Management Options for Songbirds Using the Oak Shelterwood-Burn Technique in Upland Forests of the Southeastern United States

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Abstract.—The shelterwood-burn technique is a novel method for regenerating oak-dominated stands on some upland sites while simultaneously minimizing undesirable hardwood intrusion with prescribed fire. Management options available within an oak-shelterwood burn regime will create variably structured habitats that may potentially harbor avian communities of mature forest and early successional species (canopy retention); grove-woodland species (post-harvest prescribed burn) or shrubland species (total harvest). We suggest that the management options associated with shelterwood-burn silviculture offer viable alternatives for managing songbird and timber resources where oak-dominated stands are the desired goal in upland southeastern sites.

Introduction

Songbirds have been the focus of many conservation efforts as declines in populations of many species, especially Neotropical migrants, have been recorded in the eastern United States (Askins et al. 1990). While numerous investigators have reported the effects of various silvicultural treatments on songbirds (e.g. Conner and Adkisson 1975; Webb et. al. 1977; Evans 1978; Crawford et. al 1981) there is a dearth of information addressing the effects (real or potential) of prescribed fire on songbirds in hardwood systems of the Southeast.

Oaks, *Quercus spp.*, are one of the most important food and cover resources for forest wildlife in the Southeast (Martin et al. 1956). A large number of songbirds, including many species of Neotropical migrants, occupy oak forest types in southeastern North America (Hamel et al. 1982). Additionally, oaks are a valuable economic commodity producing high quality timber for a variety of uses. Because of its value, oak regeneration is a priority on many upland sites. Shelterwood silviculture is widely used to regenerate oak stands on upland sites (Sander et al. 1983). It is employed so that the partial harvests will reduce the dense shade that suppresses vital root development of existing oak regeneration (Loftis 1990; Sander 1971).

By retaining the canopy and maintaining partial shade, the rapid growth of shade-tolerant species such as yellow poplar (*Liriodendron tulipifera*), is inhibited. The added benefit of litter and soil disturbance during harvest operations prepares seed beds for acorns and oak seedling establishment (Cook et al. 1998).

However, because of a paucity of oak seedlings and sprouts in mature oak stands and/or the inability of existing oak stock to out-compete other vegetation, shelterwood cuts alone are often ineffective in promoting oak regeneration (Smith 1993; Lorimer 1993). As a result expensive pretreatment measures such as herbicide application (Loftis 1990; Lorimer et al. 1994), low-intensity prescribed fires (Barnes and Van Lear 1998; McGill et al. 1999), tree shelters (Potter 1988) and nursery stock plantings (Bowersox 1993; Gordon et al. 1995; Schlarbaum et al. 1997) must be implemented 5-15 years before the initial harvest. Such treatments are unattractive to natural resource managers and private landowners with limited budgets.

A more efficient means of regenerating oak stands (hereafter referred to as the oak shelterwood-burn technique) was developed jointly in 1993 by research conducted by the Virginia Department of Game and Inland Fisheries (VDGIF) and Clemson University Department of Forest Resources (Clemson, South Carolina). By burning two oak-dominated shelterwood stands after an initial harvest (Keyser et al. 1996), the regeneration of yellow poplar, red maple (*Acer rubrum*), and sweetgum (*Liquidambar styraciflua)* was reduced by 67-90% while oak reproduction was reduced by only 11%. Subsequent studies of fire effects in oak-dominated shelterwood stands in the Virginia Piedmont (Brose and Van Lear 1998a; Brose et al. 1999) and the Northeast (Ward and Gluck 199) showed the same trends in fire resistance of oak and demonstrated the critical role of fire intensity coupled with growing-season burns for creating a cohort of tree seedlings dominated by oaks.

Although the oak-shelterwood burn technique was originally implemented to improve the viability of oak regeneration and the production of hardwood timber in uplands, the conservation of biodiversity is often a goal of many forest management initiatives. Because the shelterwood-burn method is a novel technique and could be adopted by increasing numbers of landowners and natural resource managers, it will be important to understand how wildlife communities might respond. Here, we examine how various management options implemented in oak-shelterwood burn sites could influence the composition of songbird communities. The potential influences of the management options described here are related to the vegetative structure and composition that will result from the three oak-

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shelterwood burn options and from inferences drawn from other bird habitat studies conducted in upland oak-dominated stands where silvicultural treatments have created habitat conditions similar to those expected in oak-shelterwood burns.

The Shelterwood Burn Technique

The oak shelterwood-burn technique is a three-step process. First, an initial shelterwood cut leaves 50-60 dominant oaks per ha (11 to 12 m^2 of basal area/ha). The remnant stand of oaks is comprised of the best stock to provide a vigorous regeneration cohort. Next, the stand is left undisturbed for 3 -5 years while the regeneration layer develops. After 3-5 years, a hot (flame length > 1.0 m) growing-season fire is applied to the stand, resulting in an oak-dominated regeneration cohort. Each of these steps and the added option of complete stand harvest after the development of a strong regeneration cohort will create three variably structured forest habitats that may be used by a wide variety of resident and migrant songbirds.

Options for Songbird Management

Option 1: Canopy Retention

Canopy retention treatments provide two-age stands twice during the shelterwood burn cycle. First, during the phase when shade-tolerant hardwoods such as yellow poplar and red maple dominate the advance-regeneration pool and second, after a satisfactory cohort of vigorous, advance oak regeneration is achieved when a portion or all of the residual overstory trees may be retained for at least half of the next rotation. Retention of a partial overstory during either phase may provide sufficient canopy habitat and vertical structure for some species of mature forest birds (Dickson et al. 1995). Relative to other even-aged silvicultural methods, canopy retention treatments would be the least intensive and probably most similar to an uneven-aged mature forest.

Crawford et al. (1981) surmised that timber management strategies altered bird communities in relationship to the degree of stand disturbance. They predicted that partial harvests would provide sufficient canopy cover to buffer complete species turnover from mature forest to early-successional species observed in clearcut forests. They further stated that partial cuts would return more quickly to site conditions conducive to mature forest species than would even-aged treatments. These findings have been corroborated by a number of other studies that have shown that although populations of some forest-interior songbirds may be reduced relative to an undisturbed stand due to habitat alteration, increased nest predation, and parasitism (Webb et al. 1977; Nichols and Wood 1995), these species are generally not entirely eliminated and population recovery may occur rapidly as the new forest matures (Conner and Adkisson 1975; Askins and Philbrick 1987).

Dickson et al. (1995) support the idea that the retention of a residual canopy (<50%) for several years after an initial harvest can provide habitats for some mature forest birds that would not inhabit stands managed using traditional even-aged management technique. In West Virginia, Nichols and Wood (1995) found that two-age stands contained a greater density, richness, evenness, and overall diversity of breeding birds than early-successional and mature stands. Total density for all Neotropical migrants was also highest in the two-age stands. Densities of forest-interior species were not different between clearcut, mature, and two-age stands. The two-age stands had densities of interior-edge species equal to or greater than the other two treatments. These patterns can be explained, in part, by the occurrence in two-aged stands of species normally associated with (a) forest interiors: veery (*Catharus fuscescens)*, American redstart (*Setophaga ruticella*), and scarlet tanager (*Piranga olivacea*), and (b) early-successional habitats: chestnut-sided warbler (*Dendroica pensylvanica*), indigo bunting (*Passerina cyanea)*, and eastern towhee (*Pipilo erythrophthalmus*). The co-occurrence of mature forest and early-successional species within the same areas indicated that two-aged stands might provide both types of habitats for these species.

Annard and Thompson (1997) reported higher species richness for breeding birds in stands treated by shelterwood cuts than in clearcuts, group selection, single tree selection, or uncut stands in the Missouri Ozarks. The number of species detected were higher in shelterwoods than in uncut controls or uneven-aged stands. As with Wood and Nichol's study, these differences were attributed to the presence of a mixture of early-successional and mature forest bird species including blue-winged warbler (*Vermivora pinus*), and prairie warbler (*Dendroica discolor*). These species occupied shelterwood stands along with birds more commonly associated with mature stands such as red-eyed vireo (*Vireo olivaceous)*, worm-eating warbler (*Helmitheros vermivorous*), and Acadian flycatcher (*Empidonax virescens*).

Nesting success must be considered in conjunction with measures of density and diversity of breeding birds. Nichols and Wood (1995) did not find any differences in nest success among treatments in West Virginia. Nest parasitism by brown-headed cowbird (*Molothrus ater*) was not a major factor in their study with only eight of 246 nests parasitized and no differences in the number of cowbirds found among treatments. Annard and Thompson (1997) and Welsh and Healy (1993) found similar results in Missouri and New Hampshire, respectively. One must remain aware, however, as patterns of predation and parasitism may vary depending on the landscape context. The impact of cowbirds and predators in extensively forested systems tends to be lower than those in agricultural and suburban landscapes (Wilcove 1985).

Canopy disturbance has been shown to benefit some forest-interior bird species that have declined in some regions. Some bird species that use early-successional gaps within mature forests may decline in areas where disturbances do not produce the regenerating ground-layer and shrub vegetation they prefer (Franzreb and Rosenberg 1997). Shelterwood harvesting increases light levels and soil disturbances that stimulate the growth of low vegetative cover, i.e herbs/forbs/shrubs. In West Virginia, Nichols and Wood (1995) found that the Kentucky warbler (*Oporonis formosus*), wood thrush (*Hylocichla mustelina*), American redstart, and black-and-white warbler (*Mniotilta varia*) were 2-3 times more abundant in two-age stands than in uncut controls.

The retention of 11-12 m^2 of oak basal area/ha (50-60 dominant oaks/ha) in shelterwood stands also provides reliable acorn sources (Healy 1997). This is important because the acorns provide seed sources for regeneration. Acorns are also one of the most important wildlife food resources as they are consumed by more than 200 wildlife species throughout North America. Among these are many species of songbirds (Martin et. al. 1951; Beck 1993). Based upon the floristic structure of stands expected after canopy retention treatments, Table 1 lists bird species that are likely to occur in the diverse two-age structure of these areas.

Option 2: Shelterwood Prescribed Burning

The second option in the oak-shelterwood burn scheme is the use of periodic prescribed fire in partially harvested stands. Among the three options discussed here, this method is likely to be intermediate in its effects on the songbird community. Ultimately, the shift in species composition will vary depending on the vegetative structure that results from the season, intensity, and frequency of the prescribed burns. Dormant-season burns produce low-growing, sprouting regeneration of shrubs and trees and stimulate the production of soft mast (Stransky and Rose 1984). These responses may provide forage, cover and arthropod prey for many songbird species (Dickson 1981).

Repeat dormant-season burning increases the abundance of oak regeneration. Oak regeneration is limited by additional fires and then released at intervals by withholding burning treatments, creating patchy stands in different successional stages. Dickson (1981) surmised that in southern pine and pine-hardwood forests, a patchwork of different successional stages within a stand (or across a landscape) could enhance bird diversity and abundance. This patchwork would obviously be dependent not only upon the frequency and intensity of fires but also on the size, topography and site capability of the area burned. In stands managed with dormant season fires that will allow the proliferation of hardwood shrubs and trees underneath an open canopy , bird communities are likely to be comprised primarily of shrub nesting (e.g.white-eyed vireo, *Vireo griseus*) and midstory species (e.g.wood thrush) along with species more characteristic of open canopy forests such as the yellow-billed cuckoo,*Coccyzus americanus,* and blue-gray gnatcatcher (*Pilioptila caerulea*). More so than other burning treatments, dormant-season fires in oak-shelterwoods are likely to produce vegetative characteristics and therefore bird communities more similar to two-age canopy retention stands.

Annual or biennial prescribed burning during the growing season would create open hardwood woodlands and savannas by gradually eliminating much hardwood shrub and tree regeneration while stimulating production of ground-level herbaceous vegetation (Thor and Nichols 1973). Oak woodland and savanna habitats were described as common landscape features by early explorers and settlers who observed the Native Americans' extensive use of fire (Pyne 1982; Buckner 1983; Van Lear and Waldrop 1989). Over time, however, oak savannas and woodlands and some of the wildlife species associated with them have become rare. The restoration of hardwood savannas and open woodlands would probably shift bird guilds from mature forest-interior species to canopy and midstory dwelling, open woodland and grove species such as great-crested flycatcher (*Myiarchus crinitus*), eastern wood-pewee (*Contupus virens*), orchard oriole (*Icterus spurius*) and summer tanager (*Piranga rubra*). Although growing-season fires might benefit some bird species, others could be negatively impacted by burns initiated so late that nesting and other breeding activities are disrupted. Therefore, spring burning should be judiciously prescribed as early as possible in the season so that direct impacts on nesting or breeding birds are minimized.

Fire intensity ("hot versus cool") also affects vegetative structure and therefore avian community composition. In a study conducted in Alabama pine-hardwood Piedmont sites, Stribling and Barron (1995) found a greater abundance and diversity of birds in burned stands subjected to cool fires, with canopy, shrub and cavity nesters being most abundant. Canopy, shrub and bark feeding species were also more abundant in cool burn sites than in untreated stands. These differences were attributed to the increased heterogeneity of vegetative structure (patchiness) of treated areas. Stribling and Barron (1995) found ground-foraging and ground-nesting songbirds to be more abundant in pine-hardwood stands treated with a hot, early-spring fire than in those treated with cooler early-spring fires. They attributed this response to the removal of litter, which they hypothesized provided better foraging and nesting areas for birds in those guilds.

Some residual damage can occur from prescribed burning. Residual overstory trees, especially thin-bark

Table 1.—Neotropical migrant birds associated with oak-shelterwood burn options in upland southeastern forests.

Canopy Retention	Shelterwood Burning	Complete Harvest
yellow-billed cuckoo (*Coccyzus americanus*)		
whip-poor-will (*Caprimulgus vociferus*)	X	
chuck-will's widow (*C. carolinensis*)	X	
ruby-throated hummingbird (*Archilocus colubris*)	X	X
Acadian flycatcher (*Empidonax virescens*)		
	eastern kingbird (*Tyrannus tyrannus*)	
great-crested flycatcher (*Myiarchus crinitus*)	X	
	eastern wood-pewee (*Contupus virens*)	
gray catbird (*Dumatella carolinensis*)	X	
wood thrush (*Hylocichla mustelina*)		
veery (*Catharus fuscescens*)		
blue-gray gnatcatcher (*Pilioptila caerulea*)		
yellow-throated vireo (*Vireo flavifrons*)	X	
red-eyed vireo (*V. olivaceous*)		
		white-eyed vireo (*V. griseus*)
Blackburnian warbler (*Dendroica fusca*)		
black-throated blue warbler (*D. caerulescens*)		
black-throated green warbler (*D. virens*)		
cerulean warbler (*D. cerulea*)		
chestnut-sided warbler (*D. pensylvanica*)		X
		prairie warbler (*D. discolor*)
yellow-throated warbler (*D. dominica*)	X	
		yellow warbler (*D. petichia*)
		blue-winged warbler (*Vermivora pinus*)
		golden-winged warbler (*V. chrysoptera*)
American redstart (*Setophaga ruticilla*)		
black-and-white warbler (*Mniotilta varia*)		
		common yellowthroat (*Geothlypis trichas*)
hooded warbler (*Wilsonia citrina*)		
Kentucky warbler(*Oporonis formosus*)		
northern parula (*Parula americana*)		
ovenbird (*Seiurus aurocapillus*)		
Louisiana waterthrush (*S. motacilla*)		
worm-eating warbler (*Helmitheros vermivorus*)		
		yellow-breasted chat (*Icteria virens*)
orchard oriole (*Icterus spurius*)	X	
Baltimore oriole (*I. galbula*)	X	
scarlet tanager (*Piranga olivacea)*		
summer tanager (P. *rubra)*	X	
indigo bunting (*Passerina cyanea*)		X
		blue grosbeak (*Guiraca caerulea*)

Habitat associations inferred from "Primary Habitats" and "Key Habitat Requirements" designations by Hamel et al. (1982): Oak-shelterwood analogs are as follows: canopy retention = sapling poletimber-sawtimber; shelterwood burning =grass-forb, sawtimber; complete harvest =seedling-sapling.

species such as maples (*Acer* spp.) and yellow poplars and those with slash accumulations at their bases (Brose and Van Lear 1999) are prone to fire-kill or damage. However, the creation of dead and dying trees (snags) provide important foraging sites for woodpeckers and other bark gleaning species such as the black-and-white warbler. Snags also provide perching/hawking sites and roosting/nesting habitats. Larger sized snags are valuable nesting habitats for both primary cavity excavators (woodpeckers) and secondary cavity nesters including Neotropical migrants such as the great-crested flycatcher (Lanham and Guynn 1993). In addition to the valuable functions snags, downed logs and other coarse woody debris (e.g. tree tops, fallen limbs) provide for birds, these features provide habitat for forest-floor-dwelling arthropods, herpetofauna, and small mammals (Hanula 1996; Loeb 1996; Whiles and Grubaugh 1996) . These provide food resources for songbirds and gamebird species such as wild turkey, *Meleagris gallopavo,* and northern bobwhite, *Colinus virginianus*. Coarse woody debris also helps to prevent erosion in steep terrain by slowing overland water flow (Van Lear and Danielovich 1987) and builds soil as it decays by slowly releasing nutrients and organic matter. These actions will affect the structure and composition of vegetation and ultimately the avian community on a harvested site. Because fire in forested stands can have such varied effects, a wide variety of bird species may be supported based upon fire frequency, intensity and various site characteristics. Because most natural resource mangers and private landowners will be primarily concerned with the production of open, oak-dominated woodlands, Table 1 lists some species likely to occur in understory (growing-season) burned treatments that result in park-like oak woodlands.

Option 3: Overstory Removal

A third option is harvesting all of the residual overstory trees. This approach creates even-aged, early-successional hardwood habitat and is the most intensive of the options described here. In the initial year after harvest, stands without an overstory will undergo a dramatic turnover in species. Species such as indigo bunting and field sparrow, *Spizella pusilla,* are common in regenerating hardwood stands during these initial grass-forb and seedling-sapling stages (Evans 1978). In subsequent years tree saplings and shrubs increase the vertical structure within a regenerating stand at which point avian diversity and abundance levels can surpass those found in mature stands (Conner and Adkisson 1975; Thompson and Fritzell 1990). Thompson et al. (1993) attributed this peak in diversity and abundance to increases in vegetative vertical structure and horizontal patchiness within and among stands. In southeastern uplands, regenerating seedling-sapling hardwood habitats are preferred by shrub-scrub species such as prairie warbler, yellow-breasted chat, *Icteria virens*, and chestnut-sided warbler. Table 1 lists some Neotropical migrant bird species typical of regenerating, early-successional hardwood stands.

As regenerating stands age to form closed canopy sapling-poletimber stands, species richness and abundance frequently decreases to levels below younger shrubland and older mature forest habitats (Conner and Adkisson 1975). However, some forest-interior songbirds such as black-and-white warbler and wood thrush will begin using pole stands at this stage (Conner and Adkisson 1975; Askins and Philbrick 1987).

Discussion and Conclusions

The hardwood forests of eastern North America are one of the largest broad-leaved, deciduous ecosystems in the world (Hicks 1997). Among these ecosystems, upland oak-dominated types are among the most widespread and important as economic and ecological resources. The songbird communities dependent upon these habitats in the Southeast include a large number of Neotropical migrants (Hamel et al. 1982; Thompson and Fritzell 1990). Since many of these species are declining, the management of their habitats has become a conservation priority. Although the prevailing songbird conservation paradigm in many eastern hardwood-dominated forests has been to limit harvests to single/ group-tree selection or eliminate cutting entirely, thousands of hectares of oak-dominated forests occur on private lands where wildlife conservation goals may be secondary to timber management priorities. This means that no cut and selection cut options are often unrealistic. Innovative management is needed to satisfy both goals.

Burning as a silvicultural technique in southeastern forests has traditionally been used in pine stands. Conversely, it has been regarded as a disturbance to be prevented in hardwood forest management. The shelterwood burn technique has been shown to be an effective method for regenerating oak-dominated stands in the southeastern Piedmont (Van Lear and Brose 1999). A number of other studies conducted in two-age shelterwood systems (e.g. Nichols and Wood 1995; Annard and Thompson 1997) have proven that shelterwood techniques offer a viable option for songbird conservation/management. Additionally, Stribling and Barron (1995) showed that fire could also play a positive role in forest bird management. We suggest that stands managed in different stages of the shelterwood-burn process across a landscape would offer habitats similar to those two-age and burned stands. The result, we believe, will be a diversity of habitats attractive to forest-interior, edge-interior, open woodland and early-successional shrubland species.

While wildlife and timber production goals are frequently in opposition, the ability to reliably reproduce oak-dominated stands using a less intensive form of even-aged management like the oak-shelterwood burn technique and the associated options might prove to be a strategic tool for both wildlife conservation and sustainable timber production in southeastern uplands. We do not suggest that the oak-shelterwood burn system offers solutions for conserving every songbird species within a given stand. We do suggest, however, that this technique offers novel opportunities for sustainable timber production and effective songbird conservation across southeastern landscapes where both are management objectives.

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