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Forest Connect

Supporting Sustainable Management of Private Woodlands

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Managing for Oak: Ecological and Social Values

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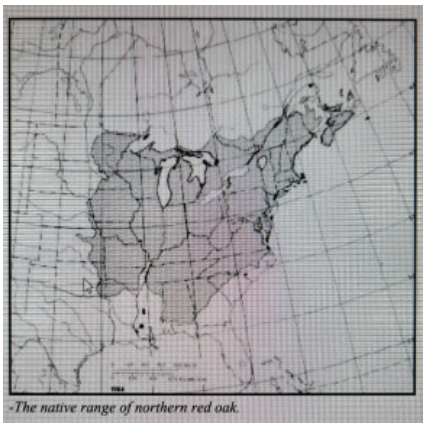
The oak genus is amazing in its breadth of values, geographic availability, uses and the awe it tends to inspire in woodland owners. There are no eminent pests of pathogens currently known as common and widespread threats to oak, such as exist with white ash and eastern hemlock, but the solutions to the forecasted future scarcity of oak may be just as challenging to resolve.

Figure 1

The geographic distribution of white oak includes most of the eastern United States. (photo adapted from the USFS Silvics Manual at https://www.srs.fs.usda.gov/pubs/misc/ag_654/table_of_contents.htm

Oak is in the genus Quercus, which includes about 450 species worldwide. Oak is in the family Fagaceae that also includes American beech and American chestnut. The US Forest Service silvics manual lists 25 oak species, which would represent most of the commercially important oaks in North America (search the Internet for "silvics manual"). The geographic range of the oaks contributes to their popularity and familiarity as seen by the wide geographic distribution of white oak (Figure 1) and northern red oak (Figure 2) from the USFS Silvics Manual.

Figure 2



The geographic distribution of northern red oak extends slightly further north and not as south as that of white oak. (photo source, same as Figure 1)

While oak remains present in the canopy of many NY and eastern forests, the concern is with the tendency for oak species to be absent from the understory. The replacement potential of oak is in question, and thus concerns about future scarcity. This issue has gained sufficient attention in some states that the White Oak Initiative was formed with private, in-

dustrial, state, academic and federal partners from a multi-state region in the Ohio River valley and mid-Atlantic states. Their goal is to ensure that oak, especially white oak, remains abundant and healthy (www.whiteoakinitiative.org). In NY the DEC's 2015 Forest Resource Assessment shows a decline in the abundance of northern red oak saplings (1 – 5" diameter) and growing stock (larger than 5" diameter) although the abundance of many other common species is stable or increasing (page 42, NYS DEC Forest Resource Assessment and Strategy, 2015). The volume of existing mature northern red oak has increased, but it doesn't appear to be replacing itself.

Figure 3

White oak lumber is prized for its mellow color, grain pattern, strength and durability.

In NY, the USFS Forest Inventory and Analysis estimates there are more than 45 million white oak (white, swamp white, chestnut and bur oaks) stems larger than 5" in diameter at breast height (dbh). The top ten counties for numbers of stems are Ulster, Sullivan, Orange, Steuben, Dutchess, Suffolk, Jefferson, Greene, Columbia, and Rensselaer. The top ten counties contain about 65% of the white oak stems larger than 5" dbh in NY. In terms of board-foot volume, these "white oaks" (see below) are estimated to total more than 3 billion board feet among most of the same counties though with the inclusion of Washington, Cattaraugus, and Otsego. The top ten counties contain about 65% of the board-foot volume of white oaks in NY.

Why the interest in oak?

Oak has benefits that align with the interests of almost everyone. Most people, even those without a woodland connection, know that acorns are the seeds of oaks and that wildlife "like" acorns. As many as 100 vertebrate wildlife species eat acorns, and acorns can constitute as much as 75% of the white-tailed deer's fall and winter diet. Wood frogs grow better in vernal pools layered with oak leaves. Professor Tallamy of the University of Delaware reports that more than 500 species of moth and butterfly, Lepidopteran, larvae use oaks. These Lepidopteran and other insects that use oak are the foundation of complex food webs and ecological dynamics in these eastern forests.

Oaks supply unique and valuable lumber. White oak containers (usually barrels but other shapes are allowable) are required for use in the production of bourbon, the official native spirit of America. Oak lumber is the quintessential material of the American Arts and Crafts – Mission Style – of furniture (https://www.museumaacm.org/furniture.html), and oak lumber is popular among furniture makers and hobbyists for a variety of uses (Figure 3).

Aside from the tangible benefits of oak to wildlife vertebrates, humans, and insects, oaks provoke images of resilience and awe (Figure 4). The often robust, massive-crowned habit of oaks creates a sense of power and majesty. Perhaps related to the sense of awe inspired by oak was the important role it often played to occupy the ecological void created by the death of American chestnut. Additional information about the values of oak are available at the White Oak Initiative.

Figure 4

White oak can attain massive size. While slow growing, their longevity allows for impressive stature. This white oak, in NY's Lake Champlain Valley, was approximately 5 ft in diameter.

The identification and ecology of oak

The oak genus is divided into two sub-genera known as the red oak and white oak groups. Some common NY species in the red oak group include northern red oak (Quercus rubra), black oak (Q. velutina), pin oak (Q. palustris), and scarlet oak (Q. coccinea). The white oak group includes white oak (Q. alba), chestnut oak (Q. montana, formerly Q. prinus), swamp white oak (Q. bicolor), and bur oak (Q. macrocarpa).

One distinguishing feature of oak is the presence of a cluster of buds at the terminal end of each twig (Figure 5). The vascular tissue that supports the bud cluster results in a star-shaped pith when the twig is cleanly sliced in cross-section. The shape of oak foliage is usually that of lobes and sinuses, with the red oak group possessing a bristle tip on each lobe. The lobes of the white oaks are rounded. However, shingle oak has an entire (meaning smooth) margin and the classic oak-leaf lobing on chestnut oak is subdued to coarsely rounded but large teeth known as a crenate rather than lobed leaf margin. Red and white oaks are further described on the ForestConnect website or in the NYFOA magazine 2016 issue no. 5 . A full taxonomic description of NY oaks, with outstanding photography, is available in "Trees of New York State Native and Naturalized" by Donald Leopold.

Figure 5

All oaks, such as the northern red oak pictured, have a cluster of buds on the terminal end of the twig, this feature is defining for the genus.

It is not surprising that a genus as diverse as the oaks has considerable variability in its ecological presence and pattern. On dry sites you are more likely to find white, scarlet, chestnut and black oak. Moist sites will have northern red oak, and wet sites pin and swamp white oaks. Bur oak can be found on either moist or dry sites, often associated with limestone soils. On the drier sites oak tend to be competitive and more easily reproduce and grow successfully. On the moist and fertile sites, oak seedlings struggle to compete with other hardwoods.

Acorn production and distribution is sporadic, although acorn formation is more regular. Most of the variation in annual acorn production is due to survival and viability of the female flowers, with weather being a key determinant. White oak acorns do not store in the leaf litter and red oaks store for up to 6 months. White oak has good acorn production in 1 of 4 years, and red oak in 1 of 3 years (average normal acorn production is approximately 1,000 to 10,000 acorns per acre). A bumper or "mast" crop year might occur 1 in 7 and yield 200,000 acorns per acre. Tree size, not age, is the best predictor of which trees produce acorns; 96% of canopy dominants and 75% of codominants produce acorns, yet only 38% of oaks with an intermediate crown position produce acorns.

Oak seedlings differ from other hardwood seedlings in their tendency to prioritize root growth over stem growth in their early years. Acorns of the white oak group mature in one growing season, drop in the fall, and immediately push out the first root known as a radicle. Within a few days a large portion of the energy stored in the acorn is redistributed from the embryo to the radicle.

Stem growth begins in the spring. In the red oak group, acorns mature over two growing seasons also dropping in the fall, but don't germinate until the spring. The two growing seasons allow managers to anticipate the size of the red oak acorn crop. Oak seedlings may have multiple growth phases or pulses each year, with each pulse allowing some of the energy to be stored in the stem and roots.

Figure 6

This northern red oak root was dug from a stand 3 growing seasons after an initial regeneration harvest. The root, though broken from digging, is about 0.75 inches in diameter and likely reflects many years of top dieback and resprouting that took advantage of the now increased sunlight.

Another feature of oak seedlings through small sawlogs, is the tendency to accumulate dormant buds on the root collar below the ground line as compared to those buds forming above ground on other hardwoods. The location of the buds and the stored energy reserves allow oaks to sprout if the stem is damaged, cut or top-killed. In fact, oak seedling stems often die back due to environmental stressors and subsequently resprout. In the absence of established seedlings or replanting, sprouting of saplings and small sawtimber trees might be the only way to bring oak into the next forest. The potential for oak to prioritize root growth (Figure 6) and the presence of below ground dormant buds able to sprout following stem dieback favor the oak in situations of low-intensity chronic (e.g., livestock grazing) or more intense episodic disturbances (e.g., fire).

Management for the persistence and abundance of oak

The ecological attributes of oaks rightfully lead to the conclusion that managing for oaks to dominate in future woodlands is a process, not an event. Owners need the patience and resolve, and managers need to implement actions, that allow for the establishment and arrival of acorns, the formation of robust root systems, the development of saplings, and the growth of saplings into the canopy. The oak regeneration process will take several years.

The presence of oaks as a dominant part of a woodland canopy is often associated with a past history of moderate- to large-scale disturbance. Disturbance is needed to provide sunlight for oaks that are typically moderately or intolerant of shade and maybe out-competed by other hardwoods. Current forests offer a different disturbance regime than likely existed when current oak-dominated forests were established. Current eastern forest disturbances tend to be small, infrequent and include abundant deer that selectively browse oak and other species. These conditions favor species other than oak, such as maple, birch, beech and yellow-poplar with differing tolerances to shade and browse, but all sensitive to fire.

Disturbance reduces oak competition with other hardwood species for sunlight. Some of these historic disturbances may have been low-intensity and chronic such as livestock grazing or fire. In other cases the disturbance was episodic and impacted the canopy, such as timber harvesting, windstorms, or the historic loss of American chestnut that co-occurred with oaks. In each case, the success of oak depends on it being well-established as a seedling or sapling with a vigorous root system. The types of disturbances that might previously have favored oaks are less common in today's forests.

Figure 7

Oaks will respond well to thinning, even small sawlog sized trees increase growth when they are released from competition for sunlight. White oak, as pictured, tends to be slower growing than norther red oak, but also responds to release.

Management of existing oak-dominated woodlands to maintain health and productivity is similar to management practices recommended for other types of forests. Oak trees respond well to thinning, especially those in the upper canopy (Figure 7). Several federal, state and university resources are available to inform oak management.

Forest managers who are working with owners to perpetuate or increase oak abundance in future forests use a variety of management practices that favor oak establishment, survival, and growth. These management practices mimic natural or historic disturbances that are associated with oak success. The White Oak Initiative describes several of these management practices in their Landowners for Oaks series. Some of the practices include options for harvesting to help fund the restorative practices, and many practices can be combined or used in sequence for an optimized outcome. The White Oak Initiative region may not struggle as much with deer impact as in NY and southern New England, so evaluate the execution of these practices in the context of our higher levels of deer browsing. These practices include:

- Enhancement (enrichment) planting – In some woodlands suitable for oak, there is no or little oak present as seedlings or mature trees to produce acorns. The goal is to ensure there are hundreds of seedlings per acre. In these examples of low acorn availability, plant oak seedlings selected such that the species matches the soil and site conditions. Protect seedlings from deer browsing if necessary. Control low-growing shrubs, ferns or mid-canopy trees to provide sufficient sunlight to allow the growth of the seedlings.

Figure 8

The number of mid-canopy stems per acre is often less than a few hundred, which are efficiently treated with single-stem selective herbicides such as this example of hack-and-squirt to a diseased American beech.

- Soil scarification – Acorns germinate better and are less vulnerable to winter freezing conditions if on mineral soil and then covered with foliage. Acorns usually drop before leaves drop. Soil scarification or soil mixing will ideally coincide with a bumper crop of acorns because most acorns in years of normal production are consumed by insects. Scarification might happen with logging equipment used to harvest lower canopy stems, or be done specifically with root rakes on bulldozers, some types of well-managed livestock, or small tractors in mostly level stands with few obstacles. Timing the scarification 5 to 15 years before a significant disturbance such as an overstory harvest will provide time for oak seedlings to establish robust root systems and the capacity to attain prominence in the seedling and sapling layer of the forest.

- Mid-canopy removal – The mid-canopy species, those below the main canopy, cast a denser shade than the main canopy simply because they are closer to the ground. Reduction or removal of the mid-canopy allows an increase in light, but not so much light as to favor early succession shade-intolerant species such as aspens, yellow-poplar or pin cherry. The mid-canopy layer often has little economic value, so the management technique might most effectively be an individual stem herbicide treatment (Figure 8) or mechanical treatments of girdling or cutting.

- Site preparation for regeneration – Before, during or after a sawlog harvest, the presence of live residual woody stems of any size or other interfering vegetation needs to be reduced or eliminated to allow adequate sunlight for natural or planted oak seedlings to develop. While some of the residual stems might have value for firewood, unless this treatment occurs as part of a harvest the action will require some investment of time or money.

- Prescribed fire – A challenge in NY and northeastern forests, unlike south-central, midwestern and mid-Atlantic states is the infrequency of weather and fuel conditions conducive to prescribed fire. These controlled burns reduce competing vegetation, allow oaks to resprout, and prepare mineral soil seedbeds. Because of the ecological attributes of oak versus other hardwoods as previously described, correctly managed controlled fire is selective and benefits oak seedlings. A favorable prognostication of climate change might be more favorable conditions in NY for the use of prescribed fire as a management tool. Additional research will be needed to determine if targeted herbicide techniques or management intensive grazing with livestock might function in a similar way as prescribed fire to favor oak seedling development.

- Crop tree release – This practice helps ensure that once oak saplings (stems 1 to 5" dbh) and poles (5" – 11" dbh) are released from the competition attributable to neighboring trees. Some people now refer to "crop tree release" or "crop tree management" as "best" tree management to reduce misunderstanding that the "crop tree" is cut rather than retained. The oak tree crowns that are release will increase their growth following removal of competition on at least three sides. That increased growth obviously increases tree volume (and all the associated benefits), but also increases the quality of the stem by compartmentalizing and healing over wounds and branch scars. The volume of wood increases and the value per unit of volume increases.

Figure 10

A portion of the CAFRI research team inspects regrowth of an oak dominated forest after 1 growing season inside a slash wall.

- Group/Gap Openings – Correctly sized gaps, those about 150 feet in diameter, offer enough sunlight to allow oak seedlings to develop but not so much light to favor early successional species. Beyond the edge of the gap, into the forest perimeter, the partial dappled light is conducive to oak seedling establishment and early development. As with other of these management practices, be alert to the presence of undesirable low canopies that will shade the oak seedlings. In NY, these small openings can also concentrate deer impacts because deer are drawn to the flush of growth that responds to the increased sunlight.

- Two-aged deferment harvest – This practice is a bit similar to a final act of desperation, or being careful to not "throw the (last) baby out with the bath water." Stands that have no oak advance reproduction and little or no oak in the canopy have few options. If the stand is planned for harvest, retain all or most of the oak, with the intention of allowing them to grow and produce acorns until the future harvest of the soon to regenerate forest. These retained canopy oaks will have many decades to produce and disperse acorns that may grow beneath the young forest of other hardwood seedlings likely to respond to the harvest. As the young forest develops, other practices mentioned here (e.g., mid-canopy re-

moval, protection from browsing) can favor the oak seedlings for future success.

Figure 9

After three growing seasons of protection by a slash wall at the Arnot Forest, these red oak seedlings are well established. The November 2019 harvest coincided with a bumper acorn crop that was mixed into the soil with logging equipment. Note the maple stump sprout, of which there are many, and likely will require some amount of control.

- Shelterwood Establishment Harvest – This common silvicultural practice, if properly implemented with attention to the needs of oak, can help already established oak develop. In NY and the Northeast, this regeneration system would include three entries for harvest. The first would prepare for seedling establishment by reducing or removing the mid-canopy with soil scarification to allow existing oak seedlings to develop. Control of competing species would likely be required. In the absence of existing oak seedlings, the USFS SILVAH-oak (see link below) protocol to optimize seedling establishment removes about 25% of the canopy stems (specifically "relative density") from the mid and lower canopy. In practice this is accomplished when the site index (the height of a tree at age = 50, usually 55 to 75 for oak) plus the basal area removed equals 100. Deer pressure, in the short term, helps control some of the browse sensitive hardwoods such as maple and birch. As the developing seedlings gain sufficient size to require more light a shelterwood cut would reduce the overstory canopy by about 50% (Figure 9), plus begin the exclusion of deer. Finally, when oak seedlings have root collars approaching 0.75" diameter, the overstory canopy could be removed. When the seedlings grow into sapling sizes (1 – 5" dbh) and the young canopy starts to close, a best tree release (see above) should be evaluated.

- Afforestation – There are approximately 1.5 million acres of open rural land in New York that is not used in support of agriculture. This acreage is minimally useful for wildlife because it is commonly dominated by golden rod, or worse, increasingly dominated by invasive shrubs. Some acorns may disperse from adjacent oak woodlands, but successful conversion to oak will require planting. The priorities for afforestation are to match the species to the soil and site conditions, prepare the planting locations by removing competing vegetation, and protect seedlings from deer. The variety of oak species provides some species for almost any site. Although more expensive and difficult to acquire, one-year old containerized seedlings will likely offer the greatest success. Vegetation management and browse control will be required for 3 to 5 years after planting.

Oaks are a fascinating and important species. The risk to the loss of oak isn't due to insects of pathogens, but depends on resolve and investment by owners and managers who commit to ensuring this symbol of eastern hardwood forest endures. Foresters should explore the use of the USFS program SILVAH-oak (https://www.fs.usda.gov/research/nrs/products/dataandtools/software/silviculture-allegheny-hardwoods-silvah-8)

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For additional information on woodland management go to:
www.ForestConnect.com & www.CornellForestConnect.ning.com

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