Regenerating and Tending Under the Vision for Resilience and Function in the Free Selection System

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Overview:

- *What is free selection?*
  The free selection silviculture system is a multi-aged stand-to-landscape management strategy where the primary objective is to strategically create compositional and structural patterns that contribute to a disturbance resilient landscape (adjusting frequency, size, and juxtaposition of patches and stands) that will produce a variety of goods and services.
- *Where and why is free selection a good option?*
  Free selection is an option in mixed species forests that contain shade-tolerant and intolerant species with different levels of disturbance resistance and a plurality of environmental adaptation (e.g., moist mixed-conifer forest). It is also an option in forests with fewer tree species (e.g., longleaf pine, ponderosa pine) where the goal includes managing for understory vegetation (grass and shrubs), surface and ladder fuels, or other ecosystem attributes. Furthermore, free selection is an option that is best suited for large patches or landscapes as the management unit. It is designed to cross stand boundaries and to create and maintain a diversity of forest cover and species.
- *What are new developments?*
  A diversity of new tending treatments are being developed and designed to create wildlife habitat, reflect historical conditions, or manage clumps of trees, but traditional silvicultural systems are not suited for this variety of complex tending strategies. The free selection system integrates regeneration, tending, and harvesting in an appropriate manner through time; fulfills basic requirements of a silvicultural system; and provides the necessary context to house treatments for irregular and variable retention harvests, variable-density tending methods, and regeneration methods.

Summary:

Management problem: Forest management goals and objectives have vastly expanded in recent decades. Many managers and silviculturists are challenged to produce more than just timber from our nation's forests. Future forests are expected to deliver complex and often integrated management objectives such as providing a unique sense of place and naturalness,

wildlife habitat and forage, and resilience to disturbance and global change—all in addition to renewable forest products.

Management need: Multi-aged silviculture can meet many of today's diverse management needs but successfully implementing the regeneration and tending phase of these silvicultural systems in western dry to mesic mixed-conifer forests has been challenging. Classic uneven-aged systems were not designed to fulfill objectives such as regeneration of early seral shade tolerant species or to create diversity in structure and composition. To meet the new suite of management objectives and avoid those problems, Graham and Jain (2005) introduced the hybrid multi-scale concept of the free selection silvicultural system in the journal *Forest Ecology and Management*, wherein system parameters were qualitatively characterized with a "vision" (i.e., desired future condition) of resilience to disturbance and functioning ecosystem components. Since then, developments in ecological silviculture and studies of treatment effects have prompted the need to reestablish relevance and further parameterize this system.

Research purpose: This work describes the free selection system in the context of contemporary management drivers, integrates newly developed silvicultural strategies under the umbrella of the free selection system, and synthesizes recent research that quantifies regeneration and tending phase treatments.

Silvicultural Concepts:

- The free selection system was designed to meet complex management objectives, where timber is an important but secondary objective to other ecosystem services. This system was developed to promote ecosystem function and resilience in mixed-conifer forests, prioritizing residual vegetation composition and structure. It is a hybrid system that contains concepts of even-aged and multi-aged silvicultural methods. While free selection can be applied at a single stand scale, the system uniquely and explicitly links stands to landscapes, and can be used to create treatment mosaics at the landscape patch scale.
- The free selection system is flexible to accommodate regenerating and tending strategies such as the variable-retention approach, irregular shelterwoods, variable-density thinning, ICO, daylighting, ghosting, etc. Each of these strategies (or combinations thereof) could be used in the context of this system, as the ecosystem and stand development require.
- New research on these ecological silviculture methods quantifies structure and response and is useful for parametrizing options in the free selection system. For instance, Larson and Churchill 2012 discuss what spatial patterns might arise when prioritizing structural retention for fire-resilient forests. Jain et al. 2001 and Smith and Beese 2021 evaluate regeneration growth under different canopy gap sizes and

overstory retention levels. Puettmann et al. 2016 and Willis et al. 2018 elaborate on the structural effects and growth tradeoffs of variable-density thinning to create forest complexity.

Management Applications:

- Complex, multi-objective and multi-scale forest management requires flexible and creative use of many tools, like the free selection system. However, agency silviculturists often need to document management activities according to rigid reporting categories (e.g., FACTS database) or coarse summary attributes (e.g., retention basal area). These restrictions often exist at the stand level. Successful free selection prescriptions and marking guides can be developed outside of such restrictions to best meet landscape and ecosystem needs and objectives if managers find creative ways to shoehorn treatments into more typical reporting categories.
- Examples from the scientific literature function as useful tools managers can use to piece together a customized, hybrid silvicultural system best suited for the site's ecological objectives. While adoption of new techniques may immediately benefit managed ecosystems, couching them in the vision (desired conditions through time) of a system like free selection promises the long-term benefits of sustainability and desired future conditions through future decades.

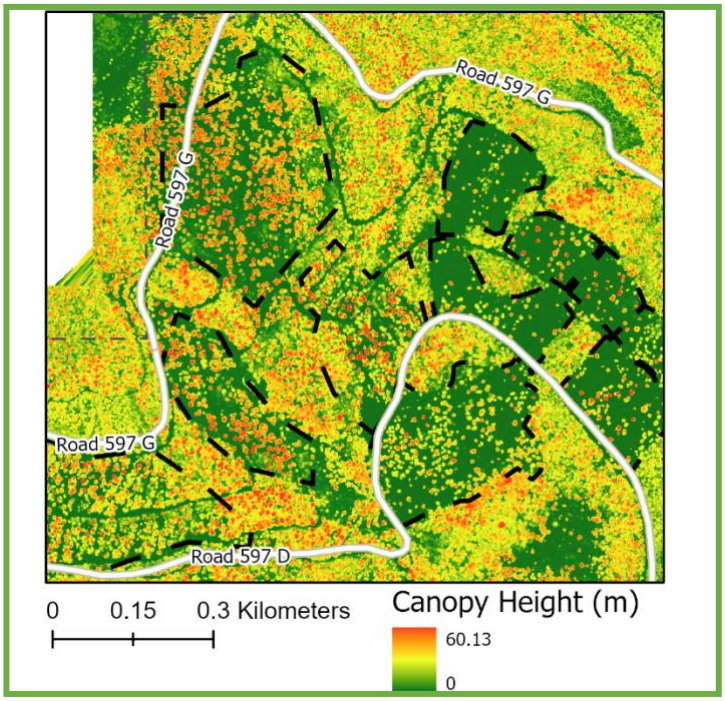

Figure 1—Example of landscape management (approximately 109 ha or 270 ac in this snapshot) using free selection in the Canyon Creek watershed of Priest River Experimental Forest. In this image, greens represent openings or forest understory, yellows represent midstory, and reds represent overstory trees. Note the complexity and heterogeneity at the tree neighborhood scale within each unit boundary, among units, and in the retention space between unit locations.

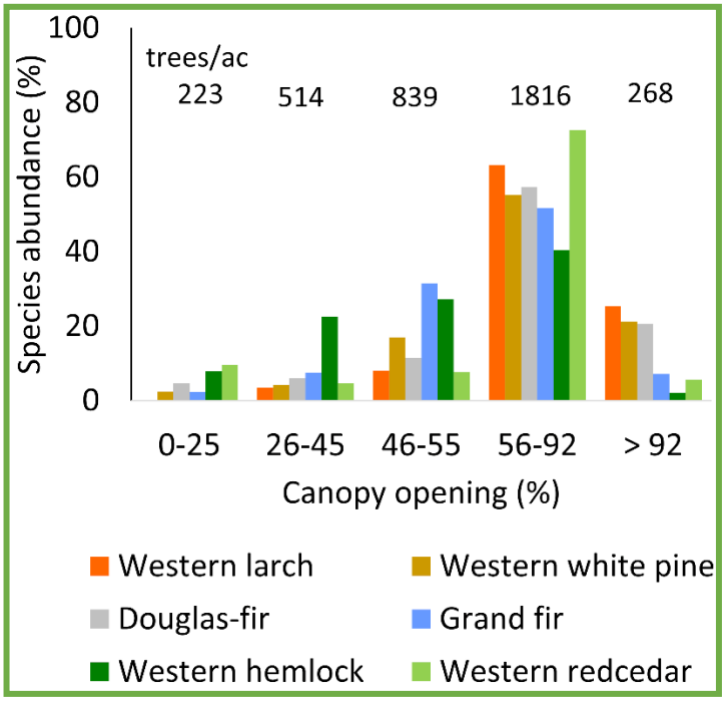

Figure 2—Relative abundance by canopy opening in the Canyon Creek watershed of Priest River Experimental Forest, a decade after free selection harvests. Percent abundance on y-axis references total abundance (by species) across canopy opening classes. These data represent recent findings and developments that parameterize examples of free selection and associated silvicultural treatments.

Table 1—Example of free selection system regulated by condition class in a dry forest stand or landscape.

Condition class	Description	Desired portion of stand	Maintenance	If current proportion exceeds desired	If current proportion less than desired
A	Mature, multi-cohort	45%	Selection harvest and ladder fuel tending, Rx fire	Thinning from below to create [B], patch cutting to create [C], or overstory removal to create [D]	Patch cutting in [B]
B	Mature, single-cohort	20%	Variable-density thinning, Rx fire	Patch cutting to create [A] or [C], or overstory removal to create [D]	Variable-density thinning in [C]
C	Young, single-cohort	15%	Variable-density (noncommercial?) thinning	Variable-density thinning to create [B]	Regeneration harvest in [A] or [B], or planting in [C]
D	Open	15%	Rx fire	Plant seedlings to create [C]	Overstory removal in [A], [B], or [C]
E	Reserve	5%	No action		

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