the nectar. The splotch turns crimson after that flower has been pollinated and is no longer producing nectar. But most trees in the forests of the Finger Lakes Region produce inconspicuous flowers that have no scent to attract insects, and no nectar as a sweet reward. In spring, before they develop leaves that would block the wind, these trees simply release copious amounts of tiny pollen onto the wind, and it is primarily their pollen that lands in the sediment. Generally, with a few important exceptions discussed below, herbaceous flowering plants are poorly represented among the pollen in the sediment cores.

A third caveat about interpreting pollen data from sediment cores deals with the location of the core and the ability of pollen to travel on the wind. The pollen that lands on the water surface came from some distance away, upwind, but we have no idea how far it travelled. Wind can carry pollen for many kilometers, thus it likely originated farther upwind than simply the lake shore. The lake itself may not have been immediately surrounded by many of the plants whose pollen we find in the sediment core, at least not at the deepest, first occurrence of that pollen type. Thus, the cores are best thought of as regional samples, rather than specific location samples, even though they are extracted at a specific location.

The last caveat in the interpretation of sediment cores for the purpose of this essay is that the rate of sedimentation may not be uniform at any given site. Typically, researchers calculate a carbon 14 date from a layer near the bottom of the core and it is tempting to interpolate the age of shallower layers between that date and the present.

Uniform sedimentation rates, however, may not always be the case, but without the effort and expense of dating samples every few centimeters along the core, these samples still provide the best temporal estimates we have. And finally, some of the earliest sediment cores drilled in the Finger Lakes Region were drilled before the use of radiocarbon dating was widespread, let alone routinely affordable. Today, it costs about 250 $US to get a date on a sample. But in the early days, the method was technically challenging with relatively few labs set up and able to perform the analysis. Nevertheless, undated cores do record a stratigraphic sequence of pollen types that can be aligned with dated cores from other regional study sites.

So, being aware of the foregoing caveats, let's dig in to the pollen record to learn about reforestation of the Finger Lakes Region after the glaciers receded. Over the past 80 years, several score of sediment cores have been drilled at locations across New York at the latitude of the Finger Lakes, and in southern Canada just north of Lake Ontario (see the map). By comparing so-called pollen diagrams, we are able to get a rough picture of the timing of the return of some members of the forest community to the Finger Lakes Region, acknowledging that the edge of the glacial ice sheet may not have retreated uniformly like a window shade rolling up, but may have moved north (or advanced again south) in fits and starts at different rates in different locations across our region.

Our post-glacial discussion so far has focused on return of the forests of the Finger Lakes Region, but step back just a moment and think about how succession of plant communities progresses today. After glacial retreat, the bare rock surface needs to build up soil before any plants can take root. The lowest layers of pollen in the sediment cores typically have large amounts of pollen from grasses, Poaceae, and relatives of grasses with triangular stems, sedges, Cyperaceae. At first glance, these plants may look similar, but I learned in my first field botany course to feel the stem – "if it has an edge, it's a sedge". These herbaceous plants, although typically small of stature, principally shed their pollen on the wind. Grassland, prairie and steppe ecosystems are dominated by grass plants which have little difficulty passing pollen to conspecifics, thus wind pollination works for them. Many species of sedges are found in moist habitats, wet meadows, swamps, and margins of bodies of water. These conditions also ease the challenge of pollen landing on a conspecific female flower if it is released on the wind. As the glaciers melted in retreat, several large lakes formed earlier than the current Finger Lakes, as was discussed in a previous geology chapter. It is likely that their margins and exposed swamp land that had never been glaciated were populated by sedges and grasses. With that reminder about succession, let's examine a couple of cores.

Several sediment cores have been drilled across the Finger Lakes Region, but most were not radiocarbon dated or contain only a single date near the bottom of the core. One of the better dated sediment cores near the Finger Lakes comes from Belmont Bog (42.222º N, -78.0258º W) in Allegheny County to the west of the Finger Lakes. The lowest date in the core is 12,565 years before present (y.b.p.) at about 5m deep, but the core extends another 2m. Sedges make up about 50% of the pollen at the deepest layers, with grasses contributing another 10 -15%. Their abundance tapers off by the 12.5K y.b.p date at 5m deep. They disappear relatively quickly, in a geologic time frame, and are gone by the 10,945 y.b.p. date, indicating that the swampy, wet area was perhaps dried up and a *terra firma* woodland had been established in the western Finger Lakes Region by about 11K y.b.p. The other principal pollen types in the deepest layers come from conifers, such as spruce (*Picea* spp.) and pine (*Pinus* spp.). Today, black spruce (*Picea mariana*), white spruce (*Picea glauca*), and to a lesser extent, lodgepole pine (*Pinus contorta*) and jack pine (*Pinus banksiana*) are the dominant trees of the Canadian Boreal forest region, or taiga biome. All but lodgepole pine still occur in the Finger Lakes region, but they are not particularly common. Within these genera, it is difficult to differentiate species from pollen morphology. Nevertheless, it is probable that the dominance of spruce pollen until 10,945 y.b.p. and pine that peaked at 10,100 y.b.p. represented a wave of forest resembling today's boreal forest biome that simply followed the glacier front up the continent as the front receded poleward. Several types of forest communities occur in the Finger Lakes Region today, but our conifer forests are dominated by white pines (*Pinus stobus*) and hemlocks (*Tsuga canadensis*), both of which begin to show up in abundance in the sediment as spruce declines around 10,945 y.b.p. Most conifers are generally more cold tolerant than are deciduous trees. As the glacier continued to recede and local temperatures warmed, pollen of our dominant deciduous trees shows up in the sediment. Pollen from oak (*Quercus* spp.) and some other hardwoods is present in small, but detectable amounts at the lowest layers of the sediment. Remember caveat number three above, that the pollen in a sediment core arrived on the wind perhaps from many kilometers away, especially at the deepest, first instance in the core. Thus, it may not represent trees growing at the core location. Nevertheless, oak pollen begins to increase in abundance just as the spruce pollen begins its decline around 12,565 y.b.p. Pollen from two of the other major deciduous trees of our forests today, beech (*Fagus* spp.) and the New York State tree, sugar maple (*Acer saccharum*), increased in abundance between 10K and 5K y.b.p. Pollen from birch trees (*Betula* spp.) also shows a marked increase between 4.7K and 3.4K y.b.p. These are large time spans, but unfortunately this sediment core also illustrates the last caveat of sediment analysis mentioned above, that the rate of sedimentation is not uniform. Thus, interpolating the time of the increases between ^{14}C radiocarbon dates would be very speculative. Nevertheless, it is tempting to see the rise of beech, sugar maple, birch and hemlock as the beginning of our characteristic "old growth" forest. Trees of these species are particularly shade tolerant, as will be discussed below, and do not do well in full sun. They did not build the pioneer hardwood forest after the first wave of spruce and pine moved northward. They could not get established until forests of sun loving deciduous trees, such as oaks (*Quercus* spp.), most hickories (*Carya* spp), ash (*Fraxinus* spp.), etc. had been established.

There are other nuggets to be mined from more detailed inspection of Belmont Bog sediments, but let's now turn our attention to a sediment core drilled some 80 km (127mi) farther north on the other side of Lake Ontario at Roblin Lake (44.0580º N, -77.4257º W). The core is deeper, almost 12m, and there are fewer radiometric dates, which are also clustered together. Nevertheless, we see many of the same trends in pollen phenology, just delayed by a few thousand years. The earliest date is 10,929 y.b.p., which is near the bottom of the core at 11m. Again, sedges and grasses are present, but are less dominant than at Belmont Bog. Spruce and pine pollen already dominate the sediment. The spruce abundance peaks around 10,621 y.b.p., whereas it peaked around 12,565 y.b.p. at the more southerly Belmont Bog. Similarly, the increase of hemlock pollen at Roblin Lake began around 7,620 y.b.p. after the decline of spruce pollen, whereas the hemlock followed the same temporal order at Belmont Bog, but the increase occurred closer to 10,945 y.b.p. At Roblin Lake, some oak is again present even in the deepest layers, but pollen of the shade tolerant species, such as beech, maple and birch, appear in the sediment together around the time that hemlock also increases.

The comparison of pollen occurrences in these two sediment cores reveals relatively similar dynamics of community succession. These general trends occur in all the cores that have been drilled in the Finger Lakes Region, from the first core drilled in New York in Sandy Ridge Bog near Syracuse, Onondaga Co. by Walter McCulloch in 1939, to half a dozen cores drilled across the eastern Finger Lakes Region by Donald Cox twenty years later. The sediment layers in these early studies were undated, but beginning in the 1970s including the study of Belmont Bog, most recent studies incorporate radiocarbon dating into the stratigraphic analysis. I do not mean to present the comparison of Belmont Bog and Roblin Lake to indicate that the glacial retreat and reforestation were monotonic and inexorable. Some cores show the development of the hemlock forest which then disappears for an extended period of time displaced by oak-beech, only to return. Other cores present a good pollen sequence in the sediment which then stops and is replaced by sand or other inorganic material indicating that a glacial lobe advanced at that location before receding again. Viewed in the aggregate, we see that across the Finger Lakes region vegetation began returning around 12k years ago after the glacier began retreating, and by about 5k years ago the composition of our forests very likely resembled the old growth forests of today.

The forests of the Finger Lakes region now grow in USDA hardiness zone 5, which includes the so-called Laurentian Mixed Forest Province, and zone 6, the Eastern Broadleaf Forest (Continental) Province. Zones are determined by 10 ºF increments in mean winter temperature. The higher zone numbers represent regions of North America with warmer winters and vice versa. Thus, the Everglades at the southern subtropical tip of Florida are in zone 10, and Hudson Bay, Canada, is in zone 1. Yes, the mean winter temperature on our continent spans 100 ºF between north and south! But the two zones of the Finger Lakes region are inverted. The warmer zone 6 with a mean winter temperature of 0 - 5 ºF occurs in more northern counties along the south shore of Lake Ontario, e.g., Monroe, Wayne, and the tip of Cayuga, with the zone extending fingers southward surrounding the valleys of the Finger Lakes in Ontario, Yates, Seneca, etc., counties. These lands sit at lower elevations, only about 400' [122m] above sea level, which are typically warmer, and the land is close to large bodies of water which buffer the temperature. None of the large Finger Lakes or Lake Ontario freezes solid, thus their water remains at 32 ºF even when the air temperature is colder. In contrast, zone 5 in the southern part of our region, e.g., Steuben, Schuyler, Chemung, and Tioga Counties, is not buffered by Lake Ontario or the valleys of the Finger Lakes, these areas sit at about 1900' [579m] above sea level on a higher plateau scrubbed flat by the glaciers. Thus zone 5 gets colder with a mean winter temperature of -10 to -15 ºF. These temperature zones, in part, will determine some of the species composition of our forests. Zone 6 is typically referred to as a Deciduous Forest zone, and the cooler zone 5 is a mixed zone of Deciduous Trees with Conifers, such as hemlocks and pines.

Finger Lakes forests after human colonization

From the analyses of dated pollen in sediment cores, we have a rough idea of the pace and species composition of reforestation of the Finger Lakes Region after the glacial retreat. We don't know when Paleoindians first moved in to the area, but archeological remains from temporary encampments are known from as early as 13,000 y.b.p. These people were members of what became the Haudenosaunee Confederacy, and they cut down some of the forest around their settlements to support their maize agriculture, and perhaps their black walnut trees, *Juglans nigra* [Juglandaceae]. The nuts are an important source of food and medicine for people, as well as food for mammals that might be hunted, but these trees have a very odd "native" distribution in New York. They are widely present across the Midwest and Eastern United States down to the Gulf of Mexico but are not native in the Alleghany Upland of western Pennsylvania and New York. Across the Finger Lakes Region, however, there are disjunct large "native" populations of the tree associated with pre-historic Iroquois settlement sites. Thus, Paleoindian people likely modified the species composition of the post-glacial forests somewhat with the introduction of black walnut trees. Nevertheless, in 1790 the landscape of the Finger Lakes Region was about 97% forested, but that was about to change in major ways.

After the American Revolutionary War, New York State passed the first Revolutionary War Bounty Lands Act in 1781, which granted parcels of land to soldiers who had served in New York regiments of the Continental Army during the war. A major general could receive 5500 acres [2226 ha] with the scale sliding down to a private, who could receive 500 acres [202 ha]. The initial parcels comprised over 1.5 million acres [607,028 ha] of "The Military Tract of Central New York" surveyed by Simeon De Witt. It was located in the Finger Lakes Region extending from Seneca Lake east to Oneida Lake, and from Lake Ontario down to the so-called Southern Tier of counties at the New York border with Pennsylvania. It included what are now Cayuga, Cortland, Onondaga, and Seneca Counties, and parts of Oswego, Schuyler, Tompkins, and Wayne Counties. I live in the Schuyler Co. in the Township of Hector in an 8 acre [3.24 ha] woodlot that fronts on to Stilwell (also spelled Stillwell) Road. James Stilwell (1755 – 1836) served as a Sergeant in Philip van Cortlandt's 4th Battalion of the 2nd New York Continental Line Regiment. He was wounded in the Battle of Stillwater in 1777 and received his pension in 1786 including a parcel of 1000 acres [405 ha] in the Township of Hector. His descendants still live in this area. In fact, Mason Stilwell, M.D., James Stilwell's 5th great grandson, grew up around the corner from my house and as a child played in our woods. He is now my wife's orthopedist.

A few years later, in 1788, the western part of the Finger Lakes Region comprising about 6 million acres [2.4 million ha] was involved in the Phelps and Gorham Purchase. The rights to negotiate for the land were bought from the Commonwealth of Massachusetts. The lands extended from Seneca Lake west to the Genesee River, just past the westernmost Finger Lake, Conesus Lake. It comprised Monroe and the remainder of Wayne County in the north down through Ontario, Yates, Steuben and Chemung Counties in the Southern Tier, and also included parts of Livingston and Schuyler Counties.

At the time, all these lands were primarily inhabited by the *Haudenosaunee*, members of the six nations comprising the Haudenosaunee (Iroquois) Confederacy. Indeed, part of the Phelps and Gorham Purchase included a small fee for the title rights from the xx Confederacy. the deal for the land was concluded with the Seneca

Some other parcels of lands had been purchased from the Gayogo̱hó:nǫ' (Cayuga), Onoñda'gega' (Onondaga) and Onʌyota'a:ka (Oneida) Indian Nations, which still have reservations in the Finger Lakes Region, as well as from the Ska:rù:rę' (Tuscarora) Nation, which has a reservation in the western edge of the state in Niagara Co.

Although it took some years for the lands to be newly occupied due to delays in finalizing titles, deeds, etc., as homesteaders moved in, they began to cut down the forests in earnest. The new colonists cleared the forests for fuel, timber and agriculture, but records of land clearing are spotty until about 1850, when the first New York Census of Agriculture was published. By that time over 50% of the forests in counties of the Finger Lakes Region had been converted to "improved" land for agriculture. The trend continued through 1880, the year when the maximum area of land in New York was under agriculture, 78% ! In counties in the Finger Lakes Region less than 25% of the initial post-glacial forests remained. More than three quarters of the land had been converted to farmland, which was similar to the average for the entire state. This amount of clearance is astounding when you consider the ruggedness of such areas as the Adirondacks, the Catskills, and Tug Hill, and how unsuited they are for agriculture. Frederick Hough from Lowville NY, a conservationist and first Chief of the US Division of Forestry (now US Forest Service), recognized this disastrous trend and lobbied for the 1885 passage of the New York Forest Preserve Act, more formally known as Chapter 283 of the Laws of 1885, and informally as the “Forever wild” act which initially protected 715,268 acres (289,458 ha) in the Adirondacks and Catskills and that “...lands now or hereafter constituting the forest preserve shall be forever kept as wild forest lands. (§8) “

Although the Finger Lakes forests were not part of the original Forever Wild legislation, its passage raised the awareness of massive deforestation and reversed the trend. Since that time, secondary and tertiary forests have again returned to the Finger Lakes Region as farming has declined. By the early 1990s, over 60% of the Finger Lakes region was reforested, providing us with valleys and hillsides flaming with outrageous fall colors as noted at the outset of this essay.

Old growth forests

Yes, we have beautiful forests in the Finger Lakes. From the dates mentioned above, however, it is obvious that most of our forests must be less than 145 years old. Fortunately, in their zeal to “improve” the landscape, the 19th century settlers didn’t cut it all down. There remain, here and there, some magnificent pockets of so-called “old growth” forest ranging from a few large parcels, such as Hemlock Lake in Livingston Co. at over 400 acres [162 ha], down to many smaller parcels, such as the 10 acres [4 ha] of forest surrounded by Zurich Bog in Wayne Co. My own local patch is Smith Woods, a 32 acre [13 ha] parcel about 10 minutes away in Trumansburg, Tompkins Co. There are lots of other patches and the internet has many incomplete lists: Whispering Creek Old Growth Forest (Ontario Co.), Fischer Woods, (Tompkins Co.), Watkins Glen State Park (Schuyler Co.), Montezuma National Wildlife Refuge (Seneca Co.), Bentley Woods (Ontario Co.), Green Lakes State Park (Onondaga Co.), Hoxie Gorge Nature Preserve (Cortland Co.) and many others. In 2005, Mary Byrd Davis published an online update for New York to her work “Old Growth in the East: A Survey”. It provides one of the more complete lists of larger patches in the Finger Lakes Region. The Finger Lakes National Forest, the only national forest in New York, is over 16,000 acres [6,475 ha] of “a land of many uses”. Unfortunately, one of those uses is not preservation of old growth forest. The Finger Lakes National Forest comprises open, free-range grazing and agricultural land, as well as many trails through secondary forest that carpets the north-south spine of high ground separating the two largest Finger Lakes, Seneca and Cayuga. It may contain individual older trees, but there are no known patches recognized as old growth forest.

What does an old growth forest look like? If you were hiking along a trail through the woods, how would you recognize if you passed into a patch of old growth trees? The US Forest Service provides quantitative definitions (FS-1215a) for different forest types in the different regions of the country. New York State DEC also has an Old Growth Rapid Evaluation (OGRE) form for scoring woodlands. But let's first think about what the forests might look like. Obviously, the trees would be big. Some would have a diameter wider than 2' [0.65m], even approaching 3' [1m], and the bark would be gnarlier. The trunks would be more cylindrical rather than tapering. Trees grow in girth as well as height, but while they are young the girth increases more quickly on the older, lower trunk than up above. As the tree reaches maturity, it reaches the characteristic height for its species and stops growing up. The branches and trunk continue to thicken, and the trunk approaches the same diameter from bottom to top. Many old growth trees would be taller than 100' [30m], with some trees reaching 150' [45m]. The canopy would be complete except for recent tree fall gaps, and the understory would be shadier.

The closed canopy restricts the growth of a shrub layer. Thus, the understory will be less diverse, but some trees, such as shadbush or downy serviceberry, *Amelanchier arborea* [Rosaceae], and flowering dogwood, *Cornus florida* [Cornaceae], are very shade tolerant and are often understory indicators of old growth forest. Slow growing mosses and lichens on tree trunks and stones would also be more diverse, including some that are especially shade tolerant.

Lungwort, *Lobaria pulmonaria*, xx

The ground surface would be different as well. It might be steeper, not because that is a sign of old growth, *per se*, but because crops are hard to cultivate on steep slopes, thus trees rooted on such topography were often spared the farmer's axe, and that patch of forest remained unscathed. There is a small 6 acre [2.5 ha] patch of old growth behind and just north of Ithaca high school, called Renwick Slope Natural Area, which is managed by the Cornell University Botanic Gardens. It is typical of small old growth patches on some of the west facing slopes at the south end of Cayuga Lake.

Looking at the forest floor you might notice other differences. Old trees eventually fall. They leave a gap in the canopy which is quickly filled in as saplings compete for sunlight, but the trunk lands on the forest floor and often wrenches the tangled root mass perpendicular from the soil. This former giant of the woods can no longer fight back the wood boring insects and decomposing fungi and slime molds that slowly recycle the nutrients through the forest ecosystem. It can take many decades for a large tree to fully decompose. Some hardwoods of our forests, such as black oak, *Quercus velutina*, or white oak, *Quercus alba* [Fagaceae], have a decay half-life of around a decade. That's the amount of time required for half their mass to be recycled. But the trunk may still be recognizable as such for another 40 years. So-called softwoods or conifers [Pinaceae], typically take longer to decay. The trunks of a Balsam fir, *Abies balsamea*, or white pine, *Pinus strobus*, have half-lives around 20 years when the rot resistant bark sloughs off, and they may still leave recognizable trunks 80 years after they have fallen to the forest floor.

Thus, if the forest is old growth, you will see trees in all stages of decomposition. Moreover, if the forest is relatively new secondary growth following a time of agriculture, the forest floor will be relatively smooth from its history of being plowed. It will lack the boulders that the glaciers deposited, the so-called glacial "erratics" discussed previously, and it will lack the "hump and hole" remains of ancient tree falls. When a tree falls in the forest, whether anyone hears it or not, the root mass is yanked from the ground, leaving a hole adjacent to the perpendicular root mass that takes longer to decompose, producing the hump. Some folks call this topography "pit and mound", or the more fanciful "cradle and pillow". I prefer hump and hole, as the alliteration makes it easier for me to remember. This uneven topography is a signature of old growth forests. The root mass hump pulls soil up free from the covering of leaf litter. This brings up nutrients and provides a clean soil surface for seeds to fall upon and germinate. Thus, as you look through the old growth forest you may notice that many trees appear to be growing on humps of soil rather than flush with the rest of the forest floor as in typical secondary forest. You may see some hump and hole topography in a secondary forest as well, but not nearly as much. Recent agriculture of the past 50 or 75 years would have cut the trees and plowed the humps level.

The humps of old growth forests are just one example of so-called "nurse trees" that aid in the propagation of younger trees in the forest. Another example is the moss beds that grow on the long-lasting trunks of fallen conifers as they slowly decay. When an old growth giant falls, the top side of the downed trunk may be 2' [60 cm] off the forest floor. It may already harbor some moss at its base, which was closer to the ground in a higher humidity microhabitat. The trunk will acquire more moss over the decades, especially after the tree begins to decay from the outside in, as is typical of conifers. Its elevation above the forest floor keeps leaves from shading moss spores that land in the deeply grooved bark. These germinate into a luxuriant cushion. Some mosses, such as the whip forked moss, *Dicranum flagellare* [Dicranaceae], reproduce sexually by spores, but also clonally by what are called brood branches. These are 1-4 mm long bits at the bristly tip of the moss leaves. Eastern Chipmunks, *Tamias striatus* [Sciuridae], seem to be the Johnny Appleseed of this moss world. As the chipmunk uses the downed tree trunk as a literal high way through the forest, it occasionally brakes abruptly, perhaps startled by a sudden sound. The skid breaks the tip of the moss leaves which then stick to the chipmunk's fur and feet like Velcro, only not as good. As the chipmunk resumes its traverse along the trunk, the brood branches fall off into waiting gaps and begin to germinate. Thus, the moss is spread along the trunk, albeit slowly, even as the old giant decays and gets closer to the soil surface.

Moss covered downed trunks, *per se*, are a noticeable difference walking in old growth versus more bare trunks of secondary growth, but the moss itself also provides a seed bed, or nursery, for certain kinds of seeds. Some trees invest in their seeds and provide a nutrient dowry along with the fertilized embryo. Think of fruit trees, or acorns, or hickory or even ash seeds. Yes, ash seeds have wings, so they fall farther from the tree than do acorns, but wherever any of these fruits land they are more likely to germinate because they carry their own starter nutrient package with them. Thus, if they land on the leaf litter above the soil, there is a good chance they have enough nutrients to grow a root down through the leaf pack to contact soil. The nutrient content of acorns varies with the species, but acorns of red oak, *Quercus rubra*, and white oak, *Quercus alba* [Fagaceae], contain about 14 kcal of nutrition. That may not sound like much, but it is more than four M&M plain chocolate candies, just to grow a short root down to the soil. On the other hand, tiny wind-borne seeds of many trees, such as birches, *Betula* spp. [Betulaceae], as well as Eastern hemlocks, *Tsuga canadensis*, and some pines, *Pinus spp*. [Pinaceae], lack a large nutrient dowry to successfully germinate when they land on the leaf pack. But the exposed soil of the hump, or the linear garden of mosses on the downed trunk make wonderful nurseries. As the new trees become small saplings, they send out roots along the shrinking nurse trunk. Eventually the trunk completely decays, but its legacy will be a line of trees in the forest, often with surface roots extending toward each other. Eastern hemlock is one of our most shade tolerant species, thus linear arrangements of this tree are an indication of old growth. Other evidence of the ghost of a nurse tree is a current tree that stands above the forest floor with an arrangement of “stilt” or “prop” roots that leave a cavity under the tree. Once upon a time, the trunk or stump of a nurse tree fit in that cavity. A seed landed and germinated in its moss bed. The new sapling sent down roots around the trunk to the ground and eventually supported the tree. Only thereafter did the nurse tree fully decay. In Smith Woods, Tompkins Co., there is an ancient black or sweet birch, *Betula lenta* [Betuaceae], which spent its adolescent decades straddling a nurse tree.

Finally, the species of trees comprising the canopy can provide some evidence of whether you are walking through old growth forest or not. With the exception of a few parasitic plants, such as the white ghost pipe, *Monotropa uniflora* [Ericaceae], which often parasitizes the ectomycorrhizal fungus *Russula* spp. on the roots of beech trees, *Fagus* spp., all plants need sunlight to provide the energy that allows them to combine CO_2 from the atmosphere with water from the soil to produce the carbohydrates that are further converted to the chemical energy that powers all the metabolic processes in the plant. If you have a garden at home, you may be keenly aware that some plants need a lot of sunlight, whereas plants of other species are tolerant of shade and perhaps even intolerant of sunny spots. Trees cover the same range. Some of our more common forest trees, such as white ash, *Fraxinus americana*, most oaks, *Quercus* spp., and most hickories, *Carya* spp., with the exception of shellbark, *Carya laciniosa*, need a lot of sun and are very intolerant of shady conditions. Thus, if you hike into a typical oak-hickory forest, even if the trees are large with a full canopy, you know that they must have grown up in an open habitat with little or no shade from an overstory. Thus, they likely represent the first generation of a secondary forest, i.e., a forest on land recovering from agriculture, rather than an old growth forest.

Other trees in forests on the Finger Lakes Region are very tolerant of shade and, in fact, do not do well in sunny conditions. American Beech, *Fagus grandifolia*, is extremely tolerant of shade. Eastern Hemlock, *Tsuga canadensis*, is even moreso. It is perhaps the most shade tolerant common species we have. The New York State Tree, sugar maple, *Acer saccharum*, is also quite shade tolerant, as are basswood, *Tilia americana*, and yellow birch, *Betula alleghaniensis*. Hop hornbeam, O*strya virginiana*, and ironwood, *Carpinus caroliniana*, are shorter in stature, reaching only 30' - 40' [10-12m], but are also very shade tolerant. Thus, if you walk into an area dominated by large American beech, sugar maple, and eastern hemlock trees, you can surmise that those trees did not grow up as saplings under clear sunny skies after the cessation of agriculture. They likely grew up under a canopy of sun-loving, shade intolerant trees and the forest composition has slowly shifted over the centuries. But the species composition of the forest is not simply a matter of sun versus shade tolerance. Other characteristics of the patch of land, such as soil type, moisture, north or south facing aspect, propensity for disturbance, mean winter temperature, etc., all contribute to which trees will be able to survive in the forest and eventually come to dominate it. However, if you keep your eyes open as you walk through the woods and take in the wealth of clues, you will be able to determine if you have likely walked in a patch of old growth forest even if you don't realize it until you walk out of it and the differences become jarring.

How old is that forest

So, how can we determine the age of the old growth forests in the Finger Lakes Region? In the southwestern US, there are continuous records of annual tree rings from Bristlecone pines, *Pinus aristata*, that go back almost 9000 years. In Northern Europe, similar records based on another pine, the Swedish pine, *Pinus sylvestris*, go back more than 7400 years. There are no deep tree ring records for our forests, perhaps because trees of the same species have not occupied the Finger Lakes Region as the climate changed with the retreat of the glaciers. The sediment core data discussed above indicate that our old growth forests could have become established between 10k and 5k y.b.p., but no continuous tree ring record has been developed as far as I am aware.

The data we can use for dating our forests come from two other sources. As mentioned above, records of land use only became standardized in the mid-1800s, which could put an old growth age at greater than 170 years, if the patch of land was forest then, survived the agriculture maximum of the 1880s, and has remained forest ever since. Such a longitudinal record requires a bit of effort to build for most parcels. There are also trees, generally called “witness trees” or sometimes more specifically “bearing trees”, that were used by early surveyors to mark the boundary locations of land parcels. Perhaps the oldest in the Finger Lakes Region is a sugar maple, *Acer saccharum*, over 400 years old in the Wetzel Woods, an old growth grove behind the Liverpool high school in Onondaga Co. Other trees in the grove, such as red maples, *Acer rubrum*, beech, *Fagus grandifolia*, and shagbark hickory, *Carya ovalis*, are over 200 years old. Without working through old land records, it is not clear how many other old trees may have served as witness trees. Hoxie Gorge State Forest in Cortland Co. preserves some old growth forest with a pair of hemlocks, *Tsuga canadensis*, dated at 285 and 281 years old, and a variety of other trees including, black or sweet birch, *Betula lenta*, red maple, and the understory tree black cherry, *Prunus serotina* [Rosaceae], that date from the late 1800s. The slopes of the southwest shore of Hemlock Lake in Livingston Co. harbor white oaks and sugar maples over 250 years old, and hemlocks over 400 years old. One fallen hemlock is said to have 515 annual growth rings.

Another source of data is more straightforward and involves drilling into and extracting a small cylindrical core, 3/16” [4-5mm] in diameter, from individual trees and counting the annual growth rings visible in the extracted core. This method does require a specialized tool called an increment borer, and is obviously invasive, although trees seal up this breach in their bark fairly quickly. A third method is more commonly used, but is only qualitative, i.e., measuring the circumference and height of the tree.

Xx This section is incomplete

Modern challenges to the Forests of the Finger Lakes

At the agricultural maximum in the 1880s, forests occupied less than 22% of New York State surface, but they have been returning. The process was slow at first and by 1910 the mean percent of forested land in the 10 Finger Lakes counties was 23%. By 1992, it had increased to about 61%. The amount of forested land in New York has remained around 62% since 2012, resulting from a balance between urbanization and development on one hand and on the other hand, consolidation of some farmland allowing woodlands to return, along with outright protection of forests. In 2024, New York ranked 10th among all states in the percent of forested landscape. Even though the amount of forested land in New York State, and the Finger Lakes Region in particular, has increased dramatically over the past 150 years, the composition of the forest has changed. We have lost and continue to lose major elements of our forest largely, but not solely, to invasive pests.

Passenger pigeons (*Ectopistes migratorious*)

One of the first major losses from our forests was the passenger pigeon, *Ectopistes migratorious* [Columbidae], which depended heavily on nuts produced by trees in the Finger Lakes Region. The wild pigeon, as it was called, was likely the most numerous bird in North America until its extinction in 1914. The number of individual birds in a flock could reach into the billions, that's with a B. As the Latin species name implies, the birds migrated in huge flocks northward in the spring months, roosted in woodland areas, fledged their squabs, fattened on mast in the fall, and flew southward to winter roosts in hardwood forests below about 35º latitude, i.e., Arkansas, Tennessee, North Carolina and further south. Their spring migrations into the northern parts of their range were searches for woodlands with trees that would produce mast, i.e., nuts produced by trees, such as American beech, *Fagus grandifolia*, and American chestnut, *Castanea dentata,* and acorns of various species of oak, *Quercus* spp., etc. In plant ecology, the term "masting", or mast fruiting, refers to the regional synchronized production of a large amount fruit, e.g., acorns, nuts, etc. in all trees of the same species. It is a population wide process and typically occurs in alternate years or even less frequently. In a mast year, generalist herbivores all turn their attention to the mast, feed on those fruits, and produce more offspring. Thus, herbivores benefit from masting, so why should tree species evolve to perform such population coordination if it benefits their herbivores? Evolutionary biologists have shown that masting is also beneficial to the plants. In a normal year, herbivores may consume most of the tree's reproductive output, its seeds, which will limit an individual tree's fitness, as well as population growth. In a mast year, however, there are simply too many nuts for herbivores to eat. This is a process called "predator satiation", here applied to herbivores, but the result is the same. "No, really. I'm stuffed and couldn't eat another bite". Thus, even though herbivores will eat a lot of the nuts, they can't eat them all in such a short time and a larger percentage will go uneaten to germinate in a mast year. This is the same process used by periodical cicadas in Brood VII in Onondaga County, and other broods elsewhere in the eastern United States. Every 17 years, or 13 years in the southern states, millions of cicadas emerge from their subterranean juvenile habitat, molt into adults, mate and die. They are relatively defenseless, slow flying, diurnally active and visually apparent, with their garish black and red-orange coloration. Every omnivore and insectivore eats their fill and is satiated for the three or four weeks that the adult cicadas are active in early summer. Birds fledge more young, and shrews raise more pups in a periodical cicada year, but still, enough mated cicada females make it through to lay eggs that will become the root feeding nymphs of the next generation that will emerge in 17 years. The few arithmetically challenged periodical cicadas that emerge a year early or a year late in the 16th or 18th year are all gobbled up by predators left hungry and searching for more. It's similar with mast fruiting. Coordinating with other members of the population benefits each individual tree.

Although all trees of a given species in a given region may undergo mast fruiting in a given year, it may be another five or seven or more years until those trees in that region repeat the phenomenon. Or perhaps trees of a different species masted in that region in the following year, or maybe not. Thus, huge flocks of passenger pigeons came out of the south every spring looking for a region that was going to have a mast year. The size of the flocks is not like anything we have experienced. The largest recorded flock around our area, was in 1860 at Fort Mississauga, Ontario, Canada, just across the New York border at Niagara Falls. The birds were fast fliers achieving speeds of 60 miles per hour (95 kph). The moving flock blocked out the sun as it flew continuously past the Fort for 14 hours! The estimated size of the flock was 3.7 billion birds, give or take a few birds, and its extent may have been as long as 300 miles (475 km) and one mile (1.5km) wide. Smaller flocks followed for a few days thereafter. That's a lot of birds looking for nuts. I've been fortunate to witness remarkable mass movements of a variety of animals. I've seen rivers in Alaska choked with migrating sockeye salmon driven past hungry brown bears by the urge to reach their spawning creeks. In the Serengeti, I've watched the wildebeest-zebra-gazelle migration stretch from horizon to horizon moving on the smell of a thunderstorm and fresh grass, but the line of animals is relatively thin. I watched fruit bats in Queensland, Australia, and Mexican free-tailed bats in New Mexico leaving their roosts at dusk to form rivers of bats in the sky that flow for an hour or more. These experiences were spectacular, but they all pale in comparison to what the movement of passenger pigeon flocks must have been like. Observers in the day witnessing a large flock commented on a "loud rushing roar succeeded by instant darkness" as they blocked out the sun for hours. When flocks found a rich area of forest, they settled into a nesting roost.

Pigeon roosts drew the Haudenosaunee people and the American settlers. In the early 1800s in Livingston County, near the current location of the Village of Leicester, there was a place called Ga-non'-da-seeh by the people of the Onöndowa'ga:' (Seneca) Nation, who camped there as a "favorite resort" during the pigeon hunting season. There are also a handful of former roosting places in New York named Pigeon Hill. One in the Finger Lakes Region in Wayne County is less than 20 miles as the pigeon flies from Sodus Point on the shore of Lake Ontario. In the summer of 1820, there is a record of a roost there that extended over 3 miles (4.5km) long and was more than 1.5 miles (2km) wide at some points. Trees were full of nesting birds breaking branches from their weight. The roost was known for several counties around and pigeoners, as the hunters were called, came from as far away as Geneva (30mi) and Canandaigua (35mi) to bag the birds. This roost was small compared to some. During the first half of the 19th century the flocks were huge, and hunting with guns and nets killed birds by the millions – with an M - for local consumption by people and livestock, as well as for shipping to far away markets in New York City, Chicago, St. Louis, etc. Our current expression "stool pigeon" came into use in the early 1800s, to describe a passenger pigeon that was tied to a jiggling stool to make it flutter its wings, which lured members of passing flocks to the ground where they could be easily netted. John James Audubon (1785-1851), the preeminent naturalist-artist, documented the bird's ecology in the text accompanying Birds of America, Havell edition, Plate 62, Passenger Pigeon. He graphically describes the activity at a roost in Kentucky.

> "*Two farmers from the vicinity of Russelsville, distant more than a hundred miles, had driven upwards of three hundred hogs to be fattened on the pigeons which were to be slaughtered. Here and there, the people employed in plucking and salting what had already been procured, were seen sitting in the midst of large piles of these birds. The dung lay several inches deep, covering the whole extent of the roosting-place. Many trees two feet in diameter, I observed, were broken off at no great distance from the ground; and the branches of many of the largest and tallest had given way, as if the forest had been swept by a tornado.*"

In the later 1800s, the flocks began to dwindle in size in the eastern states, but there were still occasional large roosts. One of the last large roosts in New York was in 1868 in Allegheny Co, just to the southwest of the Finger Lakes Region. It extended 14 mi (22 km) through the county into northern Pennsylvania. Another large one was reported in Steuben County in 1875. Hunting pressure and deforestation in New York through the 1880s lead to the decline of flocks spending summers here, although enormous flocks were still reported, and hunted, in less populous states further to the west, such as Indiana and Michigan. The last reliable report of the passenger pigeon in New York was a young male bird shot in Canandaigua, Ontario Co., in September 1898. There are several subsequent unverified reports, including a specimen in the collection at the Cornell University Laboratory of Ornithology with a date of 1909 that some commentators doubt is accurate. Hunting continued on a massive scale in the midwestern states as pigeoners could not imagine that they would ever run out of wild pigeons to catch and send to market. But run out they did. The last bird, a 29 year old captive-raised female named Martha, died in the Cincinnati Zoo in 1914. Her consort George (yes, George and Martha, as in Washington) had died in 1910 without the pair producing any offspring. The loss of the passenger pigeon was the first great modern loss to the forests of the Finger Lakes Region, other than the wholesale clearance of the forests themselves for agriculture. Unfortunately, with apologies to Canadian singer-songwriter, Joni Mitchell, we don't know what we lost even after it's gone, because no one really studied the passenger pigeon beyond understanding their natural history well enough to hunt them more efficiently. Audubon and his rival, Alexander Wilson (1766 – 1813), the so-called Father of American Ornithology, wrote down their observations about the birds, but we know very little about how they affected the communities of which they were a part. Did their destruction of roosting areas lead to turnover of species composition in mature forest ? It must have to some extent. Did the arrival of billons of mast eating migrants adversely affect the local population of nut eaters in those areas? How did the deposition of that much guano affect the nitrogen cycle of the community? Unfortunately, we will never know the answers to these and many other questions about these amazing birds.

From studies of DNA from museum specimens of passenger pigeons and other living pigeons and doves, we know that the passenger pigeon is most closely related to other New World pigeons in the genus *Patagioenas*, such as the band-tailed pigeon, *P. fasciata*, which ranges across the western US and south through Mexico, Central America, and into Argentina. It also lives in woodlands and eats acorns, berries, etc. Passenger pigeons split from the *Patagioenas* lineage about 12,000 y.b.p. Thus, it likely inhabited the Eastern Deciduous Forest just as the glaciers were receding in our region. Pollen in the sediment cores from the Finger Lakes Region indicates that among the masting trees, oak was the earliest member of that community with its sun loving saplings. Oak pollen is present near the bottom of most sediment cores with the spruce, *Picea* sp., and pine, *Pinus* sp., earlier than 12k y.b.p. in some locations. American Chestnut, and especially American beech, are much more shade tolerant, and sun intolerant, and are members of many old growth forests. Their pollen shows up in sediment cores more recently, with beech appearing roughly between 11k and 7k y.b.p., depending on the sediment core locality. Chestnut pollen is sparsely reported in pollen cores, which is surprising for such a dominant member of the old growth flora. However, chestnut sheds much less pollen on the wind than most other trees and the pollen is particularly small,18μm x 13μm, even for wind dispersed pollen. Various cores that do report chestnut pollen indicate that it appeared in our region much more recently, between 3.8K and 4.2K y.b.p.

American chestnut (*Castanea dentata*)

Passenger pigeon populations had already declined in the eastern deciduous forests when a real invasive pest started putting the end to one of their natural food sources. American chestnut trees, *Castanea dentata* [Fagaceae], were the dominant trees in the Dry Upland Forest of Eastern North America. From the pollen record in sediment cores, we can estimate their advance into the Finger Lakes Region around 4000 y.b.p. and were a major tree in our forests until around the middle of the 20th century when they became all but extinct. Pollen records from sediment cores in Lake Ontario show an abrupt decline that corroborates the observations of foresters. One of every four trees in our woodlands was an American chestnut. They numbered in the billons. Again, with a B. They were statuesque trees that could be 600 years old and reach crown heights between 50' and 100' (15-30m) with trunk diameters of 4'-5' (1.2-1.5m). Early settlers report that 8' (2.5m) diameters were not uncommon, and one specimen from North Carolina had a recorded diameter of 17' (5m). In 1840, Henry Wadsworth Longfellow (1807 – 1882), one of the most popular North American writers of the 19th century, penned the poem "The Village Blacksmith", whose opening stanza reads…

“*Under the spreading chestnut tree*
the village smithy stands.
The smith, a mighty man is he
with large and sinewy hands,
and the muscles of his brawny arms
are strong as iron bands.”

The poem goes on for half a dozen or so more verses to extoll the virtues of the blacksmith, a pillar of the community. He is good looking, honest, upstanding, hardworking, etc. But it’s the opening line that sets the tone with the majestic chestnut tree being understood as a metaphor for all the desirable qualities of the blacksmith. The tree was straight-grained and easily split, making it useful for fence posts, telegraph poles, and railroad ties as the country was expanding westward. Chestnut was also the preferred wood for a multitude of household items from cradles to coffins. I grew up calling a refrigerator an “ice box”, because that is literally what my father grew up with for keeping food cold, and it was likely made from chestnut. As firewood, it burned with very little smoke. Due to its high tannin content, the wood was virtually rot resistant, and was often referred to as “the redwood of the east”, although it was a much stronger wood. The tannin was also useful in manufacture of leather goods. Altogether, a most useful tree for human endeavors.

Its greatest value in the natural community, however, derived from its namesake fruit, the chestnut itself. Native Americans, including the Onöndowa’ga:’ (Seneca) people of the western Finger Lakes Region, ate them and likely cultivated the trees around their villages. We eat them today, although typically only in winter when pop singer Nat King Cole is crooning about “Chestnuts roasting on an open fire, [and] Jack Frost nipping at your nose”. But in woodland communities the nuts were a mainstay in the diets of a host of animals, including black bears, white tailed deer, wild turkeys, squirrels, and others, including passenger pigeons. The trees reliably produced a copious buffet of nuts every year, thus, animal (and human) populations could depend on a supply of nutritional chestnuts every fall as the animals fattened up for winter.

That all began to change, however, in 1904 when a botanist in the Zoological Park in the Bronx in New York City discovered a fungus attacking a chestnut cultivar imported from Asia. A few years later the fungus, commonly called the Chestnut blight, was identified as *Cryphonectria parasitica*, a member of the Ascomycota, or sac fungi. This group includes tasty morels that we eat, and whose location in the woods we safeguard from even our closest friends. The group also includes single-celled yeasts that ferment our adult beverages, rise our bread, and occasionally infect moist cavities of our bodies, as well as many other species that are pathogens of plants. The multicellular forms of these fungi all have in common small tubes from which they shoot their reproductive spores. The spores of the blight land on the bark of healthy trees, either carried there by the wind or water or on the feet of some animal. They germinate and produce a thread that can penetrate any crack in the bark. Immediately under this dead protective covering is a layer of living wood called the vascular cambium. This layer is composed of stem cells, both in the literal sense and also in the developmental sense that they have the ability to divide to make new types of cells. These form the tree's vascular pipes called the xylem that carries water, minerals, hormones, etc. from the roots to the top of the tree, and the other set of pipes, the phloem, that carries sugars made by photosynthesis in the leaves either up or down depending on where active tissue needs that energy the most. Every year the cells of the vascular cambium make another set of xylem and phloem tissue that comprise the yearly growth rings we see in a cut tree trunk. As the chestnut blight moves through the bark it creates a necrotic lesion, called a canker, in which the bark becomes misshapen and sunken a bit. As the blight proliferates under the bark from its initial penetration site, it releases a toxin, oxalic acid, that attacks cells of the cambium, killing them and clogging the pipes. This causes wilting of the parts of the tree above the canker. As the fungus spreads around the trunk "girdling" the tree, all branches above the girdle will die. This process may take a few years to completely choke off the supply of water and nutrients, but eventually the tree will be left standing as a "grey ghost" of the forest and may take many years until it eventually topples. To paraphrase a line from actor Billy Crystal's character Miracle Max in one of my favorite movies, The Princess Bride, "I didn't say the tree was dead, just mostly dead". The trunk and branches above the girdle are certainly dead, but the portion from the girdle to the roots is still quite alive. Thus, the stump may put up new stems. These typically grow for a few years before they too are hit by a spore that infects and kills them as well. Thus, you may still see throughout the forests of the Finger Lakes Region old "un-dead" chestnut stumps spouting new growth. There are several still standing on the Connecticut Hill section of the Finger Lakes Trail in Tompkins County. The first one I ever saw was in Schuyler Co. in the Finger Lakes National Forest on the Interloken trail section between Schuyler Route 1 and Fisher's Pond. It was a bit confusing at first. A few suckers about 3' [1m] tall issuing from the ground had alternate leaves that looked similar to American Beech, *Fagus grandifolia* [Fagaceae], but the leaves are larger and the marginal teeth are sharper with a spine at the tip. I checked it with the leaf ID app and it was American chestnut for sure. I had just never seen one before. The suckers arising from the root stock is also not the way a beech sapling would start either. Keep an eye out for these zombies when you are hiking the trail.

The spread of the Chestnut blight through eastern North America was extremely fast. After its discovery in 1904, for the first decade it was still restricted to the tri-state area of New York, New Jersey, and Connecticut. By 1920 it had moved through New England, eastern Pennsylvania, and was on the southeast doorstep of the Finger Lakes Region. It shot through our forests in about five years, taking every chestnut tree. It killed one of every four trees in the forest in about five years. Astounding. Tragic. By 1930 it had advanced across Ohio, West Virginia, Virginia and North Carolina. By 1940 it had moved through Indiana, Kentucky, Tennessee, Georgia. And then they were gone. There were no more American chestnut trees except for some undead stumps and a few trees that had a natural resistance to the blight. Thus, the American chestnut is actually not extinct, and because the stumps are still alive, they are not listed among the 900 plus plants on the U.S. Fish and Wildlife Service Endangered Species list. Stock from these trees crossed with some resistant Asian Chestnut trees has been developed by the American Chestnut Foundation (ACF) in an attempt to bring back this mainstay of our forests. But there are so many genes that confer resistance, that the resulting stocks are more Asian trees than American.

Another more recent approach has been to detoxify the fungus rather than to kill it outright. Researchers at the State University of New York College of Environmental Science and Forestry in Syracuse working with the ACF have isolated a gene from wheat that produces an enzyme that degrades the toxic oxalic acid secreted by the blight. Chestnut trees genetically engineered to carry and express this wheat gene are more resistant to the ill effects of the fungus. Because the resulting cultivars of the Chestnut, termed Darling-54 and Darling-58, were developed by genetic engineering techniques, rather than traditional horticultural crossing methods, before the trees can be freely released into the wild there are many federal regulations that must be followed, such as determining that they have no adverse effects on native flora and fauna. Such tests are currently underway in control enclosures with limited results. If they are successful, it will be many decades, perhaps even several hundred years, but American Chestnut trees may return to their place in the Eastern Deciduous Forest.

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When the majority of the tree dies and the grey ghost topples, it creates a sunlight gap in the formerly closed canopy. Saplings of sun tolerant species, such as oaks and hickories, will quickly fill the gap, but they also change the nature of the forest community. They produce hard fruits in acorns and hickory nuts, but their masting cycles are more irregular than the yearly production of the chestnut.

Threats to Ash trees (*Fagus spp.*) and Eastern Hemlock (*Thuja canadensis*)

I'll close this section with two short stories out of a sad increasing trend in the loss of our forests that is happening more and more frequently, namely the attack on our trees by invasive insects that land in North America associated with international commerce. The insects often arrive as larvae burrowed into the live wood illegally used for shipping crates or dunnage, the loose wood that is used to shim up and stabilize the crates inside ocean-going shipping containers. Once these are unpacked at ports of entry, many crates and dunnage are simply offloaded and piled out of the way dockside.

Xx This is unfinished

Ash species (white, green, black), *Fraxinus* spp. [Oleaceae]

Emerald ash borer or EAB, *Agrilus plannipennis* [Buprestidae], a metallic wood-boring beetle. Native to NE Asia, discovered in the US in 2002, in New York in 2009. 2018 in Finger Lakes. Now in all counties except a few downstate

Eastern Hemlock. *Thuja canadensis* [Pinaceae]
Hemlock wooly adelgid, *Adelges tsugae* [Adelgidae], with piercing mouthparts it kills parenchyma cells, rather than sucking vascular phloem sap as its relatives such as aphids do. Native to Japan and possibly China, discovered in the Pacific NW in 1924, in New York in 1985 in Lower Hudson Valley. 2008 in Finger Lakes