*J. For.* 112(5):446–456
http://dx.doi.org/10.5849/jof.13-083

silviculture

# Moro Big Pine: Conservation and Collaboration in the Pine Flatwoods of Arkansas

**Don C. Bragg, Ricky O'Neill, William Holimon, Joe Fox, Gary Thornton, and Roger Mangham**

Established by a conservation easement in 2006, Moro Big Pine Natural Area-Wildlife Management Area (MBP) encompasses ~16,000 contiguous acres in the pine flatwoods of southern Arkansas. This large-scale cooperative effort, focused on an ecosystem with high conservation value in a landscape increasingly dominated by planted, intensively managed loblolly pine (*Pinus taeda*), arose from an initiative by Potlatch Corporation, the State of Arkansas, and The Nature Conservancy (TNC). The MBP is a permanent easement purchased with a combination of public and private funds that seeks to balance the improvement of open pine woodlands with economic interests. Potlatch now manages the MBP under a prescription that ensures both timber production and forests capable of supporting the endangered red-cockaded woodpecker (*Picoides borealis*). State agencies, including the Arkansas Natural Heritage Commission, the Arkansas Game and Fish Commission, and the Arkansas Forestry Commission, have partnered with TNC and Potlatch to achieve a range of objectives, including the improvement of pine flatwoods, greater landscape connectivity, protection and habitat enhancement for species of special concern, and increased public access. Potlatch has also recently offered carbon credits from MBP to the California carbon market. MBP exemplifies some of the opportunities now available to private landowners and public agencies—a melding of conservation and production goals to protect working forests, improve ecosystem services, and provide recreational opportunities.

**Keywords:** ecosystem services, Forest Legacy Program, invasive species, loblolly pine, red-cockaded woodpecker

The last few decades have witnessed dramatic changes in the management of forested landscapes of the United States. Since the 1980s, major reductions in timber harvesting from public lands in the West coupled with the intensification of silvicultural practices elsewhere have thrust the Southeast to the forefront; this area now produces more industrial roundwood than any other region in the world (Fox et al. 2007, Wear and Greis 2012) from a forested landbase that has been relatively stable for decades (Brandeis et al. 2012). However, a rapidly growing population with its concurrent influences on urbanization and landscape fragmentation combined with an expansion of agriculture in certain locations (e.g., along river bottomlands) are forecast to decrease the productive timber base across most of the southeastern United States by 2060 (Wear 2013). These trends, coupled with a crash in the housing market and increasing international competition in the forest sector, have all contributed to a regional decline in roundwood production that started in the mid-1990s and continued through the recent global economic crisis (Wear et al. 2007, Brandeis et al. 2012, United Nations 2012).

New forest-related opportunities in the Southeast continue to arise, however. Bioenergy in the form of wood pellets, combustible residues, and eventually liquid fuels has or will become increasingly important, especially in areas where paper production has declined (e.g., Ince and Nepal 2012, Abt and Abt 2013). The refinement of silvicultural practices such as lower initial planting densities and precommercial thinnings, herbicide use, ripping and bedding, fertiliza-

Received November 22, 2013; accepted May 7, 2014; published online June 5, 2014.

Affiliations: *Don C. Bragg (dbragg@fs.fed.us), USDA Forest Service, Southern Research Station, Monticello, AR. Ricky O'Neill (ricky.oneill@potlatchcorp.com), Potlatch Corporation, Inc. William Holimon (billh@arkansasheritage.org), Arkansas Natural Heritage Commission. Joe Fox (joe.fox@arkansas.gov), Arkansas Forestry Commission. Gary Thornton (gwthornton@agfc.state.ar.us), Arkansas Game and Fish Commission. Roger Mangham (rmangham@tnc.org), The Nature Conservancy.*

Acknowledgments: *We thank the following for their contributions and support of this article: James M. Guldin (USDA Forest Service); Jim Newberry (Potlatch); Tom Foti and Brent Baker (Arkansas Natural Heritage Commission); Jim Jolley (Arkansas Forestry Commission); and the University of Arkansas-Monticello. Terry Cundy, Jim Newberry, Mike Shelton, Dan Saenz, and Nancy Koerth graciously provided reviews of this manuscript.*

tion, and midrotation thinnings has significantly increased volume yields (Stanturf et al. 2003, McKeand et al. 2006, Fox et al. 2007). Standing forest volume is expected to continue to increase across most of the region, much of this with good prospects for future utilization or even commercial sequestration (Wear and Greis 2013). This growing stock expansion has been achieved in part by the afforestation of marginal agricultural lands and the conversion of naturally regenerated pine, pine-hardwood, and hardwood stands into planted loblolly pine (*Pinus taeda*) (Conner and Hartsell 2002, Wear and Greis 2012).

Unfortunately, these increases may have some unintended and undesired outcomes. For instance, although the use of a limited number of genotypes to maximize fiber yield in even-aged loblolly pine plantations is an effective strategy across a range of environments, there is a risk that the reduction of genetic diversity could have serious forest health consequences under certain conditions (Ledig 1986, Lambeth and McCullough 1997, McKeand et al. 2006, Tauer et al. 2012). A strictly agronomic (intensive) approach to timber production also limits options for other forest-based goods and services. The widespread conversion of natural-origin forests to increasingly intensively managed monocultures can contribute to some conservation problems (Brockerhoff et al. 2008). For example, structurally simpler pine monocultures managed on short rotations, although acceptable habitat for a number of species, do not develop attributes required by certain taxa. As a result, many of these have declined in abundance during recent decades, often resulting in an overall reduction of biodiversity (e.g., US Department of the Interior Fish and Wildlife Service [USFWS] 2003, Russell et al. 2004, West Gulf Coastal Plains/Ouachitas [WGCPO] Landbird Working Group 2011).

Large-scale attempts to address these problems are further challenged by landownership patterns in the Southeast: as commonly found in areas with a long settlement history and productive soils, the land is overwhelmingly privately owned. Of the nearly 215 million acres of forest in the region, almost 87% are held by a variety of private owners (Smith et al. 2009). Privately owned lands are more vulnerable to land-use conversion and less subject to government regulations intended to conserve imperiled species (Bonnie 1997, Doremus 2003, Pejchar and Press 2006). For example, the extensive loblolly and/or shortleaf (*Pinus echinata*) pine-dominated forests are some of the least protected ecosystems in North America, with <12% under any form of public control (Smith et al. 2009). In response, public and private institutions have pursued a number of conservation options within the framework of private property rights in these landscapes to varying degrees of success, including landowner subsidies and education programs, voluntary incentive policies, easements, and fee-title purchases of lands (e.g., Doremus 2003, Michael 2003).

Collaborative partnerships among private landowners, government agencies, and nongovernmental organizations have arisen to combine resources and blend sometimes competing objectives, permitting the realignment of economic interests with the protection of imperiled species, improvements to ecosystem services, and other societal benefits (Cooke et al. 2012, Schultz et al. 2012). This article describes one such large-scale effort on private lands: the Moro Big Pine Natural Area-Wildlife Management Area (MBP). Whereas MBP focuses on conserving a single species, the endangered red-cockaded woodpecker (RCW) (*Picoides borealis*), this project also incorporates a range of natural resource concerns in an ecologically sensitive region highly dependent on a timber-based economy.

## MBP Description and Regional History

Established in perpetuity by a conservation easement recorded on Dec. 12, 2006, the MBP covers 15,922 acres of Calhoun County in southcentral Arkansas (Figure 1). Logistically supported by several federal agencies, MBP represents a partnership between a real estate investment trust (Potlatch Corporation), the State of Arkansas (primarily through the Arkansas Natural Heritage Commission [ANHC], the Arkansas Game and Fish Commission [AGFC], the Arkansas Forestry Commission [AFC]), and a nongovernment organization, The Nature Conservancy (TNC), each with a unique role to play (Potlatch Forest Holdings, Inc. 2006).

This portion of the Upper West Gulf Coastal Plain[1] is dominated by terraces of the Ouachita River, which flows just south of the MBP. These terraces are ecologically classified as pine-dominated "flatwoods" (Figure 2). Flatwood communities are found across the southeastern United States and typically consist of low, level, poorly drained soils dominated by species tolerant of seasonal flooding and drought—a unique combination of landform, hydrology, disturbance history, and forest composition (Sutter and Kral 1994, Klimas et al. 2005). In southern Arkansas, the natural forest cover of the flatwoods was primarily loblolly and shortleaf pine, with numerous oaks (e.g., water oak [*Quercus nigra*], willow oak [*Quercus phellos*], Delta post oak [*Quercus similis*], southern red oak [*Quercus falcata*]), sweetgum (*Liquidambar styraciflua*), and other upland hardwood species (Klimas et al. 2005). The pine flatwoods are also dissected by small streams containing bald cypress (*Taxodium distichum*) and associated bottomland hardwood species (Figure 3). Local topoedaphic and hydrologic conditions interspersed among the terraces provide additional complexity, with bayheads, seeps, vernal pools, alkaline barrens (saline glades), and nebkhas ("pimple" mounds) supporting a number of uncommon microsites and rare species (Klimas et al. 2005).

The MBP region was sparsely populated during late prehistoric times (Jeter and

### Management and Policy Implications

The Moro Big Pine Natural Area-Wildlife Management Area (MBP) provides an example of a collaboration between various interests in a largely privately owned landscape in southern Arkansas. The resistance of many private landowners, particularly in the southern United States, to regulatory control of property rights suggests that coordinated efforts between willing partners have better chances of succeeding and, hence, make for good policy when possible. The successful leveraging of available resources to achieve large-scale conservation objectives with MBP exemplifies how managers and landowners can jointly reach these goals. Habitat improvement for high-profile umbrella species, for example, can be the mechanism that benefits nontarget species and other ecosystem services. In addition to addressing environmental issues, the MBP provides the State of Arkansas a way to meet goals related to economic development and recreational access in a region with few other options.


**Figure 1. Location of Moro Big Pine Natural Area-Wildlife Management Area (MBP) in Calhoun County, Arkansas.**

Early 1999). Euroamerican exploration and settlement first occurred along the major rivers and more gradually reached the interior. Settlement was limited before the Civil War, but accelerated in the latter half of the 19th century with the expansion of railroads. The virgin pine, hardwood, and cypress forests of southern Arkansas were lumbered most heavily between 1890 and 1930, with logs hauled by rail to local population centers for milling (Morbeck 1915, Curry 1960, Darling and Bragg 2008). Calhoun County experienced substantial population growth between 1870 and 1920 as farmers and lumbermen cleared the land. The disappearance of the virgin timber and failure of many farms after 1920 led to population decline; according to the US Census Bureau, the county's 2010 population of 5,368 persons was not quite half of the peak in 1920. The forests returned, and the timber industry rebounded during the latter half of the 1900s, and now most (>84%) of the county is considered commercial timberland (Rosson and Rose 2010). MBP has been part of Potlatch's operational landbase since the 1950s (SmartWood 2005).

Today, the predominant use of the flatwoods in the Upper West Gulf Coastal Plain of Arkansas is the commercial production of timber (Klimas et al. 2005). At the time of its establishment (2006), >12,000 acres of the MBP was classified as being in a "late seral condition" (primarily mature pine, pine-hardwood, and hardwood-cypress stands of natural origin), and most of the nearly 3,800 acres of planted loblolly pine then found in the easement area were of young or midrotation stages (Potlatch Forest Holdings, Inc. 2006). Silvicultural practices in the pine flatwoods have largely shifted from naturally regenerated pine, pine-hardwood, and hardwood systems to more planted loblolly pine. Research has shown that intensive silviculture on these flatwood sites can improve the growth and survival of planted loblolly pine seedlings, especially when ripping and bedding are used in conjunction with chemical competition control and fertilization (Rahman et al. 2006).

The forest management plan that accompanied the MBP conservation easement now dictates the silvicultural practices on this property (Potlatch Forest Holdings, Inc. 2006), which remains an active part of the company's land management base (Table 1). Maturing natural-origin pine stands will be managed with seed tree or shelterwood silvicultural systems designed to keep them in pine. Potlatch can clearcut and replant the scattered parcels of planted pine designated in the conservation easement, but no new planted stands are allowed and ripping and bedding are not permitted in existing planted pine. Hardwood- and cypress-dominated stands, especially those in riparian management zones, can also be managed using natural regeneration. In addition to providing commercial fiber, timber harvesting is a critical habitat manipulation tool. Although prescribed fire is the preferred understory treatment, mechanical and chemical competition controls are possible under certain conditions in the easement. All of these vegetation management tools are used to control invasive species, improve bird nesting and foraging habitats, and reduce hardwood competition in pine stands.

## MBP Collaborative Partnership and Strategic Planning

For a conservation project such as the MBP to succeed, the partnership needed to be collaborative, goal-oriented, and coordinated around a framework based on a common theme, particularly because this project encompassed a large area and involved many different specialized elements. In this case, Potlatch has a vested interest in maintaining timber production from this significant portion of its land base (the MBP covers approximately 4% of the company's 415,000

**Figure 2. An example of a mature, open pine flatwoods community on the MBP, with an overstory of natural-origin loblolly pine and a grass- and forb-dominated understory. (Photograph by Don C. Bragg, USDA Forest Service.)**

acres in Arkansas). In doing so, the company has had to balance its economic needs while upholding various corporate, sustainability, and regulatory requirements (SmartWood 2005). Public agencies charged with resource conservation also face challenges in this part of the Upper West Gulf Coastal Plain. Functionally intact pine flatwood ecosystems, once common across the southeastern United States, have become increasingly scarce as pressures related to land development and intensified timber and agricultural production grow (Sutter and Kral 1994, Klimas et al. 2005). The State of Arkansas, acting primarily through the ANHC, AGFC, and AFC, seeks to protect declining species in the pine flatwoods, provide recreational access, and sustain forestry sector employment in a region with few other economic opportunities. TNC shares the conservation and sustainability goals of the agencies (TNC 2006a). Federal agencies likewise sought to protect and enhance this region: the US Fish and Wildlife Service (USFWS) had long partnered with Potlatch and the other state agencies to assist in the recovery of the RCW, and the US Department of Agriculture (USDA) Forest Service supports working forests through various initiatives.

## Origins of MBP

As with other large-scale conservation projects, MBP originated with concern over the RCW, a federally listed endangered species. Once considered common across the Southeast (Conner et al. 2001), the RCW became endangered after the widespread loss of the mature, open pine-dominated forests they depend on for nesting, roosting, and foraging, habitat that historically covered millions of contiguous acres across the Southeast but has since dwindled to a small fraction of that area, often in small, spatially disjunct parcels (Conner et al. 2001, USFWS 2003). The rapid disappearance of RCW habitat isolated the remaining populations, making them more vulnerable to stochastic events and reduced gene flow, further accelerating the species' decline (Walters et al. 1988, USFWS 2003). The continued decline has led to an evolving RCW recovery strategy over the years, with mixed results (Costa 1997, Bonnie 1997).

With the passage of the Endangered Species Act, large corporate landowners such as Potlatch began tracking RCWs. An initial assessment in 1976 of Potlatch's property in Arkansas found 23 breeding groups scattered across a number of sites expected to face challenges from hardwood encroachment (Potlatch Forest Holdings, Inc. 2010). Limited steps to protect known nest sites were undertaken, but little else was done until 1995, when Potlatch entered into a habitat conservation plan as a part of the company's incidental take plan with the USFWS to protect RCW habitat while continuing with commercial timber harvesting of the pine forests that dominated its Arkansas ownership.[2] The USFWS was instituting Safe Harbors in an attempt to improve RCW recovery by encouraging private landowners to engage in certain practices that benefited the bird while making management activities more predictable and flexible (Costa 1997). These Safe Harbors were a good option for forest landowners such as Potlatch because, unlike some endangered species, the RCW is not particularly sensitive to many activities including silvicultural practices that retain large live pines for cavity trees in open stands (Rudolph and Conner 1996, Hedrick et al. 1998, USFWS 2003). The portion of Potlatch's ownership in southern Calhoun County became the focal point of this effort.

Between 2003 and 2006, Potlatch and other organizations (including TNC and ANHC) formalized a number of easements in southern Arkansas (Potlatch Forest Holdings, Inc. 2010). As the science of RCW conservation revealed better management techniques, Potlatch began negotiating with the USFWS in 2004 to establish a Conservation Area (what is now MBP) to relocate and aggregate demographically isolated RCW breeding groups in a concentrated portion of the company's ownership (Potlatch Forest Holdings, Inc. 2010). In addition to creating a more suitable spatial structure for RCW habitat and thereby aiding in population persistence (Walters et al. 2002), consolidated breeding groups were also logistically easier to manage. The MBP effort continued to gain momentum, culminating with the signing of the largest conservation easement to date in Arkansas in December 2006 (TNC 2006b).

According to Potlatch's current proposed habitat conservation plan, 13,122 acres of MBP are dedicated to RCW management activities. These include timber harvests specified under the signed conservation easement, the translocation of RCWs from other sources to the MBP as they become available, and RCW habitat maintenance (USFWS 2013) (Table 1). In this proposed habitat conservation plan, Potlatch set a corporate goal to build a demographically stable RCW population of as many as 35 breeding groups in the MBP (Potlatch Forest Holdings, Inc. 2010). To date, RCW populations on MBP are dynamic but have stabilized at around 12–15 breeding groups with a slight increase in the total number of RCWs (Figure 4). Forest structure improve-


**Figure 3. From a conservation perspective, riparian zones such as bald cypress-hardwood riparian forests (A) and relatively small but unique wetland communities interspersed among the pine flatwoods (B) of the MBP offer additional opportunities. (Photograph A by Don C. Bragg, USDA Forest Service and photograph B by Brent Baker, Arkansas Natural Heritage Commission.)**

ment is critical to future RCW population growth; hence, the MBP silvicultural strategy is designed to enhance existing mature pine stands with a grass- and forb-dominated understory. To achieve this, a combination of frequent low-intensity surface fires, hardwood midstory removals, and commercial thinnings of pine have been conducted across the MBP (Figure 5). Since 2006, prescribed fire use at MBP has increased noticeably, whereas the area treated with herbicides has declined (Table 1).

RCW habitat improvement is only one of the objectives in the MBP forest management plan: other imperiled species must also be monitored, public access developed, and threats to the MBP identified. To achieve these objectives, simple perfunctory participation would not suffice because none of the individual entities was capable of implementing such an ambitious effort without the involvement and commitment of the others. Most of the partners in the MBP had good prior working relationships, making the formalization of this collaboration a relatively smooth process. For example, the ANHC and TNC have conducted periodic surveys of the biota in the MBP since its establishment to develop a list of species of special concern (Table 2) that will help guide Potlatch's management activities (e.g., TNC 2009). Data on other imperiled species in the MBP will be developed with additional surveys. Any necessary adjustments to the forest management plan arising from these surveys can then be addressed by a "Forest Management Team" convened annually to discuss past and future activities. Composed of Potlatch, TNC, and relevant state agency staff members, this Forest Management Team is advised by representatives from local universities and staff from the USFWS and the USDA Forest Service (Potlatch Forest Holdings, Inc. 2006).

## MBP and the Forest Legacy Program (FLP)

The leveraging of public and private resources to support large-scale conservation projects is at the core of most successful efforts, but finding $6.7 million to purchase the development rights for MBP proved to be no small task. Initially supported by state and private funds, TNC was the original grantee on the conservation easement. Specific language in the agreement allowed TNC to transfer their newly acquired rights to the ANHC and AGFC at a later date, a clause that permitted the State of Arkansas time to pursue additional funding support. A partial solution to the funding challenge was found in two separate grants (in 2007 and 2008) from the USDA Forest Service's FLP. Created by the 1990 Farm Bill, the FLP allows government agencies to protect environmentally sensitive, privately owned forestlands by working with willing landowners through a variety of mechanisms (USDA Forest Service 2006). After completing a process that involves the identification and documentation of forest-related conservation priorities threatened by developmental pressures (an assessment of need [AON], approved by the USDA Forest Service), states can submit specific projects for consideration. FLP grant applications for targeted projects are ranked for funding support based on a number of clear and objective criteria focused on the conservation value of the project, with the size and number of awards based on program appropriations (USDA Forest Service 2006).

The State of Arkansas completed its AON in 2004 and has since periodically updated this document as a part of its strategic forest planning (e.g., AFC 2010a, 2010b). The AON prioritized "working" forested

**Table 1. Acreage of silvicultural treatments conducted on the lands of the MBP between 2003 and 2013, inclusive.**

| Year | Thinning | Prescribed burns | Herbicide | Mechanical midstory removal |
|---|---|---|---|---|
| 2003 | 1,177 | 0 | 482 | 40 |
| 2004 | 560 | 113 | 748 | 0 |
| 2005 | 722 | 2,779 | 1,194 | 84 |
| 2006 | 401 | 1,357 | 1,503 | 62 |
| 2007 | 767 | 3,292 | 1,237 | 60 |
| 2008 | 519 | 3,446 | 1,013 | 0 |
| 2009 | 174 | 3,589 | 280 | 0 |
| 2010 | 169 | 3,505 | 0 | 87 |
| 2011 | 1,149 | 4,094 | 170 | 0 |
| 2012 | 784 | 3,762 | 353 | 62 |
| 2013 | 852 | 4,094 | 147 | 0 |

Note that the MBP Conservation Easement was registered in December 2006, so any treatments before 2007 represent preestablishment practices for the stand.

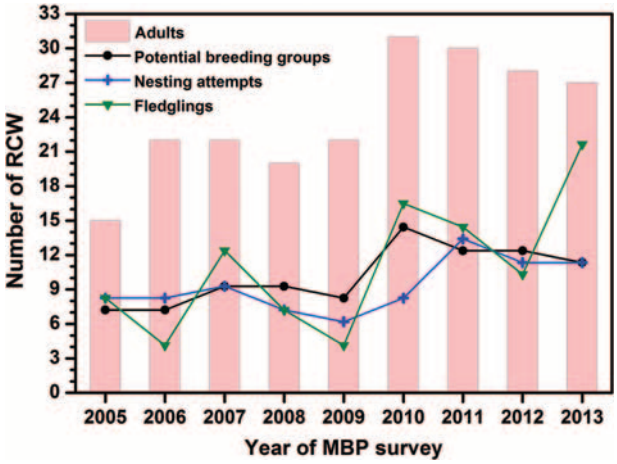


**Figure 4. RCW population trends on MBP, 2005–2013.**

landscapes across Arkansas that could be actively and sustainably managed for multiple values but lack the protections and regulatory controls of widespread public lands (AFC 2010b). High- or very high-priority Forest Legacy Areas (FLAs) cover approximately one-quarter of the state and include the Ouachita and Saline River watersheds in southern and central Arkansas (AFC 2010a). These watersheds were classified as a very high-priority FLA due to a combination of high conservation value pine flatwoods with critically imperiled species, local reliance on the timber industry, and a susceptibility to forest fragmentation and parcelization due to a relatively low proportion of public ownership (Anderson 2006, AFC 2010a). The ecological significance of this FLA has been recognized by other entities, including an Important Bird Area designation by the Audubon Society and TNC's listing as a key conservation area (TNC 2006a, AFC 2010a, WGCPO Landbird Working Group 2011). The MBP FLP awards, totaling $2.7 million, were used to reimburse a portion of the state's contribution and all of the TNC's contribution used to acquire the MBP conservation easement and reflected further validation of this project.

### MBP and Regional Conservation Efforts

The MBP plays an informal role in the regional RCW recovery strategy. Currently, southern Arkansas is not technically included in the primary, secondary, or essential support population designations of the current RCW recovery plan because most of the area is privately owned and there are few public timberlands (USFWS 2003). However, efforts are underway to build a series of RCW "stepping stones" across southern Arkansas between the Upper Ouachita and Felsenthal NWR complex (USFWS), Felsenthal-West Preserve (TNC), and the ANHC's Longview-Saline, Kingsland Prairie-Hall Creek Barrens, and Warren Prairie natural areas along the terraces of the Ouachita and Saline rivers (TNC 2006a, 2009).

The MBP easement is one of several privately owned parcels intended to help connect RCW populations, and its success can help demonstrate the value of integrating private and public conservation interests across the predominantly privately owned Upper West Gulf Coastal Plain. If the objectives of these stepping-stone corridors are realized, existing RCW populations will grow, new populations will establish, and dispersal between these small populations should help reduce their likelihood of extirpation from stochastic events, thereby producing enough viable RCW breeding groups to help meet species recovery objectives (Walters et al. 2002, USFWS 2003, WGCPO Landbird Working Group 2011, Trainor et al. 2013). Further, these north-south trending corridors could facilitate the rescue effect of local populations of other declining species (some of which are listed in Table 2), as well as regional shifts in species distribution that may be related to factors such as climate change.

## Conservation Opportunities and Challenges

As originally designed, MBP addressed a specific set of conservation and economic goals that had been identified by the partners. However, flexibility was also included in this agreement to permit the participants to pursue other opportunities, so long as the treatments would not be incompatible with the overall objectives of the conservation easement. Some of these new opportunities arose as an inevitable consequence of the improvement of existing RCW habitat, whereas others were unknown at the time of signing. And, of course, any challenges that threaten the integrity of MBP must be addressed within the constraints of the easement.

### RCW Habitat Improvement Benefits to Other Species

The MBP goal for RCW breeding groups has yet to be reached, and there is no measure yet available regarding the effectiveness of the regional RCW recovery effort. However, success of the MBP project should not be solely judged by the RCW, because it is not the only species of concern present. The RCW serves as an "umbrella" species for open pine woodlands, meaning that restoring its preferred habitat can serve to meet


**Figure 5. Treatments on the MBP to improve RCW habitat demonstrating hardwood removals (A), overstory pine thinning (B), postfire stand (C), and desired RCW conditions (D) in open, mature flatwoods surrounding a cavity tree cluster. (Photographs by Don C. Bragg, USDA Forest Service.)**

the needs of other priority species in this area (Masters et al. 1998, Conner et al. 2002, WGCPO Landbird Working Group 2011). Furthermore, the MBP also contains a number of unique microsites (e.g., seeps, bayheads, minor bottomlands, and vernal pools) (Figure 3) important to a number of species of conservation interest (Anderson 2006). The large-scale scale improvement of pine woodlands across the MBP has benefited these microsites by restoring many of the environmental conditions required by nontarget species, including a number of graminoids and forbs considered rare by the State of Arkansas (Table 2).

Not all nontarget species that will benefit are currently threatened. For example, shortleaf pine should profit from the RCW habitat improvement at MBP. Historically, shortleaf pine was considerably more common across the Upper West Gulf Coastal Plain, particularly on certain landforms (Mohr 1897, Mattoon 1915, Bragg 2008). The decline of shortleaf pine has been attributed to altered disturbance regimes, unfavorable silvicultural practices, and less successful regeneration (Bragg 2002, 2008, Moser et al. 2007, Tauer et al. 2012). Because of its ability to resprout after topkilling when young and the greater resistance of mature stems to fire than that of loblolly pine or many hardwoods, shortleaf pine should fare better under the new MBP silvicultural regimes, especially on droughty sites. Likewise, some unlisted but declining understory plants, such as the short-leaved sundew (*Drosera brevifolia*) (Figure 6) that prefer wetland habitats in open, frequently burned piney woods are also expected to benefit from RCW habitat improvement activities. High-quality examples of these increasingly uncommon microsites on the MBP are expected to become more important over time as they are lost to land cover and use change elsewhere (Anderson 2006, TNC 2006a, 2009).

## Other Ecosystem Service Opportunities

Ecosystem services, loosely defined as the direct and indirect benefits of the natural environment and its functions to human well-being, is a rather all-encompassing concept that includes a range of provisioning (e.g., wood production and huntable wildlife), supporting (e.g., species habitat and nutrient cycling), regulating (e.g., flood control and water purification), and cultural (e.g., aesthetics and recreation) contributions (Braat and de Groot 2012). Although

**Table 2. Species of special concern found on the MBP.**

| Common name | Scientific name | Global rank[1] | State rank[1] |
|---|---|---|---|
| Vertebrates | | | |
| Louisiana milk snake | *Lampropeltis triangulum amaura* | G5T4 | S3 |
| Red-cockaded woodpecker | *Picoides borealis* | G3 | S2 |
| Louisiana slimy salamander | *Plethodon kisatchie* | G3G4 | S2 |
| Vascular plants | | | |
| Pinewoods-lily | *Alophia drummondii* | G4 | S2 |
| Kral's silkyscale | *Anthenantia texana* | G3G4 | S3 |
| Wrinkled joint-tail | *Coelorachis rugosa* | G5 | S2 |
| Tall swamp rosette grass | *Dichanthelium scabriusculum* | G4 | S1S2 |
| Large-head pipewort | *Eriocaulon decangulare* | G5 | S1S2 |
| Bush's umbrella sedge | *Fuirena bushii* | G5 | S3 |
| Short-leaf skeleton grass | *Gymnopogon brevifolius* | G5 | S2 |
| Early paspalum | *Paspalum praecox* | G4 | S1S2 |
| Slender rose-gentian | *Sabatia campanulata* | G5 | S1 |
| Red-berried greenbrier | *Smilax walteri* | G5 | S2S3 |
| Yellow-eyed-grass | *Xyris ambigua* | G5 | S2S |

[1]Rankings according to the NatureServe classification (NatureServe 2013) range from 1 (critically imperiled) to 5 (secure) for either global-level (G; T for a subspecies) or state-level (S) assessment.

**Figure 6. The short-leaved sundew (*Drosera brevifolia*), an unusual if not rare understory plant found in open pine flatwood sites, is one of a number of desirable native species that should benefit from habitat improvement efforts intended to support RCWs. (Photograph by Brent Baker, Arkansas Natural Heritage Commission.)**

timber yield and endangered species protection remain the top MBP ecosystem service priorities, the conservation easement considers other supporting, regulating, and cultural services, many of which are synergistic. For example, the continuation of Potlatch's practice of using best management practices in riparian zones should help maintain water quality and aquifer recharge while enhancing wildlife habitat.

Public recreation opportunities represent another important provisional ecosystem service of MBP. Before the establishment of the state natural area and wildlife management area (WMA), the lands that now constitute the MBP were leased to private individuals and hunting clubs and, hence, were unavailable to the general public. In Arkansas, WMAs are private or public lands specifically managed by the AGFC to provide open access at little or no direct cost. Since 2007, the MBP has been operated as a special permit-only firearms zone for white-tailed deer (*Odocoileus virginianus*). Over the years, hunter use of MBP has grown steadily: AGFC records show that registered deer harvested in this WMA have risen from 37 animals in 2007 to >170 deer annually during the last 3 years (2010–2012). MBP is also open for a permitted wild turkey (*Meleagris gallopavo*) hunt and offers general access for other types of hunting, fishing, bird watching, and recreational activities.

The emergence of compliance-based carbon offset markets in California, Canada, Europe, and other parts of the world has increased interest in the sequestration of carbon dioxide in North American forests, even though the long-term contracts associated with these markets can deter private landowners who desire silvicultural flexibility (Galik et al. 2013). Under the right circumstances, landowners who are willing to forgo business-as-usual management practices and permit additional long-term carbon gain can look to that increase as a revenue opportunity.[3] On May 2, 2013, Potlatch and Finite Carbon issued a joint press release announcing the registration of the Moro Big Pine Conservation Easement Improved Forest Management Early Action Offset Project. This project has been billed as the "…nation's first improved forest management (IFM) project completed for a publicly-traded real estate investment trust" in the California offset market (Finite Carbon Corporation 2013). Under the terms of this project, >220,000 compliance-eligible carbon offsets were issued for the MBP and will be offered for auction. The sale of these credits requires a long-term commitment to the forest management and land use practices identified in the conservation easement and offered Potlatch another revenue stream to supplement income generated from the sale of timber from the MBP. The conservation efforts at MBP predated the development of this carbon market opportunity, so the sale of offsets did not influence the decisions by any of the parties to participate in this easement. However, for other projects that may lack the financial support of MBP, the ability to receive additional payments could act as a mechanism to support large-scale restoration focused on endangered species such as the RCW (sensu Alavalapati et al. 2002), because it should increase the willingness of many private landowners to enter into an agreement that otherwise requires forfeiting current and future development rights (e.g., Ruddell et al. 2007).

## Threats to the Ecological Integrity of MBP

Like any other forested lands in the southeastern United States, the MBP faces a number of threats ranging from invasive species to climate change. Under worst-case scenarios, these jeopardize the MBP's ability to support the RCW and thus its primary reason for existence. Such scenarios are unlikely because of the continuous monitoring by Potlatch and state agencies, which are actively engaged in mitigating any threats that arise. For example, Chinese tallow trees (*Triadica sebifera*) have recently been detected in parts of the MBP, including one

location where they were found scattered across 93 acres. This particular infestation was treated with herbicides in 2012 and burned in early 2013, and land managers will continue to monitor for reoccurrence. Efforts have also been made to reduce the impact of other exotic species on MBP, including feral hogs (*Sus scrofa*), but their permanent eradication seems highly unlikely. Not all harmful species are invasive exotics; outbreaks of native forest pests such as the southern pine (*Dendroctonus frontalis*), black turpentine (*Dendroctonus terebrans*), or various species of engraver (*Ips* spp.) beetles could threaten the recovery of the MBP RCW population if they kill the mature pines required for nest cavities faster than they can be replaced (Potlatch Forest Holdings, Inc. 2010).

Land-use and land-cover changes could be the biggest threat to the long-term integrity of the MBP. The conversion of natural-origin stands to short-rotation loblolly pine plantations represents the greatest threat to ecosystem integrity across the Upper West Gulf Coastal Plain (Anderson 2006, TNC 2006a). Forest type conversion has been specifically addressed in the conservation easement. However, this agreement only regulates Potlatch's management practices on the MBP itself (not its other holdings), and timber harvesting on other nearby ownerships could have an impact on MBP. Extensive residential and commercial developments are unlikely in this remote, sparsely populated region, and there is little agricultural interest in the flatwoods. A major highway does pass through the middle of the MBP, and a proposed expansion project could affect a number of active nest clusters. As long as the widened highway does not prove to be a barrier to species movement, this is not expected to be a major threat to the overall integrity of the MBP, given existing regulatory safeguards. One potential forest threat that could materialize is the development of subsurface resources both on and off of the MBP. The conservation easement specifically transferred the mineral rights from Potlatch to the State of Arkansas when they were held by the company. However, it is possible that mineral rights on some of the lands under the easement are controlled by other parties not covered by the agreement and hence not legally bound to its terms. The development of mineral or energy resources outside of the MBP boundaries could have an impact on this conservation effort, particularly if the air or water is polluted by activities such as sand and gravel mining or fossil fuel extraction, or sensitive wildlife species are harmed by nearby industrial processes and infrastructure development.

To mitigate these threats, managers at MBP have a number of options. The State of Arkansas and federal government have the legal authority to restrict or prohibit undertakings that threaten endangered species. To minimize the risk posed by natural disturbances, Potlatch has built-in redundancy to RCW nest clusters, which tends to be the primary limitation to the species. Additional unused cavities permit a rapid response in case of the degradation or loss of occupied cavities elsewhere on MBP. Furthermore, monitoring efforts on the MBP and the nature of the arrangement between the MBP partners allow for prompt action in response to rapidly changing conditions. For instance, the ability to aggressively treat a forest threat such as the invasive Chinese tallow tree before it becomes widespread should help to preserve the ecological integrity of MBP. This action is critical because left unchecked, Chinese tallow tree may become dominant across the abundant wetlands of MBP to the detriment of many organisms ranging from common bird species (e.g., Gifford and Armacost 2012) to sensitive aquatic species such as anurans (frogs and toads) (e.g., Cotten et al. 2012).

## Conclusions

Rapid population growth and its associated developmental pressures and fragmentation, coupled with large-scale forest type conversions and a changing climate are expected to continue to strain the ecological integrity of the Southeast (Wear and Greis 2013). To remain viable, partnerships between private and public entities must continue to ensure that regional conservation priorities are secured. Fortunately, conservation opportunities have increased in recent years as the nature of property ownership continues to evolve: much has been written about the willingness of many private landowners to participate in voluntary partnerships, easements, land management trusts, and other mechanisms for implementing large-scale forest conservation projects (e.g., Williams and Ellefson 1997, Alavalapati et al. 2002, Pejchar and Press 2006, Stein 2011, Labich et al. 2013).

The ability to meet both conservation and timber production objectives on privately owned land exemplifies how arrangements such as the MBP permit the permanent establishment of working forests that contribute to the quality of life in this rural, resource-dependent region. Such an arrangement would not be possible in southern Arkansas (or elsewhere) without the joint participation of government, corporate, and conservation interests and a carefully crafted balance between private property rights, public good, and environmental integrity. Although just a case study, MBP represents an example of the collaborative opportunities available to resource managers in intensively managed forested landscapes. Seven years into this project, MBP has witnessed steady progress in the improvement of RCW habitat, increased numbers of RCWs, and better public recreational opportunities. Wood continues to flow from harvests on MBP, carbon is still sequestered in trees, and a wide range of other ecosystem services remain. Monitoring efforts will show whether the priority conservation goals are met, but we expect the MBP collaboration to continue to build on its successful track record.

## Endnotes

1. For this article, the Upper West Gulf Coastal Plain will be defined as that portion of the Gulf Coastal Plain west of the Mississippi River and north of the natural distribution of longleaf pine (*Pinus palustris*); this includes most of southern Arkansas, northern Louisiana, southeastern Oklahoma, and northeastern Texas.
2. The current proposed version of the habitat conservation plan covers Potlatch's approach to managing their entire Arkansas landholdings; this article will focus on the elements specific to MBP. The most recently approved habitat conservation plan requires Potlatch to manage for only 15 breeding groups, a number that was set using updated research on RCW conservation for this location.
3. Obviously, this is an oversimplification of the process, which requires the proper inventory and documentation plus certification and a willingness to commit to a long-term legally binding contract regarding the carbon.

## Literature Cited


Abt, R.C., and K.L. Abt. 2013. Potential impact of bioenergy demand on the sustainability of the southern forest resource. *J. Sustain. For.* 32:175–194.

Alavalapati, J.R.R., G.A. Stainback, and D.R. Carter. 2002. Restoration of longleaf pine ecosystem on private lands in the US South: An ecological economic analysis. *Ecol. Econ.* 40:411–419.

Anderson, J.E. (ed.). 2006. *Arkansas wildlife action plan.* Arkansas Game and Fish Commission, Little Rock, AR. 2028 p. Available online

at www.wildlifearkansas.com/strategy.html; last accessed Sept. 23, 2013.

Arkansas Forestry Commission. 2010a. *Arkansas statewide forest resources assessment and strategy.* Arkansas Forestry Commission, Little Rock, AR. 80 p. Available online at forestry.arkansas.gov/SiteCollectionDocuments/ArkansasForestryCommAssessment.pdf; last accessed July 22, 2013.

Arkansas Forestry Commission. 2010b. *Arkansas statewide forest resources strategy.* Arkansas Forestry Commission, Little Rock, AR. 50 p. Available online at forestry.arkansas.gov/SiteCollectionDocuments/ArkansasForestResourceStrategy.pdf; last accessed July 22, 2013.

Bonnie, R. 1997. Strategies for conservation of the endangered red-cockaded woodpecker on private lands. *Endangered Species Update* 14(7&8):45–47.

Braat, L.C., and R. de Groot. 2012. The ecosystem services agenda: Bridging the worlds of natural science and economics, conservation and development, and public and private policy. *Ecosys. Serv.* 1:4–15.

Bragg, D.C. 2002. Reference conditions for old-growth pine forests in the Upper West Gulf Coastal Plain. *J. Torr. Bot. Soc.* 129(4):261–288.

Bragg, D.C. 2008. The prominence of pine in the Upper West Gulf Coastal Plain during historical times. P. 29–54 in *Freeman and Custis Red River Expedition of 1806: Two hundred years later*, Hardy, L.M. (ed.). Louisiana State University-Shreveport Museum of Life Sciences Bull. 13, Shreveport, LA.

Brandeis, T.J., A.J. Hartsell, J.W. Bentley, and C. Brandeis. 2012. *Economic dynamics of forests and forest industries in the southern United States.* USDA For. Serv., e-Gen. Tech. Rep. SRS-152, Southern Research Station, Asheville, NC. 70 p.

Brockerhoff, E.G., H. Jactel, J.A. Parrotta, C.P. Quine, and J. Sayer. 2008. Plantation forests and biodiversity: Oxymoron or opportunity? *Biodivers. Conserv.* 17:925–951.

Conner, R.C., and A.J. Hartsell. 2002. Forest area and conditions. P. 357–402 in *Southern forest resource assessment*, Wear, D.N., and J.G. Greis (eds.). USDA For. Serv., Gen. Tech. Rep. SRS-53, Southern Research Station, Asheville, NC.

Conner, R.N., D.C. Rudolph, and J.R. Walters. 2001. *The red-cockaded woodpecker surviving in a fire-maintained ecosystem.* University of Texas Press, Austin, TX. 400 p.

Conner, R.N., C.E. Shackelford, R.R. Schaefer, D. Saenz, and D.C. Rudolph. 2002. Avian community response to southern pine ecosystem restoration for red-cockaded woodpeckers. *Wilson Bull.* 114(3):324–332.

Cooke, B., W.T. Langford, A. Gordon, and S. Bekessy. 2012. Social context and the role of collaborative policy making for private land conservation. *J. Environ. Plan. Manage.* 55(4):469–485.

Costa, R. 1997. The US Fish and Wildlife's red-cockaded woodpecker private lands conservation strategy: An evaluation. *Endangered Species Update* 14(7&8):40–44.

Cotten, T.B., M.A. Kwiatkowski, D. Saenz, and M. Collyer. 2012. Effects of an invasive plant, Chinese tallow (*Triadica sebifera*), on development and survival of anuran larvae. *J. Herpetol.* 46(2):186–193.

Curry, C.C. 1960. Early timber operations in southeast Arkansas. *Ark. Hist. Q.* 19(2):111–118.

Darling, O.H., and D.C. Bragg. 2008. The early mills, railroads, and logging camps of the Crossett Lumber Company. *Ark. Hist. Q.* 67(2):107–140.

Doremus, H. 2003. A policy portfolio approach to biodiversity protection on private lands. *Environ. Sci. Policy* 6:217–232.

Finite Carbon Corporation. 2013. *Finite Carbon and Potlatch Corporation register nation's first REIT carbon project for California offset market.* Available online at www.finitecarbon.com/2013/05/02/first-reit-project-registered-for-ca-offset-market/; last accessed July 24, 2013.

Fox, T.R., E.J. Jokela, and H.L. Allen. 2007. The development of pine plantation silviculture in the southern United States. *J. For.* 105(7):337–347.

Galik, C.S., B.C. Murray, and D.E. Mercer. 2013. Where is the carbon? Carbon sequestration potential from private forestland in the southern United States. *J. For.* 111(1):17–25.

Gifford, K.L., and J.W. Armacost Jr. 2012. Year-round bird use of monotypic stands of the Chinese tallow tree, *Triadica sebifera*, in southeast Texas. *Condor* 114(4):689–697.

Hedrick, L.D., R.G. Hooper, D.L. Krusac, and J.M. Dabney. 1998. Silvicultural systems and red-cockaded woodpecker management: Another perspective. *Wild. Soc. Bull.* 26(1):138–147.

Ince, P.J., and P. Nepal. 2012. *Effects on US timber outlook of recent economic recession, collapse in housing construction, and wood energy trends.* USDA For. Serv., Gen. Tech. Rep. FPL-219, Forest Products Laboratory, Madison, WI. 18 p.

Jeter, M.D., and A.M. Early. 1999. Prehistory of the Saline River drainage basin, central to southeast Arkansas. P. 31–63 in *Arkansas archaeology: Essays in honor of Dan and Phyllis Morse*, Mainfort, R.C., and M.D. Jeter (eds.). Univ. of Arkansas Press, Fayetteville, AR.

Klimas, C.V., E.O. Murray, J. Pagan, H. Langston, and T. Foti. 2005. *A regional guidebook for applying the hydrogeomorphic approach to assessing wetland functions of forested wetlands in the West Gulf Coastal Plain Region of Arkansas.* US Army Core of Engineers Environmental Laboratory, ERDC/EL TR-05-12, Vicksburg, MS. 244 p.

Labich, W.G., E.M. Hamin, and S. Record. 2013. Regional conservation partnerships in New England. *J. For.* 111(5):326–334.

Lambeth, C.C., and R.B. McCullough. 1997. Genetic diversity in managed loblolly pine forests in the southeastern United States: Perspective of the private industrial forest land owner. *Can. J. For. Res.* 27:409–414.

Ledig, F.T. 1986. Conservation strategies for forest gene resources. *For. Ecol. Manage.* 14:77–90.

Masters, R.E., R.L. Lochmiller, S.T. McMurry, and G.A. Bukenhofer. 1998. Small mammal response to pine-grassland restoration for red-cockaded woodpeckers. *Wild. Soc. Bull.* 26(1):148–158.

Mattoon, W.R. 1915. *Life history of shortleaf pine.* USDA For. Serv., Bull. 244. 46 p.

McKeand, S.E., E.J. Jokela, D.A. Huber, T.D. Byram, H.L. Allen, B. Li, and T.J. Mullin. 2006. Performance of improved genotypes of loblolly pine across different soils, climates, and silvicultural inputs. *For. Ecol. Manage.* 227:178–184.

Michael, J.A. 2003. Efficient habitat protection with diverse landowners and fragmented landscapes. *Environ. Sci. Policy* 6:243–251.

Mohr, C. 1897. *The timber pines of the southern United States.* USDA For. Serv., Div. For. Bull. 13 (rev.), Washington, DC. 176 p.

Morbeck, G.C. 1915. Logging shortleaf pine in Arkansas. *Ames For.* 3:92–118.

Moser, W.K., M. Hansen, W.H. McWilliams, and R.M. Sheffield. 2007. Shortleaf pine composition and structure in the United States. P. 19–27 in *Shortleaf pine restoration and ecology in the Ozarks: Proceedings of a symposium*, Kabrick, J.M., D.C. Dey, and D. Gwaze (eds.). USDA For. Serv., Gen. Tech. Rep. NRS-P-15, Northern Research Station, Newtown Square, PA.

NatureServe. 2013. *NatureServe web services.* Arlington, VA. Available online at services.natureserve.org; last accessed Nov. 20, 2013.

Pejchar, L., and D.M. Press. 2006. Achieving conservation objectives through production forestry: The case of *Acacia koa* on Hawaii Island. *Environ. Sci. Policy* 9:439–447.

Potlatch Forest Holdings, Inc. 2006. *Conservation easement and forest management plan for the Moro Big Pine.* Unpublished document available from the Calhoun County, Arkansas courthouse. 54 p.

Potlatch Forest Holdings, Inc. 2010. *A habitat conservation plan for red-cockaded woodpeckers on Potlatch lands in Arkansas.* Unpublished document available from Potlatch Forest Holdings, Inc., Warren, AR. 66 p.

Rahman, M.S., M.G. Messina, and R.F. Fisher. 2006. Intensive forest management affects loblolly pine (*Pinus taeda* L.) growth and survival on poorly drained sites in southern Arkansas. *South. J. Appl. For.* 30(2):79–85.

Rosson, J.F. Jr., and A.K. Rose. 2010. *Arkansas' forests, 2005.* USDA For. Serv., Res. Bull. SRS-166, Southern Research Station, Asheville, NC. 126 p.

Ruddell, S., R. Sampson, M. Smith, R. Giffen, J. Cathcart, J. Hagan, D. Sosland, et al. 2007. The role for sustainably managed forests in climate change mitigation. *J. For.* 105(6):314–319.

Rudolph, D.C., and R.N. Conner. 1996. Red-cockaded woodpeckers and silvicultural practice: Is uneven-aged silviculture preferable to even-aged? *Wild. Soc. Bull.* 24(2):330–333.

Russell, K.R., T.B. Wigley, W.M. Baughman, H.G. Hanlin, and W.M. Ford. 2004. Responses of southeastern amphibians and reptiles to forest management: A review. P. 319–334 in *Southern forest science: Past, present, and future*, Rauscher, H.M., and K. Johnsen (eds.). USDA For. Serv., Gen. Tech. Rep. SRS-75, Southern Research Station, Asheville, NC.

Schultz, C.A., T. Jedd, and R.D. Beam. 2012. The Collaborative Forest Landscape Restoration Program: A history and overview of the first projects. *J. For.* 110(7):381–391.

SmartWood. 2005. *Forest management public summary for Potlatch Corporation Resource Management Division, Arkansas Region.* Unpublished certification report available online at www.rainforest-alliance.org/forestry/documents/potlatcharkansasregionpubsum05.pdf; last accessed Sept. 4, 2013.

Smith, W.B., P.D. Miles, C.H. Perry, and S.A. Pugh (tech. coords.). 2009. *Forest resources of the United States, 2007.* USDA For. Serv., Gen. Tech. Rep. WO-78, Washington, DC. 336 p.

Stanturf, J.A., R.C. Kellison, F.S. Broerman, and S.B. Jones. 2003. Productivity of southern pine plantations: Where are we and how did we get here? *J. For.* 101(3):26–31.

Stein, P.R. 2011. Trends in forestland: Ownership and conservation. *For. Hist. Today* 17(1/2):83–86.

Sutter, R.D., and R. Kral. 1994. The ecology, status, and conservation of two non-alluvial wetland communities in the South Atlantic and Eastern Gulf Coastal Plain, USA. *Biol. Conserv.* 68:235–243.

Tauer, C.G., J.F. Stewart, R.E. Will, C.J. Lilly, J.M. Guldin, and C.D. Nelson. 2012. Hybridization leads to loss of genetic integrity in shortleaf pine: Unexpected consequences of pine management and fire suppression. *J. For.* 110(4):216–224.

The Nature Conservancy. 2006a. *Conservation action plan for the Lower Ouachita Terraces Conservation Area.* Final project report T2-1-20. Available online at www.wildlifearkansas.com/materials/ProjectReports/T2-1-20%20%20Lower%20Ouachita%20Terraces%20CAP%20final.pdf; last accessed Oct. 31, 2013.

The Nature Conservancy. 2006b. *Largest conservation easement ever established in Arkansas: 16,000-acre "working forest" easement to become wildlife management area.* Unpublished press release. Available online at www.nature.org/ourinitiatives/regions/northamerica/unitedstates/arkansas/newsroom/potlatch-conservation-partners-announce-16000-acre-working-forest-ease.xml; last accessed Oct. 31, 2013.

The Nature Conservancy. 2009. *Restoration of woodland habitats at the Moro-Big Pine and Blackland Prairie and Woodland Conservation Areas and measuring progress towards the desired ecological conditions.* Final project report T26–05. Available online at www.wildlifearkansas.com/materials/ProjectReports/T26–05%20Moro-%20big%20Pine%20and%20Blackland%20prairie%20and%20woodland%20conservation%20FINAL.pdf; last accessed Oct. 31, 2013.

Trainor, A.M., J.R. Walters, D.L. Urban, and A. Moody. 2013. Evaluating the effectiveness of a Safe Harbor Program for connecting wildlife populations. *Anim. Conserv.* 16(6):610–620.

United Nations. 2012. *The North American forest sector outlook study: 2006–2030.* Geneva Timber and Forest Study Pap. 29. United Nations Economic Commission for Europe and Food and Agriculture Organization, Geneva, NY. 68 p. Available online at www.unece.org/fileadmin/DAM/timber/publications/SP-29_NAFSOS.pdf; last accessed Nov. 20, 2013.

USDA Forest Service. 2006. *Forest Legacy Program users' guide.* USDA For. Serv., State and Private Forestry. Available online at www.fs.fed.us/spf/coop/library/flp_usersguide.pdf; last accessed Sept. 13, 2013.

US Department of Interior Fish and Wildlife Service. 2003. *Recovery plan for the red-cockaded woodpecker (Picoides borealis)*, 2nd rev. US Department of Interior Fish and Wildlife Service, Atlanta, GA. 296 p.

US Department of Interior Fish and Wildlife Service. 2013. Incidental take permit and environmental assessment for forest management activities, southern Arkansas. *Fed. Reg.* 78(111):34669.

Walters, J.R., L.B. Crowder, and J.A. Priddy. 2002. Population viability analysis for red-cockaded woodpeckers using an individual-based model. *Ecol. Appl.* 12:249–260.

Walters, J.R., P.D. Doerr, and J.H. Carter III. 1988. The cooperative breeding system of the red-cockaded woodpecker. *Ethology* 78: 275–305.

Wear, D.N. 2013. Forecasts of land uses. P. 45–71 in *The Southern Forest Futures Project: Summary report*, Wear, D.N., and J.G. Greis (eds.). USDA For. Serv., Gen. Tech. Rep. SRS-168, Southern Research Station, Asheville, NC.

Wear, D.N., D.R. Carter, and J. Prestemon. 2007. *The US South's timber sector in 2005: A prospective analysis of recent change.* USDA For. Serv., Gen. Tech. Rep. SRS-99, Southern Research Station, Asheville, NC. 29 p.

Wear, D.N., and J.G. Greis. 2012. *The Southern Forest Futures Project: Summary report.* USDA For. Serv., Gen. Tech. Rep. SRS-168, Southern Research Station, Asheville, NC. 54 p.

Wear, D.N., and J.G. Greis (eds.). 2013. *The Southern Forest Futures Project: Technical report.* USDA For. Serv., Gen. Tech. Rep. SRS-178, Southern Research Station, Asheville, NC. 542 p.

West Gulf Coastal Plains/Ouachitas Landbird Working Group. 2011. *Open Pine Landbird Plan, West Gulf Coastal Plain/Ouachitas.* Report to the Lower Mississippi Valley Joint Venture Management Board. Available online at www.lmvjv.org/library/WGCPO_Landbird_Open_Pine_Plan_Oct_2011.pdf; last accessed Sept. 23, 2013.

Williams, E.M., and P.V. Ellefson. 1997. Going into partnership to manage a landscape. *J. For.* 95(5):29–33.