Chapter 1
Introduction: What Are Early Successional Habitats, Why Are They Important, and How Can They Be Sustained?

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Abstract There is a rising concern among natural resource scientists and managers about decline of the many plant and animal species associated with early successional habitats. There is no concise definition of early successional habitats. However, all have a well developed ground cover or shrub and young tree component, lack a closed, mature tree canopy, and are created or maintained by intense or recurring disturbances. Most ecologists and environmentalists agree that disturbances and early successional habitats are important to maintain the diverse flora and fauna native to deciduous eastern forests. Indeed, many species, including several listed as endangered, threatened, sensitive, or of management concern, require the openness and thick cover that early successional habitats can provide. Management of early successional habitats can be based on the "historic natural range of variation", or can involve active forest management based on goals. In this book, expert scientists and experienced land managers synthesize knowledge and original scientific work to address critical questions on many topics related to early successional habitats in the Central Hardwood Region. Our aim is to collate information about early successional habitats, to aid researchers and resource management professionals in their quest to sustain wildlife and plant species that depend on or utilize these habitats.

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1.1 Introduction

There is a rising concern among natural resource scientists and managers about decline of the many plant and animal species associated with early successional habitats, especially within the Central Hardwood Region (Litvaitis 1993, 2001; Thompson and DeGraaf 2001). Open sites with grass, herbaceous, shrub, or incomplete young forest cover are disappearing as abandoned farmland and pastures return to forest and recently harvested or disturbed forests re-grow (Trani et al. 2001). There are many questions about "why, what, where, and how" to manage for early successional habitats. Tradeoffs among ecological services such as carbon sequestration, hydrologic processes, forest products, and biotic diversity between young, early successional habitats and mature forest are not fully understood. Personal values and attitudes regarding forest management for conservation purposes versus preservation, or "letting nature take its course," complicate finding common ground regarding if and how to create or sustain early successional habitats.

In this book, expert scientists and experienced land managers synthesize knowledge and original scientific work to address critical questions sparked by the decline of early successional habitats. We focus primarily on habitats created by natural disturbances or management of upland hardwood forests of the Central Hardwood Region in order to provide in depth discussion on multiple topics related to early successional habitats, and how they can be sustainably created and managed in a landscape context.

1.2 Geographic Scope: The Central Hardwood Region

Broadleaved trees form the predominant forest cover type in parts of ten eastern states which Braun (1950) included in the Central Hardwood Region (Fig. 1.1). The boundaries of the region also are similar to ecoregions mapped by Bailey (1994) and bird conservation regions delineated by the US North American Bird Conservation Initiative (on the Breeding Bird Survey website (www.mbr-pwrc.usgs.gov/bbs/)). The canopy of mature upland forests is dominated by varying proportions of six broadleaf deciduous taxa. Oak (*Quercus*) and hickory (*Carya*), each represented by several species, are present in most stands. Yellow-poplar (*Liriodendron*) increases in importance east of the Mississippi River and usually dominates the canopy of moist sites in the Southern Appalachian Mountains, and maple (*Acer* spp.), beech (*Fagus grandifolia*), and birch (*Betula* spp.) occupy much of the canopy of forests in the northern and eastern parts of the region, particularly on the Allegheny Plateau. About 45% of the 130 million acres of forest land in this region is occupied by hardwood-dominated stands; mixtures of hardwoods and conifers account for an additional 5% (Smith et al. 2004). Conifers, primarily pine (*Pinus*), are minor components of many low-elevation stands on dry sites. The humid, continental climate of the region produces soil moisture regimes that are adequate for plant growth during much of the warm season, although minor water deficits can develop in late

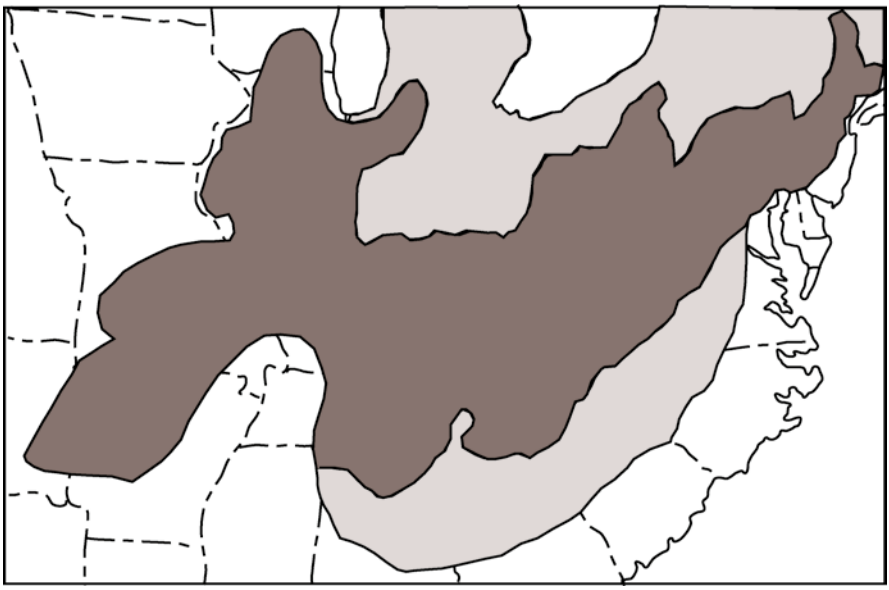

Fig. 1.1 Extent of the Central Hardwood Region in the eastern United States (dark shading). Transition to northern hardwoods occurs in the Lake States and to southern pines in the Appalachian Piedmont (light shading) (After Braun (1950))

summer. This characteristic climate (i.e., low soil moisture deficits and moderate levels of evapotranspiration) may be why forests of deciduous hardwoods dominate the Central Hardwood Region (Stephenson 1990). Detailed descriptions of forest composition and disturbance regimes characteristic of Central Hardwood Region subregions are provided in Chap. 2 (McNab).

1.3 What Are Early Successional Habitats?

Like most things ecological, there is no concise definition of early successional habitats. Early ecological studies and adoption of the term "succession" were based in part on secondary succession of abandoned farm fields (i.e., "oldfield succession"). In the southeastern USA, oldfields are first colonized by "pioneering" grasses and forbs, then gradually by pines or hardwoods, until closed forest develops (Clements 1916; Keever 1950, 1983; Odum 1960). Over time, the term "early successional" has taken on a broader meaning, to include recently disturbed forests with absent- or open-canopy and, often, transient, disturbance-adapted or pioneer species (many of them also found in old fields). Unlike oldfields, these recently disturbed forests generally do not undergo major shifts in woody species composition (Lorimer 2001). Similarly, we use the term "habitat" in this volume, as it is commonly used and understood in recent wildlife literature, to denote "a set of specific environmental features that, for a terrestrial

Plate 1.1 Examples of different types of early successional plant communities. From *left to right*: recently abandoned farmland, reclaimed surface mine, scrub-shrub, and recently harvested forest

animal, is often equated to a plant community, vegetative association, or cover type" (Garshelis 2000; but see Hall et al. 1997). We use 'early successional habitats' to refer to sets of plant communities, associations, or cover types for multiple wildlife species.

Vegetation structure in early successional habitats can range from scattered trees or snags to no canopy cover, or from an open, grass-forb understory to thickets of shrubs and vines (Plate 1.1). Abandoned farmlands, grassland, shrub-scrub, recently harvested forest, heavily wind-, fire-, or ice-damaged forests, and even ruderal habitats such as roadsides, utility rights-of-way, and restored coalfields are all early successional habitats from this functional perspective (e.g., Thompson and DeGraaf 2001). Plant composition and micro-physical structure differ considerably among these diverse early successional habitat types, and can be dominated by grasses, forbs, shrubs, seedlings, woody sprouts, or a patchy mix of herbaceous and developing woody cover. However, all have two structural attributes in common: they have a well developed ground cover or shrub and young tree component and they do not have a closed, mature tree canopy.

Recently disturbed, regenerating upland hardwood forests may not, strictly speaking, be "successional," in terms of species turnover, but they do change greatly in structure over time. Many hardwood tree species resprout after damage or harvest, such that there may be little change in woody species composition between the progenitor forest, the young regenerating forest, or the mature forest decades later. In these common cases, longer-term changes are due to change in physical structure and potential shifts in the relative abundance of species, rather than species loss and establishment over time (Lorimer 2001). In some cases, non-native species colonize following disturbance, further altering the original forest composition (Busing et al. 2009). In this volume, Loftis et al. (Chap. 5) discuss dynamical changes in structure and woody species composition, and Elliot et al. (Chap. 7) discuss herbaceous layer response to different silvicultural or natural disturbances and across moisture or fertility gradients associated with topography and physiographic regions or subregions.

Another characteristic of early successional habitats is that they are created by intense or recurring disturbances and are transient if not maintained by disturbance. Different types and intensities of natural disturbances (such as wind- or ice storms,

Plate 1.2 Examples of variation in the structure of early successional habitats in the upland hardwood forest of the Central Hardwood Region. From *left to right*: an experimental gap in the first season following its creation; ice storm damage; hot prescribed burn

wildfire, or outbreaks of pathogens) or forest management practices (such as two-age harvests, clearcuts, group selections, or hot prescribed burns) can create early successional habitats ranging from homogeneous structure with no trees to highly heterogeneous structure with scattered standing trees, multiple windthrows, or standing boles with broken tops. The scale of early successional habitats can also range from canopy gaps to thousands of hectares (Plate 1.2).

Historical and current patterns of frequency, intensity, and scale of natural and anthropogenic disturbances that create early successional habitats vary across the Central Hardwood Region. For example, catastrophic hurricanes occur at 85–380 year intervals in upland hardwood forests of the mid-Atlantic and southern New England (Lorimer and White 2003). The proportion of the landscape in young forest in this region might have varied from 40% to 50% after a severe hurricane to <3% as the forest matured (Lorimer and White 2003). In contrast, further inland where the likelihood of catastrophic wind damage is small, the proportion of early successional habitats due to wind disturbance was likely low (1–3%) and maintained by canopy gaps from single-tree death (estimated at <1% annually) (Runkle 1990) and infrequent windstorms (Lorimer and White 2003). Widespread, frequent burning was used by Native Americans and (later) by European settlers to maintain an open understory and improve conditions for travel and game or livestock for about 14,000 years, and decades of fire suppression has contributed to today's decline of early successional habitats and a shifting forest composition (Lorimer 1993; Brose et al. 2001). This variation in disturbances over time and across the landscape certainly created "nonequilibrium" or irregularity in the availability of early successional habitats, and populations of plants and animals that utilize them also likely waxed and waned in response to their availability.

In this volume, White et al. (Chap. 3) discuss how types, intensities and frequencies of natural disturbance vary across the Central Hardwood Region, and implications of these disturbances for patterns and probabilities of early successional habitats being created or maintained. Spetich et al. (Chap. 4) discuss the historic role of fire in creating and maintaining early successional habitats, and how fire suppression policies of recent decades have reduced their extent in the Central Hardwood Region.

1.4 Why Are Early Successional Habitats Important?

Most ecologists and environmentalists agree that disturbances and early successional habitats are important to maintain the diverse flora and fauna native to deciduous forests of the Central Hardwood Region (Brawn et al. 2001). Patches of early successional habitat play a pivotal role in forest dynamics as foci for tree regeneration and maintaining disturbance-dependent plant species. Hunter et al. (2001) recognized 128 bird species associated with grasslands, shrub-scrub, savannah and open woodlands, or forest gaps in eastern North America. Indeed, many species, including several listed as endangered, threatened, sensitive, or of management concern, require the openness of reduced or absent overstory, tall grasses, or thick shrub cover that early successional habitats can provide (Hunter et al. 2001; Litvaitis 2001; Thompson and Degraaf 2001).

Disturbances across the landscape and through time create habitat heterogeneity and affect the spatial and temporal availability of food resources in a forest matrix (Thompson and Willson 1978). Different disturbance types and intensities shape the size, structure, and distribution of early successional habitat patches, which may be key factors for maintaining populations of wildlife species that depend on them. Canopy gaps or small patches of recently disturbed, young forest may be sufficient for some species, whereas others require larger areas (Thompson and DeGraaf 2001). Mobile species may be able to utilize a landscape of connected or recurring smaller patches, whereas species with limited dispersal ability may require larger or less ephemeral patches. Some disturbance-adapted bird species may require grass-dominated early successional habitats (e.g., Field Sparrows (*Spizella pusilla*) or Grasshopper Sparrows (*Ammodramus savannarum*)), whereas others require brushy areas (e.g., Eastern Towhees (*Pipilo erythrophthalmus*)); open areas with the presence of nesting cavities (e.g., Eastern Bluebird (*Sialia sialis*)); or high elevation early successional habitats (e.g., Chestnut-sided Warblers (*Dendroica pensylvanica*) and Golden-winged Warblers (*Vermivora chrysoptera*)). Thus, defining high- or low-quality early succession habitat must be tempered by the species or suite of species that require specific structural conditions.

Breeding bird density and richness generally are higher in disturbed habitats, including treefall gaps (Blake and Hoppes 1986; Greenberg and Lanham 2001), intensively burned forest (Greenberg et al. 2007a), and recently harvested young forests, particularly if some tree canopy is retained (e.g., Annand and Thompson 1997; Whitehead 2003). Many bat species use early successional habitats to forage for insects (e.g., Loeb and O'Keefe 2006). The density of many salamander species declines in recently disturbed early successional habitats (e.g., deMaynadier and Hunter 1995), but the abundance of some reptile species increases in response to the same conditions (e.g., Greenberg 2002). Indeed, many wildlife species forage opportunistically for insects and fruit in resource-rich young forest patches (Greenberg et al. 2007b).

In this volume Greenberg et al. (Chap. 8) discuss the ample availability of food resources, including native forest fruit, browse, and arthropod and small mammal prey

for wildlife in recently disturbed upland hardwood forest. Franzreb et al. (Chap. 9) examine the relationship between availability of early successional (small-diameter) forest and population trends of 11 focal bird species associated with "scrub-shrub" forest structure. Loeb and O'Keefe (Chap. 10) discuss how young forest patch size, shape, distribution, and connectivity, as well as vegetation structure, influence use by different bat species in relation to roost sites, mature forest, and water sources. Moorman et al. (Chap. 11) synthesize information to provide an overview of amphibian and reptile response to forest disturbance and the creation of early successional habitats. Lanham et al. (Chap. 12) present a case for considering utility rights-of-way and other "novel" places as an option for managing bird and butterfly species associated with early successional habitats.

As noted earlier, all early successional habitats are ephemeral. For example, young upland hardwood forest reaches the stem exclusion stage within 10 or 15 years of harvest, when the density of young tree stems can exceed 20,000–25,000 stems/ha, and canopy closure reduces light availability at the forest floor (Dessecker and McAuley 2001). Habitat suitability for different wildlife species changes with changing forest structure; for example, there is rapid turnover of songbird species during this period (Thompson and DeGraaf 2001). Decline of Ruffed Grouse (*Bonasa umbellus*) also is attributed to paucity of the stem exclusion age class (6–15 years) in forests of the Central Hardwood Region (Dessecker and McAuley 2001); this age class declines with forest maturation and the absence of new disturbances. Disturbances are required to create early successional habitats and to maintain a forest with a mosaic of age classes and a structural heterogeneity that increases plant and animal diversity at local, landscape, and regional scales (Askins 2001, Shifley and Thompson, Chap. 6).

Ecosystem processes and services provided by forests, such as carbon storage and water resources, are altered by creating early successional habitats. In this book, Vose and Ford (Chap. 14) examine post-disturbance changes in water quality and quantity, and recovery over time in relation to forest management practices, woody species composition, and climate. Keyser (Chap. 15) examines how creating early successional habitats and forest regrowth affect carbon storage and sequestration at stand and landscape levels.

1.5 How Can Early Successional Habitats Be Sustained?

One approach to maintaining early successional habitats is to base forest management on the "historic natural range of variation" (Lorimer and White 2003). This requires us to determine a reference point or time period; understand both the natural range of variation and what is 'unnatural' (for example should pre-settlement clearing and burning by Native Americans be considered natural?); and be prepared to implement management actions toward the historical variation. For example, prescribed fire may be needed because wildfires are not allowed to burn the acreages they would have historically.

Alternative strategies for creating and maintaining early successional habitats include a proactive approach. We could 'look forward' by identifying desired future conditions or goals, such as amounts and characteristics of early successional habitats needed to maintain viable populations of dependant plants and animals, and create them accordingly. Chapters in this volume explore management tools for determining how much early successional habitat is needed, and how and where to create and sustain it on the landscape. Shifley and Thompson (Chap. 6), use long-term, landscape-level Forest Inventory and Analysis data to simulate management scenarios designed to create a "shifting mosaic" of age classes and sustain a target proportion of the landscape in a young forest condition. Warburton et al. (Chap. 13) focus on strategies being used to identify priority species and specific recovery goals, develop spatially explicit blueprints of desired future conditions, and implement them by creating early successional habitats to sustain target populations through regional initiatives, ventures, cooperatives, and State Wildlife Action Plans. This book concludes with a chapter using empirical forest forecasting models to project 50 year change in forest types and age distributions in relation to scenarios of land ownership, economics, demographics, and climate change (Wear and Huggett, Chap. 16).

1.6 Conclusions

Overall, our aim in this book is to collate information about early successional habitats, to aid researchers and resource management professionals in their quest to sustain wildlife and plant species that depend on or utilize these habitats. We focus primarily on early successional habitats generated by natural or anthropogenic disturbance in upland hardwood forests, which are the predominant ecosystem in the Central Hardwood Region. This focus is in part because of the rising concern over the decline of plant and animal species associated with early successional habitats in this region, and because large areas of upland hardwood forest are in public lands where, compared to privately owned lands, land management decisions can be influenced more easily by conservation concerns. Using information in this book, resource management professionals may elect to look to the past to guide management by the natural range of variation in disturbance types and frequencies, and the area and conditions of early successional habitats they created. Or, they might look forward to create conditions based primarily on an objective to sustain biodiversity and species associated with early successional habitats through future decades.

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