Issue of Concern: Competition with shade-tolerant species

Some oak forests in the Northeast are experiencing a gradual shift in species composition toward more mesic, fire-intolerant, and shade-tolerant tree species. Many interacting factors are understood to be driving this trend, though it is difficult to determine which are the most influential. Where sustaining oak forest is desired, a variety of adaptation practices may reduce the increasing dominance of these competing species.

Climate Change Impacts

Factors understood to be facilitating a shift toward increased dominance of competing species in the oak forests of Eastern North America include fire suppression and land use across the region, a long-term increase in wetter conditions, and herbivory (Nowacki & Abrams 2008, McEwan et al. 2011, Knott et al. 2019). The tree species that are becoming more dominant in some eastern oak forests as a result of these factors include sugar and red maple, birch, hemlock and American beech (Nowacki & Abrams 2008, Knott et al. 2019).

Fire suppression in oak-dominated forests is considered one of the major drivers of this shift. Evidence from early town proprietor surveys indicates that prior to colonization, more mesic species were rare within the oak- and chestnut-dominated forests of southern New England, with the exception of areas near rivers, lakes or the coast (Cogbill et al. 2002). There is evidence that fire was used as a land management tool by Native Americans in eastern deciduous forests, and that fire was also common on the landscape during early European colonization; however, frequent fires were effectively eliminated around 1940, coinciding with the start of a period of intense maple establishment (McEwan et al. 2011). Without the canopy-opening fire disturbances that are historically characteristic for oak-dominated forests of eastern North America,species less tolerant of fire are better able to proliferate. Red maple, in particular, has been found to alter forest hydrology and nutrient cycling in a way that reduces the overall flammability of the forest and perpetuates conditions more conducive to other mesic, shade-tolerant species (Alexander & Arthur 2014).

Despite the fact that species distribution projections indicate that oak will generally be favored under climate change scenarios (Iverson et al. 2017), certain climate change impacts could create conditions that contribute to a successional transition toward more shade-tolerant species. The substantial increase in precipitation in the Northeast over the last century has already contributed to the establishment of more mesic species in oak forests (McEwan et al. 2011), and annual precipitation is expected to continue increasing, though soil moisture patterns will ultimately depend on location as well as the impacts of increasing drought (Easterling et al. 2017). More physical disturbances to the overstory due to extreme storm events associated with climate change could also release more mesic, shade-tolerant species that may have come to dominate the understory (Janowiak et al. 2018).

Certain land uses have been identified as contributing to the transition of oak-pine forests toward shade-tolerant species. Frequent and intensive overstory tree removal allows for red maple, which establishes competitively after harvest, to monopolize growing space (Hanberry 2019). However, the extent to which shade-tolerant species could ultimately populate the overstory of oak-dominated forests is ultimately still uncertain, and will depend on the frequency and intensity of harvest, as well as management decisions related to fire.

Adaptation Actions for Forests

Additional actions are described in the [Adaptation Strategies and Approaches for Forests].

Site Condition	Adaptation Approaches	Example Adaptation Actions
Species competition leading to composition change	• Reduce competition for moisture, nutrients, and light • Guide changes in species composition at early stages of stand development	• Thin forest stands to remove crowded, damaged, or stressed trees to reduce competition for light, nutrients, and water • Use prescribed fire to maintain growing space for fire-tolerant species or to increase nutrient turnover • Control beech regeneration in areas affected by beech bark disease to reduce competition with the regeneration of other species • Plant or seed sufficient stocks of desired species before undesirable species become established • Use timber stand improvement to favor and promote the growth of desirable growing stock
Altered disturbance regimes favor other species	• Restore or maintain fire in fire-adapted ecosystems • Promptly revegetate sites after disturbance • Favor or restore native species that are expected to be adapted to future conditions • Promptly revegetate sites after disturbance • Realign significantly disrupted ecosystems to meet expected future conditions	• Use prescribed fire to reduce ladder fuels, invasive species, and understory competition • Promote fire- and drought-adapted species and ecosystems in areas that are expected to have increased fire risk as a result of climate change • Use natural or prescribed fire to restore the open character of oak woodlands and glades • Shift prescribed burn seasons to align with projected seasonal precipitation changes, thereby reducing the risk of unintended wildfire conditions • Create suitable physical conditions for natural regeneration through site preparation, for example by chaining after a burn to promote seed establishment

		• Monitor areas of natural regeneration more frequently, and prioritizing planting or seeding where natural regeneration is slow to succeed • Plant larger individuals (e.g., saplings versus seedlings) to help increase survival • Favor or establish oak and other more drought- and heat-tolerant species on sites that are expected to become warmer and drier
Stressors limit oak vigor, regeneration, and recruitment	• Maintain or improve the ability of forests to resist pests and pathogens • Manage herbivory to promote regeneration of desired species	• Use pesticides or biological control methods to manage pest populations (e.g., gypsy moth) in heavily infested areas • Apply repellant or install fences, bud caps, and other physical barriers to prevent herbivory • Use tree tops from forest harvest or plantings of unpalatable tree species as locations for "hiding" desirable species from herbivores to reduce browse pressure • Partner with state wildlife agencies to monitor herbivore populations or reduce populations to appropriate levels

On-the-Ground Examples

- Providence Water: Planting Future Adapted Forests
    - The forests surrounding Providence's Scituate Reservoir provide clean water to over 600,000 people, or two-thirds of all Rhode Islanders. Challenges to northern hardwood regeneration ultimately threaten water quality. Managers are experimenting with actions that promote a variety of oaks and other species that are expected to be better adapted to future conditions.
- Massachusetts Dept. of Conservation & Recreation: Protecting Riparian Zones with a Focus on Stream Crossings
    - Many of the culverts for streams that enter the Deerfield River within the South River State Forest have already failed or are threatened by increasingly heavy precipitation events. Managers are removing failing culverts and replacing them with bridges, while ensuring stream connectivity and a naturalized stream bottom.

Potential Monitoring Items

- Density of more mesic, fire-intolerant, and/or shade-tolerant species in the understory
- Species diversity of regeneration in areas of recent disturbance

Additional Resources

- The Oak Woodlands & Forests fire consortium hosts a webinar recording on mesophication
- Oak, Fire, and Global Change in the Eastern USA: What Might the Future Hold? article in *Fire Ecology*