

Between Stones and Trees
An Ecologist Hikes Western Pennsylvania



Essay:
“Old Growth Forests”

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“Old Growth Forests”

“Old Growth Forests” are also called, with slight variations of meaning or reference, “virgin forests,” or “pre-settlement forests,” or “primal forests.” They represent the forests of North America that were first observed by arriving Europeans in the sixteenth century when North America was “an ocean of woods” (Pownall 1776 (from Whitney 1994)) and was covered by “the greatest forest on the face of the earth” (Williams 1794 (from Whitney 1994)). The east coast of the new continent presented a tall palisade of trees to the arriving settlers. As F. Scott Fitzgerald wrote on the final page of his novel “The Great Gatsby,”

“...gradually I became aware of the old island that flowered once for the Dutch sailors’ eyes – a fresh, green breast of the new world. Its vanished trees, the trees that had made way for Gatsby’s house, had once pandered in whispers to the last and greatest of all human dreams; for a transitory, enchanted moment man must have held his breath in the presence of this continent, compelled into an aesthetic contemplation he neither understood nor desired, face to face for the last time in history with something commensurate to his capacity for wonder.”

If there was a pause in response to this sense of wonder, it did not last very long. Slowly at first but then with ever increasing speed and determination, the Europeans slipped through the outer wall of the New World and then, tree by tree and acre by acre, took this vast forest apart. They gathered materials to meet their needs but also very intentionally re-shaped the “godless wilderness” into which they were thrown into a form that better fit their fundamental philosophies and ideals.

The North American forests had never been cut by humans. Native Americans had used their limited technologies (like fire) to modify them, but there is little agreement among researchers as to the breadth and scope of these changes. On the one hand, clearings around villages and open fields for the planting of corn are described, while on the other vast re-sculpting of the structure of forest itself through the use of fire is hypothesized (Abrams 1992, Whelan 1995). These old growth forests, though, were probably more shaped by internal processes like ecological succession and external, natural disturbances like fire, wind, insect pests and defoliators, cyclic droughts, and climate fluctuations than by human initiated forces.

"Ecological succession" is the observed process of change in the population structure of an ecological community over time. Within any community (and the term “community” here refers to the sum of all of the species populations existing in a defined area) some species may become less abundant over some time interval, or they may even vanish from the ecosystem altogether. Similarly, over some time interval, other species within the community may become more abundant, or new species may even invade the community from adjacent ecosystems. This observed change over time in the qualitative and quantitative features of what is living in a particular ecosystem is the essence of "ecological succession".

Every species has a set of environmental conditions under which it will grow and reproduce most optimally. This is equally true for both animals and for plants. In a given ecosystem, and under that ecosystem's set of environmental conditions, those plant and animal species that can grow the most efficiently and produce the most viable offspring will become the most abundant organisms. This is one of the fundamental observations

in Charles Darwin's theory of Natural Selection, and it is applicable not only over vast time frames demanded by evolution but also over very short time frames that can be observed in almost any ecosystem.

As long as the ecosystem's set of environmental conditions remains constant, those species optimally adapted to those conditions will continue to flourish. If the environmental conditions of the ecosystem change, though, then new species may be better fitted to thrive and reproduce under these changed conditions.

One of the key internal factors of an ecosystem that leads to changes in the environment is the interactive influence of an ecosystem's existing species. The "engine" of succession, then, the principle cause of gradual ecosystem change, is the impact that established species have upon their own environments. Ecosystems change, they undergo succession, simply because the species of that ecosystem change the conditions within the ecosystem to favor new densities of existing species or even new species all together.

Ecosystem change, succession, may also occur when the conditions of an environment are suddenly and drastically altered. A forest fire, wind storm, the invasion of a pathogen or defoliator, can each rapidly alter the conditions of an organism's environment. These massive forces may also destroy species and thus alter the dynamics of the ecological community triggering a scramble for dominance among the species still present or opening functional places ("niches") in the damaged community into which new species can invade. Human activities, like agriculture or logging, can also act as some of these "massive" external forces that can initiate or influence the direction of a successional change sequence.

Succession is often described as a step by step sequence of system change and growth that begins with relatively simple "pioneer sere" communities and ends with complex, stable "climax ecosystems." The linearity and inevitability of this sequence, though, is a creation of convenience and economy of language. Natural ecosystems seldom precisely fit our underlying vocabulary of progress and orderly change. Take the concept of a "climax" ecosystem, for example. "Climax" implies an end point, a target for the trajectory of change that, once reached, would result in a stable, constant, ecosystem. Climax implies an end to succession and the achievement of a permanent, immortal ecosystem.

But are these climax ecosystems permanent? No. Climax ecosystems are under constant and often spectacular stress. The trees that comprise these forests, like most organisms in a natural setting, seldom reach their maximum potential ages or sizes. Their populations as a consequence of these early deaths are in a constant state of fluctuation and change, and these fluctuations are the end results of a myriad of predictable and decidedly unpredictable events.

As the old bumper sticker put it so succinctly, "S*** Happens." For a tree, these "happenings" may be any one of thousands of potentially random occurrences that could kill it at almost any of its life stages. The seed (or nut) that could become the tree could be eaten, or it could fall in or be carried to a place that is too wet or too dry to allow survival. A young seedling could be stepped on by a passing animal, or eaten by a browsing animal, or crushed by a branch that fell from a bigger tree. A suppressed seedling might never get a light gap open up over it to allow its growth, or a light intolerant seedling might have a canopy break above it and be bathed by too much light and, thus, be killed. Caterpillars could repeatedly eat the tree's leaves, nematodes could invade its stem, fungi could rot away its roots, causing the tree to never grow.

If all of these possibilities and more are avoided and the tree does reach a sapling stage, a bigger tree rotten with age or shoved by a wind blast may fall on it. Animals just in passing or seeking relief from the itch of some

ectoparasite may rub vigorously against it damaging its delicate bark, or some other animal might pause by the tree and stretch against it and sharpen its claws scratching holes in the bark that allow the invasion of pathogens. Insects may repeatedly eat its leaves, wind may break its branches, or fire may maim or destroy it.

Or, finally, maybe the tree's genetic makeup is faulty or just not optimally matched to the environment its seed or nut was deposited into, so the tree lives but never thrives and maybe senesces well before reaching its expected longevity or before it can reproduce.

Every standing tree in a forest is a miracle of luck and design! Every tree that lives long enough to reproduce has survived by fortuitous location, optimal physiology, and sequences of blind serendipity. The razor's edge upon which each individual organism is balanced must be recognized. Every influence no matter how small has the capacity to tip the fate of an individual organism in both positive (growth, survival, reproduction) and negative (inhibition, destruction, and death) directions. In a population, the laws of probability will cancel out the influences of the extremely random and the advantages of fortuitous genetics will usually be observed. Even incremental advantages in genetic and physiological "fitness" will be favored and conserved over time. But for the individual, almost anything can happen.

In a forest, in any ecosystem, all of these internal and external forces are exerting themselves simultaneously. A slow, uniformitarian process of genetic selection is occurring right along with the sudden, random, calamitous riot of catastrophism. Optimal genetics will benefit the population, but will not help the individual unlucky enough to be crushed by a landslide or swept away in the funnel of a passing tornado.

The Old Growth forests of North America were flickering in these dynamics of individual catastrophes and population change. The "stable, end-product" of succession was neither terribly stable nor close to any sort of a natural end point.

What did these forests look like?

Flagg (1872) said that Old Growth Forests all had a "universal dampness of the ground." Their soil surface was covered with a great abundance of leaf and woody litter that had accumulated steadily over the many years the forest existed. These organic materials were undergoing a slow and steady physical and chemical transformation via fragmentation and decomposition. The litter layer was thick and stratified and had at its lower interface with the upper layers of the mineral soil a dense, dark layer of humus.

The canopy of the forest shaded the forest floor and thus greatly slowed evaporation. The surface leaves of the litter layer were wet from rains that might have occurred weeks before, the underlying fragmenting and decomposing leaves were wet, the humus was wet, and the soil was wet. Huge volumes of rain water were stored in these organic layers. They acted like a great, ecological sponge that soaked up the initial rain and surface water, and then steadily released that water in between rain storms into the ecosystem's streams and runs. The wet leafy mould and soil also provided moisture for continued plant growth even during prolonged periods of drought. The hydrological benefits of these intact forest soil systems were profound.

A second growth forest (a forest that arises after an old growth forest is cut) "stands on drier foundation" (Flagg 1872). The thick, leaf litter and humus system is gone or significantly reduced because of the direct

impacts of logging or subsequent exposure to more intense sunlight (which accelerates organic decomposition and also dries the litter sufficiently to allow wind erosion). Rain drops are no longer dispersed by collisions with leaves and branches and are able to cause both the physical disruption of the litter materials and also the acceleration of water transport and erosion of both the litter and the soil. The reduced ability of the fragmentary over-story canopy to both disperse incoming rain and also hold moisture as water films on leaves and branches causes the forest to become increasingly dry.

Incoming rains directly flow through the forest system at rates significantly greater than previously seen in the old growth system. These rains then fill the streams of the forest's watershed more rapidly than previously seen (and these streams flow into the larger and larger rivers of the watershed at rates and water volumes much greater than previously observed). Heavy rains, then, have a greater potential to cause floods down the river systems of the altered forests.

Also, the lack of water retention in the disrupted forest "sponge" removes an important water source for the streams and runs of the forest ecosystem. In an old growth ecosystem these streams continue to flow between rain storms because they are fed by the steady water release from the forest soil's organic layers. In second growth ecosystems, these streams frequently run dry in between rain storms and cease to deliver appreciable water volumes to their larger, draining rivers.

Noah Webster ((1790) from Cronon 1983) noted the connection of dried up streams and springs and floods in New England following destruction of the old growth forests (I have taken the liberty to put Mr. Webster's unique spelling and syntax into a more conventional form):

"The amazing difference in the state of a cultivated and an uncultivated surface of the earth is demonstrated by the number of small streams of water which are dried up by clearing away forests. The quantity of water falling upon the surface may be the same, but when the land is covered with trees and leaves it retains the water. When it is cleared the water runs off suddenly into the large streams. It is for this reason that floods in the river have become larger, more frequent, sudden and destructive than they were formerly."

Old growth forests also contained many fallen trees. These trees, in the cool, shaded, moist environment of the forest floor were covered with mosses and fungi and were slowly rotting away. These fallen trees, depending on the nutrient and moisture dynamics of the forest, may even have been covered with growing plants including tree seedlings. In the maritime forests on the east coast barrier island of Assateague, for example, fallen, rotting trees lay on the very well drained (and therefore very dry), sandy soils of the system and are an important seed bed for the next generation of trees of the forest. These decaying "nurse trees" cause the seedlings to grow in straight lines and impose an unexpected geometric order to the subsequent forest. Possibly this phenomenon was also observed in the well drained, outwash soils that favored old growth white pine in Western Pennsylvania.

Growing on the trees in an old growth forests were abundant epiphytes (plants that grow on other plants) and, especially in cooler climates, lichens. Lichens in particular, because of their very slow growth rates and

very limited ability to disperse over appreciable distances, may be a particularly important sign of an old growth ecosystem. Fungi and their mushrooms also thrived in the shady dampness of an old growth forest, but the prodigious ability of these fungi to make spores and the distances these spores can travel in the wind probably preclude their place as features characteristic of Old Growth.

Thoreau (from Whitney 1994) noted the above features of primal forests. He described New England's old growth forests as having a "wild, damp, shaggy look" and being choked with "countless fallen and decaying trees."

Old growth forests should also have, and this feature seems so obvious that it might not need to be mentioned, old, and, therefore, large, trees. But, not all of the trees in an old growth forest were necessarily old and large. Kalm (1772) observing a primal forest in Eastern Pennsylvania observed that "there are very few tree of an uncommon age" and that many of these larger trees were in stages of rot and decay. Further, he noted, "several trees are likewise torn out with their roots by the power of the wind."

Most of the trees in an old growth forest, then, were only some proportion of their maximum ages and sizes. There were, though, always a few individual trees that either because of their particular genetic or physiological vigor or, and this is more likely, because of a perfect historical convergence of fortuitous events (or "non-events") were able to attain the great age and great size possible for their species. These giants, though, were always rare.

Finally, old growth forests had dense and complex undergrowth layers of vegetation. This undergrowth included the seedlings of the next generation, or iteration, of the forest. Parkman (1892) writing lyrically and, possibly under the intellectual influences of Darwin and Spencer, described the undergrowth of an old growth forest in New England as full of abundant seedlings "crowding, choking, and killing each other, perishing by the very abundance."

So, old growth forests were damp and had a thick litter and humus layer. They were full of downed trees that were coated with mosses and lichens. They contained at least some large, old standing trees well covered with epiphytes and lichens. They also had a well developed layer of undergrowth vegetation in which seedlings of the next generation or form of the forest were densely found.

I have identified nine Old Growth Forest sites in Western Pennsylvania (Davis 1996, Thwaites 1999, Ostanger 2000, Kershner and Leverett 2004). Each represents a small patch of forest that through random chances or survey uncertainties escaped the near total destruction of the pre-settlement forest. Each of these sites will be explored and described and specifically compared to our model of an Old Growth ecosystem. These descriptions will be published in 2009.

Old Growth Sites in Western Pennsylvania:

Group #1: Laurel Hill State Park, Sweet Root Natural Area, Ferncliff in Ohio State Park

Group #2: Alan Seeger Natural Area, Detweiler Run

Group #3: Tionesta Natural Area, Heart's Content, Ander's Run, Cook's Forest

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