

Quercus macrocarpa var. *macrocarpa*

Mossy-cup Oak

Fagaceae



Quercus macrocarpa var. *macrocarpa* by Senna Bryce Robeson, 2023

***Quercus macrocarpa* var. *macrocarpa* Rare Plant Profile**

New Jersey Department of Environmental Protection
State Parks, Forests & Historic Sites
Forests & Natural Lands
Office of Natural Lands Management
New Jersey Natural Heritage Program

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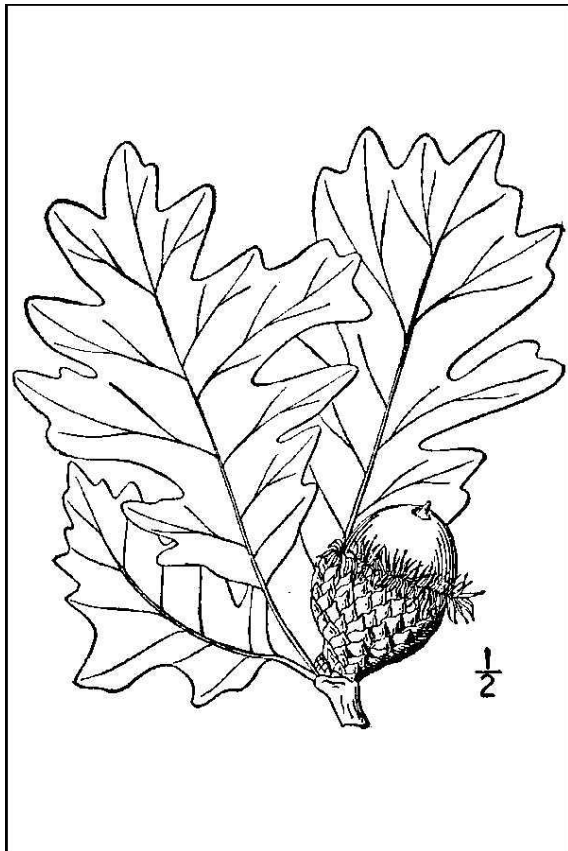
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Life History

Quercus macrocarpa var. *macrocarpa* (Mossy-cup Oak) belongs to Subgenus *Quercus*, often referred to as the "white oaks", which are distinguished from the "red oaks" by their leaves (typically round-lobed and lacking bristle-tips) and by having acorns that mature in a single year. Variety *macrocarpa* is a large tree, while smaller, shrubbier forms in the northwestern part of the species' range are sometimes identified as var. *depressa* (Nixon and Muller 2020). The trees are large and long-lived. Mature specimens often exceed 25 meters in stature, and heights of nearly 50 meters have been reported. Crown spread may surpass height, and the trunk one Philadelphia tree was noted to be over two meters in diameter. The acorns of *Q. macrocarpa* (the specific name means large fruit) are among the biggest produced by eastern oaks, sometimes reaching 5 cm in length and 4 cm in width, although their sizes can vary depending on location. Individual trees may continue to be productive at ages of up to 400 years (Johnson 1990, Aizen and Patterson 1990, Gilman and Watson 1994, Cosgriff and Brown 2004, Koenig et al. 2009, Nixon and Muller 2020, Piper 2023). Weaver and Cramer (1932) examined the root system of a mature (65 year-old) Mossy-cup Oak tree, noting a tapering taproot over four meters long with well-developed lateral roots. Many of the secondary roots arose near the surface, extended outward for 6–18 meters, then turned sharply downward and continued to lengthen—sometimes surpassing the taproot.



Left: Britton and Brown 1913, courtesy USDA NRCS 2025a. Right: Brandon Corder, 2025.

Quercus macrocarpa var. *macrocarpa* has dark gray bark that can be scaly or shallowly to deeply ridged. The young twigs are reddish and hairy but they become smooth and gray with age. The leaves are also pubescent as they emerge but as they develop the upper surfaces turn smooth, dark green, and somewhat shiny while the undersides remain lighter. The round-lobed leaves are usually separated into two sections by a pair of deep sinuses, with the largest lobes occurring above. Oak flowers are clustered in unisexual catkins: Kaul (1985) provided detailed information regarding flower structure in the genus and the floral development of *Q. macrocarpa* was described by Macdonald (1979). The mature acorns of *Q. macrocarpa* are distinguished not only by their large size but by their cupules (caps), which cover 50–85% of the associated nuts and have fringe-like extensions on the terminal scales. (See Britton and Brown 1913, Fernald 1950, Petrides 1988, Gleason and Cronquist 1991, Nixon and Muller 2020).



Left: Courtesy Julie Makin, Lady Bird Johnson Wildflower Center. Right: Steve Hurst, courtesy USDA NRCS 2025b.

Quercus macrocarpa flowers from March to mid-June throughout its range, commencing earlier at lower latitudes. Blooming generally takes place shortly after the leaves appear. The acorns develop in a single growing season and may be dispersed from August through November, although September to October is typical (Johnson 1990, Weakley et al. 2024). Jaganathan et al. (2024) observed that *Q. macrocarpa* dispersed its fruits earlier than many other North American oaks. Fall leaf color is yellow to copper (Gilman and Watson 1994). The winter buds of *Quercus macrocarpa* are ovate and 2–5 mm long, clustering at the ends of the twigs like those of typical oaks: They may be smooth or hairy. The twigs often have corky wings, which may help to identify the trees in winter (Symonds and Chelminski 1958, Petrides 1988, Nixon and Muller 2020).

The identification of oaks can be challenging due to frequent hybridization within the genus. *Quercus macrocarpa* crosses with other species in Subgenus *Quercus* (e.g. *Q. alba*, *Q. bicolor*, *Q. michauxii*, *Q. muehlenbergii*, *Q. stellata*) so routinely that many of the hybrids have been named, and some backcrossing with hybrid offspring has also been reported (Palmer 1948, Fernald 1950, Johnson 1990, Gleason and Cronquist 1991, Rhoads and Block 2007, Nixon and Muller 2020).

Pollinator Dynamics

Like many early-flowering trees, the oaks are pollinated by wind (Kaul 1985, Sork 1993). In *Quercus macrocarpa*, pollen tube development occurs at greater frequency when the pollen has originated from an unrelated tree, promoting cross-fertilization (Johnson 1990). Studies of the species have found significant levels of long-distance pollination, with individual trees typically being fertilized by multiple donors (Dow and Ashley 1996, 1998). High rates of genetic diversity have been recorded in *Q. macrocarpa* (Schnabel and Hamrick 1990) and that appears to be attributable to connectivity between different populations via wind-mediated pollen transmission (Craft and Ashley 2007, 2010).

Quercus macrocarpa produces large crops of acorns every two to three years but few to none in the intervening years, a process known as mast fruiting (Johnson 1990). Wright (1953) observed that heavy flowering did not always result in heavy fruiting. Some studies of other oaks have suggested that levels of fruiting can be influenced by weather conditions, but that alone cannot account for episodic mass production. It appears that it usually takes several years for the trees to accumulate sufficient resources to develop acorns from their fertilized flowers (Sork 1993, Sork et al. 1993).

Seed Dispersal and Establishment



The significance of mass fruiting in *Quercus* species is best understood in terms of their dispersal strategy, because most of the oaks rely on predators to distribute their seeds and large numbers of propagules are lost in the process (Kittelsohn et al. 2009, Jaganathan et al. 2024). Blue Jays (*Cyanocitta cristata*) are important dispersers for species with small to medium acorns (Moore and Swihart 2006) but the large fruits of *Q. macrocarpa* are disseminated by rodents—mainly squirrels. In the northeastern United States the primary dispersers are the Gray Squirrel, *Sciurus carolinensis*, and the Eastern Fox Squirrel, *Sciurus niger* (Johnson 1990, Hewitt and Kellman 2002, Moore and Swihart 2007), although the latter species is presumed extirpated in New Jersey (NatureServe 2025). Some gravity-dispersed acorns can germinate

close to their parent trees but the seedlings may fail to develop if they are heavily shaded. In contrast, Dow and Ashley (1996) determined that squirrels could move the fruits over fairly long distances and often placed them in locations that were favorable for germination and establishment, such as gaps and edges.

Quercus flowers have three carpels with two ovules apiece so they have the potential to form six seeds but usually only one develops. Garrison and Augspurger (1983) found that *Q. macrocarpa* produces two-seeded acorns at rates of 0–20% per tree. Although smaller, both of the seeds in a double-seeded acorn are viable and they germinate sequentially. Larger *Q. macrocarpa* seeds produce more vigorous seedlings (Aizen and Patterson 1990, Iakovoglou et al. 2007), but Garrison and Augspurger suggested that any disadvantages of smaller seeds in dual-seed acorns would probably be countered by the benefit of insect damage avoidance for the second seed.

Quercus macrocarpa seeds can germinate without any pretreatment (Leopold 2005), but they are able to retain viability in moist storage for at least six months (Schroeder and Walker 1987). In natural settings germination usually occurs shortly after the acorns are dispersed—typically within a month—although sprouting may be deferred until spring in some northern locations. Larger seeds germinate faster and permit seedlings to establish in more difficult circumstances. Germination and establishment are most successful in microsites that are free of leaf litter, reducing the odds of seed predation or fungal disease in seedlings (Aizen and Patterson 1990, Johnson 1990, Cosgriff and Brown 2004).

The first phase of seedling development in *Quercus macrocarpa* takes place below the ground. A taproot is quickly established, elongating for about three weeks before the shoots emerge. More than half (65%+) of the seedling's energy goes into root development, and the taproot usually exceeds a meter in length within three months. Following the initial surge, the pace of growth slows to a steady pace (Weaver and Cramer 1932, Danner and Knapp 2001). The saplings grow more rapidly in sites with an open canopy (Wyckoff et al. 2012). Johnson (1990) indicated that *Q. macrocarpa* typically begins bearing fruit when the trees are 35 years old, but nursery-grown individuals transplanted and monitored by Piper (2023) began much younger: One-year-old seedlings gained an average of 3–4 dm in height annually and started producing acorns within a few years, and substantial recruitment was noted within a decade of planting.

Habitat

Quercus macrocarpa grows at elevations of 0–1,000 meters above sea level, occupying a wide array of habitats (Nixon and Muller 2020). The species is tolerant of a broad range of moisture conditions, occupying both drought-prone locations and sites that are periodically inundated. *Q. macrocarpa* can establish on many different kinds of soil but in upland settings it is often associated with calcareous substrates. Mossy-cup Oak can thrive in sun or partial shade but light is especially important during the establishment phase. Reported habitats include floodplains and bottomland forests, dry to moist woods, and fire-prone prairies (Coddington and Field 1978, Johnson 1990, Leopold 2005, Rhoads and Block 2007, Wyckoff et al. 2012, Nixon and Muller 2020, Weakley et al. 2024). The New Jersey occurrence is situated over limestone and some trees are growing in an open fen while others are in an adjacent swamp (NJNHP 2024). *Q.*

macrocarpa typically associates with a rich and diverse fungal community strongly dominated by ascomycetes, but the components can vary dramatically depending on the habitat (Jumpponen and Jones 2009). The species is tolerant of soil compaction, air pollution, and salinity and has successfully been grown in urban settings (Gilman and Watson 1994), although landscape level changes resulting from extensive urbanization have probably contributed to the decline of some natural occurrences (Catton et al. 2007).

In forested sites, *Quercus macrocarpa* is often associated with other oaks and hickories (*Carya* spp.) (Monk et al. 1990, Breden et al. 2001). However, it is seldom found in the understories of woodlands where it comprises a large portion of the canopy, so as the trees age they are usually replaced by other species like maples (*Acer* spp.), elms (*Ulmus* and *Celtis* spp.), or ashes (*Fraxinus* spp.) (Beightol and Bragg 1993, Kittelson et al. 2009). Johnson (1990) noted that *Q. macrocarpa* is one of the earliest trees to establish along the edges of prairies but it is typically succeeded by other types of trees in those sites as well. The species' high light requirements during its seedling and sapling stages make it a poor competitor in closed-canopy situations (Wyckoff et al. 2012).

Wetland Indicator Status

The U. S. Army Corps of Engineers divided the country into a number of regions for use with the National Wetlands Plant List and portions of New Jersey fall into three different regions (Figure 1). *Quercus macrocarpa* has more than one wetland indicator status within the state. In the Eastern Mountains and Piedmont region, it is facultative, meaning that it is equally likely to occur in wetlands or nonwetlands. In the rest of the state it is a facultative upland species, meaning that it usually occurs in nonwetlands but may occur in wetlands (U. S. Army Corps of Engineers 2022).

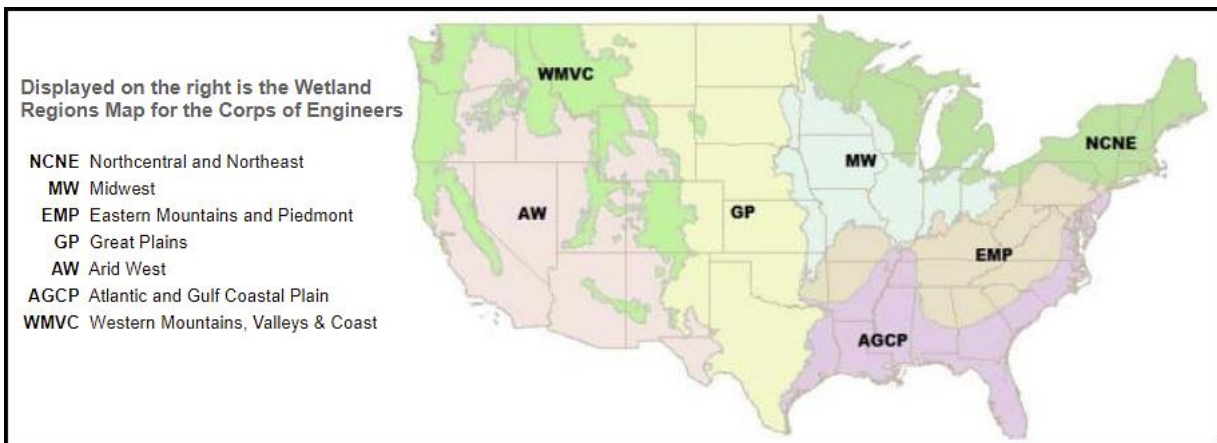


Figure 1. Mainland U. S. wetland regions, adapted from U. S. Army Corps of Engineers (2022).

USDA Plants Code (USDA, NRCS 2025c)

QUMAM

Coefficient of Conservancy (Walz et al. 2020)

CoC = 8. Criteria for a value of 6 to 8: Native with a narrow range of ecological tolerances and typically associated with a stable community (Faber-Langendoen 2018).

Distribution and Range

The global range of *Quercus macrocarpa* is restricted to the United States and Canada. The map in Figure 2 depicts the extent of var. *macrocarpa* in North America. Variety *depressa* is only known from the northwestern portion of the species range (Kartesz 2015, NatureServe 2025, POWO 2025, USDA NRCS 2025c).

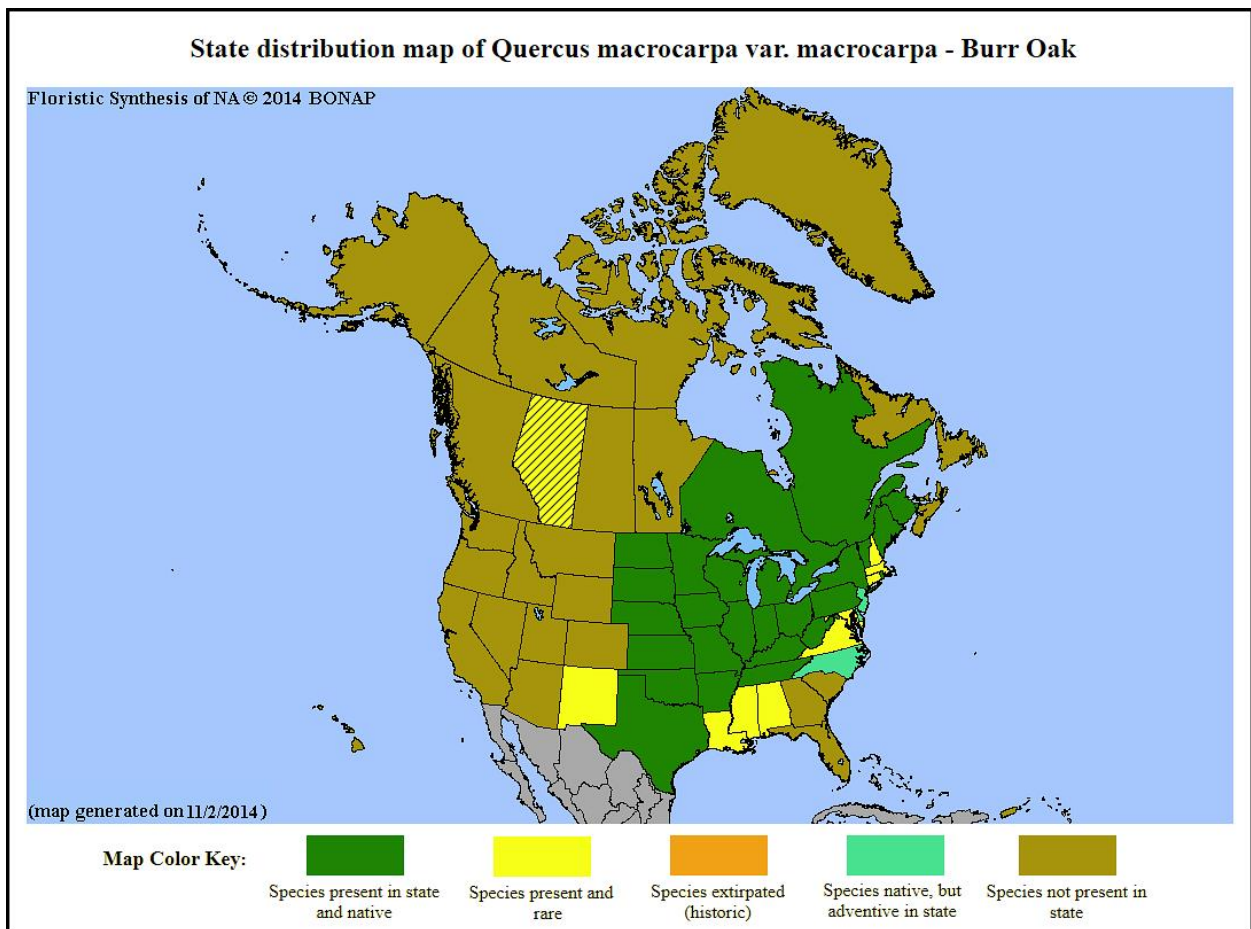


Figure 2. Distribution of *Q. macrocarpa* var. *macrocarpa* in North America, adapted from BONAP (Kartesz 2015).

The USDA PLANTS Database (2025c) shows records of *Quercus macrocarpa* var. *macrocarpa* in five New Jersey counties: Burlington, Cape May, Hunterdon, Passaic, and Sussex (Figure 3). The data include historic observations and do not reflect the current distribution of the species.

broad statewide protection for the plants. Additional regional status codes assigned to the tree signify that it is eligible for protection under the jurisdictions of the Highlands Preservation Area (HL) and the New Jersey Pinelands (LP) (NJNHP 2010).

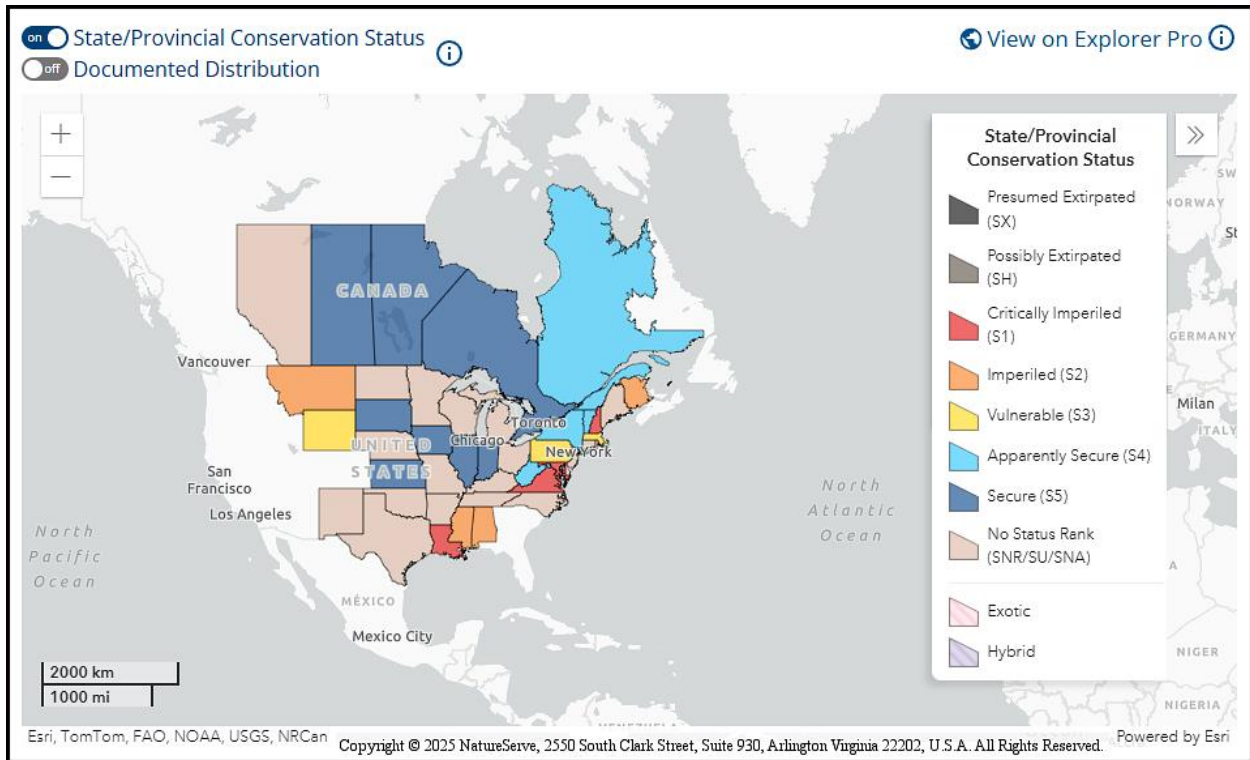


Figure 4. Conservation status of *Q. macrocarpa* in North America (NatureServe 2025).

Nathaniel Lord Britton included one *Quercus macrocarpa* record from Atlantic County in his preliminary catalogue of New Jersey plants but retracted it in the final edition due to a lack of substantial evidence (Britton 1881, 1889). A different Atlantic County location was reported by Keller and Brown (1905) but Taylor (1915) did not list any occurrences for New Jersey. Some of the county records depicted in Figure 3 appear to be based on specimens that were collected from cultivated trees (Mid-Atlantic Herbaria 2025) and some of the others may have originated from hybrids. The only confirmed occurrence of Mossy-cup Oak in the state is in Sussex County, where it was discovered by David Snyder in 2001 (NJNHP 2024).

Threats

Because *Quercus macrocarpa* cannot regenerate under a closed canopy, the long-term persistence of populations can be threatened by normal successional processes (Johnson 1990, Kittelson et al. 2009). Fire suppression has been identified as a primary cause of Mossy-cup Oak decline in other parts of its range (Treher 2018). Both natural succession and the proliferation of more competitive non-native woody plants were identified as concerns at the site of the New Jersey occurrence (NJNHP 2025).

Quercus macrocarpa is highly resistant to burning, and in some places it is viewed as a fire-dependent species. Young trees are often only top-killed by fire and can reestablish from root sprouts, so saplings that are only a meter tall may survive a low-severity burn. *Q. macrocarpa* trees that are 12–15 years of age can usually tolerate repeated burning (Johnson 1990, Gucker 2011). As the trees get older their fire resistance increases because they develop very thick bark that contains few volatile materials and has a high moisture retention capacity (Hengst and Dawson 1993). Fire does not promote the establishment of new individuals because the species does not maintain a seed bank (Seig and Wright 1996).

Forwood and Owensby (1985) determined that the foliage of *Quercus macrocarpa* is of low quality from a nutritional standpoint; nevertheless, the species experiences significant impacts from herbivory (Granger et al. 2017). White-tailed Deer (*Odocoileus virginianus*) pose a particular threat, as they are known to have a significant detrimental effect on the regeneration of oaks in general (Stange and Shea 1998, Rooney and Waller 2003). Studies that included *Q. macrocarpa* found that the saplings are preferentially browsed, reducing their size or abundance (Wyckoff et al. 2012, Larson 2018, McLinn and Russell 2019). Deer also consume the acorns, as do cottontail rabbits, mice, ground squirrels, and wood ducks (Johnson 1990).

Quercus macrocarpa acorns can be lost to insects as well. The majority of damage is caused by weevils (*Curculio* and *Conotrachelus* species) and a lesser amount is due to the Filbertworm Moth, *Cydia latiferreana* (Gibson 1971). The impact varies from one year to the next but it can sometime be extensive and occasionally an entire crop is destroyed (Garrison and Augspurger 1983). The leaves of *Q. macrocarpa* are eaten by a wide variety of larval moths, June beetles (*Phyllophaga spp.*), and the Oak Lacebug (*Corythucha arcuata*), and large outbreaks of a particular species can occasionally result in defoliation. A scale insect (*Kermes pubescens*) has been known to cause leaf deformities and twig death. *Quercus macrocarpa* is reportedly resistant to some common oak diseases such as oak wilt and verticillium wilt but it is susceptible to anthracnose and a number of other fungal infections that cause cankers or root rot (Johnson 1990, Gilman and Watson 1994). A recently identified disease known as Bur Oak Blight (*Tubakia iowensis*) is a growing concern in the midwestern United States (Harrington et al. 2012).

Craft and Ashley (2007, 2010) concluded that genetic isolation was unlikely to be a problem for *Quercus macrocarpa* because their research demonstrated that gene exchange over long distances had been effected by wind-borne pollen. However, a study that examined the genetic diversity of trees in different age classes indicated that gene flow in the species had declined over the past century, as younger populations exhibited lower levels of differentiation (Kittelsohn et al. 2009). A decrease in genetic variation might result in reduced fitness and less adaptability to changing conditions (Charlesworth and Charlesworth 1987, Jump and Peñuelas 2005).

Climate Change Vulnerability

Information from the references cited in this profile was used to evaluate the vulnerability of New Jersey's *Quercus macrocarpa* var. *macrocarpa* population to climate change. The species was assigned a rank from NatureServe's Climate Change Vulnerability Index using the associated tool (Version 3.02) to estimate its exposure, sensitivity, and adaptive capacity to changing climatic conditions in accordance with the guidelines described by Young et al.

(2016) and the state climactic computations by Ring et al. (2013). Based on available data *Q. macrocarpa* was assessed as Less Vulnerable, meaning that climate change is not expected to have a notable detrimental impact on its extent in New Jersey by 2050.

Calculations of the oak's likely habitat shifts in the eastern United States predicted either a small increase or a modest decrease in range depending on the climate change scenario tested by the model (Iverson et al. 2005) and the results also varied for different populations that were assessed in Illinois (Iverson and Taft 2022). In New Jersey, climate change is resulting in higher temperatures, a longer growing season, more frequent and intense precipitation events, and increasing periods of drought (Hill et al. 2020). The range of *Quercus macrocarpa* spans a broad range of plant hardiness zones (Gilman and Watson 1994) so any New Jersey occurrences could be expected to adjust to warmer conditions. Mossy-cup oak can probably withstand short-term flooding: Its acorn germination rates were not reduced following 60 days of experimental submergence (Cosgriff and Brown 2004) and the seedlings can also tolerate brief periods of inundation (Tang and Kozlowski 1982). *Q. macrocarpa* seeds might be more sensitive to drought, as embryos of oaks in Subgenus *Quercus* tend to be somewhat prone to desiccation (Jaganathan et al. 2024). The seedlings and established trees are able to survive in dry conditions because they rapidly establish a long taproot after germination, maintain a deep root system, and exhibit other characteristics that can minimize drought impacts such as membrane integrity and a capacity for osmotic adjustment (Kuhns et al. 1993, Danner and Knapp 2001). Transplantation experiments conducted by Bergen (2024) showed that *Q. macrocarpa* individuals from the southern part of the oak's range had a greater ability to limit water loss than those from northern populations, but the species' potential for adaptation to warmer conditions may depend on the rate at which the changes take place.

Changing climactic conditions might increase the vulnerability of *Quercus macrocarpa* to certain diseases. Warming-induced shifts in foliar fungal communities have been documented on other oaks (Faticov et al. 2021), and the spread of *Tubakia iowensis* in midwestern populations may have been facilitated by a greater volume of spring rainfall in recent decades (Harrington et al. 2012). In the east, the existing threat from invasive plant species is likely to be exacerbated as the climate continues to warm (Bellard et al. 2013, Salva and Bradley 2023).

Management Summary and Recommendations

Iverson and Taft (2022) suggested that management will be key in determining the outcome of climate change for individual populations of *Quercus macrocarpa*. Efforts should focus on strategies that will maximize opportunities for the species to reproduce, which may include maintaining canopy gaps, controlling the spread of invasive competitors, and protecting young plants from herbivores (Kittelsohn et al. 2009, Larson 2018). Maintenance of the New Jersey population is likely to require an approach that addresses all three issues. Regular monitoring visits are recommended to check the oak trees for signs of disease so that any outbreaks can be identified promptly and—for those that are treatable—dealt with in a timely manner.

Synonyms

The accepted botanical name of the species is *Quercus macrocarpa* Michx. var. *macrocarpa*. Orthographic variants, synonyms, and common names are listed below (ITIS 2025, POWO 2025, USDA NRCS 2025c).

Botanical Synonyms

Cerris oliviformis (F. Michx.) Raf.
Quercus macrocarpa var. *abbreviata* A. DC.
Quercus macrocarpa var. *alata* Coleman
Quercus macrocarpa f. *appressa* Trel.
Quercus macrocarpa var. *minor* A. DC.
Quercus macrocarpa f. *oliviformis* (F. Michx.) Trel.
Quercus macrocarpa ssp. *oliviformis* (F. Michx.) A. Camus
Quercus macrocarpa var. *oliviformis* (F. Michx.) A. Gray
Quercus macrocarpa f. *orbiculata* Trel.
Quercus oliviformis F. Michx.

Common Names

Mossy-cup Oak
Bur Oak
Burr Oak

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Corder, Brandon. 2025. Photo of *Quercus macrocarpa* var. *macrocarpa* from Wisconsin. Shared via iNaturalist at <https://www.inaturalist.org/observations/278485898>, licensed by <https://creativecommons.org/licenses/by/4.0/>

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