Increasing Oak Forest Resiliency in Southern New England

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ABSTRACT

The iconic southern New England landscape is a densely populated region in which historic villages and growing cities are set within an expansive forest. While oaks are dominant or significant species in 60% of these forests, they face pressures that compromise their health and ability to regenerate. Threats include deer herbivory and insect defoliation, while drought and climate-change stresses compound other disturbance factors. With traditional silviculture methods no longer working reliably and landowner motivations changing, new management options are needed.

A 2019-22 initiative led by the Forest Stewards Guild and state agencies has engaged partners in Connecticut, Massachusetts, and Rhode Island to collaborate in promoting stewardship that will support and improve the resiliency of the region's oak forests. One promising output of this collaboration is a web-based Oak Resiliency Assessment Tool that professionals and landowners can use.

Looking forward, researchers at the University of Connecticut and University of Rhode Island are leading a study designed to test different management approaches to help regional oak forests adapt to changing climate conditions.

Keywords: adaptation, climate change, decision support tool, foresters, landowners, silviculture, stakeholder engagement

Introduction

Forests dominated by oaks are a defining feature of the landscape in southern New England, a subregion of the Northeastern United States encompassing three of the country's smallest states (Connecticut, Massachusetts, and Rhode Island). Situated along the Northeast Corridor between Boston and New York, this region is one of the most densely populated areas of the country and yet remains mostly forested. Oaks are dominant or significant species in 60% of the regional forest (Butler et al. 2015; Brett Buttler pers. comm.). Although their deep red, brown, and yellow fall leaves might not produce the most brilliant colors among local trees, oaks are an understated but essential part of the regional identity due to their ubiquitous presence.

Southern New England is where the Central Hardwood Forest type extends farthest to the northeast, giving way to a broad transition zone with the Northern Hardwood-Conifer Forest type in Massachusetts (Fralish 2003). These woods are known for their diversity of tree species. In addition to *Quercus* (oaks), some of the most common hardwoods include *Carya* (hickory), *Acer* (maple), *Betula* (birch), *Fagus* (beech), *Fraxinus* (ash), and *Nyssa sylvatica* (black tupelo), while *Pinus rigida* (pitch pine), *P. strobus* (white pine), and *Tsuga canadensis* (Eastern hemlock) are important native conifers.

The most common oak species in these forests include *Q. rubra* (northern red oak), usually found on the most productive mesic sites, along with *Q. velutina* (black oak) and *Q. alba* (white oak) found on a variety of sites. On poorer, drier sites *Q. rubra* typically drops out and upland forests are dominated by a mix of three species: *Q. alba*, *Q. velutina*, and *Q. coccinea* (scarlet oak). *Quercus montana* (chestnut oak) is less common but notable for its presence on ridgetops and the rockiest soils. While these five species are the most common in the woods, other oaks are present in the region, including *Q. palustris* (pin oak) in floodplains and wet areas, as well as other species planted in urban settings.

Another defining characteristic of this region's forests is the prevalence of family land ownership, with 68% of woodlands owned by families and individuals (Butler et al. 2015). There are no national forests; most public forests are owned by states and municipalities and only a few corporations are major landowners. The average parcel size is less than 10 acres (4 hectares) and tracts of greater than 50 acres (20 hectares) are considered large. The future of these woodlands depends on tens of thousands of family landowners whose collective decisions will determine how the forest is cared for, or how much of it will remain forested at all. Surveys show that these owners are becoming less interested in traditional reasons for owning land, such as timber income and hunting, while they increasingly value their land for its scenic and recreational value and for opportunities to protect nature and wildlife habitat (Sass et al. 2021). Therefore, it is increasingly important for professionals to understand owners' changing motivations and to offer the services that meet their needs.

Native oak species are generally projected to be able to adapt to changing conditions in the region. Their prognosis is favorable compared to that for other common species with respect to invasive insects or increased moisture stress (Janowiak et al. 2018). Southern New England oak forests nonetheless face pressures that compromise their health, including defoliation by insects, heavy deer herbivory, seasonal drought, and climate-change stresses. These impacts in turn affect wildlife species that depend on oaks for food and shelter, create hazard trees in backyards and along public roadsides, and create financial challenges for families who rely on timber income to offset ownership costs. Because oaks are such a dominant component of the forests in this region, the impacts of stresses they face are magnified. A grasp of the current situation requires an understanding of regional land-use history, changing ecosystem dynamics, and new stressors and challenges. Fully integrating this information allows for the development of updated stakeholder engagement approaches and on-the-ground management techniques.

Land-use history, ecosystem dynamics, and climate change

Southern New England has a complex history of evolving land uses in recent centuries as its human population has changed and grown. Native American tribes have been present in the region for a very long time and indigenous people influenced the landscape in many ways, although there is uncertainty about the manner in which they affected plant communities (Fuller et al. 1998; Parshall and Foster 2002; Abrams and Nowacki 2020). Many Native American people in the region practiced subsistence agriculture (Cronon 1983) and stripped bark from large trees for shelters. Fire was used in coastal areas, river valleys, and other sites dominated by oak and pine to enhance conditions suitable for small-scale agriculture, increase hard mast and berry production, and facilitate hunting, travel, and defense. (Janowiak et al. 2018; Nowacki and Abrams 2008; Fuller et al. 1998; Patterson and Sassamann 1988; Abrams et al. 2022; Reo and Parker 2013).

Since Europeans arrived in North America, dramatic changes to forests have occurred (Stambaugh et al. 2022). European colonizers brought European diseases that devastated Native American populations, consequently eliminating many anthropogenic fires from the landscape and causing formerly fire-maintained woodlands to transition to closed-canopy forests (Stambaugh et al. 2022). When colonists established permanent settlements beginning in the 1600s, most of the upland forest was in a late-successional stage of growth. European settlers applied their traditional agrarian methods, clearing the forest to grow crops, keep livestock, and provide a source of lumber. By the 1830s, most of the land was cleared for agriculture with forest remaining only in hard-to-farm locations. Most agricultural land use was temporary, however, and within a few decades forest vegetation returned. *Pinus* grew in old fields and then were cut, and composition typically reverted to second-growth hardwood forest dominated by *Quercus*, *Castanea*, and other genera. While conifers remain an important part of the species mix, the composition of which has changed over time (Foster and O'Keefe 2000), the oak-dominated forests present today are the result of these anthropogenic activities.

Photo 1/ Heavy oak mortality that can be seen in places in southern New England.

Forest history researchers examined colonial-era property deeds and surveys that reference witness trees marking forested property boundaries and corners. From this analysis they provided a description of past forest composition across much of New England. In Connecticut, Rhode Island, and eastern Massachusetts, these historic documents show a higher percentage of *Quercus* than of any other genus, with *Castanea* and *Carya* also well represented. Charts showing the species composition of the pre-colonial and modern forest look very different. The current forest has a greater range of species and a much higher percentage of *Betula* and *Acer* (Thompson et al. 2013).

Historically, fire was an important ecological process in these forests, but it is uncommon in most places now. Fires from both natural and anthropogenic ignitions were typically low-level burns mostly affecting the forest understory, rather than being stand-replacing events. Fire-tolerant oaks thrived in these conditions (Nowacki and Abrams 2008). As the human population grew and spread farther into wooded areas over the course of the 20th century, fire suppression policies and advances in fire detection and response dramatically reduced both the number of fires and acres burned. Between 1900 and 2000, the annual number of acres burned each year in Rhode Island dropped from tens of thousands of acres to a few hundred or less (Buffum 2015). Prescribed burning now is mostly limited to small areas of pitch pine-scrub oak forest in undeveloped coastal areas.

Nowacki and Abrams (2008) hypothesized that the species and composition changes in upland forests of the Eastern United States over the 20th century have been mainly due to the exclusion of fire. They describe the process of open stands of *Quercus* and *Pinus* species being gradually colonized by shade-tolerant, fire-sensitive *Betula* and *Acer* species, which help create cool, damp conditions that serve to further the proliferation of these species. The researchers coined the term “mesophication” to describe this recurring feedback loop and predicted that a return to fire-adapted ecosystems favoring oaks will not happen without significant intervention (Nowacki and Abrams 2008). In a later publication, the same authors point out that mesophication is making oak-pine forests increasingly susceptible to the warming and drought associated with climate change (Abrams and Nowacki 2020).

Responding a few years later, McEwan et al. (2011) proposed that Eastern US oak forest dynamics are highly complex and that composition and structure changes cannot be explained by the exclusion of fire alone but is rather the result of “multiple interacting ecosystem drivers.” These researchers considered several additional factors, including the effects of land-use change on the regrowth and condition of the forest. Exotic pests and pathogens have caused heavy impacts; for example, *Lymantria dispar* (spongy moth) affecting oaks and *Cryphonectria parasitica* (fungus responsible for chestnut blight) eliminating *Castanea dentata* (American chestnut), once known as the “king of the Eastern forest”, from the canopy. Wildlife species have also influenced oak regeneration conditions (McEwan et al. 2011).

Climate change is also creating additional stresses. Warmer temperatures, longer growing seasons, and shorter winters are anticipated in many locations. One of the most significant shifts in southern New England is altered precipitation patterns, which are already being experienced. Rather than precipitation being distributed evenly throughout the year, it tends to be concentrated in intense storm events with periods of little precipitation in between. This can lead to altered soil moisture and increased risk of drought stress. Climate change is most disruptive in how it serves as a “threat multiplier” exacerbating existing stresses, increasing the frequency and intensity of disturbances, and introducing new insect pests and diseases. The results of these factors interacting can be difficult to predict, but they put additional strain on ecosystems (Janowiak et al. 2018).

Odocoileus virginianus (white-tailed deer) and common regional invasive plants are two interrelated factors that are having increased impacts on Northeastern US oak forests in a changing climate. Deer have become so well adapted to living near humans that their population has increased dramatically in recent decades. Their preference for browsing on oaks and other hardwood seedlings and saplings already inhibits oak regeneration and alters the species composition of many forests (Rawinski 2014). With fewer predators and more individuals surviving warmer winters deer populations are expected to increase (Weiskopf et al. 2019). For all the understory vegetation that deer eat, land managers have observed that they typically avoid the common forest invasives of the region, including *Berberis thunbergii* (Japanese barberry), *Celastrus orbiculatus* (Asiatic bittersweet), and *Rhamnus cathartica* (buckthorn). These invasive species are expected to expand their ranges in warmer conditions and are among the few plant species that can take advantage of elevated carbon dioxide levels and gain a competitive edge (Dukes et al. 2009). Climate change may also lead to new invasive species expanding their range into southern New England.

Recognizing the changing conditions and the many factors to be considered, natural resource professionals and landowners are addressing the challenges confronted by oak forests in the region. Two complementary projects are fostering stakeholder engagement and applied research to address these complex issues.

Working with professionals and landowners to increase resiliency

Funded by a grant from the USDA Forest Service Landscape Scale Restoration Program, a recently concluded three-year project (2019-22), focusing on innovation in outreach and stewardship, featured parallel tracks engaging both natural resource professionals (especially foresters) and landowners. This effort, led by the Forest Stewards Guild, the state environmental agencies of Connecticut, Massachusetts, and Rhode Island, and additional partners in all three states, had four main goals:

- increasing implementation of forest stewardship activities supporting oak resilience;
- empowering professionals with tools for assessing oak forest health;
- building landowner awareness of regeneration challenges and solutions; and,
- fostering communication between different states and their agencies about strategies for addressing these challenges.

The message at the heart of the project was succinctly summarized by one public service forester who noted, “If you manage for oak, you’ll still get birch, beech, and maple, but if you don’t manage for oak, you’ll only get birch, beech, and maple.”

Like other outreach efforts that took place during the height of the COVID pandemic, organizers had to improvise when there was no choice but to pivot from indoor meetings. Fortuitously, these new formats yielded some unexpected positive results. An online town-hall-style meeting allowed landowners from different parts of the region to meet and interact with each other in novel ways. Two-part workshops, a webinar followed by a field trip, proved successful enough that this structure will continue to be used after the pandemic recedes. This format allowed individuals to gain an introduction to an oak-

Photo 2/ Bringing together natural resource professionals and landowners.

related topic via webinar, with a subsequent safe outdoor field trip allowing for more in-depth examination and higher-level discussion of the topic at a specific forest property.

A central theme that emerged was the importance of fostering relationships between foresters and family landowners. Most landowners want to be good stewards of their land but have busy careers and family lives and may not be aware of all the issues affecting their woodlands. Foresters can help landowners develop stewardship plans for their properties, point them towards potential cost-share funding sources to implement recommended practices, and help them connect with like-minded landowners nearby. Flipping the traditional outreach model, a webinar for professionals from a landowner's point of view underscored the importance of foresters being able to listen to, and communicate effectively with, family members, motivated not just by learning about the issues, but also about the steps they can take to help find solutions.

Photo 3/ Slash wall at the USDA National Resource Conservation Service (Rhode Island).

In response to the challenge

of regenerating regional oak stands heavily impacted by deer herbivory, the project investigated and shared information about "slash walls" as an emerging innovative on-the-ground practice. Pioneered at Cornell University's research forest in nearby New York State, these are linear piles of logging slash and brush impenetrable to deer, that are constructed during a timber harvest around the boundaries of stands or areas where the goal is to secure regeneration of oaks and other species. While the first demonstration slash walls have been built on public lands, available financial assistance from the USDA Natural Resources Conservation Service (NRCS) will make the practice accessible to more private landowners in these states (NRCS 2020). The Connecticut Agricultural Experiment Station is researching the effectiveness of slash walls in protecting regeneration and initial results suggest that they are working (Jeffrey Ward, pers. comm.).

One of the most significant project outputs was the development of a web-based Oak Resiliency Assessment Tool (Forest Ecosystem Monitoring Cooperative 2021) to quickly size up the health and vulnerability of specific oak forests or stands. Primarily intended for professionals, the tool guides the user through a series of questions that help to quantitatively estimate the climate vulnerability and adaptive capacity of the forest. When results are calculated, users are provided with a report that rates their site as High, Moderate, or Low vulnerability with an attendant list of key considerations and potential management options that could increase oak resiliency (Fig. 1). The outputs of this tool are designed to enable professionals to quickly and easily translate the various threats and opportunities related to oak forests to family landowners and other stakeholders. The Oak Resiliency Assessment Tool was developed through collaboration between the Forest Ecosystem Monitoring Cooperative, the Forest Stewards Guild, and the Northern Institute of Applied Climate Science, a collaborative partnership led by the USDA Forest Service. It is now used independently as training for regional land managers (Forest Ecosystem Monitoring Cooperative 2021).

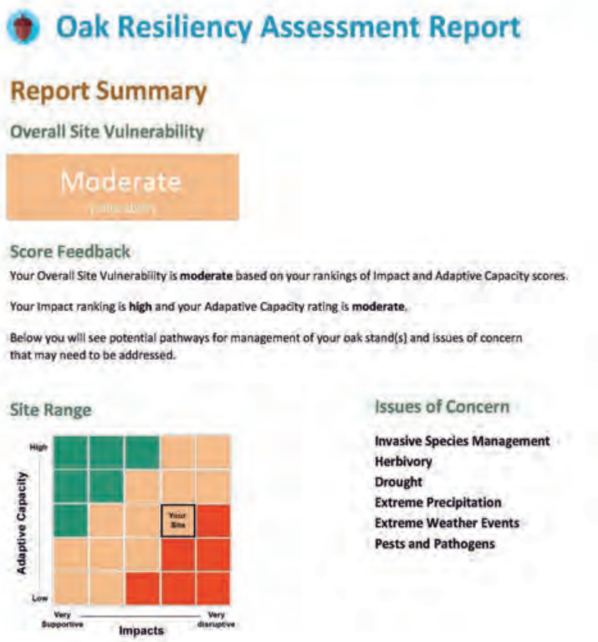

Figure 1/ Oak Resiliency Assessment Report (FEMC 2021).

Adaptive forest stewardship for climate change

Recently instituted applied research seeks to integrate climate resiliency into management strategies for exurban southern New England oak-hickory forests. Initiated by the University of Connecticut in 2020, with the University of Rhode Island joining as a partner in 2021, this project leverages funding from two separate initial USDA grants and support from the environmental agencies of each state. It is affiliated with the larger

Adaptive Silviculture for Climate Change (ASCC) project, a nationwide collaborative effort to establish a series of long-term experimental silvicultural trials across a network of different forest ecosystem types (Nagel et al. 2017).

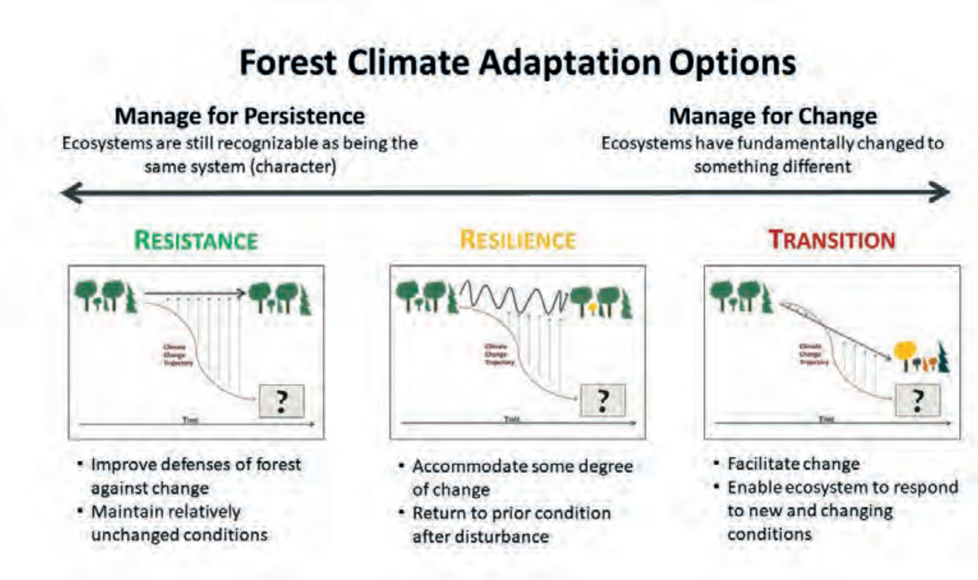

Figure 2/ Forest Climate Adaptation Options (Adaptive Silviculture for Climate Change Network 2022).

The project follows an established methodology common to all ASSC sites. Informed by a climate vulnerability assessment (Janowiak et al. 2018) and input from local professionals, researchers are developing, implementing, and monitoring forest management prescriptions for three different climate adaptation options (Nagel et al. 2017; Miller et al. 2007) while also monitoring an unmanaged control area (Fig. 2). A conservative "resistance" treatment seeks to maintain the current species mix and enhance the ability of the forest to resist anticipated climate changes. This entails a reduction in density of all species and diameter classes of trees, and the promotion of oak and hickory regeneration through a traditional multi-stage shelterwood treatment. A "resilience" treatment is intended to enable the existing forest community to accommodate some change while also enhancing its ability to rebound from disturbances. In exurban southern New England oak-hickory forests the treatment includes expending canopy openings to promote species diversity, and planting a range of native oaks and hybrid chestnuts. Finally, a "transition" treatment incorporates assisted species migration with the goal of enabling the ecosystem to respond to new conditions. On these sites, larger gaps will promote the development of a multi-aged stand with future climate-adapted species, including planted chestnuts and oaks native to more southerly areas. With high levels of deer herbivory, the monitoring of some sites will include evaluating the effectiveness of different types of barriers and repellents in protecting seedlings from deer browse.

To heighten the relevancy and practical value of the project to southern New England landowners, ASCC site protocols are being adapted to the region's exurban landscape with its small parcels and fragmented forest cover. ASCC treatments are generally applied at a scale more suited to large, unfragmented forest ownership, but researchers and partners are implementing locally relevant treatments at smaller replicate sites in different locations. To date, three such replicate sites have been established on public forests, including two in eastern Connecticut and one in southern Rhode Island. At each of these sites, about 10 acres (4 hectares) of forest is receiving each of the three experimental climate-adaptive treatments along with the no-intervention control (Fig. 3). Annual vegetation monitoring will assess the silvicultural effectiveness of the treatments, and researchers are also working to identify the socioecological, logistical, and economic factors affecting the design, implementation, and efficacy of the treatments.

Another important part of the project is integrating the findings of the research component into outreach and extension programs. Researchers are collaborating with partners to develop and adapt guidelines for climate-smart forestry practices tailored to southern New England forests and landowners. Like the 2019-22 regionwide forester and landowner engagement project, some program offerings and media are intended for professional natural resource managers and students, some target landowners and land conservation organizations, and others are geared for interested members of the public. Presentations to audiences at regional foresters' meetings and a statewide land conservation conference, for example, will emphasize different aspects of the project and vary in level of technical detail. Field tours of research replicate sites are providing opportunities for different groups to view and discuss the treatments in person.

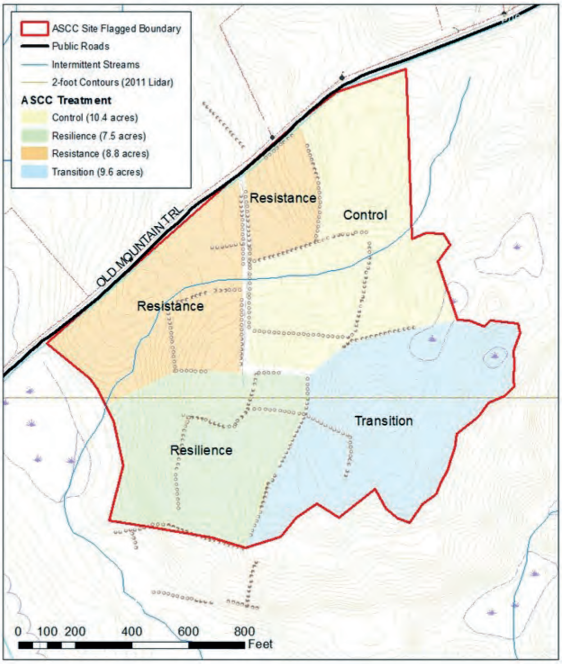

Figure 3/ Layout of one of southern New England's exurban oak-hickory forest Adaptive Silviculture for Climate Change projects.

Conclusion

It is clear that family landowners are critical stewardship partners in promoting the resiliency of the region's oak forests, given the pattern of land ownership in southern New England. As forestry practices are updated to address new issues, building relationships between landowners and professionals facilitates the implementation of forestry practices that directly address climate impacts. Climate-smart forestry practices being developed and tested can help landowners address emerging threats to their oak woodlands, while also being practical and sensitive to their needs. Deliberate and intentional integration of climate change considerations can enhance the impact of forest conservation and stewardship activities.

Photographers. Title page: Christopher Riely (Healthy oak-hardwood stand in Rhode Island). Photos 1-3: Christopher Riely

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