

Discussions

The 21st Century Silviculturist

Theresa Beneavidez Jain[®]

Introduction

As a discipline, silviculture has a long legacy of practitioners who mentored the next generation, passing their knowledge—and vision for the future—onward. For example, silviculturists in the northern Rocky Mountains such as Julius Larson, Irvine Haig, Chuck Wellner, and Russ Graham (Graham 2009) followed this mentoring process, leaving a legacy of knowledge and irreplaceable experiences that many others have been privileged to incorporate into their own careers. Along these lines, we offer this discussion. The unique opinions and perspectives of this group of silviculturists from across the United States are intended to contribute to the mentoring process by offering our thoughts on the promises and challenges facing 21st century silviculturists, beginning with my own insights concerning the future of our profession.

Ecosystem Management and Collaboration

Theresa Beneavidez Jain

In the early 1980s, silviculture was defined as the art and science of controlling the establishment, growth, competition, health, and quality of forest vegetation and could only be applied in a given forest cover and locality if there was a clearly defined management objective (Helms 1998). In a recent silviculture textbook by Nyland et al. (2016, p. 16), the authors expanded the definition. “Silviculturists apply different treatments to make forests more productive and more useful to a landowner and society on a sustainable basis,” and the discipline requires “integrating biologic and economic concepts to devise and carry out treatments most appropriate in satisfying the objectives of a landowner.”

Nyland et al. (2016) continue by also stating “the philosophies of ecosystem management, sustainable forest management, or ecological forestry refine the definition of silviculture as a process for creating, maintaining, or restoring an appropriate balance of essential components, structures, and functions that ensure long-term vitality, stability, and resiliency.” A silviculturist designs and implements silvicultural methods to develop stand composition and structures that may be reflected in natural disturbed ecosystems and thereby fulfill objectives that produce tangible (harvestable commodities) and intangible (ecosystem structure and function) benefits. Given this definition, a successful silviculturist in the 21st century will need broad skills to ensure that a high level of innovation is used to develop and implement silvicultural systems that meet resource-management demands today and into the future. A major component of this skillset is effective communication skills (oral and written).

Evolution of Silvicultural Systems and Methods

The practice of silviculture, particularly in the 1930s through 1970s within the northwestern United States, was often single objective focused, and consisted of even-aged silvicultural systems and the assumption that forest growth and development were predictable and relatively stable. However, for the 21st century, this historical paradigm is shifting to include multiresource management objectives that integrate, for example, wildlife, fuels, recreation, and forest products. Rather than viewing ecosystems as static, we now view ecosystems as dynamic and less predictable because of invasive species, wildfires, and large-scale insect infestations. Increased public and stakeholder engagement in forest management requires continuous engagement with the public. Last but not least, not knowing how

the future climate will influence forest development introduces an element of uncertainty. These shifts in how we manage forests require increased innovation in the silviculture profession.

Silvicultural terms now include “legacy trees,” “green tree retention areas,” “required opening sizes for regeneration establishment, competitive advantage, and free-to-grow,” “individuals, clumps, and openings (known as ICO) (Churchill et al. 2013),” “clearcuts with reserves,” “commercial thinning,” “variable density thinning,” and “precommercial thinning.” This terminology is associated with silvicultural systems and methods that focus on leaving residual overstory trees designed to create essential components, structures, and functions that, for example, enhance wildlife habitat or restore the historical pattern of trees to increase disturbance resilience. For example, free selection (an uneven-aged silvicultural system) is designed to add diversity in forest structure, yet create large enough opening sizes to encourage successful regeneration of shade-intolerant species (Graham and Jain 2005). The ICO silvicultural method attempts to maintain groups and clumps of trees separated by small openings and gaps to reflect historical ponderosa pine characteristics. As forestry progresses over time, most likely new methods and silvicultural systems, and terminology, will evolve.

The Silviculturist Skillset

To meet these forest-management challenges, a strong partnership between science and management will become the norm. A 21st century silviculturist will need general knowledge on several subjects, particularly if ecological forestry is the foundation of the management objectives. I often state that silviculturists know something about many subjects, but rarely are experts in any one subject. Subsequently, they will need to depend on a strong science background to synthesize different sources of information (e.g., basic and applied sciences, technical knowledge, economics, and policy), combined with the management objectives and their knowledge of forest dynamics and silvics to create a vegetative management scenario. Only through a strong partnership between science and management will the silviculture profession be able to implement these complex treatments. It will become common practice for scientists and managers to work closely together to develop, implement, and evaluate silvicultural methods and systems to ensure outcomes meet multiresource objectives in the

short- (post-treatment) and long-term (decades to centuries).

People inside and outside the profession view silviculturists as leaders in forest management. With more public and stakeholder engagement, particularly on federally administered lands, a silviculturist needs to be an effective communicator in both the oral and written arenas. Today, silviculturists communicate with an assortment of forest resource specialists on interdisciplinary teams, as well as with forest management stakeholders and the public. As an effective communicator, a silviculturist spends time and energy on listening, internal and external emotional awareness, speaking clearly, and using simple language (avoiding jargon). Silviculturists must be confident, but not defensive, when speaking, be open to feedback, and take time to learn another person’s perspective. As with oral communication, writing becomes paramount.

For example, a silviculture prescription is a written document that describes the series of planned treatments that are applicable throughout the life of a stand to meet a management objective. However, there are times when writing becomes particularly challenging. For example, designation-by-prescription or designation-by-description are clearly written criteria that describe which trees should be cut or left, and then it is the contractor’s responsibility to implement these criteria based on the descriptions provided. This requires silviculturists to write a clear “vision” of what post-treatment outcomes they want to achieve so a contractor, contracting officer, or sale administrator who may or may not have a forestry degree can implement the treatment. This can become challenging when a management objective requires forest structures and species compositions that enhance vegetative biodiversity, produce snags, create nest sites for particular species, and perpetuate processes that lead to disturbance resilience. A silviculturist uses a variety of tools, including GIS, remote sensing, modeling, and other forms of technology to understand and write their desired treatment outcomes that address these complex and multiresource objectives.

Fortunately, the silviculture discipline is well suited to meet these challenges; the foundation of the profession has always included knowledge integration and a close relation between science and management. Multidisciplinary thinking will continue to be a part of silviculture, and excellent communication skills are always a component of this portfolio. Current

objectives, communication skills, and meeting the desires of the landowner today just requires a bit more art and a broad ecological, economic, and social science background. Innovation is a part of this profession; it is just what silviculturists do. It is truly a fun time to be a silviculturist.



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The 21st Century Silviculturist: Climate Change and Technology

Constance Harrington[®]

How does the skill set of the successful silviculturist in the past differ from that of the present or in the future? Jain tackles this question in her Discussion piece and concludes that success currently and in the future requires broad skills, a high level of innovation and effective communication skills. I agree with her conclusions; however, I smiled when thinking about the topic of communication as I recall discussions going way back to the 20th century (!) when both university faculty and employers lamented that many people went into forestry to work in the woods and communication skills were not high on their priority list. And I've heard that lament repeated many times in my career. But getting work accomplished both in the past and in

the future always has and always will require dealing with people, and that requires communication skills. These days many of us work on projects that require buy-in from a diverse set of clients and stakeholders and people from other disciplines. As a researcher I can attest that I don't have to just persuade a supervisor that a line of research is promising to be able to implement a project, I often need to also persuade multiple landowners, clients, and funding sources. My research projects are on a wide array of land owning and land management organizations including family-owned companies (large and small), traditional and nontraditional industrial owners (TIMOS, REITS, and the like), and numerous state, federal and tribal organizations and NGOs. I would expect that diversity of clients to continue and expand in the future and communicating with all of them will be critical.

Jain mentions several changes in silviculture, such as using more complex and variable prescriptions to achieve a broader array of management objectives, especially on public lands. I agree with her observation, and in spite of greater complication of designing and implementing the treatments, I think many silviculturists appreciate the opportunity to implement more complex prescriptions to take advantage of the variation in stand characteristics and management objectives. Implementing and monitoring those more variable prescriptions have become and are likely to continue to become easier to do with our current and future tech tools and toys. Who would have dreamed in the last century of what we can now view on a Google map on a phone, or how we can monitor a treatment with a drone?

The biggest challenge for the 21st century silviculturist in my mind is climate change. It is likely to add greater variation in plant responses as well as increasing the frequency of extreme events. Foresters often pride themselves on developing local rules of thumb such as "I get good survival if I plant in this time window" or "Vegetation control treatments are effective if applied in this time window." But those rules of thumb are based on plant phenology—especially the timing of plant growth. If the climate changes (and it already has changed to some degree) then those rules increasingly break down. Silviculturists will need to think more in the future about which biological factors are important in response to treatments and how stand responses will vary with predicted changes in temperature and precipitation.

The lowlands of the Pacific Northwest typically have wet, relatively mild winters and dry, but still fairly mild summers. In the last few years in the Pacific Northwest we have had several record setting

hot and dry summers. This can reduce tree survival, especially in the first year or two of plantation establishment. Should silviculturists in the 21st century be rethinking the timing of when they plant trees on stressful sites, or if pre- or postplanting treatments need to be considered to increase survival? It will always be important to match the climate of a seed source with the climate of the planting site—but climate change means that the definition of “local” may change to “climatically suited” rather than lines on a map delineating static seed zones. Should future silviculturists be considering planting other species or mixtures of species in different ways? Should they be thinking of the increasing likelihood of extreme events and how they might anticipate them when planning intermediate stand operations and final harvests?

Another change we may see is a social one. Will silviculturists in the future continue to work long periods of time for one or a limited number of employers? Or will they follow other broad societal trends that result in working fewer years per employer or fewer years at a specific location? How would those trends change our record keeping? How can we ensure continuity in objectives across time for stands managed on long time horizons? Most of us could improve our communication skills and the written documents we leave behind in which we lay out which treatments were applied in each stand and why those treatments were selected. I suggest that documenting our prescriptions and the rationales behind them will become increasingly important as job turnover rates increase so our successors understand what the thoughts were behind particular prescriptions.

Many of us will still want to work in the woods by ourselves in the future—after all many of us went into forestry to get away from the hub bub of the cities—but most of us would still like to take our cellphones and GPS units and online apps and drones and GIS generated maps with us! Let’s embrace the 21st century tools and the challenges that come with changing employers, markets, and climate to ensure that we achieve our objectives and still enjoy our jobs!



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Educating 21st Century Silviculturists

Andrew S. Nelson

The evolution of silviculture—the science and application, and eventually its definition—is well framed in the article by Jain. We continue to see broadening of management objectives as well as constraints, both of which influence the ability of silviculturists to manage forests. One of the first opportunities future silviculturists learn about the history of these changes and become exposed to realities of their future careers is during their undergraduate forestry education. Most forestry programs have kept pace with evolving management by teaching relevant topics, yet emerging generational changes are forcing programs to re-evaluate teaching strategies that align with how students learn. Educators, myself included, need to adapt to these new learning styles, while also ensuring we prepare students with skills demanded by employers such as technical knowledge, communication strategies, and understanding how management impacts ecosystems.

Students entering forestry programs directly from high school belong to generation Z, generally agreed as people born between 1996 and the present. Generation Z differs from previous generations in a few respects. They have lived their conscious lives with immediate access to the Internet, prefer to work with authorities rather than ignoring them, and believe they should pursue a career that allows them to solve problems (Mohr 2017). In addition, a 2016 news article suggests generation Z prefers to work by themselves (Strong 2016). They expect the Internet to be always available for immediate answers, which has the benefit of increasing their knowledge but can also lead to blurred perceptions on plagiarism and professional ethics. Many of these traits result in students that learn best with hands-on activities, something forestry education has excelled at for many years.

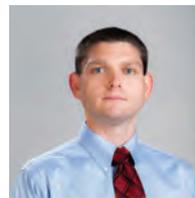
A quick Internet search shows considerable discussion around educating generation Z, most of which highlights the importance of active learning. Even though hands-on education forms the foundation of many forestry bachelor’s degrees across the country, we can do more to engage with our students. A great example is how students at the University of Minnesota created videos of their silvicultural prescriptions with smart phones (Windmuller-Campione and Carter 2017). Not only did this exercise demonstrate the

depth of knowledge students learned in their silviculture course, but it allowed them to creatively express themselves, demonstrate critical thinking, and improve their verbal communication. This is but one example of educating future silviculturists to develop the skills demanded by their profession but also resonates with their beliefs and learning strategies. All educators should be thinking about similar creative ways to integrate technologies students use daily into silvicultural learning. Such strategies have the potential to spark enthusiasm and lead to deeper comprehension.

Technology is not only changing how students learn and interact but increasingly becoming part of daily tasks in their future careers. Forestry employers are rapidly adopting technologies that increase the efficiency of silviculturists, including for example field computers with real-time mapping and inventory capabilities for regeneration inspections and development of thinning prescriptions. Combined with restricting operating budgets and steady-to-declining graduation rates, these technologies facilitate an individual silviculturist in managing thousands of acres of forestland within the context of more complex management objectives. Generation Z's affinity for technology in their daily lives should allow them to quickly pick up these skills once they graduate. Universities can facilitate this transition by integrating these technologies into our courses that will both increase comprehension of concepts by the students and also expose students to various technologies they may one day use.

Of course, integrating technology into our courses and figuring out how best to engage with our students are just a part of educating 21st century silviculturists. Even though generation Z students prefer to work by themselves, that is not the reality of silviculture—or any career for that matter. We often must engage with colleagues to critically evaluate alternative solutions to problems. These group discussions foster individual creativity but also lead to collective outcomes that minimize irrational decisionmaking. It may be uncomfortable, but students should work within groups during college, especially in silviculture when they must determine appropriate treatment sequences for complex management objectives. Group discussions among the students help prepare them to communicate with people that may have different viewpoints than their own. No matter how much they complain, it is part of our role as instructors to guide them through uncomfortable situations by providing critical feedback on ways to interact with each other (and their supervisors) inside and outside the world of social media.

Change is inevitable. We see it in the next generation of students, technology, and silviculture. Society has moved in a direction where a person is expected to obtain a college degree to succeed professionally. Even though a college degree has been the norm in forestry for many years, students are more demanding of their educational experience partially due to their expectations but also due to rising costs of tuition. It behooves us to educate students to be future silviculturists that embrace their ability to multitask and solve complex problems when developing complex solutions to multiobjective silviculture. The result will hopefully be a new generation of silviculturists to continue the sustainable management of our forest resources.



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21st Century Silviculture: The Best-Kept Secret?

John M. Kabrick and Lauren S. Pile[✉]

We read Jain's commentary "The 21st Century Silviculturist" with great interest. It largely reaffirms our experience—it is an exciting time to be a silviculturist! The 21st century may prove to be the "golden age" of silviculture. Today's silviculturists are having to meet increasingly complex management objectives, and address new management problems and emerging challenges unseen in the past. However, the extensive knowledge base from our strong roots as applied forest managers and the inherent adaptive and innovative nature of our work will help to address these challenges.

Jain points out that during the past century silvicultural objectives have evolved and have become much more complex, having grown beyond the single-focus of producing a reliable and sustainable supply of timber to include producing suitable habitat, sustaining biodiversity, and enhancing ecosystem services. Today's silviculturists are still working within the multiple resource objectives of the recent past but are now dealing with ever increasing complex problems related to uncertainties in climate, dramatic shifts in forest composition and structure, and loss to wildfires, invasive species, and insect pests (Millar and Stephenson 2015, D'Amato et al. 2018). To some these issues may seem daunting. However, most silviculturists view these as intriguing challenges to tackle and unique opportunities to be active stewards in the forests of tomorrow that will require a sophisticated understanding of many disciplines to resolve.

As Jain's commentary suggests, today's silviculturists are ideally positioned to deal with these complexities. Silviculturists today have a phenomenal broad-based knowledge and understanding about forest regeneration and stand developmental processes for the forest types and ecoregions in this country. Much of the knowledge was developed and gained through partnerships with Forest Service research scientists and through experiments conducted on our nation's Experimental Forests and Ranges (EFRs). Although EFRs are maintained by the US Forest Service, much of this valuable work is conducted with close collaboration with universities and state agencies. Maintaining these partnerships and establishing new research on emerging issues, EFRs—to borrow some words from Raphael Zon—will “furnish the most valuable, instructive, and convincing object lessons” (Pinchot 1947, p. 309) for addressing the silvicultural challenges of the future. Unlike a century ago, today's silviculturist has access to a broad spectrum of information and resources. This includes forest inventory data afforded by the Forest Inventory and Analysis program, digital soil information provided by the National Cooperative Soil Survey, and a variety of computer software and new tools for enhancing ecological insight needed for resolving management problems during this golden age of silviculture. In addition, inherently broader thinkers will comprise this new generation of silviculturists, with university natural resource programs seeking to provide a greater breadth of learning opportunities, an increased importance on collaboration and coordination with diverse specialty areas, user and interest groups (Underhill et al. 2014), while also maintaining our core

foundations in applied forest management (Sample et al. 2015).

Jain also describes the qualities of a successful silviculturist with terms such as a good listener and communicator, an integrator and synthesizer of information, and a leader. Clearly, these are qualities of the discipline's brightest and most capable people, which reminded us of another important problem that silviculture is facing. Namely, silviculture appears to be one of the best-kept secrets in the profession. Although many young people are eager to tackle the host of challenges facing forest managers, few realize that silviculturists have the training and knowledge to help resolve these challenges. Therefore, it is imperative for those who have this broader perspective and viewpoint about silviculture to share it widely, particularly with young people who potentially will become the next generation of silviculturists. We must impart to our students interested in careers in natural resources that silviculture is not just timber management, but the management of healthy, resilient forested communities (Sharik et al. 2015). It truly is a fun time to be a silviculturist and we need to ensure that we continue enlist the best and the brightest minds to carry out our increasingly broadening mission. Let's spread the word and not keep silviculture one of the best-kept secrets!



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Avoiding Irrelevance in the 21st Century

Don C. Bragg^o

The very same day that I was asked to respond to Jain's discussion article I heard about the termination of General Electric's (GE's) CEO John Flannery, who had failed to turn around the slumping fortunes of one of America's largest and most influential companies. This was the latest in a string of corporate indignities for GE that included years of shedding assets, "refocusing on their core mission," and their removal from the Dow Jones Industrial Index (GE was the last of its original dozen companies). Now, don't get me wrong—GE still has thousands of employees, billions of dollars in sales, and plays a significant role in American industry, technology, and even politics. But their fall from prominence was not an unforeseen event—signs of problems had appeared years ago as GE struggled to maintain its relevance in these rapidly changing times.

I worry that silviculture faces a comparable relevance challenge. At one level, silviculturists tend to be introspective on our history. As a whole, I think most of us now recognize that management focused on a single objective (timber) has failed to deliver other desired goods and services. Societal expectations of providing multiple forest resources has spurred the need to renew—and perhaps even reissue—our social license to practice silviculture. At the same time, many silviculturists continue to insist upon the supremacy of a limited suite of options based solely on *perceived* maximum economic return. This is particularly true in the southeastern United States, where fealty to intensive pine-plantation silviculture continues to dominate. But at what cost? A recent exposé by *The Wall Street Journal* (Dezember 2018) recounted the experiences of many landowners that embraced production-focused silviculture and invested heavily in planted pine. What once seemed intuitive—the replacement of less productive natural stands, the use of improved pine genetics, refined planting techniques, and density management for volume gains—has produced a slew

of unintended environmental and social consequences. Furthermore, a persistent slump in the lumber-dominated housing industry following the 2008 recession (Ince and Nepal 2012) put many landowners in a financial bind and, when coupled with the widespread and continuing decline of once-formidable consumers of southern pine (e.g., paper, newsprint, and plywood mills; Latta et al. 2016, Wear et al. 2016), has dimmed once bright prospects.

What do these have to do with the relevance of silviculture in the South? As a "wall of wood" (oversupply) keeps stumpage prices persistently low, many landowners are turning away from silviculture and looking to other nontimber options. How do we keep them engaged and forests as forests? In the short term, silviculturists can help landowners find value in less conventional products. For example, *The Wall Street Journal* article mentioned more financially rewarding options such as southern pine telephone poles or the long-neglected hardwood component of otherwise pine-dominated landscapes. In the long-term—and forestry is all about the long-term—we need to expand our notions of what constitutes good silvicultural practices. We must reject formulaic approaches to our profession because forests represent a broad portfolio of ecosystem services from which to choose (Sills et al. 2017). Although the valuation of ecosystem services beyond commodity production is still a developing field and some do not readily translate into cash terms (Sills et al. 2017), opportunities to better optimize all services abound if we are aware of them! Silviculturists have a duty to listen to those they work for and communicate *all* of the possibilities. Carefully implemented, carbon credits, wetlands and/or species mitigation, forest-based recreation, agroforestry, and even water credits are increasingly viable options that silviculturists can help deliver to forest owners. As an example, I recently attended a field tour of a private holding in southwestern Louisiana on which the owner raises both livestock and longleaf pine in a manner tuned to the ecological needs of his land. In doing so, he promotes a wide range of ecosystem services that features commodities (cattle and wood) while simultaneously including habitat for endangered species, water management, and soil development.

I agree with Jain that 21st century silviculturists face socioeconomic and ecological complexities, rapidly advancing tools and technologies, numerous communication issues, and the need for a clear vision of the future—these are the enduring challenges of forestry.

Southern silviculture comes with a uniqueness all its own, driven in part by an overwhelming predominance of privately held land and a population generally amenable to timber management. Unlike our colleagues in other parts of the world, southern silviculturists can quickly adapt existing systems to develop new products—such as mass timbers for building construction or pellets for power generation—to help ensure relevance. Emerging global markets can also provide opportunities southern silviculture can support, if we can provide a quality product in an environmentally friendly manner.

But we need not look internationally for opportunities to avoid irrelevance—as the South's population continues to grow and further fragment our forested landscapes, we must adapt our practices. For instance, what role can silviculture play in expanding the ecosystem service offerings of our forests? How will we retain important tools such as prescribed burning available as health concerns related to air quality continue to mount? Can we keep loggers and mills in business when their ability to practice keeps getting more restricted and economically tenuous? How do we meet the growing demands of niche markets—such as white oak staves for whiskey barrels—when much of the required resource has been replaced by pine or made unavailable by development? Can we support new market opportunities (e.g., cross-laminated timbers) with material of sufficient quality and quantity for their more demanding specifications? How do we turn this wall of wood into a brighter future for rural communities facing decreasing populations and diminishing opportunities? And can we ensure that silviculture has a role in reshaping the wildland–urban interface

to blunt the increasingly tragic impacts of wildfire, forest fragmentation, water conflict, and native species loss? I would argue that adapting for the needs of the whole, rather than focusing on doing one thing spectacularly well, is the best way for silviculture—in the South, the West, or wherever—to avoid irrelevance in the 21st century.



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