

# RESTORATION OF LONGLEAF PINE IN THE SOUTHERN UNITED STATES: A STATUS REPORT

R. Kevin McIntyre, James M. Guldin, Troy Ettel, Clay Ware, and Kyle Jones

**Abstract**—In 2009, the America’s Longleaf Restoration Initiative set an aggressive goal of increasing the area of ecosystems dominated by longleaf pine (*Pinus palustris*) from 4.29 to 8 million acres by 2025. In 2015, a 5-year review of progress using Forest Inventory and Analysis data showed that gains in longleaf pine acreage were offset by losses and that total longleaf pine acreage remained unchanged since 2010. As a result, Federal, State, and private partners engaged in a review during the summer of 2016 to discuss how to modify or respond to this lack of progress; they agreed to retain the original 8-million-acre goal, and to develop a revised set of strategies to attain that goal. These include efforts to increase restoration and to better understand the causes for the decline of longleaf pine on both public and private lands. Most of these will require changes in agency policy, enhanced restoration through planting and prescribed burning, and developing additional financial and managerial resources for implementation. Key to these efforts will be diversification of longleaf pine silviculture, including novel approaches to managing stands that contain a minor but manageable component of longleaf pine.

## INTRODUCTION

Over the last 2 decades, interest in restoration and management of longleaf pine (*Pinus palustris*) ecosystems has substantially increased. Longleaf pine ecosystems have many attributes that are compelling to those managing both public and private lands. They provide opportunities for economic utilization through harvest of timber (especially utility poles and high-quality dimension lumber) and nontimber forest products. They offer outstanding opportunities for wildlife including game species such as white-tailed deer (*Odocoileus virginianus*), eastern wild turkey (*Meleagris gallopavo*), and northern bobwhite quail (*Colinus virginianus*), as well as non-game species of concern such as gopher tortoise (*Gopherus polyphemus*), brown-headed nuthatch (*Sitta pusilla*), and Bachman’s sparrow (*Peucaea aestivalis*). Appreciation for longleaf pine also includes extraordinary but less tangible values, including aesthetics and the cultural significance of the iconic role that longleaf pine played in the history of the southeastern landscape. Once the dominant forest type on over about 92 million acres from southeastern Virginia to eastern Texas (Frost 2006), the longleaf pine forest type had been reduced to less than 4 percent of its original extent by the mid-1990s (Outcalt and Sheffield 1996).

Always important to a small cadre of biologists and land managers in the Southeast, the longleaf pine ecosystem began to garner broader attention once the red-cockaded woodpecker (*Leuconotopicus borealis*) and other longleaf-associated species were listed as endangered or threatened under the Endangered Species Act. Through the 1980s and 1990s, interest in saving this remarkable ecosystem continued to grow. There was both a greater emphasis on longleaf pine restoration and management on public lands, as well as increased private sector efforts that were aided by U.S. Department of Agriculture (USDA) incentive programs such as the Conservation Reserve Program and others.

In 2007, a regional working group of 22 public agencies and private organizations formed to develop the America’s Longleaf Restoration Initiative (ALRI). A core concept in the development of ALRI was that the task of achieving restoration of longleaf pine ecosystems at a meaningful scale was beyond the capacity of any one agency or organization, and would require a coordinated effort across the historic range of longleaf pine. A stakeholder engagement process facilitated input from a diverse group of conservationists and managers across the Southeast, and a rangewide conservation plan for longleaf pine was released in 2009 (ALRI 2009).

---

Author information: R. Kevin McIntyre, Education Coordinator, Joseph W. Jones Ecological Research Center, Newton, GA 39870; James M. Guldin, Supervisory Research Ecologist & Project Leader, U.S. Department of Agriculture Forest Service, Southern Research Station, Hot Springs, AR 71902; Troy Ettel, Forest Conservation/Longleaf Integrated Landscape Director, The Nature Conservancy, 100 Peachtree St. NW, Suite 2250, Atlanta, GA 30303; Clay Ware, Longleaf Pine Recovery Coordinator, U.S. Department of the Interior, Fish and Wildlife Service, 1875 Century Boulevard, Suite 200, Atlanta, GA 30345; and Kyle Jones, Regional Longleaf Pine Restoration Coordinator, U.S. Department of Agriculture Forest Service, Southern Region, 325 John Knox Road, Suite F-100, Tallahassee, FL 32303.

Kirschman, Julia E., comp. 2018. Proceedings of the 19th biennial southern silvicultural research conference. e-Gen. Tech. Rep. SRS-234. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 444 p.

The broad goal of the conservation plan was to increase the acreage of longleaf pine from 4.29 to 8 million acres by 2025, and more detailed goals related to the manner by which that might occur were also outlined. Although approximately 4.29 million acres existed when the plan was released, only about 1.5 million acres were considered to be in “maintenance” condition, defined by ALRI as containing the desired fire-maintained vegetation structure to provide habitat for longleaf-associated wildlife species. The plan articulated a goal of moving another 1.5 million acres into this category, for a total of 3 million acres in maintenance condition. Other specific goals and objectives outlined in the plan relate to prescribed fire, spatially explicit focal areas, understory restoration, and other considerations. The plan recognized the importance of both public and private lands in achieving the acreage goals for longleaf pine and outlined broad strategies for both.

In 2010, a Memorandum of Understanding (MOU) was signed between the Departments of Agriculture, Interior, and Defense establishing a Federal Coordinating Committee (FCC) to begin implementation of the plan. The MOU called for the establishment of a broader partnership to include State agencies, non-profit conservation organizations, and private sector participants. A stakeholder scoping process was conducted to gather input on the structure and function of this broader partnership and in fall of 2011, the initial meeting of the Longleaf Partnership Council (LPC) was held. The primary purpose of the LPC is to serve as a forum for communication and collaboration in implementation of the plan. The LPC has 33 seats, which are designed to be representative of the diversity of interests in the longleaf pine conservation and management community. Since the founding of the LPC, local implementation teams have formed around each of the focal areas, which are now called Significant Geographic Areas (SGA). These teams consist of local stakeholders and longleaf pine conservationists working collaboratively to manage and restore longleaf pine within their respective SGAs. One important function of the LPC and the local teams is to report restoration accomplishments annually across the range and to critically assess the overall progress towards the goals of the plan (LPC 2014, 2015, 2016).

## CURRENT STATUS OF LONGLEAF PINE

The implementation of the ALRI conservation plan began in 2010; coincidentally, 2010 also marked the completion of a full panel of Forest Inventory and Analysis (FIA) plots for longleaf pine. Forest Inventory and Analysis considers two forest types as longleaf pine – longleaf pine and longleaf pine/oak – and plots sampled in these forest types indicated a total of approximately 4.29 million acres in 2010 (Oswalt and others 2012). Also in 2010, the USDA Natural Resources Conservation

Service launched the Longleaf Pine Initiative, which offers incentives and technical assistance to private landowners interested in longleaf pine (USDA NRCS 2017). In 2012, a small working group from the LPC developed a 3-year strategic plan for implementation of the conservation plan that spanned the years 2013–2015 (LPC 2012). This plan set yearly goals for longleaf pine establishment, prescribed fire, and other restoration activities. The year 2012 also marked the beginning of the Longleaf Stewardship Fund, a public-private grant fund, administered by the National Fish and Wildlife Foundation, that provides more than \$4 million annually to support the local implementation teams and on-the-ground restoration activities.

Through these efforts and programs, in 2013 the LPC began collecting data to measure progress towards the ALRI goal. With 3.7 million acres needed to meet the 8-million-acre goal by 2025, an annual average of about 250,000 acres would be required. As 3-year step-down goals were set for the 2013–2015 strategic plan, it was assumed that initial goals from 2013–2015 would realistically be less than that average, but hopefully momentum would grow sufficiently to reach the target by 2025. For 2013–2015, longleaf pine planting goals were initially set at 105,000–130,000 acres, with prescribed fire to benefit longleaf pine at a target of 1.4–1.7 million acres (LPC 2012). These goals were largely achieved—newly-established plantations of longleaf pine exceeded 150,000 acres annually, for a 3-year total of almost 460,000 acres, and prescribed fire gradually increased to attain a 3-year total of 3.9 million acres burned.

Acreage totals for planted stands were calculated using two sources of information. Approximately half of the establishment acreage every year was supported under incentive programs, with related reporting and monitoring. The remaining acreage figures were gleaned from longleaf pine seedling sales data from the Southern Forestry Nursery Cooperative at Auburn University.<sup>1</sup> Assumptions used to calculate acreage from number of seedlings sold were that 1) 90 percent of the seedlings sold were planted, and 2) that seedlings were planted at 650 trees per acre. These assumptions should yield relatively conservative estimates since many landowners plant at lower densities for wildlife benefits. When the establishment data are combined with seedling sales data from 2011 and 2012, it is estimated that the first 5 years of the ALRI resulted in 724,000 acres of newly established longleaf pine which, when added to the 4.3-million-acre estimate in 2012, suggests that there should be nearly 5 million acres of longleaf pine rangewide in 2015.

<sup>1</sup> Personal communication. 2016. Scott Enebak, Director, Southern Nursery Management Cooperative, 3301 Forestry and Wildlife Sciences Building, Auburn University, AL 36849-5418.

Unfortunately, this optimistic accounting of increased establishment does not factor in the reality that longleaf pine acres are being lost to other forest types and land uses. Forest Inventory and Analysis data suggest that between 2010 and 2015, the longleaf pine forest type increased by 204,000 acres, while longleaf pine/oak forest type decreased by 209,000 acres, for a net loss of 5,000 acres. Essentially, the total acreage of longleaf pine-dominated forest types remains unchanged since 2010. America's Longleaf Restoration Initiative data suggest that there were substantially more acres of longleaf pine forest type established than FIA data suggest. This is not necessarily inconsistent – whereas ALRI figures represent a total inventory, FIA numbers are derived from a coarse-scale distribution of sampling plots, of which 20 percent are re-measured annually across a 5-year cycle, creating a potential time lag for reporting. The important point that emerges from the FIA data is that whatever the actual numbers may be, indications are that losses are still equivalent to gains.

These estimates of gains and losses are sobering for those working on the restoration of longleaf pine across the South. Despite tremendous efforts and momentum, longleaf pine acreage remains essentially unchanged over the last 5 years. Clearly, the goal of reaching 8 million acres is even more challenging now. Throughout 2016, the LPC and FCC reviewed this situation and discussed options. Ultimately, the consensus was that the acreage goal and the timeline would remain the same, and the LPC was tasked with developing a proposed framework for a redoubled effort for ALRI.

## GAME CHANGERS

In response, a list of seven action areas, or “game changers,” has been developed and proposed. Collectively, these strategies have the potential to significantly accelerate progress toward the goal. A common thread running through the strategies is that they each involve additional effort, and additional resources, dedicated to longleaf pine restoration.

### Increased Restoration on Public Lands

Public lands represent perhaps the best investment of resources for longleaf pine restoration. These lands are permanently protected from development, dedicated to long-term management that includes conservation goals, and managed by agencies with natural resource professionals on staff. Within the range of longleaf pine, there are approximately 13.6 million acres of Federal and State-owned public lands (USGS 2016). Even though only a subset of the total public lands are suitable longleaf pine sites, clearly there is room for expansion of longleaf pine acres in the public sector. For example, about 4 million acres of National Forest System (NFS) ownership lies within the historic range of longleaf pine (USGS 2016), but currently, estimates of existing longleaf

pine on NFS lands are approximately 800,000 acres. There are certainly opportunities to add to the current total; for example, the Francis Marion National Forest recently revised its management plan and identified a long-term goal for longleaf pine that doubled the acreage identified in the old plan (USDA Forest Service Southern Region 2016).

Although the USDA Forest Service has taken a leadership role in assessing their public lands resources relative to longleaf pine, there are also significant acreages of other public lands where similar opportunities to expand longleaf pine on suitable sites exist. These include Department of Defense properties, National Wildlife Refuges, State forests, State wildlife management areas, and others. There are currently significant numbers of acres of mixed stands containing longleaf pine, other southern pines, and hardwoods on public lands that could be shifted to longleaf pine dominance with judicious removal of the non-longleaf pine components (Guldin and others 2016). Because the acreages potentially available for longleaf pine restoration on public lands are large, it should be recognized that the time necessary to execute restoration on the ground is likely to exceed the timeline of the ALRI goal. Conversion of such large acreages will involve extensive planning and sequencing of treatments that realistically incorporate the time required to conduct operations, as well as practical considerations such as allowing existing younger stands to reach sufficient maturity for harvest and subsequent conversion to longleaf pine. Assessment of progress towards the goal should acknowledge the time scale inherent in forest management and factor into accounting those acres committed to longleaf pine restoration, but not yet operationally underway or completed.

### Increased Restoration on Private Lands

Privately owned forests will be a critical component in reaching the 8-million-acre goal for longleaf pine. In 2012, private ownership controlled approximately 87 percent of the South's forests, with about one-third of that in corporate ownership and two-thirds held by noncorporate or “family forest” owners (Oswalt and others 2014). From 2013–2016, private lands have accounted for 82 percent of the documented longleaf pine establishment, with about half of that acreage supported by incentive programs (LPC 2014, 2015, 2016). Although incentive program support for longleaf pine establishment is substantial, several States typically have demand for these programs that exceeds available funding. We estimate that longleaf pine establishment on private lands will need to at least double to make meaningful progress towards the goal. With stand establishment costs (site preparation and planting) of roughly \$300 per acre, this could mean as much as \$45 million will be needed annually to

support an additional 150,000 acres of establishment on private lands. Although demand for incentive support currently exceeds the supply of funds, even if that much additional funding was available there is no guarantee that demand would increase under current policies that focus on smaller-acreage landowners.

### **Seek Opportunities to Engage Large-acreage Corporate Landowners in Longleaf Pine Restoration**

Corporate landowners include common forestry businesses such as timber investment management organizations (TIMOs) and real estate investment trusts (REITs), but also include family trusts, limited liability corporations, and others. Historically, these entities have not been eligible for most incentives programs due to the programs' limits on adjusted gross income or acreage caps. Furthermore, when judged simply by volume growth and capital value over a short time horizon, the economic performance of longleaf pine investments is lower than investments in faster-growing pines like loblolly and slash pine. As a result, managers often decide to choose species that are economically competitive to satisfy fiduciary obligations to their principals. However, corporate ownerships represent an untapped opportunity to increase longleaf pine establishment on private lands and grow demand for incentive programs. Revision of current Farm Bill policies to allow larger corporate landowners to access these programs could, in many cases, lessen fiduciary concerns for corporate owners. Income from incentive support early in the analytical cycle could minimize or eliminate economic opportunity costs, and thus fiduciary liabilities, associated with managing longleaf pine relative to other species of southern pine. More fully incorporating the long-term nature of forest dynamics and forest management into policy could also foster greater engagement from this group of landowners.

### **Shift in the Message of Urgency and Importance**

One of the major drivers in the longleaf pine restoration efforts has been the desire to benefit the unique suite of plant and, especially, animal species that depend on the habitat provided by the mature, fire-maintained, open structure of well-managed longleaf pine forests and woodlands. Currently, there are 30 species associated with longleaf pine ecosystems that are listed under the Endangered Species Act (ESA) and over 50 additional at-risk species (USFWS 2017). Further listings of longleaf-associated wildlife would bring significant economic costs, particularly for forest industry and private landowners, and could jeopardize the Nation's military readiness by restricting training on Department of Defense installations. For example, the Bonneville Power administration estimated the annual economic impact of salmon conservation efforts at \$350 million for the year 1994 (NRC 1995). A recovery plan that increased the survival odds for the northern spotted owl to 91

percent was estimated to decrease economic welfare by \$33 billion dollars (1990 dollars), with a majority of the impact related to the regional forest products industry (Montgomery and others 1994).

Forestry is a significant component of the South's economy. The total economic output of the region's wood-related sectors in 2009 was approximately \$230 billion (Abt 2013). Successful restoration and management of longleaf pine ecosystems at the scale articulated by the ALRI goal can play a critical role in precluding the need to list many of these species, thus providing justification for the significant investments required and avoiding the economic impact of further listing. Conservation strategies that encourage, rather than discourage, landowners from managing longleaf pine ecosystems and that offer more regulatory certainty would provide better outcomes for both at-risk species and private landowners. Broader articulation of the importance of reducing the need to list additional species is necessary to bolster the case for greater resources and accelerated restoration of longleaf pine ecosystems.

### **Promote Longleaf Pine Opportunities and Proposals for Gulf Restoration Funding**

The 2010 British Petroleum oil spill in the Gulf of Mexico resulted in the largest civil penalty ever assessed in the United States, approaching \$21 billion dollars. As much as two-thirds of these funds are earmarked for natural resource restoration and remediation. Adequate quantity and quality of freshwater is critical to assist in the recovery of nearshore estuarine systems and coastal wetlands (Alber 2002). Fire-maintained, moderately stocked longleaf pine forests use less water than other pine forest types, potentially increasing fresh water downstream (Brantley and others 2017). Strategically located longleaf pine restoration and land protection projects that buffer creeks and rivers can benefit coastal ecosystems by supplying greater quantities of high-quality fresh water. Thus, a strong argument exists for the use of some of these funds to further the ALRI goals. Federal agencies at the departmental level and State governments have some degree of purview over allocation of these funds, and these entities should advocate for funding of longleaf pine restoration projects where appropriate.

### **Increase Support for Prescribed Burning**

Frequent, low-intensity fire is an essential and naturally occurring ecological process that maintains the structure and function of longleaf pine forests and the habitat that they provide. Today, prescribed fire is the land manager's surrogate for this ecological process. To achieve the 8-million-acre goal, maintenance of a fire return interval of no more than 3 years will require annual prescribed burning on an additional million acres above current

levels (estimated at 1.6 million acres in 2016). Assuming an average cost of \$25 per acre, this could represent a cost of \$25 million dollars annually. Beyond direct costs, increased acreage of prescribed fire will require greater capacity for implementation, including more trained personnel, equipment, and agency support. Although realization of the 8-million-acre goal for longleaf pine may be years away, many of the ecological benefits, such as habitat for at-risk species, could be achieved sooner by greater application of prescribed fire to existing mature stands of other pine species in anticipation of their actual conversion to longleaf pine.

### **Expand Support for Land Protection through Fee Title and Easement Acquisitions**

Considerable progress continues to be made in establishing new plantings of longleaf pine, but concurrent losses continue to hold back potential net acreage gains. Some proportion of those losses can be attributed to harvest and land use change. Many of these losses are from older, mature stands and although new plantings may potentially offer the long-term benefits associated with longleaf pine ecosystems, it will take decades for those attributes to develop. Land protection is an important component of an overall conservation portfolio for longleaf pine and is key to maintaining the investment in time that mature longleaf pine represents. Identification of significant vulnerable longleaf pine tracts and prioritization of those sites through land protection programs such as the Forest Service Forest Legacy Program, the Land and Water Conservation Fund, nongovernmental land conservation organizations, and others are needed to slow the loss of these important sites.

### **SUMMARY**

Although the continued loss of longleaf pine has largely offset the acreage gains that ALRI has achieved, in the absence of the ALRI efforts the decline of longleaf pine acreage would have continued. It is hoped that future FIA estimates will begin to reflect gains as the time lag inherent in spreading plot surveys over 5 years catches up to known establishment figures documented by the LPC. Encouragingly, 2016 data from Alabama and North Carolina show net gains of approximately 30,000 acres (Miles 2017). The LPC is also exploring details of losses, which are occurring only in the longleaf pine/oak forest type – are these losses due to land use change such as urban development, conversion to pine plantations, or natural succession to other forest types due to fire suppression? The answer to these questions will help direct efforts to reduce such losses in the future.

Overall, ALRI has been successful and is often held up as a model conservation partnership. These achievements have been sustained by the tremendous commitment and enthusiasm of the longleaf pine conservation and management community, enabled

through moderate amounts of financial support from Federal agencies and the private sector. However, more work and more funds are needed if the 8-million-acre goal is to be met in a timeframe that is reasonably close to that set forth in the ALRI conservation plan. The proposals outlined in these seven game changers are ambitious and represent a significant increase in resources dedicated to the ALRI goal. The justification for this is simply stated—unlike other forest types, longleaf pine forests and their associated biota are extremely underrepresented on the southern forest landscape.

Although the level of funding that these proposals represent may seem unrealistic at first glance, this level of expenditure is not without precedent. For example, faced with the potential Federal listing of the greater sage grouse, the USDA Natural Resources Conservation Service (NRCS) launched the Sage Grouse Initiative (SGI) in 2010. The SGI is a partnership of ranchers, agencies, universities, non-profits, and businesses working to conserve sage brush habitat and its associated wildlife through sustainable ranching. Through Farm Bill programs, the NRCS has dedicated \$751 million to the SGI. In 2015, largely due to the unprecedented conservation partnership of the SGI, the U.S. Department of the Interior Fish and Wildlife Service's status review for the sage grouse determined that protection under the ESA was not warranted and withdrew the species from the candidate species list. Elevating the ALRI to a similar level of support could have similar results for the many species of longleaf-associated wildlife that are currently listed or under consideration for Federal listing, such as the red-cockaded woodpecker, gopher tortoise, gopher frog (*Rana capito*), striped newt (*Notophthalmus perstriatus*), and Louisiana pine snake (*Pituophis ruthveni*).

Longleaf pine ecosystems are among the rarest ecosystems in North America (Noss and others 1995), with many of the wildlife associates similarly imperiled. Although the costs for redoubling efforts to achieve the goals of the conservation plan are high, the costs of continued loss of habitat and the economic impacts of further listing of species under the ESA may be higher (Brown and Shogren 1998). The ambitious ALRI goal was established as a long-term strategy designed to reverse the loss of longleaf pine acreage, establish management regimes that ensure the development of ecosystem values while maintaining working forests, and ultimately restore viable populations of declining wildlife species that help preclude further listings under the ESA. ALRI has demonstrated the ability to make significant progress with relatively modest resources, but we are not on pace to meet the goal. Greater resources will be required to achieve the desired results, and the ALRI track record suggests the initiative is up to the challenge.

## LITERATURE CITED

- Abt, K.L. 2013. Employment and income trends and projections for forest-based sectors in the U.S. South. In: Wear, D.N.; Greis, J.G., eds. 2013. The Southern Forest Futures Project: technical report. Gen. Tech. Rep. SRS-178. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station: 103–121.
- Alber, M. 2002. A conceptual model of estuarine freshwater inflow management. *Estuaries*. 25(6B): 1246–1261.
- America's Longleaf Restoration Initiative [ALRI]. 2009. Range-wide conservation plan for longleaf pine. Regional working group for America's Longleaf. March 2009. [http://www.americaslongleaf.org/media/86/conservation\\_plan.pdf](http://www.americaslongleaf.org/media/86/conservation_plan.pdf). [Date accessed: April 12, 2017].
- Brantley, S.T.; Vose, J.M.; Wear, D.N.; Band, L. 2017. Potential of longleaf pine restoration to mitigate water scarcity and sustain carbon sequestration: planning for an uncertain future. In: Kirkman, L.K.; Jack, S.B., eds. *Ecological restoration of longleaf pine*. Boca Raton, FL: CRC Press.
- Brown, G.M., Jr.; Shogren, J.F. 1998. Economics of the endangered species act. *The Journal of Economic Perspectives*. 12(3): 3–20.
- Frost, C. 2006. In: Shibu, J.; Jokela, E.J.; Miller, D.L., eds. *The longleaf pine ecosystem: ecology, silviculture, and restoration*. New York, NY: Springer: 95–133.
- Guldin, J.M.; Rosson, J.F., Jr.; Nelson, C.D. 2016. Restoration of longleaf pine--the status of our knowledge. In: Schweitzer, C.J.; Clatterbuck, W.K.; Oswalt, C.M., eds. *Proceedings of the 18th biennial southern silvicultural research conference; 2015 March 2–5; Knoxville, TN*. e-Gen. Tech. Rep. SRS-212. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station: 323–331.
- Longleaf Partnership Council [LPC]. 2012. America's Longleaf Restoration Initiative strategic priorities and actions 2013–2015. <http://www.americaslongleaf.org/resources/strategic-priorities-and-actions/>. [Date accessed April 12, 2017].
- Longleaf Partnership Council [LPC]. 2014. America's Longleaf Restoration Initiative 2013 range-wide accomplishment report. Longleaf Partnership Council. <http://www.americaslongleaf.org/resources/2013-range-wide-accomplishment-report-and-executive-summary/>. [Date accessed April 12, 2017].
- Longleaf Partnership Council [LPC]. 2015. America's Longleaf Restoration Initiative 2014 range-wide accomplishment report. Longleaf Partnership Council. <http://www.americaslongleaf.org/resources/2014-range-wide-accomplishment-report-and-executive-summary/>. [Date accessed April 12, 2017].
- Longleaf Partnership Council [LPC]. 2016. America's Longleaf Restoration Initiative 2015 range-wide accomplishment report. Longleaf Partnership Council. <http://www.americaslongleaf.org/resources/2015-range-wide-accomplishment-report/>. [Date accessed April 12, 2017].
- Miles, P.D. 2017. Forest Inventory EVALIDator web-application Version 1.6.0.03. St. Paul, MN: U.S. Department of Agriculture Forest Service, Northern Research Station. Available only on internet: <http://apps.fs.fed.us/Evalidator/evalidator.jsp>. [Date accessed: May 2, 2017].
- Montgomery, C.; Brown, G., Jr.; Darius, M. 1994. The marginal cost of species preservation: the northern spotted owl. *Journal of Environmental Economics and Management*. 26: 111–128.
- National Research Council [NRC]. 1995. *Science and the Endangered Species Act*. Washington, D.C.: National Academy Press.
- Noss, R.F.; LaRoe, E.T., III; Scott, J.M. 1995. *Endangered ecosystems of the United States: a preliminary assessment of loss and degradation*. Biological Report 28. Washington, DC: U.S. Department of the Interior, National Biological Service.
- Oswalt, C.M.; Cooper, J.A.; Brockway, D.G. [and others]. 2012. *History and current condition of longleaf pine in the Southern United States*. Gen. Tech. Rep. SRS-166. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 51 p.
- Oswalt, S.N.; Smith, W.B.; Miles, P.D.; Pugh, S.A. 2014. *Forest resources of the United States, 2012: a technical document supporting the Forest Service 2010 update of the RPA Assessment*. Gen. Tech. Rep. WO-91. Washington, DC: U.S. Department of Agriculture Forest Service, Washington Office. 218 p.
- Outcalt, K.W.; Sheffield, R.M. 1996. *The longleaf pine forest: trends and current conditions*. Resource Bull. SRS-9. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 28 p.
- U.S. Department of Agriculture [USDA] Forest Service, Southern Region. 2016. *Francis Marion National Forest revised Land Management Plan*. R8-MB 149A. Atlanta, GA: U.S. Department of Agriculture Forest Service, Southern Region.
- U.S. Department of Agriculture Natural Resources Conservation Service [USDA NRCS]. 2017. *Longleaf Pine Initiative: conservation beyond boundaries*. [https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/home/?cid=nrcsdev11\\_023913](https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/home/?cid=nrcsdev11_023913). [Date accessed: April 13, 2017].
- U.S. Department of the Interior Fish and Wildlife Service [USFWS]. 2017. *At-risk species finder*. <https://www.fws.gov/southeast/finder/#/>. [Date accessed: May 4, 2017].
- U.S. Geological Survey [USGS]. 2016. *National Gap Analysis Program Protected Areas Data Portal*. <https://gapanalysis.usgs.gov/padus/>. [Date accessed: April 13, 2017].