

# RESTORATION OF LONGLEAF PINE IN THE SOUTHERN REGION OF THE U.S. FOREST SERVICE: AN OVERVIEW OF THE MILLION-ACRE CHALLENGE

Jeff M. Matthews, Janet Hinchee, and James M. Guldin

**Abstract**—The forested landscapes of the Southern United States have been dramatically altered by land management practices over the last 150 years, which have in turn greatly reduced the extent of several unique ecosystems and the native flora and fauna to which they are adapted. A case in point is the current status of fire-adapted longleaf pine (*Pinus palustris*) ecosystems, which have declined by 97 percent since European colonization. Although resource managers across the South began efforts to restore longleaf pine on public and private lands more than 70 years ago, efforts are now underway on National Forest System lands in the Southern Region to increase the pace and scale of the restoration of longleaf pine. We focus on efforts to restore longleaf pine under the auspices of America's Longleaf Restoration Initiative, which was authorized by Congress in 2009. In October 2017, the Forest Service, U.S. Department of Agriculture, launched the Million-Acre Challenge, whose goal is to put an additional 1 million acres of longleaf pine-dominated ecosystems back in our national forests. This restoration effort will bring longleaf pine back to sites where it had been eliminated or reduced in scale and scope, and on sites to which it is ecologically adapted, in an effort to increase resilient landscapes that are adaptable to future climate changes. As one of the largest public land management agencies in the longleaf range, the Forest Service embraces the opportunity to lead this restoration effort and to provide successful results that can support and encourage other public agencies and private landowners to follow suit.

## INTRODUCTION

There are many compelling reasons to restore longleaf pine (*Pinus palustris*). The species is renowned for high-quality lumber, has excellent resistance to insects and diseases, and is tolerant of drought. Importantly, it is highly adapted to survive and thrive with frequent surface fires, and a host of wildlife and plant species are uniquely adapted to these ecosystems (Kirkman and Jack 2017). Moreover, more than any other southern forest type, longleaf pine ecosystems have an extraordinary historical and cultural legacy (Finch and others 2012).

To restore more acres of longleaf pine, managers need to have an understanding of the historical and current extent of longleaf pine ecosystems and the opportunities to increase the prominence of the species in the future—specifically, where restoration is ecologically appropriate, operationally efficient, and can achieve important ecological outcomes with flora and fauna that depend upon bringing fire-adapted ecosystems back to the landscape. The historical perspective is depressingly easy to establish. Forests in which longleaf pine was dominant or prominent once covered 92 million acres

from Virginia to Texas (Frost 1993) but had declined to just over 3 million acres by the 1990s (ALRI 2009).

A large-scale effort to restore this keystone species across its range will certainly have opportunities and challenges. First, the critical importance of prescribed fire in these fire-adapted longleaf pine ecosystems means that priorities might be given to ownerships where controlled burning can be more easily done, such as public lands or large private ownerships, rather than family forests smaller than 100 acres for example. Longleaf pine stands also reach their best habitat value for fire-adapted flora and fauna at ages 40–50 years and older, which again can probably be more easily attained on public lands or conservation-based private ownerships rather than private lands managed for timber value. Third, private lands such as family forests tend to change owners over time, and changes in ownership often are tied to changes in management plans; lands in the public domain or private lands under conservation easement offer a long-term land tenure suited to management of older stands of this iconic species. Finally, efforts to restore habitat for the endangered red-

---

Author information: Jeff M. Matthews, Forest Silviculturist, U.S. Department of Agriculture, Forest Service, George Washington and Jefferson National Forests, Roanoke, VA 24019; Janet Hinchee, Regional Silviculturist, U.S. Department of Agriculture, Forest Service, Southern Region, Atlanta, GA 30309; and James M. Guldin, Station Silviculturist, U.S. Department of Agriculture, Forest Service, Southern Research Station, Hot Springs, AR 71901.

Citation for proceedings: Bragg, Don C.; Koerth, Nancy E.; Holley, A. Gordon, eds. 2020. Proceedings of the 20th Biennial Southern Silvicultural Research Conference. e-Gen. Tech. Rep. SRS-253. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 338 p.

cockaded woodpecker (*Leuconotopicus borealis*) are a key driving force to restore longleaf pine on public lands.

## RESTORATION OF LONGLEAF PINE: EFFORTS IN THE PAST DECADE

The America's Longleaf Restoration Initiative (ALRI), authorized by Congress in 2009, is a collaborative effort across agencies, organizations, and partners who collectively address the concern over loss of longleaf forests and work together to reverse the downward trend. The first action under the ALRI was the preparation of a Range-wide Conservation Plan (ALRI 2009), developed through the collaboration of 22 State agencies and private organizations, along with support from several Federal agencies. Over the last 10 years, this plan has been the guiding document of restoration efforts to reach the ALRI goal of 8 million acres of longleaf pine either restored or on the path to restoration by 2025.

Under the ALRI, the U.S. Departments of Agriculture, Defense, and Interior entered into a Memorandum of Understanding in 2010. Agency representatives from each department have met regularly each quarter to share successes and offer support to the grander

longleaf restoration efforts, and senior executives from each of the three organizations guide the strategic effort as the Federal Coordinating Committee (FCC). The Longleaf Partnership Council (LPC) was formed in 2011 as a 33-member body that coordinates efforts and advocates for increased restoration efforts. This is a diverse group of land managers, conservation experts, scientists, and landowners representing State, Federal, private, and industrial interests who come together for the greater good. The leadership of the LPC meets regularly with the FCC to coordinate the strategic aspects of restoration. However, the work on the ground is coordinated by the LPC, primarily within 17 Significant Geographic Areas (SGA). Each SGA is managed by a Local Implementation Team (LIT) (fig. 1) comprising resource managers, conservation experts, and other partners interested in working with longleaf pine. Most of the national forests with significant longleaf pine acreages are tied to a LIT.

Of course, the key to making this work successful is funding. The primary source of funding for ALRI's restoration program is the National Fish and Wildlife Foundation (NFWF) Longleaf Stewardship Fund, which pools funds from public and private sources, and

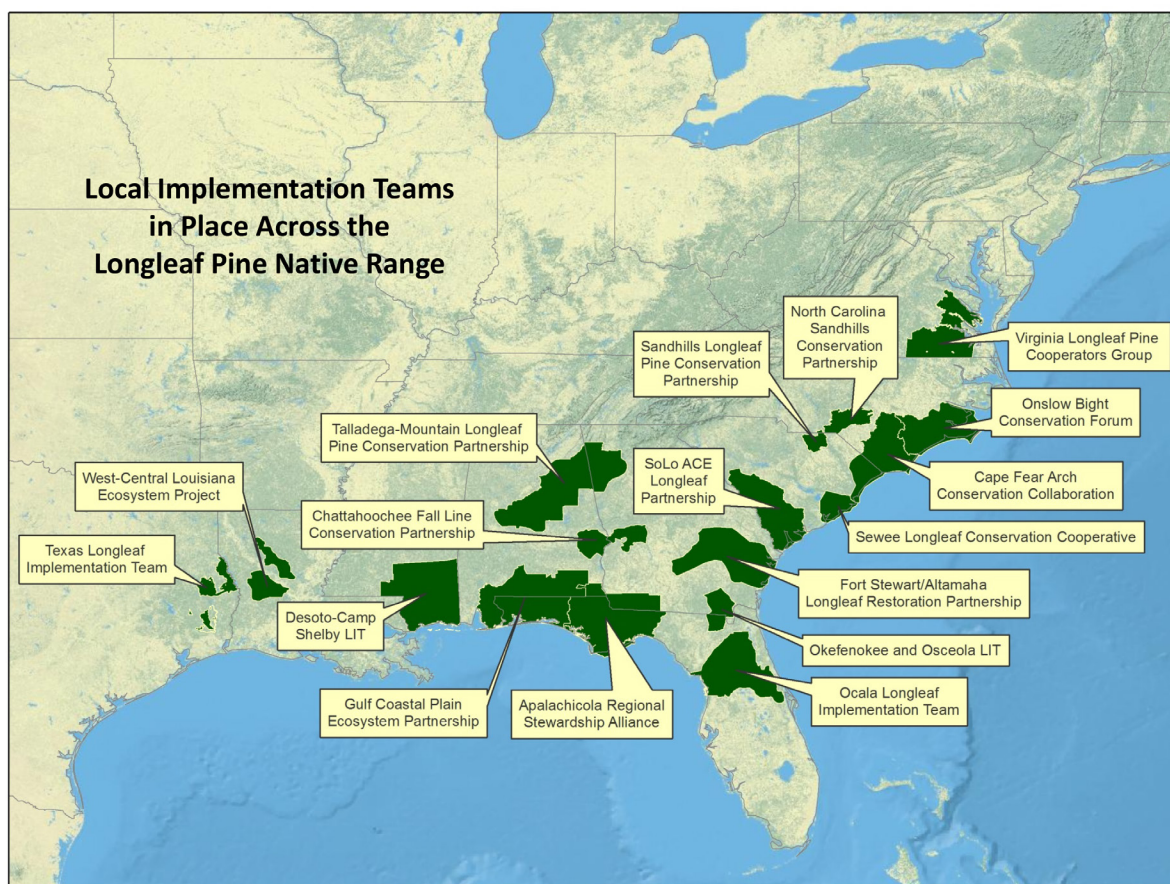


Figure 1—Local Implementation Teams across the range of native longleaf pine.

distributes those funds to the LITs through competitive grants. The NFWF Longleaf Stewardship Fund has been the single largest financial contributor to longleaf pine restoration. This fund has been able to increase the pace and scale of restoration and promote shared stewardship and collaboration. The Longleaf Stewardship Fund is supported by private entities such as the Southern Company, International Paper, Altria Group, Moore Charitable Foundation, and the American Forest Foundation, as well as Federal agencies. Since 2012, the fund has awarded \$30.6 million for projects to restore 92,500 acres and to enhance 1,400,000 acres of existing longleaf pine (ALRI 2018). In 2018 alone, over \$6.5 million were awarded for longleaf pine projects. In 2018, rangewide accomplishments included over 2 million acres of habitat improvements, a number that includes documented acres of prescribed burning and midstory/understory work in addition to roughly 130,000 acres of planted longleaf pine stands that were established. Seventy percent of the accomplishments occurred on public lands, and 68 percent of the accomplishments occurred within the SGAs.

However, to achieve the ALRI goal of 8 million acres by 2025, an additional 3.3 million acres of longleaf pine must be established (ALRI 2017). With the current progress of 150,000 acres per year of new planted stands, and assuming no losses, longleaf-dominant acres should equal 6,050,000 acres in 2025. In March 2016, the LPC discussed the rate of change in longleaf pine area based on Forest Inventory and Analysis (FIA) data and they concluded that restoration efforts were lagging behind the rate needed to attain the 8-million-acre goal by 2025 (McIntyre and others 2018). Even though FIA data have yet to capture the acres that are moving towards dominance by longleaf pine (Guldin and others 2016), more needed to be done—and it would have to happen on Federal lands. Indeed, the LPC identified increasing longleaf pine restoration efforts on Federal lands as one of the “game changers” (in other words, the “specific, action-oriented strategies that will significantly accelerate the pace of restoration”) in stemming the decline of longleaf pine (ALRI 2017: 15).

## THE MILLION-ACRE CHALLENGE ON NATIONAL FOREST SYSTEM LANDS

In response to LPC leadership’s April 2016 report on this lag to the FCC, the Forest Service Southern Regional Forester, Tony Tooke asked the Regional Office staff a simple question in July of 2016: “Where are we at in the region with longleaf restoration and how can we do better?” This was key—as the manager of the largest number of acres in the longleaf range, the Forest Service has been and will continue to be a key partner for the ALRI, and is viewed by the ALRI as a leader in longleaf pine restoration for public and private land managers across the region. These questions led to the formation of the Regional Longleaf Restoration Team (RLRT),

comprising Regional Office staff, Forest and District line officers and staff, and Southern Research Station scientists. The RLRT spent about 5 months taking an assessment of the opportunities and barriers associated with increasing the pace and scale of restoration, an initial effort that led to the building of many relationships and an increased enthusiasm for longleaf restoration.

By January 2017, a draft regional longleaf strategy had been approved by the directors in the Regional Office; the Regional Forester also approved but emphasized that the plan needed “good numbers and good maps.” In response, a subgroup of resource specialists in data interpretation, ecosystem modeling, and Geographic Information Systems (GIS) worked together for about 3 months to develop draft estimates of the current area in longleaf pine, as well as the area that had biological potential to be restored to longleaf pine. The RLRT sent these estimates to the national forests in the summer of 2017 for validation. Feedback from that validation was used to develop a comparison between the desired longleaf acres from each national forest’s Land and Resource Management Plan (forest plan), the biological potential for longleaf pine based on ecosystem models or LANDFIRE vegetation and fuels data products, and estimates of both the current acres in longleaf pine and the acreage goals that could be attained by 2025 for each national forest.

As all of these estimates and revisions were being made, especially acknowledging the validation of data by the respective national forests, it became apparent that there was an opportunity to make a landmark announcement not just to the Southern Region of the Forest Service, but also to the FCC, the LPC, and to public and private land managers across the South. As a result, on October 23, 2017, the new acting Regional Forester, Ken Arney, issued the “Million-Acre Challenge”—stating that the national forests of the Southern Region were committed to establishing an additional 1,000,000 acres on the path towards restoration of longleaf pine.

In February 2018, Forest Supervisors and their key Staff Officers met with Regional Office leadership to discuss increasing longleaf restoration efforts and how the Regional Office could best support the field units. In March 2018, Forest Supervisors were asked to develop the specific strategies they would pursue to achieve their acreage goals, including annual milestones for attaining these goals. Each national forest was then asked over the summer of 2018 to spatially assess acres currently on the path towards restoration and specific plans for acres to be put on the path in fiscal years 2019 and 2020. As a result, each national forest has a challenge acreage goal to reach by 2025, and a spatial representation of planned progress that will further aid future planning and coordination across ownerships within the greater longleaf range. In addition,



over the course of fiscal year 2018, Regional Office staff conducted a series of field visits to meet with Forest Leadership Teams and discuss concerns with achieving acreage goals.

How can this Challenge be met under the limited options available? Currently, the two silvicultural approaches to widespread restoration of longleaf pine are to replant it in areas to which it is adapted (and where it is absent) and to encourage (increase) the dominance of longleaf pine in stands where it is currently a minor component. Given the limitations on the former, the latter may prove more promising. Recent research (Guldin 2018, Guldin and others 2016) suggests the possibility of managing stands with a minor component of longleaf pine through free thinning that harvests the non-longleaf component, retains longleaf, and thereby increases the dominance of longleaf after thinning (fig. 2). If that management approach is successful, estimates of the area of longleaf pine that can be restored based on the RLRT's calculation method may increase substantially. This idea was vetted with LPC leadership and then included

in regionwide recommendations for longleaf pine restoration (ALRI 2017).

After all, the current estimate of 4.7 million acres of longleaf pine rangewide does not include all of the acres being actively managed for longleaf restoration that have yet to achieve longleaf dominance. Hence, to further develop the Million-Acre Challenge, the RLRT defined the concept of a stand “on the path towards restoration” by identifying the first concrete step that managers have taken to implement a restoration treatment (table 1). In an effort to better account for all the good work being done on the ground, the RLRT worked with the LPC leadership in the fall of 2016 to develop a “three-step trigger system” for counting National Forest System acres on the path towards longleaf pine restoration (fig. 3). The idea started with a conversation around Forest Inventory and Analysis data in comparison with data available in the FSVeg (U.S. Forest Service 2017) stand exam database. Current regional estimates of longleaf pine are based on Forest Inventory and Analysis data; those data are augmented on National Forest



Figure 2—Free thinning (harvesting pines that were not longleaf) in a mixed-pine stand on the Francis Marion National Forest retained the longleaf pine trees in the overstory and in regenerating groups. (Photo by James M. Guldin, U.S. Forest Service)

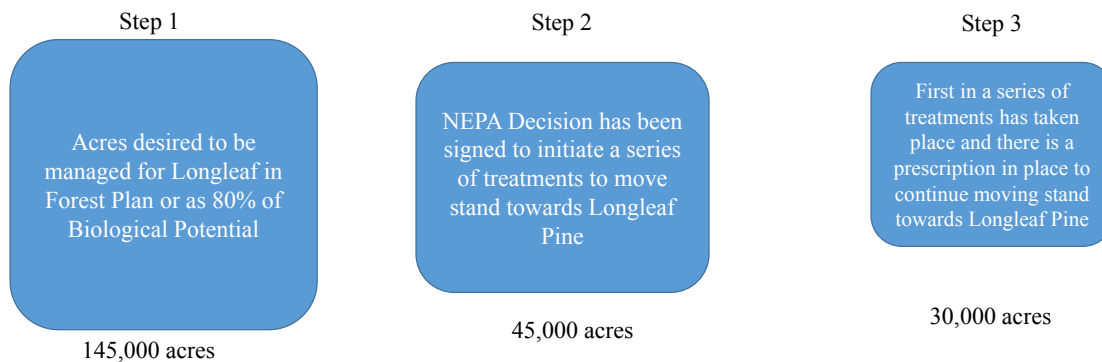
**Table 1—Development of the Million-Acre Challenge to increase the pace and scale of longleaf pine restoration on National Forest System lands**

Forest	Historical longleaf range	Current longleaf range	Potential additional range	Longleaf present but not dominant	Desired <sup>a</sup> 2008	Desired <sup>a</sup> 2017	Challenge: New acres on the path by 2025
<i>acres</i>							
NFs in Alabama	229,397	160,430	68,967	24,477	201,400	201,400	40,970
Chattahoochee-Oconee NFs	1,006	526	480	20	1,100	30,150	29,624
NFs in Florida	552,264	219,031	333,233	37,691	220,548	441,811	222,780
Francis Marion and Sumter NFs	140,396	50,432	89,964	12,496	53,501	112,317	61,885
Kisatchie NF	339,920	128,569	211,351	59,068	263,000	271,936	143,367
NFs in Mississippi	580,345	247,477	332,868	2,787	580,345	580,345	332,868
NFs in North Carolina	41,453	15,917	25,536	1,529	34,300	34,300	18,383
NFs in Texas	231,373	30,891	200,482	7,044	138,180	185,098	154,207
Savannah River Site <sup>b</sup>	—	47,133	—	—	—	—	—
Regionwide	2,116,154	853,273	1,262,881	145,112	1,492,374	1,857,357	1,004,084

NF: National Forest.

<sup>a</sup> Forest plan data were compiled in 2008 for the America's Longleaf Restoration Initiative conservation plan published in 2009. Since then, some national forests have increased the biological potential for longleaf pine based on ecosystem modeling/LANDFIRE analysis.

<sup>b</sup> The Savannah River Site is managed by the U.S. Forest Service but is administered by the U.S. Department of Energy, so the accomplishments and goals were not represented nor included in the totals for accomplishments on national forests or the Million-Acre Challenge.



**Figure 3—An example of the three-step trigger system to count acres on the path towards longleaf pine restoration on a national forest. NEPA = National Environmental Policy Act.**

System lands using FSVeg stand exam data, which is based on forest type. As a result, stands that are being transitioned from a different forest type into longleaf pine over time are missed under the current reporting method. The RLRT also recognizes that the process of restoration does not occur overnight and in fact may go on for 30 to 40 years or more. Moreover, the ALRI does use forest type as its metric for restoration, so the three-step trigger system will improve the consistency of quantifying the pace of restoration on National Forest System lands.

Figure 3 provides an example of a national forest that may have some stands currently on the path towards restoration (step 1), where there is a signed National Environmental Policy Act (NEPA) decision (step 2), and a prescription to move a stand to a desired condition of longleaf and a restoration process that has begun (step 3). Counting acres on the path towards restoration at step 1 or step 2 would be premature as no treatments have taken place on the ground yet. At step 3, the three-step trigger system ensures that acres are not counted until restoration efforts have actually begun on the ground and there is a plan in place to see the process



through. Acres “on the path” is a category of acres that to date has not been counted, but it is important to include these in our regional assessments (table 2). This inclusion is valuable for two reasons: 1) it is important to capture and be aware of the great work that resource managers are doing to restore longleaf; and 2) when the year 2025 arrives and if the restoration has not met the 8-million-acre ALRI goal, it will be important to objectively specify how much area is currently in longleaf pine-dominant stands and how much area is actively on the path to restoration.

Using the National Forests in Alabama as an example, the historical range of longleaf pine was established at 229,397 acres. Currently, there are 160,430 acres of longleaf pine-dominant stands (Forest Type 21) within the range. This difference represents the potential additional acres (the opportunity) of 68,967 acres. According to stand exam data summarized in FSveg (U.S. Forest Service 2017), there are also 24,477 acres with a minor component of longleaf pine. This is based on the 20 percent of stands that have stand exam plot data across the region, where the stand is not typed as a pure or mixed longleaf pine stand types, but there are some longleaf trees recorded in the plot data. In the forest plan, there were 201,400 acres shown as desired for longleaf pine (National Forests in Alabama 2004). The 2017 desired column in table 1 is based on the greater of either the area cited in the forest plan or 80 percent of the biological potential in the

ecosystem modeling/LANDFIRE analysis. That “80 percent of biological potential” calculation was used as a conservative estimate to allow for errors in the data, and for operability issues or other ecological or managerial constraints on the ground. So, the final column in table 1 is the challenge for the National Forests in Alabama, which is to put an additional 40,970 acres on the path towards restoration by 2025. This number may seem daunting, but it does not mean that the plan would be to clearcut and plant that many acres. It also does not mean that land managers are going to advocate planting longleaf everywhere; as with all decisions being made in the agency, the goal is to re-establish longleaf pine where it is biologically appropriate.

Based on the responses from the eight national forests and the Savannah River Site, there are 370,653 acres currently on the path towards restoration, which account for 37 percent of the goal of 1 million acres (table 2). That is exciting, because for the first time the RLRT has an accounting of the acres that are on the path to restoration, which helps tell more of the story of the restoration efforts on the ground. This does not mean that there are an additional 370,653 acres in longleaf-dominant stands today; rather, this represents the future stands that will be present if treatments continue to keep these stands on the path towards restoration. With the planned addition of 254,546 acres on the path in FY2019 and FY2020, the national forests could reach 62 percent of the million-acre goal by the end of 2020 (table 2).

**Table 2—Area of National Forest System lands currently on the path towards restoration based on the three-step trigger system**

Forest	Challenge: New acres on the path by 2025	Currently on the path	Additional planned on the path in 2019	Additional planned on the path in 2020
<i>acres</i>				
NFs in Alabama	40,970	24,477	1,194	2,062
Chattahoochee- Oconee NF	29,624	11,953	12,000	12,000
NFs in Florida	222,780	0	51,487	69,687
Francis Marion and Sumter NFs	61,885	9,189	990	6,868
Kisatchie NF	143,367	88,130	11,349	11,349
NFs in Mississippi	332,868	203,543	7,744	6,148
NFs in North Carolina	18,383	684	1,700	1,900
NFs in Texas	154,207	32,677	29,485	28,583
Savannah River Site <sup>a</sup>	24,549	10,174	—	—
Regionwide	1,004,084	370,653	115,949	138,597

NF: National Forest.

<sup>a</sup> The Savannah River Site is managed by the U.S. Forest Service but is administered by the U.S. Department of Energy, so the accomplishments and goals were not represented or included in the totals for accomplishments on national forests or the Million-Acre Challenge.

## THE VALUE OF PARTNERSHIPS IN LONGLEAF PINE RESTORATION

The ALRI goal of 8 million acres by 2025 is ambitious. If each of the public and private landowners in the region went about restoring longleaf pine on their own, no doubt some progress toward the goal would be made. But it is certain that even more can be achieved if land managers work collaboratively, strategically, and across boundaries of ownership in a shared stewardship approach. Just because ownership boundaries exist does not mean the potential vegetation types should change. Tools and mechanisms already exist for jointly conducting burns and other land management activities. Patience will also be required. After all, it takes time to shift and make longleaf pine a higher priority in NEPA analysis and hence it is to be expected that planned 2019 accomplishments are lower than those planned for 2020. If national forests have maps of work planned in 2019 and 2020, then this information will be available for conversations with partners and adjacent landowners to collaborate on projects.

Partnerships are among the most valuable assets available and will prove critically important: the Forest Service will not be fully successful with the Million-Acre Challenge and the restoration of longleaf pine without the support of and collaboration with partners. It is not just restoration on National Forest System ground that is important, but also working with partners and neighboring landowners to link up blocks of habitat. Many avenues exist that can coordinate and provide that support. Partners can provide additional funding and resources. For example, on a good burning day, weather might permit several prescribed fires on a given national forest ranger district, but the district may not have the staff or assets to properly implement multiple prescribed burns. However, when partners bring their staff and assets to the table, the mission can be more easily accomplished. Partners are also able to advocate for Forest Service restoration efforts, both with the public and with lawmakers at the State and Federal level. Sometimes people do not believe what the Forest Service line officer or resource specialist suggests about a given management practice; however, those same publics will listen to a valued partner.

An example of a partnership that is working well is the North Carolina Sandhills Conservation Partnership. This group formed nearly 20 years ago and consists of many Federal, State and private partners across a large landscape with a focus on common goals of restoring longleaf pine (fig. 4). The shared resources of the partnership enable managers to achieve more than if each individual entity focused on their own piece of land. Moreover, this partnership has developed its own goals in terms of priority areas to focus on for habitat connectivity and to maximize the effectiveness of the treatments. Collectively, proposals are developed to

seek out grant funding to conduct treatments across many land ownerships and that all contribute towards advancing the goals of the broader group. Resource managers with the North Carolina Sandhills Conservation Partnership have worked with the Uwharrie National Forest to improve landscape management, including input on where to focus restoration efforts, providing opportunities to engage with landowners, leveraging funding, and maintaining a focus on restoration when the forest is distracted by other events such as hurricanes.

## SUMMARY

The Southern Region of the Forest Service has worked hard to map existing longleaf pine stands and to identify areas that have the potential for longleaf pine. In doing so, the ambitious “Million-Acre Challenge” will go a long way toward achieving the equally ambitious ALRI goal of 8 million acres of longleaf pine restored, or on the path to restoration, by 2025. In one sense, the work being done on national forests is a model for other public and private landowners to refocus their efforts in longleaf pine restoration across the South. But equally importantly, the Southern Region recognizes and embraces the value of working with partners across ownerships in a shared stewardship context, to achieve not only the National Forest System challenge but the ALRI challenge as well. These are goals that will continue through the year 2025 and for the duration of the 21<sup>st</sup> century. All the while, it is important to remember that the goal of restoration is not just to bring back longleaf pine as a dominant tree species; it is to restore the fire-adapted mature pine ecosystems that are so dramatically underrepresented on the landscape and to provide for the many species of flora and fauna that depend upon these ecosystems. After all, while the number of acres of longleaf-dominant forests is an important *measure* of success, the response in wildlife and species diversity associated with fire-adapted longleaf pine ecosystems is the equally if not more important *outcome*.

## LITERATURE CITED

- America's Longleaf Restoration Initiative (ALRI). 2009. Range-wide conservation plan for longleaf pine. Atlanta, GA: America's Longleaf Restoration Initiative. 42 p. [http://www.americaslongleaf.org/media/86/conservation\\_plan.pdf](http://www.americaslongleaf.org/media/86/conservation_plan.pdf). [Date accessed: March 27, 2019].
- America's Longleaf Restoration Initiative (ALRI). 2017. America's Longleaf Restoration Initiative 2016 accomplishment report. Atlanta, GA: America's Longleaf Restoration Initiative. 24 p. [http://www.americaslongleaf.org/media/23979/fy16\\_llp\\_rangewideaccompreport\\_final\\_web.pdf](http://www.americaslongleaf.org/media/23979/fy16_llp_rangewideaccompreport_final_web.pdf). [Date accessed: March 27, 2019].
- America's Longleaf Restoration Initiative (ALRI). 2018. America's Longleaf Restoration Initiative 2017 accomplishment report. Atlanta, GA: America's Longleaf Restoration Initiative. 24 p. <http://www.americaslongleaf.org/media/26741/2017-accomplishment-report.pdf>. [Date accessed: March 27, 2019].





Figure 4—A maintenance-class longleaf pine stand on State game lands in the Carolina Sandhills, Moore County, North Carolina. (Photo by James M. Guldin, U.S. Forest Service)

- Finch, B.; Young, B.M.; Johnson, R.; Hall, J.C. 2012. Longleaf, as far as the eye can see: a new vision of North America's richest forest. Chapel Hill, NC: University of North Carolina Press. 176 p.
- Frost, C.C. 1993. Four centuries of changing landscape patterns in the longleaf pine ecosystem. In: Hermann, S.M., ed. The longleaf pine ecosystem: ecology, restoration, and management. Proceedings of the 18th Tall Timbers fire ecology conference. Tallahassee, FL: Tall Timbers Research Station: 17–43.
- Guldin, J.M. 2018. Silvicultural options in forests of the southern United States under changing climatic conditions. *New Forests*. 29(6): 62–78.
- 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. e-Gen. Tech. Rep. SRS-212. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station: 323–331.
- Kirkman, L.K.; Jack, S.B. 2017. Ecological restoration and management of longleaf pine forests. Boca Raton, FL: CRC Press. 451 p.
- McIntyre, R.K.; Guldin, J.M.; Ettel, T. [and others]. 2018. Restoration of longleaf pine in the southern United States: a status report. In: Kirschman, J.E., comp. 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: 297–302.
- National Forests in Alabama. 2004. Revised land and resource management plan, National Forests in Alabama. Management Bulletin R8-MB 112 A. Atlanta, GA: U.S. Department of Agriculture, Forest Service, Southern Region. [https://www.fs.usda.gov/Internet/FSE\\_DOCUMENTS/fsbdev3\\_002528.pdf](https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsbdev3_002528.pdf). [Date accessed: March 27, 2019].
- U.S. Forest Service. 2017. FSveg—common stand exam user guide, version 2.16.0. Washington, DC: U.S. Department of Agriculture, Forest Service, Natural Resource Manager. <https://www.fs.fed.us/nrm/fsveg/index.shtml>. [Date accessed: March 27, 2019].