A STATUS REPORT ON SILVICULTURE IN THE SOUTH—AMAZING SUCCESSES, AND CHALLENGES THAT REMAIN

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ABSTRACT

Over the past century, foresters in the Southern United States have achieved remarkable success in the practice of silviculture. Key elements of success include learning how to plant southern pines, which gave rise to genetic improvement and cultural practices that have placed short-rotation planted pine stands on a quarter of the South's timberlands. A second element was the application of conservative silvicultural practices, including uneven-aged methods in southern pines, to help recover cutover but partially stocked stands. Both these advances contributed to retaining industrial forestry capacity in the South through the middle of the 20th century, with the result today that the South has become the "woodbasket" of the Nation. Other key silvicultural advances were the success in applying seed-tree and shelterwood methods in pines, shelterwood methods in oaks, and restoration of prescribed fire which has helped recover open fire-adapted pine-dominated forests and woodlands across the South. Despite these successes, the South faces silvicultural challenges in the 21st century within the realm of economics, ecological issues, and social concerns. It's certainly an exciting time, and a challenging one, for foresters in the first decade of their careers.

INTRODUCTION

The period of aggressive harvesting of virgin forests in the Southern United States lasted for about 40 years, roughly from 1880 to 1920. Private investors bought timberland, built sawmills, and milled dimension lumber that served as the primary raw material for a rapidly growing Nation, especially for residential construction. In 1903, President Theodore Roosevelt embraced that view in his address to the new Society of American Foresters (SAF) when he highlighted that the purpose of the forest policy of the United States was the "making of prosperous homes" (Roosevelt 1905).

But when the virgin pine timber was all harvested, some mill owners followed the "cut out and get out" philosophy—they closed the mill, abandoned the cutover land and the towns built to support it, loaded the mill's machinery onto rail cars, and moved a thousand miles or more to harvest the remaining virgin timberlands in the Western United States. Other mill owners made a different gamble, placing a bet on the inherent productivity of southern pines and on the new profession of forestry. A century later, the success that foresters enjoy in southern silviculture has been directly related to the ways the profession responded to the varying conditions that remained following the harvest of those virgin stands.

FOREST CONDITIONS AT THE START OF THE 20th CENTURY

Foresters faced a host of difficult conditions through the 20th century, but four general types of conditions stand out.

The first was typified by conditions found on the lower Gulf Coastal Plain west of the Mississippi River. Millions of acres were completely cutover, with virtually no residual seed sources or standing volume (fig. 1). Wahlenberg (1960)

Figure 1—Cutover landscape in the early 1940s on the lower Gulf Coastal Plain on the Longleaf Tract, Palustris Experimental Forest, near Alexandria, LA (USDA Forest Service photo).

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Figure 2—Planting the arboretum at the Crossett Experimental Forest, Ashley County, Arkansas, spring 1935. A caption on the back of the photo states "the timber stand in the background is typical of the unmanaged second-growth stands at Crossett EF" (USDA Forest Service photo).

estimated that there were 29 million acres of cutover forest land in need of regeneration.

A different challenge was found on millions of acres of cutover land that retained some degree of stocking after the virgin stands were cut. Harvests were basically a stump-limit harvest; trees were cut if they had a stump diameter of 15 inches, or roughly a diameter at breast height (d.b.h.) of 12 inches and were not defective (Reynolds 1959). After that harvest, depending on local conditions, an understocked stand of pines and hardwoods typically remained, consisting of trees that were smaller than 12 inches d.b.h., augmented by new pine seedlings and saplings that either predated the harvest or became established from seedfall of the mature defective pines that remained scattered across the stand (fig. 2).

In bottomland hardwood systems such as those found in the lower Mississippi Alluvial Valley, flood control and agriculture played significant roles in the loss of bottomland hardwood forests. More than half of the landscape was deforested by the early 1900s, and by the latter part of the 20th century, deforestation had removed 70 percent of the original bottomland hardwood forest cover (figs. 3A and 3B) (Gardiner 2014). Much of this was converted into agricultural land that still today provides crops that feed and clothe the Nation, but the loss of those bottomland hardwood forests is still being felt.

In the Appalachians, the profession dealt with the unimaginable loss of the American chestnut (*Castanea dentata*). American chestnut constituted 25-50 percent of the canopy trees in its native range; it was 25 percent of all timber cut in the Southern Appalachians, and it was the most widespread and abundant species in the Eastern United States since the last glaciation (Wang and others 2013). Hepting (1974) noted that most of the land formerly occupied by chestnut has been taken over by young growth of oaks, maples, poplars, ashes, and other species that were associated with the chestnut. The challenges that foresters face with oak regeneration and the imbalance of mature hardwood age classes across the Eastern United States in the 21st century may well date back to the loss of chestnut.

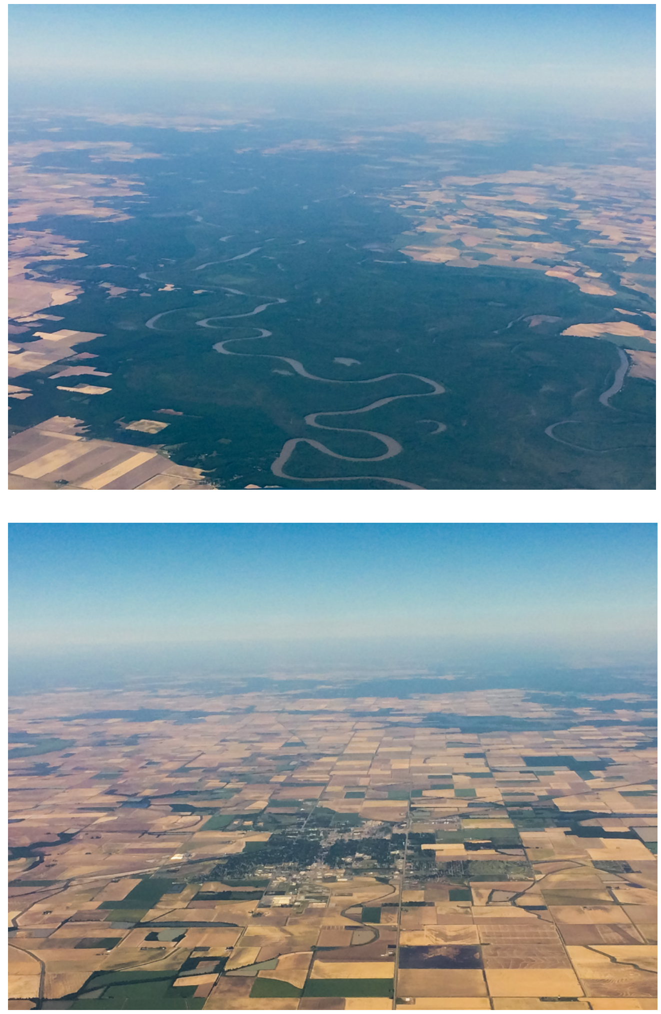

Figure 3—Changes in bottomland hardwood forests illustrated by two current images: (A) aerial view of the White River National Wildlife Refuge near Stuttgart, AR, showing heavily forested bottomland hardwood forests found in the Mississippi Delta; (B) aerial view of the town of Stuttgart, AR surrounded by modern agricultural fields (USDA Forest Service photo by James M. Guldin).

SUCCESS STORIES FROM THE 20th CENTURY

Across the South, creative silvicultural approaches emerged in response to the challenges faced by resource managers a century ago. Their combined efforts allowed forest products companies to stay in the South. The modernization of industrial forestry enabled the growth of cities and towns across the South, and helped build the vibrant regional forest products economy that landownersand managers enjoy today.

Success Story 1—Learning How to Plant Trees

The harvests of virgin pine forests led directly to the first amazing success of southern silviculture. In the middle of the 20th century, foresters realized that they had to learn how to plant southern pines, and to raise them in huge quantities in nurseries. Since then, genetic improvement and cultural practices have combined to produce trees that grow to sawtimber size in 25 years or less, on nearly 25 percent of the forested land base in the South.

The only solution in completely cutover stands with no residual stocking was to develop research and technology for the widespread application of artificial regeneration of southern pines. The pinnacle of this excellent effort was the publication of Wakeley's monograph, "Planting the Southern Pines" (Wakeley 1954), which became the most frequently cited publication in the U.S. Department of Agriculture (USDA) Forest Service's Research and Development deputy area in the 20th century. Wakeley's work spoke to cone collection, seed extraction, seed sowing, nursery practice, and outplanting, all of which remain applicable today.

The real advantage of the idea of raising pine seedlings in nurseries was also to take advantage of genetic improvement (Dorman 1976). Extraordinary genetic gains in volume growth, stem straightness, stem form, and disease resistance have been obtained through several generations of breeding, especially in loblolly pine (*Pinus taeda*) (McKeand and others 2003) and slash pine (*P. elliottii*) as well. After two decades in the 21st century, third-cycle selections for loblolly pine are widely operational, and fourth- and fifth-cycle selections are in progress (McKeand 2019, McKeand and others 2015). Volume gains at age 6 from open-pollinated third generation selections average 48 percent greater than unimproved checks; of the top 100 families for volume gain, 48 of those families have volume increment that is, on average, 63 percent greater than unimproved checks (McKeand 2019). However, full-sib families developed by crossing the best parents produce trees that are faster growing, straighter, and more fusiform rust resistant than open-pollinated families (McKeand 2019). As a result, roughly 173 million full-sib seedlings were planted across the South in 2018 and 2019, which represents 21 percent of all loblolly planted seedlings. Southwide, that number is likely to increase annually in the foreseeable future (McKeand and others 2021). McKeand and others (2021) report that a gain of at least 1 percent annually will continue for decades, but they provide an important caveat—if resources to continue tree improvement efforts remain available.

Cultural practices have been equally important in realizing the potential of planted loblolly pine and slash pine stands (Fox and others 2007), especially from the operational perspective. Advances in nursery production and seedling transportation have led to seedling survival rates that typically exceed 90 percent. Site preparation, especially chemical site prep for control of both woody hardwoods and herbaceous weed control, has been instrumental in optimizing seedling growth, especially in the first year of outplanting (Allen and others 2005). Fertilization has also been important both in giving a boost to newly planted seedlings, and to maintain volume growth during mid-rotation using N and P fertilization. As a result, stands are managed through the first commercial thinning around age 12, followed by a clearcut harvest between the ages of 22 to 25 years (fig. 4). This intensive silvicultural practice produces yields in excess of 10 tons per acre annually (Fox and others 2007).

Figure 4—First thinning in a planted loblolly pine stand at age 12, Ashley County, Arkansas, May 2014 (USDA Forest Service photo by James M. Guldin).

As an interesting historical silvicultural aside, the development of the concept of 25-year rotations for southern pines was based on data taken during the final clearcut harvest of the Sudden Sawlog Study which lasted from 1947 to 1992 on lands of the Crossett Lumber Company and, later, the Georgia-Pacific Corporation near the Crossett Experimental Forest in Ashley County, Arkansas (fig. 5) (Baldwin and others 1998, Burton 1982). During the final harvest of the Sudden Sawlog Study in the early 2000s, scientists from Weyerhaeuser, the USDA Forest Service Southern Research Station, and the USDA Forest Service

Figure 5—The Sudden Sawlog Study, on Georgia-Pacific Company timberlands in Ashley County, Arkansas, April 1983 (USDA Forest Service photo by James M. Guldin).

Forest Products Laboratory took detailed measurements and wood samples. Data from that final harvest showed that trees from the Sudden Sawlog Study had a high specific gravity, which meant that trees <30 years old could be sawn for dimension lumber.

In bottomland hardwoods, planting has also become an important management tool. In the second half of the 20th century, the most productive stands in the South were probably planted stands of cottonwood (*Populus deltoides*) on batture lands of the Mississippi River in north Mississippi, planted using improved cottonwood cuttings on pulpwood rotations of 10-11 years. These trees were managed to produce fiber for high-quality magazine paper, with mean annual increment varying with site conditions from 4 to 7 green tons per acre depending on soils (Carter and others 2015, McKnight 1970, McKnight and Biesterfeldt 1968, Stanturf and Portwood 1999). More recently—over the past few decades—abandoned agricultural lands in the Lower Mississippi Alluvial Valley have been planted under the U.S. Department of Agriculture Natural Resources Conservation Service Conservation Reserve and Wetlands Reserve programs, primarily in bottomland oaks (*Quercus* spp.) and sweet pecan (*Carya illinoinensis*); to date, more than 500,000 acres have been planted (Gardiner 2014).

Finally, planting is a critical tool used to re-establish species on sites to which they are adapted, but from which they have been locally extirpated due to past management or land use practices. The best example of this is the restoration of longleaf pine (*P. palustris*) on National Forest System lands as well as other public and private lands across the South (fig. 6). Nearly one-third of longleaf pine-dominant forests currently found in the South are of planted origin, and younger than 40 years old (Oswalt and Guldin 2021)—which bodes well for ongoing efforts to recover that iconic ecosystem.

Figure 6—Rhett Johnson, co-founder of The Longleaf Alliance, stands in a longleaf plantation entering its fourth growing season on the Winn Ranger District of the Kisatchie National Forest, May 2009 (USDA Forest Service photo by James M. Guldin).

Success Story 2—Restoration of Understocked Stands

Not all cutover sites required planting after the harvest of the virgin southern pine forests. Many stands retained some measure of stocking that could be returned to productivity, if managed using judicious silvicultural treatments. During the Depression, foresters undertook the development of the art and science behind recovery of understocked stands, using conservative thinning practices and natural regeneration to regenerate southern pines and hardwoods. The archetytpal example was found in south Arkansas and north Louisiana. The owners of the Crossett Lumber Company enlisted the support of Yale professor, H.H. Chapman, who was convinced that mixed stands of second-growth loblolly and shortleaf pine (*P. echinata*) could produce good dimension lumber and advised the company to mix the harvest of the last of their old growth with this developing second-growth timber (Chapman 1942, Reynolds 1980).

The silvicultural approaches used to manage cutover stands took two directions over time. At the Crossett Lumber Company and in a number of longleaf pine (*P. palustris*) ownerships, an uneven-aged management approach was very effective in restoring pine stands to full stocking (Guldin

Figure 7—Uneven-aged cutting cycle harvest marking in the Good Farm Forestry Forty, Crossett Experimental Forest, March 2011 (USDA Forest Service photo by James M. Guldin).

and Baker 1998; Reynolds 1959, 1969; Reynolds and others 1984). But stands managed using uneven-aged silviculture on private forest lands in the Southern United States are increasingly rare (fig. 7). In some ways, the method was a victim of its own success—5,000 board feet Doyle per acre is a highly liquid capital asset when forest lands change ownership. The high dollar value of the standing volume in continuous-cover stands factors into the purchase price during land sales, and the new landowners are often eager to harvest that valuable standing volume to help recover the costs of the land purchase. For example, in Arkansas, that reality led to the sale of the two largest family forest land holdings who practiced uneven-aged silviculture on a large scale—the Crossett Lumber Company, whose 2.1 million acres of forest lands were sold to Georgia-Pacific in 1962, and the Dierks Forests, whose 1.75 million acres were sold to Weyerhaeuser in 1969. The few southern yellow pine stands remaining in the United States that are managed using continuous-cover methods are increasingly on public forest lands and private timberlands where conservation is a dedicated goal of ownership, and where the future sale of forest lands is unlikely.

Success Story 3—Even-aged Silviculture Using Natural Regeneration in Pines and Oaks

As pine and hardwood stands come back to full stocking, awareness grew that even-aged seed tree and shelterwood approaches with natural regeneration could be effective, especially in conjunction with the application of prescribed fire. The seed tree method, as applied by Georgia-Pacific in south Arkansas, maintained relatively open stands at low residual basal area throughout the 45-year rotation (fig. 8). Prescribed fire helped reduce the need for herbicides, both mid-rotation and at site preparation. In the 1980s, the company had the first large-scale active prescribed

Figure 8—Loblolly-shortleaf pine stand late in the 45-year rotation on timberland managed by Georgia-Pacific Corporation in Drew County, Arkansas, 1983, showing the influence of thinning and prescribed burning (USDA Forest Service photo by James M. Guldin).

fire program in Arkansas. A detailed tabulation of typical company silvicultural practice was clearly presented in Zeide and Sharer (2000, 2001), and could easily be a cookbook approach for landowners interested in this approach to forestry today.

The shelterwood method also showed promise in upland oak. Ivan Sander and colleagues in the Missouri Ozarks led the way to identify the importance of oak advance growth present in stands in advance of a harvest using the shelterwood method (Sander 1979, Sander and others 1984, Schlesinger and others 1993). Scientists followed up by developing shelterwood systems in the Appalachians to capture the conditions needed there for oak advance growth (Brose 2010, Grayson and others 2012, Keyser and Loftis 2015, Loftis 1990). This includes work to explore the relationship of prescribed fire in upland oak stands, especially from the advance growth perspective (Arthur and others 2012; Brose 2011, 2014; Brose and others 1999, 2001). This approach in developing advance growth and overstory conditions to release it is expanding to include consideration of increasingly diverse structures, such as small openings (Keyser and Loftis 2021, Spetich 2020).

But arguably the best description of the shelterwood method was outlined for longleaf pine on the Escambia Experimental Forest in southern Alabama. In 1956, Forest Service scientist Tom Croker had one of those "chance favors the prepared mind" moments when he reported on the establishment and release of accidentally-obtained advance growth of longleaf pine (Croker 1956). That work grew into an outstanding synthesis of research to support practical implementation in the field. Croker and Boyer (1975) described key elements of the shelterwood method to include management before regeneration, making the preparatory and seed cuts, monitoring the seed crop, preparing the seed bed, protecting reproduction, making the removal cuts, and making post-harvest treatments (fig. 9). It's interesting to note that Croker and Boyer included a list of 10 longleaf pine demonstration areas that were established in 1966 as part of this new shelterwood effort in longleaf pine. The site on the Catahoula Ranger District of the Kisatchie National Forest is still active (fig. 10). It would be very interesting to learn whether the other sites still exist and what they might look like today.

Figure 9—One of the shelterwood study treatments in longleaf pine on the Escambia Experimental Forest near Brewton, AL, 1982 (USDA Forest Service photo by James M. Guldin).

Figure 10—The Croker Shelterwood demonstration in longleaf pine, on the Catahoula Ranger District of the Kisatchie National Forest in Grant Parish, LA, May 2017 (USDA Forest Service photo by James M. Guldin).

Success Story 4—Reintroduction of Fire to Fire-Adapted Ecosystems

The final category of unabashed success in southern silviculture has been the awareness of the importance of prescribed burns in fire-adapted southern pine and pine-hardwood ecosystems, and increasingly to some degree in hardwood-dominated ecosystems as well. The major driver for this has been widespread concern about the loss of mature open forest and woodland habitat—especially, in southern pines, for the endangered red-cockaded woodpecker (*Leuconotopicus borealis*). Three of the four major southern pines have unusual adaptations to coexistence and dependence on fire. Shortleaf pine will resprout if young growth is top-killed by fire, an attribute noted as early as 1915 by Mattoon, who reported that virtually all of the shortleaf pine-dominated forests in Arkansas were of coppice origin (Mattoon 1915). This sprouting ability has been nicely characterized in the past decade by Rodney Will and his students at Oklahoma State University (Bradley and others 2016, Lilly and others 2012a, Lilly and others 2012b). Longleaf pine saplings are protected by physiognomy, with the arrangement of long needles in whorls and budscales that insulate the bud from the heat of a fire (Croker and Boyer 1975). Loblolly pine has a different tactic, especially in the western part of its range, where it produces bumper seed crops 4 years in 5 (Cain and Shelton 2001). Essentially, the loss of a new age cohort of loblolly pine due to fire is often followed by a bumper seed crop on the recently burned site.

The judicious use of thinning in conjunction with prescribed burning has been instrumental in bringing back pine-grassland habitat in loblolly pine-dominated systems such as

Figure 11—A shortleaf pine stand in the Shortleaf Pine-Bluestem Management Area on the Poteau Ranger District of the Ouachita National Forest in Scott County, Arkansas. The tree with aluminum band supports an active nest cavity for the endangered red-cockaded woodpecker, January 2018 (USDA Forest Service photo by James M. Guldin).

at the Moro Big Pine Management unit in south Arkansas (Bragg and others 2014) and Felsenthal National Wildlife Refuge on the Arkansas-Louisiana border, in longleaf pine-dominated stands especially on National Forest System lands in the Southern Region, and notably in shortleaf pine-dominated ecosystems on the Ouachita National Forest in western Arkansas (fig. 11). In all of these examples, a primary justification for the work has been to create habitat for the recovery of the red-cockaded woodpecker. There have been other benefits for all manner of species of flora and fauna adapted to these open pine forest and woodland conditions maintained by the use of prescribed fire (Guldin 2019a).

CHALLENGES FOR THE 21ST CENTURY

There is plenty of opportunity for foresters in the first decade of their career to solve problems faced by the profession, and some of these are difficult to the point of being intractable. They can be subjectively grouped into three general categories—economic, ecological, and social challenges.

Economic Challenges

The first challenge is that our success with planting the southern pines has led to an ever-growing surplus of standing pine volume. As a result, stumpage prices to landowners have been depressed, and experts doubt that these will be alleviated any time soon (Dezember and Mong'a 2021). During 2020, writers with the Wall Street Journal (WSJ) argued that home improvement projects during the pandemic have led to increased demand for lumber, but sawmills have a buyer's market for logs because of the high levels of supply. This followed a similar report in the WSJ in October 2018 that noted investments by family forest landowners in planted southern pine stands have not provided financial returns that were expected, because supply far outstrips demand (Dezember 2018).

Data available from the Forest Inventory and Analysis Evalidator online web portal show that across the 13 Southern States, growing stock volume in 2018 was at 356.4 billion cubic feet, an increase of 21 percent from 2005. Similarly, forest land area in 2018 was at 265.5 million acres, an increase of only 0.6 percent since 2005. The area of forests in plantations as of 2018 was 47.6 million acres, an increase of 2.3 million acres since 2005, and virtually all of this as of 2018 was on private lands, primarily real estate investment trust (REIT) and timber investment management organization (TIMO) lands. One might also suspect that it may be a difficult investment decision for a family forest landowner to replant after harvest, given the likelihood of depressed stumpage prices for another decade or two.

A second economic challenge for forest landowners tiers to changes in sawmill configuration and logging technology. Sawmills are optimized to produce #2 common lumber from logs with d.b.h. 16-18 inches, which is the least expensive feedstock for the mill. Logging technology has also adapted to efficiently harvest 16-18 inches trees grown in uniform conditions found in planted stands. And with the dissolving of vertically-integrated forest products companies in the last decade of the 20th century, long-term supply agreements for logs are increasingly common between mills, loggers, and REIT-TIMO forest lands.

Logger demographics are consistent with this trend. Chain-saw felling of pine timber is virtually extirpated in the South; most businesses are fully mechanized, using feller-bunchers and grapple skidders. As a result, logging safety has increased substantially and the implementation of best management practices has also increased (Conrad and others 2018a). Additionally, logging business owners "aging in place" is a nationwide trend in the logging industry. In 2017, fewer than 25 percent of logging business owners were younger than 40 years old and approximately one-third were 60 years or older (Conrad and others 2018b). This raises the question of what a logging crew will look like in 2050, and what changes in a logging business model will occur as a result.

These economic trends have a number of implications for silviculturists to consider. Because of the changes in sawmill configuration and supply agreements with large private landowners, family forest landowners have increasingly difficult access to markets and loggers. For example, logger capacity is limited for family-owned forest land in Arkansas; REIT and TIMO and other institutional ownerships are using most of the logging capacity (Tian and Pelkki 2021). Limits on the size of logs that are merchantable as stumpage are also increasingly common; as sawlog size reaches d.b.h. >24 inches, logging equipment that is designed to harvest trees 16-18 inches can't easily harvest larger logs, and mills can't easily or efficiently process them. This raises questions about how foresters should manage stands where management objectives emphasize long rotations that will result in retaining trees >20 inches d.b.h., such as on National Forest System lands, on conservation easement properties, and on family forest lands managed for diverse ecological and economic goals.

Moreover, the need for consistency of size and easy access for logging equipment is complicating the market for small diameter feedstocks, or for salvage cutting after disturbances such as windstorms and insect infestations that kill, break, or uproot trees at a broad scale. For example, efforts to salvage loblolly pine mortality in Mississippi caused by the southern pine beetle in the past decade often resulted in no-bid sales; similarly, windstorm salvage in the Florida panhandle after Hurricane Michael in 2018 was difficult to obtain, and if a contractor was found, stumpage prices were less than $1 per ton.

With respect to these economic issues, nothing about silviculture will be easy, especially for family forest landowners with limited access to forestry advice and forest products markets. If there is no market for the trees that a landowner is growing, loggers don't have equipment or incentive to harvest trees, and mills are reluctant to use diverse feedstocks, forestry advice to landowners will be very difficult. Advice that was common in the latter part of the 20th century, such as to encourage nonindustrial private landowners to grow high-quality southern pine sawlogs to large diameter, will certainly need to be reconsidered in light of changing markets in the 21st century.

Ecological Challenges

Foremost among the ecological challenges that foresters face are the stand-level silvicultural decisions to account for changing climatic conditions. In the latter part of the 20th century, Dave Smith at Yale University defined silviculture as an ecological art and science subject to economic and social constraints (Smith 1986). Even in the last few decades of the 20th century, foresters generally acted as if the broad parameters of temperature, precipitation, and seasonality were likely to be more or less constant on any given site.

Scientists know now that the ecological background will not be constant over the 21st century. The prevailing temperature, precipitation, and seasonality at any given location will change, but the exact magnitude of those changes is difficult to precisely quantify—though different models do consistently suggest that warmer and drier conditions will generally prevail (Wear and Greis 2013). Even backyard gardeners are aware of this, given the changes that USDA made in 2012 in updating the boundaries of the Plant Hardiness Zone map, when zone boundaries crept northward across the region from 50 to 100 miles. Foresters are still asking questions and installing studies to better understand silvicultural concepts of resistance, resilience, and adaptation that can be accomplished in the event that the prevailing temperature and precipitation at a given site changes (Nagel and others 2017). It seems unlikely that major regional efforts to assist in the broad migration of species northward is ecologically or silviculturally feasible; it's more likely that landowners who are actively managing their forest lands will be able to make decisions about species composition when stands are being regenerated or thinned (Guldin 2019b).

It is already apparent, though, that disturbance events associated with changing climatic conditions are likely to increase in frequency and severity. In the 20th century, foresters were adept at responding to disturbance, provided that salvage could occur. But as discussed previously, recovery from 21st-century disturbance events will be more difficult if markets and logging capacity make salvage logging impractical.

An example of an effect that has its origins in changing climatic conditions is the apparent increase in hybridization in wind-pollinated pines, especially in shortleaf pine stands west of the Mississippi River. Shortleaf pine hybridization rates were 3 percent in the 1950s and increased to 46 percent in 2012 (Stewart and others 2012), with increasing hybridization when native shortleaf pine stands are in close proximity to loblolly pine planted stands (Stewart and others 2013). Dorman and Barber (1956) show that the timing of pollen ripening in loblolly pine at a given latitude is about 3 weeks earlier than that seen in shortleaf pine. With increasingly warm spring temperatures, this window of pollen ripening may be reduced to the point where shortleaf pine cones are receptive to pollination when loblolly pollen is still airborne. Shortleaf pine stands that may already contain hybrids may produce hybrid progeny that might outgrow native shortleaf, all things being equal. Hybrids do not resprout as effectively if top-killed by fire (Bradley and others 2016); prescribed burning of new age cohorts frequently can help eliminate hybrids and maintain pure shortleaf genotypes (Stewart and others 2015, 2017). But it takes a silviculturist with a certain measure of fortitude to burn a 2-year-old age cohort of planted or naturally-regenerated shortleaf pine that has been successfully established.

The management of hardwood-softwood mixtures or mixed woods was largely neglected by silvicultural research in the 20th century, perhaps with the exception of Doug Phillips, Dave van Lear, Tom Waldrop, and their students at Clemson University (Blizzard and others 2006, Brose 2011, Phillips and Abercrombie 1986, Randles and others 2002, Waldrop 1989). But Guldin (2019b) pointed out that silvicultural options are a hedge against changing climatic conditions, such as ensuring that stands have genetic diversity, species diversity, and structural diversity. The mixed woods initiative underway between the Northern Research Station and Southern Research Station to study efforts to manage mixed stands of hardwoods and pines illustrates opportunities and challenges (Kabrick and others 2017, 2020; Kern and others 2021; Schweitzer and others 2016). Mixed stands are probably the rule rather than the exceptions within the range of shortleaf pine east of the Mississippi River, and in the Appalachians, in conjunction with pitch and Table Mountain pines (Waldrop 1989).

In bottomland hardwood stands, mixtures of different hardwood species offer opportunities to take advantage of differences in developmental dynamics to provide both short-term and long-term silvicultural benefits. For example, the canopy stratification effects between oaks and sweetgum that are known to exist (Lockhart and others 2006) may provide opportunities for recommendations other than a planted stand consisting of a single hardwood species for landowners under the Conservation Reserve or Wetlands Reserve programs (Gardiner 2014).

Social Challenges

The social challenges the profession faces in the 21st century were eloquently summarized by His Royal Highness, Charles, the Prince of Wales, in his opening address at the 2014 International Union of Forest Research Organizations World Congress in Utah.[1] The major challenge is the ever-burgeoning population in the United States, and in the world. Between 1940 and 2017, the U.S. population grew from 132 million to 326 million, a 2.5x increase; over that same timeframe, the world population grew from ~2.3 billion to 7.5 billion people. Projections of the United Nations suggest that the global population will reach 11 billion people by 2100.[2] Few of our problems with resource management, either in the United States or globally, will be easier to handle as the world population continues to grow at these rates.

Related to this, there are cultural differences at play in the United States that have a basis in whether one is from urban vs. rural settings. In 1950, roughly two-thirds of the U.S. population were found in urban areas, and one-third in rural areas. In 2010, Census data show that 80 percent of the U.S. population was urban, and 20 percent rural. Without efforts to educate people in urban settings about the value of resource management in rural areas, the social license to continue to practice resource management that includes harvesting of trees and activities such as prescribed fire may be at risk.

Finally, there are issues of concern with research capacity in the forestry sector. McGinley and others (2019) reported that the number of research scientists on the faculty at SAF-accredited institutions, within the Forest Service, and with forest industry, has decreased by approximately 12 percent since 2002. They also report that within the USDA Forest Service Research and Development deputy area, the number of research scientist positions has declined from 985 in 1985, to 540 in 2016; moreover, research foresters declined from 350 in 1985 to 104 in 2016 (McGinley and others 2019). In short, the profession has seen a sharp reduction in the number of research scientists, especially in fields related to production and management, over the past four decades, at a time when expanded research is critically needed to address the challenges in resource management that society is facing in the 21st century.

SUMMARY

Our late colleague, Kurt Gottschalk, offered advice to the Society of American Foresters in 2015 that urged leadership to “Play the Rookies” (Gottschalk 2015). In his essay, Gottschalk noted the importance of getting young professionals active in the leadership of the profession at an early stage of their career. This advice has value with respect to the challenges the profession faces in the 21st century. It will be the research scientists and land managers in the first decade of their career who will do the hard work needed to rise to the challenges the profession faces in the 21st century. But, as Kabrick and Pile (2019) report, the 21st century is an exciting time to be a silviculturist in the Southern United States. Those of us in the last decade of our career wish our younger colleagues all the best, and we’ll be around to offer feeble advice if asked, and probably sometimes if not asked, too.

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