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silviculture

Introduction: 2017 National Silviculture Workshop: Forest Management Policy, Forest Restoration, Disturbance Resilience, Climate Adaptation

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Since 1973, the National Silviculture Workshop has provided a forum for USDA Forest Service managers and scientists to deliberate on management topics, issues, or challenges that reflect the progression of Federal forest management in the United States (Table 1). Rotating the meeting location around the United States to expose the attendees to many different ecosystems and management concerns and practices, early workshops explored techniques of uneven-aged management, controlling stand density in second-growth stands, tree improvement, and fertilization for timber management (Barton et al. 1973, Nelson et al. 1974, Usher et al. 1976). In response to passage of the National Forest Management Act of 1976 (NFMA) Section 4, the focus of subsequent workshops expanded to reforestation and the maintenance of forest cover (Cargill et al. 1977). Since the 1980s, the Forest Service and other public agencies have addressed the public's concerns about the environment and forestry by emphasizing and managing for other benefits of forests beyond timber production. The forestry profession identified the value of silviculture in the pursuit of these new goals by pointing out that silviculture was an effective approach not only in timber production but also in managing for other forest ecosystem benefits (Table 1). Five workshop themes—"Successes in silviculture" (McCoy et al. 1985), "Silviculture for all resources" (1987), "Silvicultural challenges and opportunities in the 1990s" (Sesco et al. 1989), "Communicating the role of silviculture in managing National Forests" (Northeastern Experiment Station 1997), and "The past, present, and desired future of silviculture's role and practice" (Barras 2001)—reflect the profession's adaptation to these shifts in policy and the workshops' conclusions that silviculture was designed to meet a variety of management objectives.

Along with the change in objectives for forest management from the purely economic to support of multiple ecosystem benefits, the scale of policy and management goals broadened. Particularly on Federally administered lands, the scope of management grew to encompass the ecosystem and the landscape. Workshop themes expressed this shift, with topics such as "From the cradle of forestry to ecosystem management" (Foley 1994) and "Forest health through silviculture" (Eskew 1995). The ever-widening application of forest-management policies in the new millennium was reflected in workshop themes that highlighted "Beyond 2001: Silvicultural odyssey to sustaining terrestrial and aquatic ecosystems" (Parker and Hummel 2002) and "Silviculture in special places" (Shepperd and Eskew 2004). The greater interest in ecosystem restoration and the need to deal with wildfire inspired the 2005 and 2007 workshop themes "Restoring fire-adapted ecosystems" (Powers 2007) and "Integrated restoration of forested ecosystems to achieve multi-resource benefits" (Deal 2008), respectively. The increasing profile of climate concerns and carbon storage resulted in a 2009 workshop that emphasized these topics (Jain et al. 2010). After no workshop was held in 2011 because of the agency's concerns about travel costs, the 2013 ("Silviculture matters" (Guldin and Buford 2014) and 2015 ("Climate change strategies, tactics and practical prescriptions" (Guldin and Buford 2017) workshops were incorporated into the Society of American Foresters National Conventions.

The most recent workshop in 2017 reflected the increasing complexity of forest management. This workshop focused on topics related to restoration, resilience, and climate adaptation in more than 30 different presentations and a day-long field trip in the ponderosa pine forest of northern Arizona. Attendees visited the Forest Service's oldest forest experiment station, established in 1908, Fort Valley Experimental Forest. Morning discussions on the ecology and management of ponderosa pine (*Pinus ponderosa* [Lawson & C. Lawson]) followed by afternoon presentations on implemented projects reflected a robust science–management partnership

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Table 1. National silviculture workshop themes since the workshop's inception in 1973.

Year	Theme	Citation
1973	Forestry to meet special objectives: A look at uneven-aged management	Barton et al. 1973
1974	Tree improvement and fertilization	Nelson et al. 1974
1976	Density of stocking control	Usher et al. 1976
1977	Silvicultural implications of section 4, NFMA 1976	Cargill et al. 1977
1978	Silvicultural examination, prescription, and related activities	Gould et al. 1978
1981	Hardwood management	Gillespie et al. 1981
1983	Economics of silvicultural investments	Row et al. 1983
1985	Successes in silviculture	McCoy et al. 1985
1987	Silviculture for all resources	Woolever et al. 1987
1989	Silvicultural challenges and opportunities in the 1990s	Sesco et al. 1989
1992	Getting to the future through silviculture	Murphy 1992
1993	From the cradle of forestry to ecosystem management	Foley 1994
1995	Forest health through silviculture	Eskew 1995
1997	Communicating the role of silviculture in managing the National Forests	Northeastern Experiment Station 1997
1999	The past, present, and desired future of silviculture' s role and practice	Barras 2001
2001	Beyond 2001: A silvicultural odyssey to sustaining terrestrial and aquatic ecosystems?	Parker and Hummel 2002
2003	Silviculture in special places	Shepperd and Eskew 2004
2005	Restoring fire-adapted ecosystems	Powers 2007
2007	Integrated restoration of forested ecosystems to achieve multiresource benefits	Deal 2008
2009	Integrated management of carbon sequestration and biomass utilization opportunities in a changing climate	Jain et al. 2010
2013	Silviculture matters	Guldin and Buford 2014
2015	Silviculture and changing climate strategies, tactics, and practical prescriptions	Guldin and Buford 2017
2017	Restoration, resilience, and climate adaptation	

working to improve resistance and subsequent resilience to climate- and fire-induced disturbance.

This special section in *Forest Science* presents four stories from across the United States that illustrate restoration, enhancing resilience, or climate adaptation. Guldin (2019) and Riling et al. (2019) present two examples of how active forest management may overcome challenges of restoring forest ecosystems. Zhang et al. (2019) draw the reader's attention to the applicability of long-term data in understanding forest resilience to insects and drought. Crotteau et al. (2019) outline the installation of a long-term study in the northern Rocky Mountains specifically designed to quantify how different forest conditions and species assemblages adapt to climate change.

In "Restoration of native, fire-adapted, southern pine-dominated forest ecosystems", James Guldin (2019) presents a variety of silvicultural tools to restore longleaf pine (*Pinus palustris* L.) and shortleaf pine (*Pinus echinata* Mill.). Guldin noted that the two trends of installing and managing fast-growing plantations of loblolly pine and the withdrawal of fire from southern pine-dominated ecosystems have led to the decline of mature native fire-adapted southern pine ecosystems. These forests contained mature and old-growth open pine forests and woodlands that created habitat for a variety of flora and fauna across the South. Such ecosystem attributes take time to develop, however, and were incompatible with the economics of short-rotation forestry intended to produce pulpwood and small sawlogs. To facilitate the restoration of pre-Euro-American settlement conditions in the southern pine forests, Guldin (2019) identified three management strategies: (1) planting longleaf and shortleaf pine where they once thrived and are still adapted; (2) reintroducing fire to create open forests and woodlands; and (3) where longleaf and shortleaf still exist, encouraging regeneration of these species, or promoting the release of these species, using prescribed fire where appropriate. Although there are several challenges resulting from the expansion of these southern pine ecosystems, programs such as America's Longleaf Restoration Initiative and the Shortleaf Pine Initiative have become important, as they focus attention on the restoration and recovery of these two iconic species of southern pine.

The National Silviculture Workshops have provided opportunities for managers and scientists alike to present lessons learned and innovative approaches, all of which can inform forest-management decisions. Riling et al. (2019) describe how forest managers on the Boise National Forest applied concepts from Van Pelt (2008), and the scientific method to refine legacy tree characteristics for ponderosa pine, Douglas-fir (*Pseudotsuga Menziesii* [Mirb.] Franco), and grand fir (*Abies grandis* [Douglas ex D. Don] Lindl.). As a consequence of this administrative study, the Boise National Forest developed its own legacy tree guide intended to ensure that old trees remain on the landscape. This guide recommends minimal use of arbitrary diameter caps so that larger diameter (usually older) trees are retained. The greatest benefits from this administrative study included (1) using a scientific basis to inform decisions, (2) evaluating the effectiveness of legacy tree in characteristics in the field to ensure legacy trees could be identified, and (3) stakeholder input in the evaluation process. These types of studies with input from scientists, managers, and stakeholders contribute to management decisions on this national forest, thereby fostering a sense of shared stewardship.

Zhang et al. (2019) report on how ponderosa pine long-term plot data (40–65 years measured periodically) can be used to evaluate survival and growth of trees exposed to disturbance and drought. The research was located in California where several permanent plots that varied in tree density were summarized. The authors identified three primary results. Not surprisingly, tree density was shown to drive tree size (diameter); the lower the tree density, the larger the trees become. The greatest mortality events occurred in waves that reflected either the influence of multiple drought years or higher tree density. This study illustrated the continuity of silvicultural principles and practices, as density-management techniques discussed in the 1976 silviculture workshop continue to be an important tool for today's managers as they manage forests to increase their resilience to disturbance.

Climate adaptation was the topic of the last paper. Crotteau et al. (2019) present a study in western larch (*Larix occidentalis* Nutt.) forests in western Montana, a location in the Adaptive Silviculture for Climate Change Network (Nagel et al. 2019). They outline the vulnerability of these forests to climate change and describe a research study explicitly related to climate adaptation. Crotteau et al. (2019) report on the development and implementation of treatments intended to promote forest structures and compositions that (1) are resistant, (2) are resilient, or (3) have the potential to transition to a warmer and drier climate. Climatic changes may induce shifts in disturbances such as fire regimes, drought persistence, and insect and disease infestations. This long-term study will afford the opportunity for scientists and managers to collaborate in treatment development, implementation, data collection, and interpretation of results. This information will help them gain insight into how to manage these forests well into the future.

The National Silviculture Workshop, as originally intended, continues to provide the setting for managers and scientists to regularly meet to discuss challenges they face in forest management. The 2019 workshop will be held in Bemidji, MN. This workshop will highlight the powerful partnerships between science and management that foster shared stewardship for the long-term sustainability of forests in the United States.

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