RESEARCH BRIEF

Refining the oak-fire hypothesis for management of oak-dominated forests of the eastern United States

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The oak-fire hypothesis has gained significant traction in scientific and land management communities throughout eastern US deciduous oak (*Quercus*) forests. This hypothesis proposes that oak forests require periodic fire disturbances for their continuation. Land managers are applying fire for silvicultural and ecological restoration purposes due to their increased understanding of the important role historical and pre-historical fire has played in eastern US oak forests, as well as concerns about the structure and composition of today and tomorrow's forests (read: oak regeneration). In this article Mary Arthur and co-authors develop a framework for considering the ecological context in which fire may be an effective land management tool. The physiological and ecological basis for using prescribed fire in eastern US oak forests are discussed; limitations of prescribing fire toward sustaining oak dominance are revealed; and responses to fire at different stages in oak life history are examined.

Disturbance events in the mid-late 19th and early 20th centuries, such as European settlers' use of fire, grazing and logging, removal of voracious mast consumers (i.e., passenger pigeons), and loss of competitors (*Castanea*), allowed oak advanced regeneration accumulating in forest understories to recruit into the forest canopy, thus originating the oak-hickory forest we have today across the eastern US. With the widespread cessation of fire in the 1930s and 1940s, along with other shifts in forest disturbance regimes, the mid- and understories of today's eastern US oak forests are increasingly dominated by shade-tolerant species such as red maple, sugar maple, and black gum. The fallen leaves of these species, in chemistry and structure, are less flammable than oak leaves. These dense mid- and understories block significant amounts of light and reduce the fine fuels of grasses and forbs. These changes in forest structure/composition complicate both the manner in which fire can be applied to these systems, and the results land managers might expect following prescribed fire treatments.

Table 1 of this article should be considered mandatory reading for anyone considering using fire as a silvicultural tool in oak forests. Four

MANAGEMENT IMPLICATIONS

- Oak/hickory forests across the eastern US are largely the result of widespread disturbance events in the late 19th and early 20th centuries
- Due to broad variations in climate, soils, and competing species, one fire management prescription does not fit all eastern US forests; site and species specific factors should be considered

Photos by Neal Humke, L-A-D Foundation (left) and Vern Wilkins, Indiana University, Bugwood.org (right)

Increasing amounts of less flammable leaf litter from mesophytic tree species (e.g., red maple and black gum) can hinder the application of fire as a management tool in upland oak forests of the eastern US.

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Refining the oak-fire hypothesis

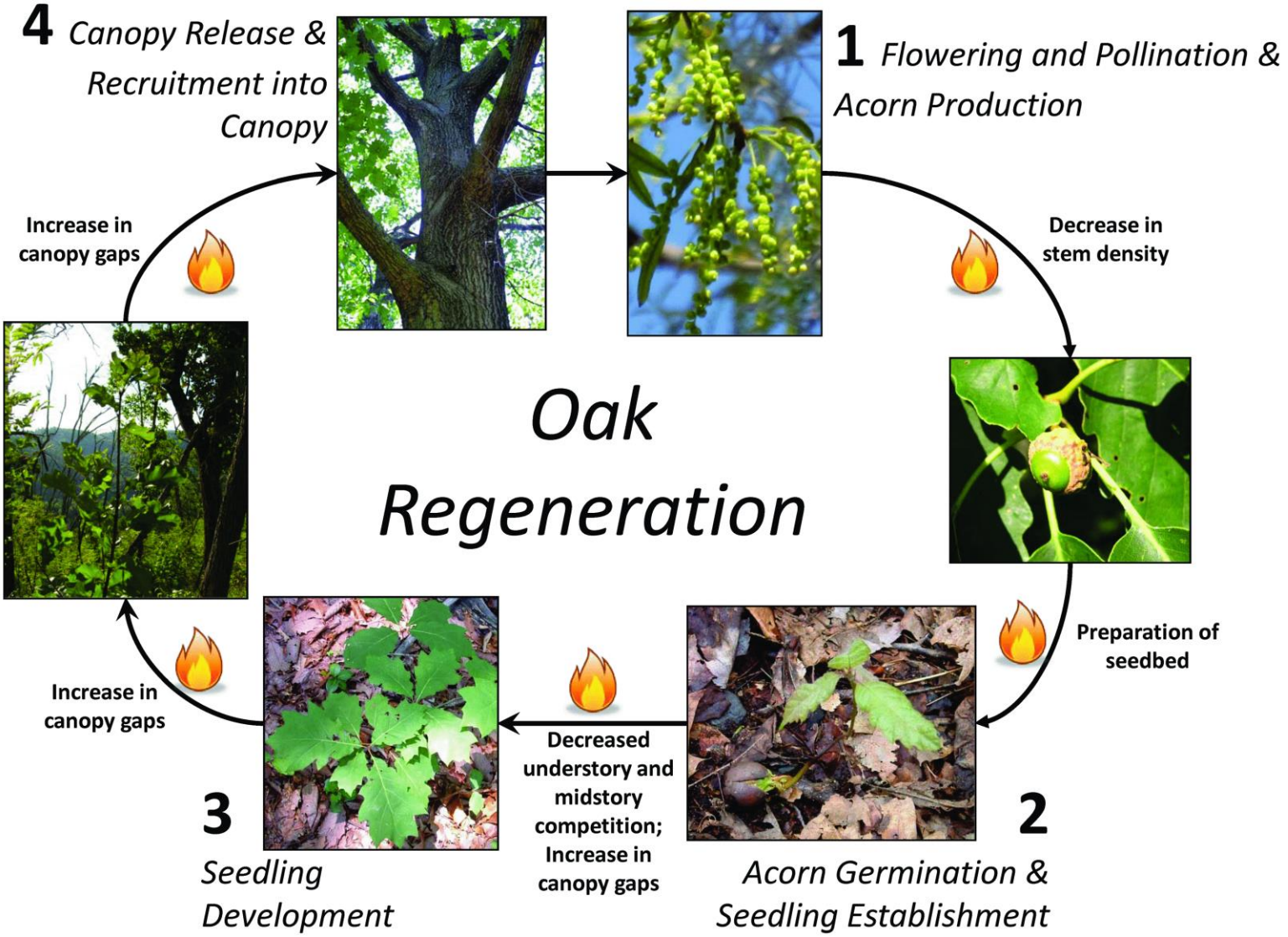

Illustration of the key life stages for oak regeneration: (1) flowering, pollination, and acorn production; (2) acorn germination and seedling establishment; (3) seedling development; and (4) release from overstory competition and recruitment into the canopy. The text in bold provides descriptions of the processes by which fire disturbance may influence oak regeneration success.

prominent stages in the life history of oaks - from acorn production to canopy recruitment - are closely inspected for the potential of beneficial fire use. In each stage, fire application considerations, as well as potentially more appropriate alternative methods are discussed. The above figure summarizes Table 1.

The incredible diversity in species and environmental conditions represented across eastern oak ecosystems requires that management decisions be made with regional and perhaps community specific knowledge. Considering the broad variations in climate, soils, topography, and competing species represented in eastern US oak ecosystems, a single prescription is not likely to be appropriate for all sites. In determining the appropriate timing and manner of prescribing fire, timely site and species specific information must be coupled with clear achievable prescription goals, and skillfully executed. There is good news for land managers and researchers in coming generations, as many facets concerning fire and oak ecology are identified and laid out in this article.

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