

FLOODPLAIN ECOSYSTEMS OF THE SOUTHEAST: LINKAGES BETWEEN FORESTS AND PEOPLE

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Abstract: Floodplain forests are critically linked to society's welfare and will rise immensely in value as water related issues become increasingly important. Although progress has been made in promoting the importance of floodplain wetlands to the public and in successfully manipulating wetland systems toward particular goals, we are still quick to generalize and may neglect some of the complexities of these systems during our research, management, and restoration efforts. Within the Southeast, floodplain inundation varies from near constant to none, and forest net primary productivity (NPP) ranges from near the highest of the temperate zone to among the lowest. The complex entanglements of hydroperiod and all other floodplain forest processes and traits are daunting. Our greatest challenge may be to understand and base actions on societal influences and landscape evolution within watersheds and floodplains. It will become increasingly less relevant to study, manage, or try to restore portions of floodplains without due consideration of past, current, and future socioeconomic drivers and land use trends within basins and watersheds. The human footprint on these critical systems has been very distinct for the last 200–300 years; now, it is becoming enormous and must be fully taken into account if we are to be successful in maintaining significant amounts of floodplain forests in the Southeast.

Key Words: forest floodplains, legacy impacts, land use, societal linkages

INTRODUCTION

Humans have been integral components of floodplain forest and riverine swamp ecosystems of the southeastern United States since the region was first inhabited more than 10,000 years ago (Hudson 1976). Humans have consistently modified floodplain forests to varying degrees with those modifications becoming more pronounced after European colonization and as technology advanced (Fredrickson 2005). Regardless of the nature of the interactions, the quality of human life has always been closely associated with rivers and riverine forests. However, that linkage has become much more complex and less direct as southeastern society evolved from Native American culture, through early European colonization and the industrial age, toward an increasingly urbanized population. Economic benefits have always flowed from these ecosystems; however, as our dependence has become less obvious, the tendency to take these forests for granted has increased.

Floodplain Forests Prior to Major Manipulations

Early accounts of floodplain and swamp forests from the first two centuries following European

contact indicate that floral and faunal species diversity was pronounced (Bartram 1791), standing crops of aboveground forest biomass were quite large (Bakeless 1961 describing the De Soto expedition of 1528), and that cultivated as well as abandoned fields along floodplains were quite common (Bartram 1791, Bakeless 1961, Hudson 1976, King et al. 2005). For example, along the present-day Chattahoochee River in Georgia, Bartram observed *Platanus occidentalis*, *Liriodendron tulipifera*, *Populus deltoides*, *Laurus* sp., *Ulmus* sp., *Salix nigra*, *Ammona glabra*, *Fraxinus* sp., *Quercus* sp., *Juglans nigra*, *Fagaceae* sp., and *Symplocaceae* sp. He also emphasized the large size of some floodplain trees, e.g. 'Platanus, populus, Liquidamber, and others are by far the tallest, straightest – most enormous that I have seen' (description of trees in Mobile River Delta). Similarly, Bartram noted that the floodplain of the present-day Apalachicola River in Florida 'abounds with excellent fish; the forests and meadows with wild game, as bear, deer, turkeys, quail, and in the winter, geese, ducks, and other fowl'.

Hudson (1976) refers to Native American agriculture in the Southeast as primarily riparian in nature given the close proximity of many towns and villages (and, consequently, fields) to streams and

ivers. The alluvial locations were critical in sustaining production of their principal staple, corn, a relatively nutrient demanding crop. Sustained production around large towns could occur only with periodic influx of fertile alluvium from flooding.

Native American cultivation techniques in the Southeast often consisted of ‘working up small hills a foot or more in diameter’ (Hudson 1976). Corn was planted on these mounds which were laid out roughly in lines. Squash, beans, and other crops were grown between the corn mounds. This style of cultivation would entail minimal soil disturbance and, probably, little soil export occurred during sheet flow events. In the Southeast, abandoned fields would have quickly revegetated, as evidenced by Bartram’s descriptions of grass and shrub occupation of what were probably recently abandoned areas.

In addition to fields and forests, another feature of floodplains that must have been very common given the frequency with which these were noted in early accounts were canebrakes. ‘Expansive plains of Cane meadows’ (Bartram 1791), ‘impenetrable breastwork of dense green’(US Dragoon in Arkansas, early 19th century as cited by Bakeless 1961), ‘well nigh impenetrable to a man on horseback’ (Roosevelt 1908)) were some of the expressions used to describe these plant communities. Bartram (1791) noted one such brake in Florida as ‘the most extensive – to be seen on earth – appears to have no bound but the sky’ and identified the cane as *Arundo gigantea*. In the Mobile River Delta, he recorded cane 9–12 m in height and 7–10 cm in diameter. According to Bakeless (1961), a canebrake might extend as far as 160 km with a width of 5 km and Hudson (1976) observed that cane often occupied better drained areas that were potentially productive sites for corn. Consequently, from the perspective of those considering land clearing for cultivation, canebrakes may have represented the most easily accessible locations since they were easier to clear than forests (Roosevelt 1908).

Canebrakes had provided valuable habitat for a number of wildlife species. In particular, Bachman’s warbler (*Vermivora bachmanii*) was closely linked to the cane and loss of those systems is thought to be major contributor to the species’ radical decline or extinction (King et al. 2005).

Most Europeans explorers and colonists did not place much value on floodplain and swamp forests. This was, in part, due to the utilitarian philosophy which, out of necessity in a time of low standards of living, valued New World forests in direct proportion to practical aspects of human welfare and

economy. Also, mild repugnance was sometimes evident in their descriptions of these forests. As an example, Philip Henry Gosse, an English tutor who appreciated and recorded many aspects of natural flora and fauna in western Alabama, used the following descriptors in characterizing a cypress – tupelo swamp there: ‘gloom, savage, somber, dismal, half-tepid, stagnant, ragged, dreariness, and desolation’ (Gosse 1859).

A philosophical dichotomy regarding southern swamps and floodplain forests is evident in Theodore Roosevelt’s description of the Tensas River floodplain of Louisiana in 1907. Roosevelt, a leading conservationist of the period, clearly marveled at the broad array of flora and fauna observed there and at the ‘towering majesty’ of the trees. However, he also observed that the trees of this floodplain had little value since they were difficult to harvest. He added that the area was unsuitable for settlement as long as unpredictable floods could strike but that ‘soon, the chances of disaster from flooding will be over’ (Roosevelt 1908), an apparent reference to construction of levee systems on the Mississippi and other rivers.

Conversions and Stand Level Utilization

The clearing and draining of wetlands for conversion to agriculture over several centuries clearly represents the most pronounced human signature on the floodplain and swamp forest environments. In combination, the need for improvement in standards of living and repugnance of ‘wet’ forests served as catalysts for eradication and utilization of these systems. Efforts to drain ‘swamps and overflow lands’ for implementation of agriculture were numerous but scattered from the early 17th to the late 18th century. As examples, in 1754, South Carolina authorized the drainage of Cacaw Swamp for agriculture and in 1763, George Washington and the Dismal Swamp Land Company undertook the drainage of the latter wetland system (Dahl and Allord 1996). The primary limitation to these efforts was the dependence on hand labor; however, once technological developments such as the steam engine occurred in the early 19th century, the extent of wetland drainage increased substantially (Dahl and Allord 1996).

In 1850, the Swamp Lands Act (<http://douglass.vcdh.virginia.edu/history/engine>) was passed to transfer federal ownership of swamp and overflow land to the States for facilitation of ‘reclamation’ into farmland. Apparently, this and other similar efforts were deemed insufficient by many so that a First National Drainage Congress (NY Times, April

11, 1913: <http://query.nytimes.com>) was formed in 1912 to 'revive interest in drainage and reclamation of non-arable land in the United States'. In addition, the introduction of soybeans around 1925 provided an agricultural crop with the capacity to grow on soils that were too wet for cotton or corn (Fredrickson 2005). Consequently, acreage that had previously been of marginal interest for agriculture could now be converted and utilized.

As a result of these and other efforts, over half of the wetlands in the US were lost between 1600 and 1985 (Dahl and Johnson 1991). Of the original four million hectares of bottomland hardwoods in the Southern US, only about one million remain at present. As King et al. (2005) have pointed out, it is also important to note that, in addition to removing vegetation, the drainage, levees, and other engineering modifications associated with agricultural conversion altered hydrology and consequently caused major degradation of function as well.

During the same time period (i.e., 1600–early 19th century), logging was actively practiced in many areas that were not converted to agriculture. From the time of colonization until the advent of the steam engine, these activities were primarily confined to better drained floodplain sites during periods of non-flooding. In those areas, manual labor combined with mule, oxen, and river transport were effective in extracting many deciduous species. The arrival of the steam engine allowed the development of logging systems that utilized cables from pull-boats (Mancil 1980) or steam 'donkey' engines to extract logs over long distances. These were more adaptable to wetter sites and enhanced access to the baldcypress-tupelo (*Taxodium distichum-Nyssa aquatica*) systems.

The availability of steam powered railroads and cable logging systems greatly accelerated harvesting in the late 19th and early 20th centuries and the impacts on floodplain forests have been referred to catastrophic (King et al. 2005). However, the longterm impact of logging on residual floodplain and swamp forests may vary depending on the particular functions of interest. There is no doubt that there have been major changes in age class distributions following logging of old growth systems and that the largest trees, if accessible, were the primary targets. Consequently, when feasible, large, old growth hardwoods and baldcypress were removed.

Changes in structure and age class distributions in second growth forests altered the composition of bird communities (Dickson 1999). Some species such as the ivory-billed woodpecker (*Campephilus principalis*) were eliminated or populations were drasti-

cally reduced (Fitzpatrick et al. 2005) as old growth was removed. Shifts in tree species composition have been noted as well. Early harvesting focused on species and tree sizes of most value and, consequently, many residual floodplain forests lack the magnitude of oak component that was present prior to cutting. This practice, called high-grading, is less common today but was often the rule rather than the exception well into the 20th century on Southern floodplains (Putnam et al. 1960).

As specialists have long been aware, changes in wetland hydroperiods have the potential to significantly alter functions of particular systems. Some of the log extraction methods called for digging canals for operation of the pull boats and, consequently, concerns regarding the effect of those canals on hydrologic processes may be raised. It is possible that some areas in close proximity to the canals were better drained for an indefinite time period. However, the canals may have been sufficiently far apart so that overall system effects were minimal. On a smaller scale, residual ditches from cone skidding (use of a large metal cone placed over the end of logs to facilitate their movement across wet areas) are evident in many floodplains and swamps of the Southeast. As an example, soil wetness categories near old cone ditches in the Mobile River Delta seem similar to those of areas that are not in close proximity to the ditches.

Evaluations of ground and aerial techniques used in current harvest methods have indicated that most floodplain functions related to water filtration, herpetofaunal habitat, and NPP are minimally affected as long as best management practices are followed and regeneration occurs rapidly (Lockaby et al. 1997a). It is likely that, while historical logging caused alterations in some key traits, other critical functions of floodplain forests were maintained.

Catchment Level Impacts

While impacts of clearing, draining and logging were particularly evident at the stand level, human activities were also underway on upland areas surrounding the floodplains and swamps. These offsite, catchment or basin scale activities have had profound impacts on residual lowland forests. Foremost in terms of impact was the 'cotton era' which extended from approximately 1820–1930 in the Southeast. As cotton became profitable, forestland was cleared and plowing began over extensive areas, including uplands. Not surprisingly, major erosion occurred and soil was exported into streams and riparian areas. This was particularly true in the Southern Piedmont physiographic region where

clayey upland soils, significant slopes, and reduced surface roughness from farming combined to essentially lower the Piedmont landscape by up to 0.1–0.3 m (Trimble 1974). Much of the eroded soil was deposited in headwater areas within stream channels and on associated floodplains. Channels were elevated considerably and streams meandered across floodplains, increasing the wetness of those areas. Eventually, downcutting occurred and streams became channelized again, albeit in a highly incised manner (Trimble 1974). As a result, existing floodplain trees were subjected to burial of stem bases and increased wetness. Although few comparative data are available, it is probable that significant shifts in tree species composition and other attributes occurred in many floodplain forests. Similarly, the hydrology and biotic integrity of streams was likely altered as well.

A great deal of the agricultural legacy sediment remains evident today. Sedimentation studies in the Georgia Piedmont have indicated that approximately 1.6 m of historical sediment remains on the Murder Creek floodplain (Jackson et al. 2005). Jackson et al. estimated that approximately 6,000–10,000 years would be required for the mass of historical sediment to be exported from the watershed at current rates. Similarly, investigations in the upper coastal plain of Georgia reveal significant depths of legacy sediment accumulation along Bonham Creek (unpublished data - Felipe Casarim, Auburn University). In the latter system, 1.5–2.0 m of clayey sediment has accumulated atop a sandier layer that is thought to be the historic floodplain surface. Partially decayed roots and stumps are common within the uppermost portion of the sandy material, indicating that the zone became anaerobic relatively quickly as sediment was deposited. Within the stream channel of nearby Sally Branch, similar clayey sediments are to be seen although those are clearly being exported, a process that has exposed the original stream bed in the lower portion of the watershed.

Conceptually, we understand that sediment influx to a floodplain forest can be either a stress or a subsidy in terms of growth resources for vegetation (Megonigal et al. 1997). However, the threshold at which that switch occurs remains very unclear. In headwater riparian forests in the upper coastal plain of Georgia, average sediment accumulation of 0.2–0.3 cm year over a 25 yr period has been shown to reduce above- and belowground net primary productivity as well as rates of nutrient circulation (Cavalcanti and Lockaby 2005, 2006). Similar rates of sedimentation can be found in several southeastern floodplain forests and, consequently, there is a

risk that these systems may degrade as sediment influx increases in association with catchment level land use changes (Lockaby et al. 2005).

As an example, the forests along the Cache River floodplain in Arkansas represent highly productive, intact systems that have not been subjected to logging disturbance for many years (Gorham et al. 2002, King et al. 2005). However, approximately 70–80% of the Cache basin is in agriculture and, consequently, sediment loads in the river and deposition on the floodplain are very high (Kleiss 1996). Whether or not that deposition, over many years, may represent a stress to the Cache forests is unclear but represents a critical consideration as we categorize floodplain systems according to our perception of degree of disturbance.

Dikes, Dams, and Roadways

In conjunction with clearing floodplains for farming, dikes were often built to protect cultivated areas from flooding. These were designed to retain floodwaters between the dikes on both sides of the river and, consequently, flood velocity and depth would be increased within that zone. Conversely, the areas outside the dikes became drier. As an example, portions of the Flint River floodplain near Fort Valley, Georgia were diked in the mid-19th century and the legacy of the historic alterations in hydrology is still evident in the species composition of the forests that have regenerated there (Lockaby et al. 1997b). Often one of the major questions in some restorations of riverine wetlands is whether to ‘break the dike’ and restore the original hydrology (Sparks et al. 1998).

The rate of major dam construction in the Southeast accelerated during the 1930s (Dahl and Allord 1996) with the formation of Tennessee Valley Authority and expansion of the US Army Corps of Engineers. Numerous dams were built from that period through the 1970s and many hectares of floodplain forests were destroyed as a result. As an example, the construction of the dam for the Santee-Cooper Lake in South Carolina required the permanent flooding of 72,000 hectares of timberland during the 1930s (<http://www.santeecooper.com/historyofsantee-cooper/>).

Following colonization, the earliest passages across streams and rivers in the Southeast utilized ferries and a limited number of wooden bridges. One of the early bridges built across significant expanses of floodplain forest was the 1800 m long bridge across the Warrior River near Colquitt, Georgia (Georgia State Archives) which was active in 1900. These bridges often did not involve major embank-

ments or other structures that restricted the hydrology of the riverine wetlands so that influences on the forests were very minor. However, later construction techniques for bridges and roadways utilized embankments that sometimes constrained the width of the floodplain and changed velocities and hydrographs during sheetflow events. Such alterations in hydrology due to the presence of roadways have been shown to impact growth rates of floodplain tree species (Young et al. 1995).

Current and Future Trends

Almost 80% of the floodplain forest resources in the Southeast have been lost due to conversion to other uses, flooding by dams, and other causes (Haynes and Moore 1988). Traditionally, agricultural conversion has been the dominant cause of wetland loss in the United States. However, since 1992, urbanization has accounted for most wetland losses nationally (Hansen 2006) and is currently the primary cause of wetland loss in the Southeast (Faulker 2004). Although rates of forested wetland loss have diminished since land clearing for agriculture became less profitable, threats to existing systems remain significant. Generally, these threats can be separated into two categories: on-site and catchment level.

Loss statistics measure on-site conversions and the future magnitude of those losses is difficult to project. In spite of protection measures such as the Coastal Management Act of 1972 (NOAA://coastalmanagement.noaa.gov), as a species, humans are drawn to live near the water and so, rising rates of residential development will put increasing pressure on remaining floodplain forests. This is particularly true near coastal areas where urbanization rates remain very high (Bourne 2006).

At the catchment level, it is clear that landscapes in much of the Southeast have transitioned from forest-agricultural mosaics toward forest-development patterns (Wear and Greis 2002). This is particularly true from the middle of northern Alabama eastward through Georgia, Florida, both Carolinas, and Virginia. To the west, in Mississippi and Louisiana, there have been net increases in forests as some agricultural fields have been converted to tree cover.

The 2020 projections of Wear and Greis (2002) clearly indicate that urbanization is the primary cause of forest loss and that considerable losses (and, conversely, development) will occur in many Southeastern river basins. A comparison of the locations of projected forest losses (Wear and Greis 2002) with the southeastern river basins described in

Benke and Cushing (2005) suggests that basins such as the Coosa, Tallapoosa, Chattahoochee, Flint, Savannah, Santee, Great Pee Dee, Roanoke, and James (among others) will undergo significant urban development in the next 12 years.

As forest cover declines and impervious surfaces increase in the headwaters of these basins, we can expect significant alterations in hydrology and sediment loads. Watershed proportions as low as 10–15% impervious surface have been documented as a threshold beyond which water quality and hydrology are likely to degrade (Schueler 1995). Although catchment level impacts can degrade forests relatively quickly (Cavalcanti and Lockaby 2006), these changes are more subtle than on-site conversions and may not receive the consideration warranted. Given the nature of the urbanization impact, i.e., high persistence and wide departures from natural habitat (Faulkner 2004), it is imperative that both on-site as well as catchment level impacts be anticipated and addressed. Otherwise, while floodplain forests will continue to exist, many will undergo degradation of structure and function as the southeastern landscape continues to evolve.

CONCLUSIONS

In the Southeast, the link between forested floodplains and people has always been very strong. Goods and services from these ecosystems have maintained or increased the quality of life in the region for centuries. However, during the last 200 years, the linkages have become less obvious, more complicated, and more easily taken for granted. Simultaneously, human impact on these systems has increased dramatically. As the interrelationships have become less distinct, it has been easier to overlook our dependence on riverine forests and allow a significant fraction to become lost or degraded.

One way to protect and ensure sound management of our remaining forested floodplains is to re-establish obvious, direct ties between society and those ecosystems. The ties should be so obvious, as once was the case, that there is no chance for overlooking critical benefits. Although this would be a complex undertaking, a contribution toward that goal could entail embracing the opportunities afforded by real valuation of ecosystem services. If the ecosystem or water quality service concept became real in a financial sense, the value of forested floodplains could not be overlooked. Society would either pay or be paid for water quantity and quality services derived from forests and conservation measures (Pires 2004). Consequently, it would be

in the interest of society to maintain, protect, and enhance the ecological basis from which water quality services are generated. In a very real sense, our linkages to and dependence on floodplains would be obvious once again. Perhaps this would provide a significant incentive for maintaining forested floodplains during the major changes in store for Southeastern landscapes.

LITERATURE CITED

- Bakeless, J. 1961. *America as Seen by its First Explorers*. Dover Publishing, New York, NY, USA.
- Bartram, W. 1791. *Travels of William Bartram*, M. Van Doren (ed.) 1928 edition. Dover Publishing, New York, NY, USA.
- Benke, A. C. and C. E. Cushing. 2005. *Rivers of North America*. Elsevier Academic Press, Amsterdam, Netherlands.
- Bourne, J. K. 2006. America's coasts: land on the edge. *National Geographic*. July. <http://ngm.nationalgeographic.com/ngm/0607/feature2/index.html>.
- Cavalcanti, G. G. and B. G. Lockaby. 2005. Effects of sediment deposition on fine root dynamics in riparian forests. *Soil Science Society of America* 69:729–37.
- Cavalcanti, G. G. and B. G. Lockaby. 2006. Effects of sediment deposition on aboveground net primary productivity, vegetation composition, and structure in riparian forests. *Wetlands* 26:400–409.
- Dahl, T. E. and C. E. Johnson. 1991. *Wetlands – status and trends in the conterminous United States, mid-1970s to mid-1980s*. U.S. Fish and Wildlife Service, Washington, DC, USA.
- Dahl, T. E. and G. J. Allord. 1996. *History of wetlands in the conterminous United States: National Water Summary on Wetland Resources*. USGS Water Supply Paper 2425. US Geologic Survey. Washington, DC, USA.
- Dickson, J. G. 1999. Birds of the southeastern United States: a historical perspective. p. 233–243. *In* G. W. Benz and D. E. Collins (eds.) *Aquatic Fauna in Peril: the Southeastern Perspective*. Lenz Design and Communications, Decatur, GA, USA.
- Faulkner, S. 2004. Urbanization impacts on the structure and function of forested wetlands. *Urban Ecosystems* 7:89–106.
- Fitzpatrick, J. W., M. Lammertink, M. D. Luneau, T. W. Gallagher, B. R. Harrison, G. M. Sparling, K. V. Rosenberg, R. W. Rohrbaugh, E. C. H. Swarthout, P. H. Wrege, S. B. Swarthout, M. S. Dantzker, R. A. Charif, T. R. Barksdale, J. V. Remsmon, S. D. Simon, and D. Zollner. 2005. Ivory-billed woodpecker (*Campephilus principalis*) persists in continental North America. *Science* 308:1460–62.
- Fredrickson, L. H. 2005. Contemporary bottomland hardwood systems: structure, function, and hydrologic condition resulting from two centuries of anthropogenic activities. p. 19–35. *In* *Ecology and Management of Bottomland Hardwood Systems: The State of Our Understanding*, L. H. Fredrickson, S. L. King, and R. M. Kaminski (eds.) University of Missouri – Columbia. Gaylord Memorial Laboratory Special Publication No. 10.
- Gosse, P. H. 1859. *Letters from Alabama*. University of Alabama Press, Tuscaloosa, AL, USA.
- Haynes, R. J. and L. Moore. 1988. Reestablishment of bottomland hardwoods within National Wildlife Refuges in the Southeast. p. 95–103. *In* J. Zelazny and J. S. Feierabend (eds.) *Increasing Our Wetland Resources*. National Wildlife Federation Conference, Washington, DC, USA.
- Hansen, L. 2006. Wetlands: status and trends. p. 42–49. *In* K. Wiebe and N. Goolehorn (eds.) *Agricultural Resources and Environmental Indicators*. Economic Information Bulletin No. (EIB-26), July 2006. USDA - Agricultural Research Service. Washington, DC, USA.
- Hudson, C. 1976. *The Southeastern Indians*. University of Tennessee Press, Knoxville, TN, USA.
- King, S. L., J. P. Shepard, K. Ouchley, J. A. Neal, and K. Ouchley. 2005. Bottomland hardwood forests: past, present, and future. p. 1–17. *In* L. H. Fredrickson, S. L. King, and R. M. Kaminski (eds.) *Ecology and Management of Bottomland Hardwood Systems: The State of Our Understanding*. University of Missouri – Columbia. Gaylord Memorial Laboratory Special Publication No. 10.
- Jackson, C. R., J. K. Martin, D. S. Leigh, and L. T. West. 2005. A southeastern piedmont watershed budget: evidence for a multi-millennial agricultural legacy. *Journal of Soil and Water Conservation* 60(6):298–311.
- Lockaby, B. G., R. Governo, E. Schilling, G. Cavalcanti, and C. Hartsfield. 2005. Effects of sedimentation on soil nutrient dynamics in riparian forests. *Journal of Environmental Quality* 34:390–396.
- Lockaby, B. G., J. A. Stanturf, and M. G. Messina. 1997a. Effects of silvicultural activity on ecological processes in floodplain forests of the southern United States: a review of existing reports. *Forest Ecology and Management* 90:93–100.
- Lockaby, B. G., R. G. Clawson, K. Flynn, R. Rummer, S. Meadows, B. Stokes, and J. Stanturf. 1997b. Influence of harvesting on biogeochemical exchange in sheetflow and soil processes in a eutrophic floodplain forest. *Forest Ecology and Management* 90:187–94.
- Mancil, E. 1980. Pullboat logging. *Journal of Forest History* 21:135–41.
- Megonigal, J. P., W. H. Conner, S. Kroeger, and R. R. Sharitz. 1997. Aboveground production in southeastern floodplain forests: a test of the stress – subsidy hypothesis. *Ecology* 78:370–84.
- Pires, M. 2004. Watershed protection for a world city: the case of New York. *Land Use Policy* 21:161–75.
- Putnam, J. A., G. W. Furnival, and J. S. McKnight. 1960. *Management and inventory of southern hardwoods*. Agric. Handbook No. 181. USDA Forest Service. Washington DC, USA.
- Roosevelt, T. 1908. *In the Louisiana Canebrakes*. Scribner's Magazine 43:47–60.
- Schueler, T. 1995. The importance of imperviousness. *Watershed Protection Techniques* 1:100–11.
- Sparks, R. E., J. C. Nelson, and Y. Yin. 1998. Naturalization of the flood regime in regulated rivers. *BioScience* 48:706–20.
- Trimble, S. W. 1974. *Man Induced Erosion on the Southern Piedmont: 1700–1970*. Soil Water Conservation Society, Ankeny, IA, USA.
- Wear, D. N. and J. G. Greis. 2002. *Southern Forest Resource Assessment*. Technical Report GTR SRS-53. USDA Forest Service. Asheville, NC, USA.
- Young, P. J., B. D. Keeland, and R. R. Sharitz. 1995. Growth response of baldcypress to an altered hydrologic regime. *American Midland Naturalist* 133:206–12.

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