EXPERIMENTAL FORESTS OF THE SOUTHERN RESEARCH STATION: HIGHLIGHTS OF FOUNDATIONAL SILVICULTURE STUDIES

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Abstract—The U.S. Department of Agriculture Forest Service, Southern Research Station is home to 19 Experimental Forests (EFs) that provide unique opportunities for long-term experimentation and demonstration on forest management practices (fig. 1). Numerous studies on silviculture practices, growth and yield, applied ecology, reforestation, and prescribed fire have originated on EFs and were possible because of partnerships with National Forest System, State and Private Forestry, and other stakeholders. Experimental Forests allow for demonstrations of innovative management practices built on long-term research findings developed in the 20th century to be applied in the 21st. Here, we highlight a selection of foundational studies at EFs in Arkansas, North Carolina, and Louisiana.

Natural Pine Management

Established in 1934, the Crossett EF in southeastern Arkansas conducts research on pine competition control and stand establishment, the rehabilitation of understocked pine stands, and silvicultural practices in natural-origin loblolly (*Pinus taeda*) and shortleaf pine (*P. echinata*). When established, the primary goal of the work at Crossett was to determine if large high-value saw logs could be produced from these cutover, understocked, second-growth southern pine stands (Guldin 2009). Over the years, lessons learned on the Crossett EF have been adapted to help national forests move from intensive plantations toward management that relies on natural regeneration (Guldin 2009). Today, the Crossett EF continues to serve the demonstration and field laboratory needs of researchers, who still follow long-term studies of even- and uneven-aged silviculture, growth and yield, regeneration, and unmanaged stand development in naturally regenerated loblolly and shortleaf pine. In addition, studies of a plus-tree progeny test (Bragg and others 2016) and pine-hardwood regeneration (Olson and Bragg, in press) have been reactivated, joining new research into the management of mature pine stands for old-growth-like conditions and new tools (eddy covariance tower) in Crossett's ever-growing research portfolio.

Upland Hardwoods

The Henry R. Koen EF is located south of the Buffalo River on the Ozark National Forest. Established in the early 1940s, it was originated to develop principles for forest management. In its first decade, Koen was instrumental in developing best practices for cruising based on accuracy and efficiency. Early studies by Mesavage and Grosenbaugh (1956) determined that plot size and arrangement could be optimized for any given stand. These foundational studies formed the basis for our modern system of hardwood inventory and cruise techniques in upland hardwood forests. Our

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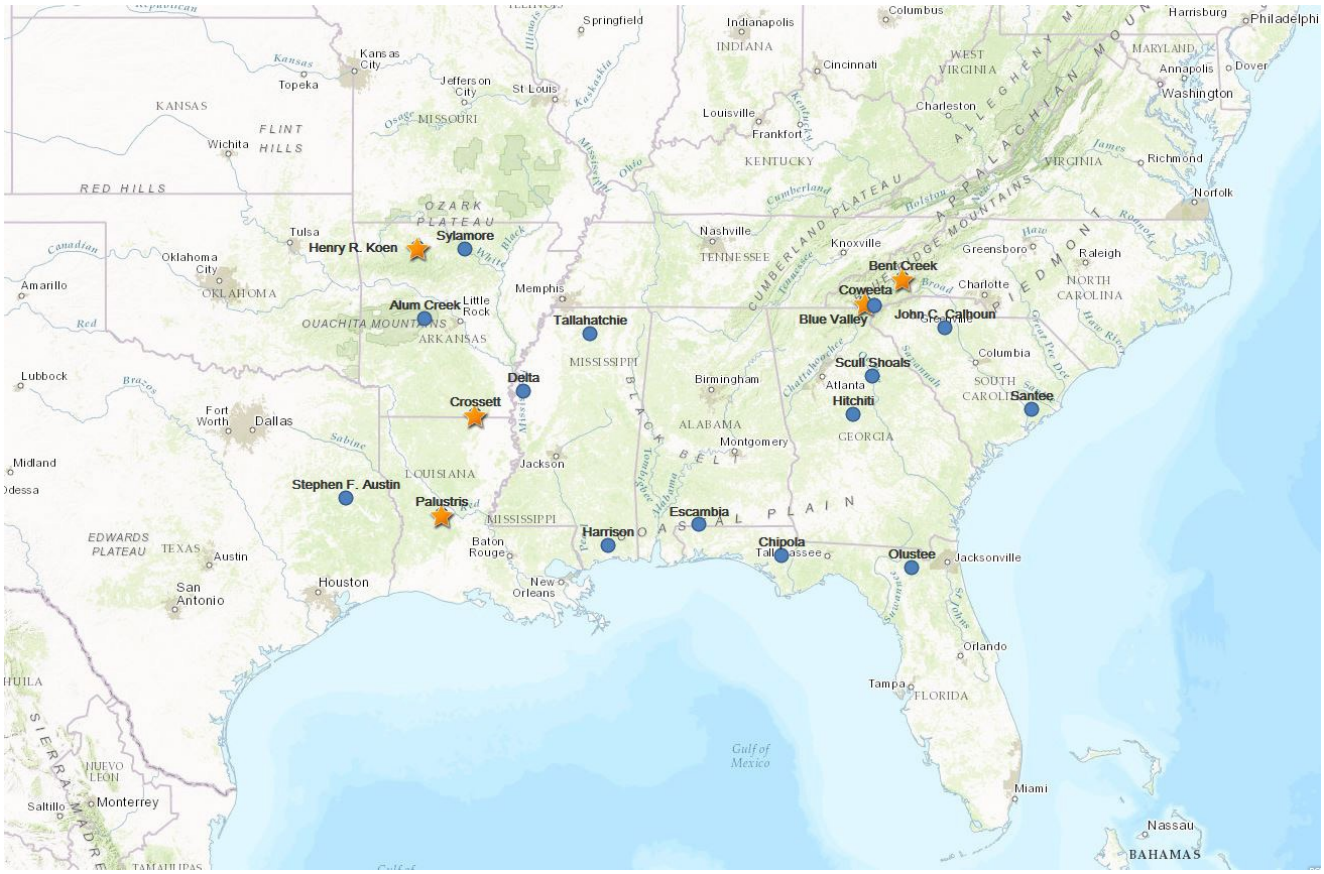

Figure 1—Blue dots mark the location of the nineteen Experimental Forests (EFs) of the Southern Research Station. Yellow stars indicate the locations described in this abstract.

understanding of successional patterns of oaks (*Quercus* spp.), hickory (*Carya* spp.), and shortleaf pine in Ozark uplands comes from the long-term datasets of the Koen. Other research highlights included shortleaf regeneration and seedbed test preparation, stand structure of merchantable white oaks (*Q. alba*), hardwood and pine plantation tests on abandoned agricultural fields, management of eastern red cedar (*Juniperus virginiana*), and loblolly pine suitability in the Ozarks.

Currently, the Koen houses studies that include work on woody species reproduction, stand composition, forest species restoration, quantitative silviculture, and the development of forest management methods. This integrated research program addresses upland hardwood forest dynamics and includes short- and long-term studies of upland hardwood forests at individual tree, stand, landscape, and regional scales.

Bent Creek, the oldest EF in the eastern United States and the second oldest in the country, originated in 1928 on the Pisgah National Forest in western North Carolina. It was established to conduct research on silvicultural practices that would aid in the rehabilitation of cutover, abused lands and promote sustainable forestry, and to provide a field demonstration of forest management practices. Prior to the 1960s, research consisted of case studies documenting regeneration response to disturbance (primarily clearcutting). Case studies were eventually replaced by replicated, data-intensive studies. At Bent Creek, these focused on species composition and structure, and growth and yield (Loftis 1990). Researchers are currently working on topics including oak restoration, hardwood regeneration, fire ecology, forest stand dynamics, acorn and native forest fruit production, invasive plant species, American chestnut (*Castanea dentata*) restoration, wildlife response to forest management practices, and ecosystem classification.

Forest Structure and Composition

Located in the Southern Appalachians of North Carolina, the Coweeta Hydrologic Laboratory was established in 1934 on the Nantahala National Forest. Early research focused on how natural resource management affected forest hydrology using the paired watershed approach to compare managed and unmanaged forests (Swank and others 2001). At the same time, long-term changes in forest structure and species composition of these deciduous forests were measured at the watershed level

(Elliott and Swank 2008). Silvicultural treatments were implemented to evaluate the management applications of the time including the effects of grazing, exploitive logging, and species conversion on forest watersheds (Elliott and Vose 2011). In addition, Coweeta was instrumental in early studies on road design, clearcutting, cutting methods using cable yarding, partial harvests, and post-disturbance measurements.

Currently, researchers are leading studies that include the effects of wildland fire on ecosystem processes, Eastern hemlock (*Tsuga canadensis*) decline due to the hemlock wooly adelgid (*Adelges tsugae*), measurements of ecosystem carbon dioxide and water flux using an eddy covariance tower, and the continuous monitoring of the long-term climate and streamflow network that has been in place since 1934.

Longleaf Pine

Located in central Louisiana and established in 1935 on the Kisatchie National Forest, the Palustris EF was used for early research on reforestation techniques of the four major southern pine species (Wakeley 1954). Under the umbrella of pine regeneration and management, research included seedling production and quality, stocking and thinning regimes, growth and yield modeling, and site preparation. The Palustris was also heavily involved in pine plantation management with studies on soil quality and management, fire as a management tool, and longleaf pine (*P. palustris*) silviculture.

In 2005, research on the Palustris changed from a pine plantation management focus to one of longleaf pine restoration (Sung and others 2013). Current and future research has been designed to support the Range-wide Conservation Plan for Longleaf Pine (Sword Sayer and others 2010). These topics include: longleaf pine restoration and management, seedling quality and establishment, and flower and cone physiology.

Future of Experimental Forests

As we look to the future, we are working across the EF network to look at the "big" environmental and social issues of the 21st century, using inputs from synthesis work, national assessments, and input from partners to ask questions across multiple scales. As in the 20th century, our forests face new and emerging threats. We can use EFs to develop integrated approaches and strategies to mitigate impacts that will sustain the overall health of forests and grasslands, improve environmental conditions, and reduce economic costs. Experimental forests will continue to be locations with long-term datasets and the ability to sustain experiments and measurements over multi-year periods, places of traditional and novel experiments, valuable demonstration sites, and sites where monitoring is used for change detection. Experimental Forests can leverage these core attributes and serve as important facilities for collaborative research, partnerships, and platforms for development of new tools and technologies.

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