Fall colors and environmental changes

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With autumn rapidly approaching, we in hilly New England are fortunate to witness spectacular displays of fall colors as the deciduous trees lose their leaves for the winter. This remarkable process gives us a brief ability to observe the interactions between the landscape characteristics and the tree communities. Because different species turn colors at different times, we can view the distribution of the various tree species as their populations rise and fall in response to changes in the environmental characteristics of the landscape. For instance, we will see the brilliant reds of the red maple most often in wet areas, and the green conifers will begin to stand out both in abandoned pastures and at higher elevations. These relationships illustrate a characteristic of plant communities that is increasingly important as we manage our forests in the face of environmental changes; species compete for growing space and respond to environmental factors that can vary in space and can change with time. When these factors change, as they do across a landscape, competitive relationships change and species composition shifts.

The most noticeable gradient of environmental change in our part of New England, with the exception of human-caused disturbances, is elevation-related. Many tree species will rise and fall in dominance, or the amount of the canopy that they occupy, in response to environmental characteristics that vary with elevation. Look at any mountainside when the leaves are turning and you will see changes in the abundance of each species as you gaze up, or down, the mountain. Sugar maples provide a good example, since the reds and oranges of their fall foliage is easy to discern and they tend to decrease in importance beginning around 2000 feet elevation. Many environmental factors, such as snowpack, growing degree-days, and soil depth, vary with elevation and this shifts the competitive relationships between the forest trees. In the case of sugar maple, the going begins getting tough around 2000 feet, and they are generally uncompetitive and absent by 2500 feet. In contrast, paper birch increases in importance across roughly the same elevation range, and the coniferous spruce and fir trees dominate by 3000 feet.

Most of the transitions in the forest are like the sugar maple and paper birch, gradual shifts in predominance in response to changing growing conditions across the landscape. Every organism has needs that it must meet – in the case of forest trees these are primarily water, nutrients, and sunlight – as well as vulnerable points in its life cycle, for instance seedling establishment, that it must complete in order to persist at a site. Each species' characteristics will mean that some sites are optimal, some marginal, and in

many the species might theoretically grow, but cannot compete with better-adapted species. Thus we see species distributions rise and fall along major environmental gradients in the landscape.

There are some more abrupt shifts, as well, and these also speak to the interactions between environmental conditions, tree life-cycles, and forest composition. Abandoned pastures are a good example of one of these more abrupt changes. Nineteenth-century New England had far more open farm and pasture than it does today, and far less forest. As agriculture declined in the region the farms gradually reverted back to forest, but with a significant change. While they were overwhelmingly in vegetation zones dominated by hardwoods, they often reverted to forests dominated by conifers. Why the change? The elevation gradient just discussed would clearly predict hardwoods, but an important factor changed. Where before the trees were competing for growing space with other trees in a forest environment, now they were up against grasses and some grazing in pastures. The competitive environment changed, and this shifted species composition.

So what does this tell us about our landscape, and, aside from giving us a little more to ponder as we marvel at the fall colors, what relevance does it have to our lives? First, it tells us that the factors that are important to trees vary across the landscape and different locations favor, or are difficult for, certain tree species. This is relevant because we live in times of rapid environmental changes, and these changes will alter the characteristics of sites and thus can change the competitive relationships between species. Where in the late 19th and early 20th centuries we had agricultural abandonment as a new twist to plant competition, we now have acid rain changing the soil chemistry. Sites low in calcium seem to be becoming less favorable for trees, like sugar maples, with relatively high calcium needs. Climate-related factors are also clearly important to some vegetation transitions, and many of those factors are changing as well. Forest composition is ultimately determined by which species compete best on a site, and human activities, largely through their effects on the atmosphere, are altering many site characteristics.

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