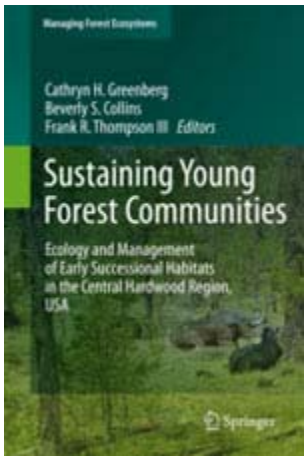
Sustaining Young Forest Communities: Ecology and Management of Early Successional Habitats in the Central Hardwood Region, USA



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Oaks and hickories characterize the Central Hardwood Region, with its temperate, humid climate and deep soils. Several xerophytic species characterize stands on xeric sites; mesic sites usually have greater diversity of oaks and hickories and include maple, ash, beech, and yellow-poplar. Ice and wind storms are common disturbances across the region; wildland fires ignited by lightning are uncommon and generally confined to small, stand-size areas. Variable environmental conditions, topography, and forest species compositions from the eastern Appalachians to the western Ozarks can require different silvicultural prescriptions to create early successional habitats, even in stands of similar appearance.

3. Natural Disturbances and Early Successional Habitats. Peter S. White, Beverly Collins, Gary R. Wein

Largely a legacy of stand-replacing human disturbances, today's central hardwood forests exhibit a narrower range of stand ages and structures than those in the presettlement landscape. Although natural disturbance types and frequencies vary within the region, large stand-replacing natural disturbances have always been infrequent; typical return intervals in excess of 100 years are longer than current forests have existed. Many present-day stands are dominated by early to mid-successional species in the overstory and late successional species in the understory; natural disturbances often serve to increase dominance of the understory late successional species, unless they are severe enough to disturb the canopy, forest floor, and soil. In any case, only the most severe natural disturbances or combinations of disturbances (including human disturbance) initiate large patches of early successional vegetation. Will the amount and spatial arrangement of early successional habitats created by natural disturbances be sufficient to meet management goals? We do not have the information to answer this question at present; the answer is further complicated by the potential effects of climate change on the rates and intensities of natural disturbances.

4. Fire in Eastern Hardwood Forests through 14,000 Years. Martin A. Spetich, Roger W. Perry, Craig A. Harper, Stacy L. Clark

Fire helped shape the structure and species composition of hardwood forests of the eastern United States over the past 14,000 years. Periodic fires were common in much of this area prior to European settlement, and fire-resilient species proliferated. Early European settlers commonly adopted Native American techniques of applying fire to the landscape. As the demand for wood products increased, large cutover areas were burned, sometimes leading to catastrophic fires and subsequent early successional habitats. By the early 1900s, these catastrophic fires resulted in political pressure leading to policies that severely restricted the use of fire. Fire suppression continued through the twentieth century due to an emphasis on commodity production and under-appreciation of the ecological role of fire. Without fire, fire-sensitive species were able to successfully outcompete fire-adapted species such as oak and pine while early successional habitats matured into older and more homogeneous forests. In the late twentieth century, land managers began reintroducing fire for ecosystem restoration, wildlife habitat improvement,

hazardous fuel reduction, and forest regeneration. Responsible expanded use of prescribed fire and other management tools in the region could help mitigate past actions by increasing the amount and distribution of early successional habitats, plant and animal diversity, and landscape heterogeneity.

5. Structure and Species Composition of Upland Hardwood Communities After Regeneration Treatments Across Environmental Gradients. David L. Loftis, Callie J. Schweitzer, Tara L. Keyser

Early successional habitats can be created with a broad array of silvicultural techniques that remove all or most canopy trees in one to several cuttings and small to large patch sizes. Composition and early structural development of the resulting vegetation can be variable. Arborescent species composition is a function of regeneration sources already present and those that arrive during or after the cutting. The suite of species available for regeneration of a site, large or small, is a cumulative effect of disturbances and varies across multiple environmental gradients that include moisture, elevation (temperature), and soil chemistry.

6. Spatial and Temporal Patterns in the Amount of Young Forests and Implications for Biodiversity. Stephen R. Shifley, Frank R. Thompson III

Forest inventory data provide simple indicators of forest structural diversity in the form of forest age distributions and their change over time. A result of past land use and disturbance, more than half of the 51 million ha of forest in the Central Hardwood Region is between 40 and 80 years old and young forest up to 10 years old constitutes only 5.5% of the area. Simulations of a sustained level of management over time produce more uniform (flatter) age-class distributions. A management scenario designed to maintain about 7% of total forest area as young habitat results in a region-wide young forest deficit of one million ha relative to current conditions. However, management activities that create an average of 200 ha of additional young forest per county per year would be sufficient to erase that deficit.

7. Herbaceous Response to Type and Severity of Disturbance. Katherine J. Elliott, Craig A. Harper, B. Collins

The herbaceous layer varies with topographic heterogeneity and harbors the great majority of plant diversity in eastern deciduous forests. We described the interplay between disturbances, both natural and human-caused, and composition, dynamics, and diversity of herbaceous vegetation, especially those in early successional habitats. Management actions that create low to moderate disturbance intensity can promote early successional species and increase diversity and abundance in the herb layer, although sustaining communities such as open areas, savannahs, and woodlands may require intensive management to control invasive species or implement key

disturbance types. A mixture of silvicultural practices along a gradient of disturbance intensity will maintain a range of stand structures and herbaceous diversity throughout the central hardwood forest.

8. The Role of Young, Recently Disturbed Upland Hardwood Forest as High Quality Food Patches. Cathryn H. Greenberg, Roger W. Perry, Craig A. Harper, Douglas J. Levey, John M. McCord

Young (1–10 year post-disturbance) upland hardwood forests function as high-quality food patches by providing abundant fruit, and nutritious foliage and flowers that attract pollinating and foliar arthropods and support high populations of small mammals that, in turn, are prey for numerous vertebrate predators. Reductions in basal area increase light penetration to the forest floor, which stimulates vegetative growth and promotes fruiting. Fruit biomass (dry edible pulp) can be 5 to nearly 50 times greater in young forest than mature forest as “pioneer” species, such as pokeweed and blackberry, ericaceous shrubs, various forbs and grasses, and stump sprouts of many tree species produce fruit. Forage production can increase substantially after disturbances that significantly reduce overstory basal area, such as timber harvests, heavy thinning, or intense prescribed fire. Hard mast (nut) production can be sustained in young forests if some mature, good mast-producing oak, hickory, or beech trees are retained. Balancing the creation of young, recently disturbed upland hardwood forests with the desired amount and distribution of other forest age-classes will sustain high-quality food patches for wildlife within a landscape context.

9. Population Trends for Eastern Scrub-Shrub Birds Related to Availability of Small-diameter Upland Hardwood Forests. Kathleen E. Franzreb, Sonja N. Oswalt, David A. Buehler

Early successional habitats are an important part of the forest landscape for supporting avian communities. As the frequency and extent of the anthropogenic disturbances have declined, suitable habitat for scrub-shrub bird species also has decreased, resulting in significant declines for many species. We related changes in the proportion and distribution of small-diameter upland hardwood forest throughout the eastern USA (US Forest Service Forest Inventory and Analysis data) with North American Breeding Bird Survey data (US Geological Survey) on population trends of 11 species that use early successional hardwood forest. The availability of small-diameter upland hardwood forest has changed over the past four decades, with the biggest differences seen as declines from the 1990s to the 2000s. Most scrub-shrub species also declined since the inception of the Breeding Bird Survey in 1966. The declines in most of the bird species, however, did not closely track the changes in small-diameter forest availability. Scrub-shrub birds use a variety of habitats that originate from a diverse array of disturbance sources. The total availability of these habitats across the region apparently limits the populations for these species. A comprehensive management strategy across all of these types is required to conserve these species.

10. Bats and Gaps: The Role of Early Successional Patches in the Roosting and Foraging Ecology of Bats. Susan C. Loeb, Joy M. O'Keefe

Early successional habitats are important foraging and commuting sites for the 14 species of bats that inhabit the Central Hardwood Region, especially larger open-adapted species such as hoary bats (*Lasiurus cinereus*), red bats (*L. borealis*), silver-haired bats (*Lasionycteris noctivagans*), and big brown bats (*Eptesicus fuscus*). Forest gaps, small openings, and the edges between early successional patches and mature forest are especially important habitats because they are used by both open-adapted and clutter-adapted species. Several bat species select roosts in close proximity to early successional patches, perhaps to minimize foraging and commuting costs. Future research on effects of early successional patch size, shape, vegetation structure, and connectivity on bat use, and the distribution of early successional habitats in relation to mature forest, roosting sites, and water sources will assist managers in providing the optimal types and distribution of early successional patches on the landscape.

11. Reptile and Amphibian Response to Hardwood Forest Management and Early Successional Habitats. Christopher E. Moorman, Kevin E. Russell, Cathryn H. Greenberg

Herpetofauna responses to forest management and early successional habitats are influenced by species-specific adaptations to historical disturbance regimes. It can take decades for woodland salamander diversity to recover after heavy overstory removal for even-aged forest regeneration or hot fires that yield higher light, drier microclimates, and reduced leaf litter cover, but some frog and toad species may tolerate or even increase after disturbances. In particular, disturbances that retain some canopy cover, such as selection harvests or low intensity burns, can mitigate effects on terrestrial salamanders. The same early successional conditions that are detrimental to salamanders can benefit many reptile species, such as fence lizards (Sceloporus undulatus). Maintaining stand age diversity across central hardwood forest landscapes, including retention of mature forest communities, should provide habitats for both early successional wildlife and mature forest species.

12. Managing Early Successional Habitats for Wildlife in Novel Places. J. Drew Lanham, Maria A. Whitehead

Utility rights-of-way stretch for thousands of kilometers across the North American landscape. In deciduous forests of the Central Hardwood Region, rights-of-way provide opportunities for conserving early successional species, including a broad array of songbirds and butterflies. Although the millions of hectares managed by the utility industry to provide electricity, natural gas, and other services are not usually viewed by the public as beneficial for wildlife conservation, we suggest that rights-of-way can be valuable early succession habitats in addition to more "traditionally" created areas like clearcut harvests.

13. Conservation of Early Successional Habitats in the Applachian Mountains: A Manager's Perspective. Gordon S. Warburton, Craig A. Harper, Kendrick Weeks

The plight of species dependent upon disturbed or early successional habitats of Appalachian Mountain forests has been documented by wildlife managers across the region. We conducted surveys of managers and examined State Wildlife Action Plans and initiatives aimed at addressing conservation of these species and their habitats. Although the decline of disturbance-dependent species and the types of habitats they need are well documented, determining the amount and quality of existing early successional habitats is difficult. Few managers have clear goals of how much early successional habitat is needed and where it should be located, although most agree that much more is needed. Recently developed game bird and songbird plans represent some of the best efforts to date to address levels of habitat needed. Managers have prescriptions but face serious social and cultural barriers to establishing early successional habitats on the ground. Ecological forestry and collaborative management approaches may be the best solutions to overcome these barriers.

14. Early Successional Forest Habitats and Water Resources. James M. Vose, Chelcy R. Ford

Tree harvests that create early successional habitats have direct and indirect impacts on water resources in forests of the Central Hardwood Region. Streamflow increases substantially immediately after timber harvest, but increases decline as leaf area recovers and biomass aggrades. Post-harvest increases in stormflow of 10–20%, generally do not contribute to downstream flooding. Sediment from roads and skid trails can compromise water quality after cutting. With implementation of Best Management Practices (BMPs), timber harvests are unlikely to have detrimental impacts on water resources, but forest conversion from hardwood to pines, or poorly designed road networks may have long lasting impacts. Changing climate suggests the need for close monitoring of BMP effectiveness and the development of new BMPs applicable to more extreme climatic conditions.

15. Carbon Dynamics Following the Creation of Early Successional Habitats in Forests of the Central Hardwood Region. Tara L. Keyser

Across a forested landscape, stand-level management actions or natural disturbances that create early successional habitats result in a short-term loss of carbon in any given stand, but are often offset by carbon gains in other, undisturbed stands. Standing carbon stocks and rates of sequestration vary with species, site productivity, stand age, and stand structure. The age distribution of forest stands has a particularly large effect on landscape-level carbon storage. Consequently, forest management activities, including creation of early successional habitats, have short-term implications for stand-level carbon storage, but their impact on forest- or landscape-level carbon storage ultimately depends upon the temporal distribution and spatial scale of young forest stands on the landscape.

16. Forecasting Forest Type and Age Classes in the Appalachian-Cumberland Subregion of the Central Hardwood Region. David N. Wear, Robert Huggett

This chapter describes how forest type and age distributions might be expected to change in the Appalachian-Cumberland portions of the Central Hardwood Region over the next 50 years. Forecasting forest conditions requires accounting for a number of biophysical and socioeconomic dynamics within an internally consistent modeling framework. We used the US Forest Assessment System (USFAS) to simulate the evolution of forest inventories in the subregion. The types and ages of forests in the Appalachian-Cumberland portions of the Central Hardwood Region are likely to shift over the next 50 years. Two scenarios bracket a range of forest projections and provide insights into how wood products markets as well as economic, demographic, and climate changes could affect these future forests. Shifts in the future age distributions of forests are dominated by projected harvest regimes that lead to qualitatively different forest conditions. The future area of young forests correlates with change in total forest area—as total forest area declines, so does the area of young forests. However, changes in the area of young forests and forest age class distributions are most directly altered by the extent of harvesting within the Appalachian-Cumberland subregion.