



The Oak Triangle: reviewing the role of oaks in the Lake States in the face of climate change, fire, and predation

Written by: Chase T. Brooke and Jessica Miesel
(Michigan State University)

Across the southern boreal and temperate forests of the Lake States, fire, climate, and animals play a strong role in determining the development and species composition of these forests. Frelich et al (2017) reviewed existing literature on the role of oak forests as a nexus for forest development. Oak species are fire-tolerant trees which are able to persist in a wide variety of forest and disturbance regimes. As such, the authors created the concept of the oak triangle, which describes the niche of oak species in savannas, temperate mesic forests, or southern boreal forests in the Lake States region. This concept was used as a basis for describing changes in those ecosystems due to climate change, fire, and the fauna of those areas.

The first cause for forest change identified by the authors was the impact of increasing temperatures due to climate change. In the southern boreal forests, oaks were historically stunted and restricted in range due to the long, cold winters. Thus, increasing temperatures in the southern boreal forest will improve growing conditions for oaks and allow them to establish themselves. Temperate forests were also likely to be affected by warming climates. Severe droughts will likely kill less drought tolerant species like maples and favor more drought tolerant ones like oaks.

The authors identified fire as the second determining factor in oak prevalence in forests. Fire served two purposes for promoting oaks: first, they created gaps in existing forests which provide openings for oaks to establish. Second, fires also reduce the prevalence of less fire-tolerant species such as maples. Therefore, they found that shorter mean fire return intervals (MFI) led to more open grassland ecosystems and longer MFI lead to



MANAGEMENT IMPLICATIONS

1. Under warmer climates, oaks are expected to expand into southern boreal forests. This transition may provide areas for new oak savannas to develop with the assistance of fire application.
2. Fire can be used to improve oak regeneration in Lake States temperate mesic forests. The rate of fire application is a primary factor controlling oaks, with invasive earthworms and deer potentially offsetting the benefits of fire.
3. Warming climates will allow oaks and deer to expand into the southern boreal forests. Warmer temperatures may improve oak survivability and growth, but deer browsing may limit oak growth.

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Jessica Miesel
Michigan State University
mieselje@msu.edu; 517-355-8239

forested ecosystems (Table 1). Long periods of time between fires (>100 years) transitioned forests to shade tolerant and fire intolerant tree species such as red maple and basswood. Fire return intervals of 20-40 years promoted dominance by oaks mixed maples mesic species. If the MFI was further shortened to 2-10 years, there is a conversion to grasslands and oak dominated forests.

While fire may aid in promoting oak regeneration in forests, deer and invasive earthworms were found to inhibit oak establishment by either browsing the leaves of saplings or by reducing soil nutrients and organic matter. Warming climates were associated with the expansion of deer populations into the southern boreal forest. Deer, unlike the more cold hardy moose, preferentially browse the leaves of young oak shoots. Thus, the authors posed a theory that deer expansion would offset the growth benefits of oaks from warmer temperatures.

In the temperate mesic forests, invasive earthworms were also listed as a potential force of forest change. These earthworms were found to reduce forest soil organic matter, soil nutrients, and soil moisture. Thus, in these drier conditions, forests could shift towards tree species more tolerant of the dry and nutrient-poor soils. However, the dynamics of the oak-earthworm interactions were still considered to be poorly understood and a potential avenue for future research.

The dynamic between climate, fire, and fauna was considered to be a critical component of future oak forest range and extent. By considering the concept of the oak triangle as a descriptor for ecosystem change, the authors tied together a wide breadth of research to describe this transitional forest type. While future conditions may potentially inhibit oak forest reestablishment in the Lake States region, the increased use of prescribed and managed fire would outweigh the limitations and would be a net positive for oak forests in the area.

Table 1. Ecosystem changes from oak forests as a function of Mean Fire Interval in the Great Lakes region. As MFI increases, maples and other mesic species begin to dominate forest composition.

Mean Fire Interval	Oak forest transition as a function of Mean Fire Interval
>100 years	Mesic Hardwood Forest
20-40 years	Mixed Oak-Maple Forest
10-20 years	Oak Forest
2-10 years	Oak Savanna

Reference

Frelich, L. E., Reich, P. B., & Peterson, D. W. (2017). The changing role of fire in mediating the relationships among oaks, grasslands, mesic temperate forests, and boreal forests in the Lake States. *Journal of Sustainable Forestry*, 1-12.