Southeastern Forests and Climate Change

TENNESSEE SUPPLEMENT

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This supplemental document is intended to accompany the Project Learning Tree Southeastern Forests and Climate Change Secondary Environmental Education Module (Monroe & Oxarart, 2015). It is intended for educators who are teaching their students about climate change with a focus on the forests of Tennessee, and it gives a general background on the state's forests, products, projected impacts of climate change, and pests. This supplement has been written in conjunction with the Kentucky Association for Environmental Education.

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KENTUCKY STATE UNIVERSITY

Tennessee Forest Background *(for general use and with activities #1, #3, #5, #13)*:

Tennessee forests are prized, much due to the efforts of Tennessee Division of Forestry over the past 100 years, for a great number of benefits including beauty, wildlife habitat, timber production, recreation, air and water quality, energy conservation, carbon sequestration, enhanced property values, storm water control, and natural heritage (Tennessee Division of Forestry, n.d.). The agro-forestry industry of Tennessee provides vital economic and ecological services to residents, generating $66.4 billion of economic impact to the state's economy and employing more than 337,880 people, or 9.6 percent of the total employed population (Tennessee Department of Agriculture, Department Report & Statistical Summary, 2011). Tennessee forests cover approximately 14 million acres, which is equivalent to 52 percent of the state (Tennessee Division of Forestry, n.d.). Tennessee is a leading producer of hardwood lumber products in the South and, in 2011, the total exported forest products outside the United States totaled close to $1.0 billion. Paper products had the highest export value at $682.3 million, followed by wood products ($180.1 million), furniture and related products ($90.6 million), and forestry and logging operations ($79.5 million) (Menard, 2013). Major countries receiving Tennessee's forest product exports include Mexico for paper products, China for wood products, and Canada for furniture, fixtures and logging (Menard, 2013). Tennessee, one of the top hardwood lumber producing states, generated 881 million board feet of hardwood lumber and 15 million board feet of softwood lumber in 2008 (Tennessee Division of Forestry, n.d.). In a report issued by the Tennessee Division of Forestry, Tennesseans identified the following themes as most pressing to the state's forests: wildfire, insect and disease, lack of proper management, and urban expansion (Tennessee Division of Forestry, n.d.).

The Trees and Products of Tennessee Forests *(for use with activities #3, #5, #12)*:

In the South, Tennessee is one of the top three leading production states for hardwood forest products that are sent across the country and around the world (Menard, 2013). The Tennessee forest ecosystem is dominated by oak/hickory, and includes the following species: white oak, red oak, hickory, yellow poplar, and maple as some of the more predominant hardwood species (Menard J. E., 2013). For softwoods, loblolly pine, Virginia pine, red cedar, and shortleaf pine are major species (Menard, 2013). Each of Tennessee's 95 counties contributes to the economic impact of its forests; there are more than 356 logging firms and 700 processing facilities across the state including sawmills, pulp and paper mills, as well as flooring, barrel, and cabinet manufacturers (Tennessee Division of Forestry, n.d.).

Potential Impacts of Climate Change on Tennessee Forests *(for use with activities #4, #5)*:

Tennessee has been dubbed the "Hardwood Capital of the World"

Time Required to Produce Various Products from Common Tennessee Trees

Ash (green and white)	Pulpwood 30-50 yrs. / Logs (handle stock, lumber) 40-70 yrs.
Maple, soft (silver and red)	Pulpwood 20-30 yrs. / Logs (lumber & veneer) 40-60 yrs.
Maple, hard (includes sugar)	Logs (lumber & veneer) 40-90 yrs.
Oak, upland	Posts 20-30 yrs. / Logs (lumber & veneer) 40-80 yrs.
Oak, bottomland	Logs (lumber & veneer) 40-70 yrs.
Poplar, yellow (tulip)	Pulpwood 20-30 yrs. / Logs (lumber & veneer) 40-60 yrs.
Pine, eastern white	Christmas trees 7-10 yrs. / Pulpwood 15-25 yrs. / Logs 40-80 yrs.
Pine, loblolly	Pulpwood & posts 15-30 yrs. / Poles & piling 35-50 yrs. / Logs 40-60 yrs.
Pine, Virginia	Christmas trees 8-15 yrs. / Pulpwood & posts 15-25 yrs. / Logs 40-60 yrs.
Pine, shortleaf	Pulpwood & posts 20-30 yrs. / Poles & piling 40-50 yrs. / Logs 40-79 yrs.
Red cedar, eastern	Christmas trees 8-15 yrs. / Pulpwood & posts 25-35 yrs. / Logs 40-80 yrs.
Walnut	Logs (lumber & veneer) 40-80 yrs. / Nuts 12+ yrs. (30-130 yrs. best)

Source: Tennessee Division of Forestry, 2014

for good reason—the state is the number one producer of hardwood flooring and is ranked second in the United States in hardwood lumber production (US Department of Commerce, Economics and Statistics Administration, 2005a). To date, research on effects of climate change on forests have focused on changes in distribution of individual tree species, abundance, richness, and community types (Iverson and Prasad, 1998; Iverson et al., 1999; Schwartz et al., 2001; Iverson and Prasad, 2001; Iverson et al., 2004; Iverson et al., 2005; McKenney et al., 2007; Iverson et al., 2008). In addition to native forest tree species, some exotic species may also change in distribution and abundance (Simberloff, 2000).

Forest productivity is influenced by various environmental factors; slight increases in temperature or precipitation can stimulate forest growth. Higher concentrations of carbon dioxide also can increase productivity through "carbon fertilization" (Fuhrer, 2003). One study found that a 50 percent increase in concentration of atmospheric carbon dioxide resulted in a 23 percent increase in forest productivity (Zhang, 2007). If such an increase occurred, it would add nearly $8.7 billion to the state's economy by increasing forest output (Regional Economic Studies Institute at Towson University, 2008). A 50 percent increase of atmospheric carbon dioxide, however, would cause a 5° F increase in global temperature that could cause catastrophic changes in sea levels, temperatures, and precipitation and lead to a major disruption of the global economy (Metz, 2008). Such pronounced climatic changes are likely to counteract any potential benefit to the state's economy; thus, the net effect on Tennessee forestry sector production remains uncertain (National Conference of State Legislatures and the University of Maryland's Center for Integrative Environmental Research, 2008). In addition, at some point, increases in tree growth due to increased carbon dioxide will slow or disappear if growth becomes limited by other factors such as reduced soil nutrients or water availability.

Specific impacts on tree growth and mortality, forest insect or disease epidemics, and the associated economic gains or losses are difficult to assess, and it is expected that most forest management responses will occur after an impact is observed (U.S. Global Change Research Program, 2014).

Pests in Tennessee's Forests *(for use with activities #3, #4)*:

There has been an increase in forest disturbances including the extent and virulence of insects and pathogens due to increased tree stress, changes in phenology, and a change in insect and pathogen lifecycles (U.S. Global Change Research Program, 2014). There are a number of threats to Tennessee's rural and urban forests, including the hemlock woolly adelgid, southern pine beetle and gypsy moth, which are all common pests of Tennessee forests.

The hemlock woolly adelgid, *Adelges tsugae*, an insect species native to Asia, was first identified in the eastern United States in the early 1950s in Richmond, VA (Ward, 2002). In the South, it is currently established in the mountains around the Shenandoah Valley and is spreading southward along the Blue Ridge Mountains affecting eastern hemlock trees (Ward, 2002). Eastern hemlock is an important component of riparian ecosystems, providing cooling shade for streams, contributing nutrients for streams through litterfall, and providing winter shelter for wildlife (Ward, 2002). It may also be important as a feeding and nesting niche for neotropical migrant birds (Rhea and Watson, 1994). Once infested by the adelgid, hemlocks are weakened, gradually defoliate, and become unable to refoliate or to produce cones (Ward, 2002). Mortality occurs after complete defoliation, generally within 5 years of initial infestation (McClure, 1987). It appears that all untreated hemlocks, with the possible exception of small geographically isolated populations, could eventually be killed by the adelgid (Rhea, 1996).

The southern pine beetle (SPB), *Dendroctonus frontalis*, is the most destructive insect pest of pine forests in the South (Thatcher and Conner, 1985). Populations build rapidly during periodic outbreaks and kill large numbers of trees. Average annual losses may exceed 100 million board feet of sawtimber and 20 million cubic feet of growing stock (Ward, 2002). From 1991 to 1996, total value of trees killed by SPB in the southern United States was estimated at $493 million (Price and others, 1998). The SPB, which attacks all species of pines, prefers loblolly, shortleaf, Virginia, pond, and pitch pines but seldom attacks longleaf pine. Recently, SPB has been observed to successfully infest white and Table Mountain pines (Ward, 2002). Mature trees in pure, dense stands have long been considered most susceptible to SPB attack, but in recent years unthinned pine plantations have increasingly supported SPB infestations (Ward, 2002). Currently a catastrophic infestation of SPB is threatening pines in Virginia, Kentucky, Tennessee, North Carolina, and Georgia (Ward, 2002).

The gypsy moth, *Lymantria dispar*, is native to Europe and Asia. In 1869, Leopold Trouvelot introduced the European strain of the gypsy moth into the United States (Ward, 2002). Since then, it has spread across the landscape of the eastern United States, defoliating vast acreages of forest. The insect spread into northeastern Virginia in the early 1980s (Ward, 2002). By the middle 1990s, it had reached the eastern seaboard of North Carolina, and had infested much of Virginia (Ward, 2002). At the insect's current rate of spread, specialists predict that a significant portion of the Southeast will be infested in the next 30 years (Ward, 2002). The gypsy moth causes damage by feeding on and defoliating forest and shade trees during the caterpillar stage (Doane and McManus, 1981; U.S. Department of Agriculture Forest Service and Animal and Plant Health Inspection Service, 1995). Caterpillars feed on a wide range of trees and shrubs (Liebhold and others, 1995; Zhu 1994) but prefer oaks. Management of gypsy moth utilizes three strategies: eradication, suppression, and slowing the spread (Gottschalk, 1993; U.S. Department of Agriculture Forest Service and Animal and Plant Health Inspection Service, 1995). Eradication concentrates on the elimination of gypsy moth populations outside the quarantined area. Suppression concentrates on managing gypsy moth populations in the quarantine area to limit defoliation. Slowing the spread concentrates on limiting population spread along the leading edge of the quarantine area (Ward, 2002).

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