

The Natural Farmer

Woodland Ecosystems - Spring 2002 Special Supplement on AgroForestry

by Jack Kittredge

As Bill Mollison describes so well in "Permaculture, A Designer's Manual", forests are unique ecosystems without which life on earth would be vastly different. A tree itself is a complex organism whose extension in space and time vastly alters its location. It has many zones with different purposes – crown, stem, leaves, roots. It functions as a huge oscillating pump, trapping the sun's energy in the leaves and pumping it downward, absorbing water and nutrients in the roots and pumping them upward. It regularly discards large amounts of soil-creating biomass, releases oxygen and water moisture into the atmosphere, moderates the ambient temperature, protects the soil from erosion and filters particulate matter from the wind.

Soil

Trees, whose roots reach deep into the underlying rock of most northeastern soils, break that rock down with both the mechanical force of root pressure and the chemical force of humic acids. They then take up the resulting minerals and other nutrients into their biomass as trunk, branches, leaves, roots, etc. Eventually this material is deposited back in the forest floor as organic matter to build the soil. Over a lifetime, trees shed many times their own mass to the soil in which they grow.

Air

Some scientists estimate that forests may be producing as much as 80% of the oxygen in our atmosphere. Deforested areas such as cities no longer produce the oxygen they consume. Besides the reactive chemical services that trees provide to air, they also clean it. Windstreams confronting a forest are partially deflected (about 60%) over it, and partly enter it. Before penetrating a mile into forests, this air is slowed to a standstill, resulting in a small temperature and humidity increase. In this process fine dusts and aerosols are removed within a few hundred yards of the forest edge and negative ions produced by organisms in the forest cause positively charged dust particles to aggregate and precipitate out. This windbreak effect of forests is crucial defending against wind erosion and maintaining soil in exposed areas like islands and on hills.

Temperature

Trees moderate temperature extremes. Air coming in over a forest is forced to rise and thus to cool. When it cools, however, some of the moisture in air is condensed out as precipitation, warming the

remaining air significantly. In addition, leaves are approximately 86% water and have a specific gravity twice that of soil – remaining cooler than it by day and warmer by night. On the whole, plants can be as much as 25 degrees F warmer than the surrounding air.

Water

Forests have an enormous impact on local moisture. A medium size elm will evaporate 15,000 pounds of water on a clear, hot and dry day. But on the whole, trees increase local precipitation — as has been demonstrated consistently through history from the Canary Islands to the Sahara Desert. Warmer air in forests rises toward evening, drawing in cooler, moisture laden air over bodies of water. Leaves provide a surface cooling effect that then condenses water vapor. The resulting condensation drip is estimated to be as much as 80% of the total precipitation in upland coastal areas and is a major contributor to such dense rainforests as those of Tasmania, Chile, Hawaii, the Pacific Northwest and Scandinavia. In addition to increasing precipitation, temperate forests can spread its effects around the year by delaying snow melt. Over 75% of snowfall in forested areas is held in shade and is given off slowly, to the soil, rather than melting rapidly in the Spring and running off as surface water.

Fungi

Trees have evolved in combination with another complex form of life, fungi. As Paul Stamets makes clear in this issue and elsewhere, it is hard to overestimate the importance of mushrooms in forest life. Their mycelia form a complex forking network of interwoven strands of cells that grow beyond the immediate tree's root zone, extending, in extreme cases, over many acres. The mycelial content of topsoil in a Pacific Northwestern Douglas Fir forest has been estimated to be as much as 10% of biomass! Each mycelium gives off enzymes which unlock organic compounds in the surrounding matrix, releasing carbon, nitrogen, and other elements that are then absorbed and concentrated directly into the network.

Most of this work occurs in the rhizosphere, the area where roots and soil come into contact. About a millimeter in width, it surrounds both tree root hairs and mycorrhizae (the mycelia of certain mushrooms which form a symbiotic relationship with the roots of host plants). At the boundary of the root hairs, soil and mycelia, so many cells interpenetrate each other it is not so much an interface as a jelly, constantly exchanging water, carbohydrates, organic acids, vitamins and other substances. Both fungi and tree benefit from this collaboration, and ecologists believe that a healthy forest is dependent upon the presence of an abundance and variety of mycorrhizal organisms.

Another role of fungi in forest life is the decomposition of wood. Trees are largely composed of lignin-cellulose tissue, which gives them the structural firmness to withstand the force of gravity. Saprophytic mushrooms have developed specific enzymes to break down lignin-cellulose into soil. Primary decomposers such as Shiitake, Oyster, and King Stropharia mushrooms grow quickly and send out rosy mycelium equipped to breakdown wood into compost. Then secondary varieties such as button mushrooms take over, further reducing the mass and concentrating the nitrogen of the material. Heat, carbon dioxide and various gases are given off as by-products of this stage. Finally, soil-dwelling varieties such as the Orange Peel mushroom can finish the process where nutrients remain to sustain fungal growth.

Because of their ability to rapidly decompose complex hydrocarbons into their basic constituent elements, fungi have recently been the focus of interest in decontaminating toxic waste sites. They can be used on-site without transporting the toxic material, a significant cost advantage over other

technologies. Varieties such as white rot fungi and brown rot fungi, which produce powerful lignin peroxidases and cellulases, are particularly efficient at such bioremediation. Others are under investigation for use in clean-up of radioactive wastes because of a talent at sequestering heavy metals.

Plants

Many plants with unique properties are at home in a forest. Many medicinal herbs, for instance, grow wild only in woodland settings. Often the medicinal aspect of the plant is related to some survival ability (pungent taste, powerful aroma, desensitizing chemical compound, etc.) which has proven of value in that complex environment. Obviously woody products such as black locust (for no-rot fence posts), rushes for basket weaving, barks for staining and dyeing, and greens for floral displays are grown in the woods.

While harvesting of many wild plants is no longer acceptable (and in many cases is illegal) because of declining populations, culturing such plants in a sustainable woodland setting is becoming an industry. In addition to the environmental and ecological advantages the northeastern farmer may encourage by proper attention to his or her woodlot, there are increasing opportunities to integrate that part of the farm into supporting the overall homestead.