Pinus pungens

Table Mountain Pine

Pinaceae

Pinus pungens by Billy Gottenstrater, 2023

***Pinus pungens* 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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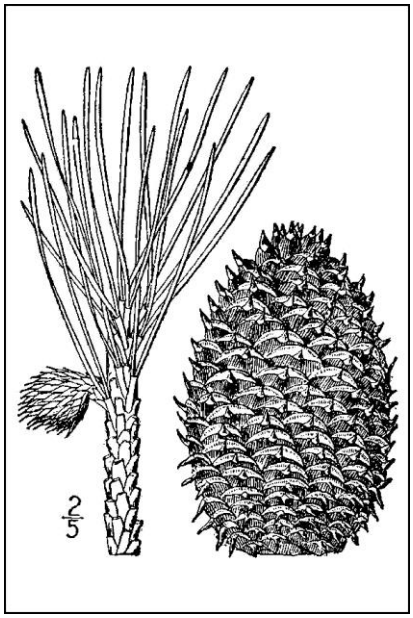
Life History

Pinus pungens (Table Mountain Pine) trees may have different growth forms depending on where they are located. Individuals that develop in relatively open sites tend to be somewhat straggly in appearance: The trunks may be crooked and the branches are long and horizontal, with the lowest often close to the ground. Some branches can be nearly equal in length to the height of the tree, or occasionally even longer. When growing in crowded conditions, *P. pungens* trees are more likely to be tall, straight, and slender with only a few living branches near the top (Best 1886, Della-Bianca 1990). Meehan (1897) noted that the adaptable morphology of the species made it easy to prune the messy-looking trees into more pleasing shapes, and Farjon and Frankis (2002) observed that *P. pungens* was well-suited for bonsai.

Table Mountain Pines are usually relatively small, seldom exceeding 12 meters in height or 6 dm in diameter, although in some instances heights of up to 29 meters and diameters of nearly a meter have been recorded. The bark is made up of irregular scaly plates that are reddish or grayish brown. *Pinus pungens* leaves (needles) may be 3–10 cm long; an average length of 6.8 cm has been reported. Average needle width is 1.7 mm (range 1.2–2.4 mm). There are usually two needles per fascicle but occasionally there are three and they are generally stiff and twisted. Pines produce two kinds of cones: male and female. The pollen-producing cones of *P. pungens* are yellow and 15 mm long. The seed cones are egg shaped—frequently with asymmetrical bases—and they average 7.2 cm in length (range 4–10 cm). *P. pungens* cones are notable for their clawlike spines, which are stout, 3–8 mm long, and spreading or upwardly curved. (See Britton and Brown 1913, Fernald 1950, Zobel 1970, Della-Bianca 1990, Gleason and Cronquist 1991, Kral 2020). *Pinus pungens* is most similar to *P. virginiana*, with which it may co-occur, but the latter species has narrower (1 mm), more flexible needles and its smaller cones are tipped with shorter (1–3 mm), straight, slender spines (Williams 1990, Gleason and Cronquist 1991, Weakley et al. 2024).



Left: Britton and Brown 1913, courtesy USDA NRCS 2024a. Right: Zac Peterson, 2022.

The male cones of *Pinus pungens* release pollen during the spring and the seed cones become ripe during the autumn of their second year (Zobel 1969, Kral 2020). It is typical for a large proportion of *P. pungens* cones to remain closed for years, and some have been known retain their seeds for more than two decades (Della-Bianca 1990). The trees can mature rapidly: Cones are common on saplings and Meehan (1897) observed some cones on several trees that were only three years old. However, Gray (2001) found that seeds produced by *P. pungens* trees under 10 years of age had lower viability than those of older individuals. The lifespan of a Table Mountain Pine may exceed 200 years—The longest-lived tree observed during a study of population age structure was 230 years old (Brose and Waldrop 2006) and a life expectancy of 250 years has been projected for the species (Della-Bianca 1990).

Table Mountain Pines usually shed pollen before the other pine species that share their habitat (Dorman and Barber 1956, Zobel 1969). The earlier pollen dispersal is likely to limit opportunities for hybridization, although *P. pungens* has occasionally been known to hybridize with *P. echinata* or *P. rigida*. Hybridization is most liable to occur when pollen release by *P. pungens* is delayed by unusually cool or wet conditions, causing it to overlap with the pollination time of other pines (Della-Bianca 1990, Brown 2021).

Pollinator Dynamics

Pinus pungens is pollinated by wind (Feret et al. 1979). Pollen may be carried for long distances in the open habitats where *P. pungens* is typically found. Recent studies have indicated that Table Mountain Pine exhibits very little genetic differentiation throughout its range, suggesting a high level of gene flow between populations (Bolte et al. 2022, Potter et al. 2023).

Pinus pungens initially produces female cones in whorls of five but usually only 1–3 of them reach maturity. Fertilization is delayed, usually taking place about 13 months after pollen has been deposited. Once fertilized the cones develop rapidly (Schopmeyer 1974, Gibson and Hamrick 1991). The majority of viable seeds produced by *P. pungens* result from cross-fertilization. The probability of cross-pollination might be increased by staggered periods of receptivity in various parts of a female cone or among cones on different parts of a tree. More resources may also be invested in the growth of ovules that have been fertilized by outcrossing, in which case seeds would be more likely to develop from self-pollination in isolated trees (Gibson and Hamrick 1991).

Seed Dispersal and Establishment

The body of a *Pinus pungens* seed is only 6 mm long, but the seeds have wing-like projections that are 10–30 mm in length (Kral 2020). The large wings facilitate wind dispersal (Farjon and Frankis 2002). The cones of *P. pungens* are serotinous, meaning that their opening is often delayed. While some cones can open and release their seeds as soon as they have matured it is common for a large percentage to remain tightly closed and attached to the trees for years. The cones that remain on the trees open at irregular intervals; consequently some of the available seeds are usually dispersed each year and a typical *P. pungens* tree in an undisturbed setting is

likely to have cones of varying ages present on its branches. *P. pungens* seeds that are retained in cones on living branches may remain viable for a decade or more. High temperatures (>32° C) can trigger a mass dispersal event and those often occur as a result of fire, particularly in the southern part of Table Mountain Pine's range. The cones do not usually remain on the trees for long once the seeds have been released (Meehan 1880, McIntyre 1929, Schopmeyer 1974, Barden 1979, Gibson and Hamrick 1991). Squirrels sometimes drop branches bearing *P. pungens* cones to the ground to access the seeds (Della-Bianca 1990), but it is not clear if their activities ever result in dispersal.

Gibson and Hamrick (1991) reported a 62% germination rate in a sample of 5,698 seeds that were extracted from *Pinus pungens* cones. In natural settings the seeds germinate at the surface. In rocky habitats a strong taproot anchors the seedling into a crevice and then secondary roots spread laterally into available soil (Della-Bianca 1990). A *Pinus pungens* seedling may have 4–9 cotyledons (Zobel 1970). The young plants grow rapidly—Meehan (1879) observed that they could increase their diameter by as much as 4 cm per year. Zobel (1968) noted that the lateral branches often grow faster than the terminal shoot. The growth rate of *P. pungens* usually slows down once the trunk has reached a diameter of about 18 cm (Della-Bianca 1990).

Growth of *Pinus pungens* seedlings is enhanced by the presence of mycorrhizae (Zobel 1969). Studies in the Great Smoky Mountains found that *P. pungens* seedlings were often associated with pyrophilous fungi (which develop fruiting structures following fires) such as *Laccaria trichodermophora* and *Sphaerosporella* spp. (Hughes et al. 2020a, 2020b). During the interim between wildfires *Sphaerosporella* can persist as an endophyte in *P. pungens* leaves, so when the needles drop off after a fire they might serve as a source of fungal symbionts for germinating pine seedlings (Hughes et el. 2020b).

Habitat

Fridley et al. (2007) characterized *Pinus pungens* as a specialist species of stressful habitats. Experimental studies have demonstrated that *P. pungens* is able to grow better in more fertile soils (Zobel 1969, Feret et al. 1979) but the species' poor competitive abilities apparently preclude its establishment in such locations. Table Mountain Pine typically occurs in nutrient-poor sites on dry ridgetops, cliffs, or steep slopes with a substrate of shale, gravel, or sand. In the open, sunny places favored by *P. pungens*, shade from the trees' long lower branches helps to conserve moisture in the root zone. *Pinus pungens* is most often found at elevations of 500–1,350 meters above sea level but it has been documented in locations as low as 46 meters and as high as 1,762 meters (Zobel 1969, Della-Bianca 1990, Rhoads and Block 2007, Kral 2020, Weakley et al. 2024). Schopmeyer (1974) noted that trees growing at higher elevations appeared to produce smaller cones and seeds. *P. pungens* has occasionally been known to occur in very wet habitats, including some bogs in southeastern states and on an island in the Susquehanna River (McIntyre 1929, Della-Bianca 1990). The New Jersey population is located in an atypical site: The species colonized an abandoned agricultural field at an elevation of about 100 meters (Best 1886, NJNHP 2024). At least one population in Pennsylvania also established on formerly cultivated land (Brose 2017).

Open sites with abundant light and a minimal litter layer are essential for *Pinus pungens* seedling establishment. A thin layer of pine litter is optimal because it permits germination and growth while helping to retain an adequate amount of moisture for the developing plants (Williams 1989, Williams et al. 1990, Williams and Johnson 1992, Mohr et al. 2002). Barden (1977) observed that *P. pungens* seedlings which sprouted directly under mature trees often remained small until the larger trees died and then grew rapidly in response to the increased availability of moisture and nutrients.

Fire has played an important role in maintaining many of the habitats that currently support populations of *Pinus pungens*. Both wildfires resulting from lightning—which are more prevalent during the summer—and winter or early growing season burns initiated by humans to manage particular parts of the landscape had been regular occurrences in *P. pungens* habitat until the early 1900s (Delcourt and Delcourt 1997, Welch and Waldrop 2001, Armbrister 2002, Mohr et al. 2002, Stambaugh et al. 2018). Historic fire return intervals of about 10 years (Sutherland et al. 1995) or every 2–3 years (DeWeese 2007) have been estimated for various sites. Although *P. pungens* cannot regenerate leaves from shoots on its branches or trunk after burning, the trees do have basal buds that can sprout following a fire (Della-Bianca 1990). As fires clear the understory in *P. pungens* stands they simultaneously trigger the opening of serotinous cones, causing a copious amount of seed to be released at a time when the fast-growing seedlings can take advantage of the newly available habitat. Many young pines grow quickly but the growth of *P. pungens* seedlings is even likely to outpace that of frequently co-occurring pines like *P. rigida* or *P. virginiana* (Zobel 1968). Although fire is beneficial to *P. pungens* it is not an absolute requirement. In some cases harsh habitats are sufficient to minimize competition and allow Table Mountain Pine populations to persist (Barden 1977, Hessl et al. 2011, Silver et al. 2013). The widespread loss of chestnuts (*Castanea dentata*) to the blight created a recruitment opportunity for *P. pungens*, and some anthropogenic habitats created by clearing forests for timber or the charcoal iron industry have also been utilized by the pine (Williams and Johnson 1990, Brose 2017).

When growing in mixed stands, *Pinus pungens* is typically associated with other pines (eg. *P. rigida*, *P. virginiana*, *P. strobus*, *P. echinata*) and Chestnut Oak (*Quercus montana*). Other frequently noted species are Red Maple (*Acer rubrum*), Black Gum (*Nyssa sylvatica*), and Sourwood (*Oxydendrum arboreum*). Black Locust (*Robinia pseudoacacia*) and Sassafras (*Sassafras albidum*) are important in some locations. Additional oaks (*Quercus* spp.), hickories (*Carya* spp.) and ericaceous shrubs are often present, and those plants tend to become increasingly dominant in the absence of disturbance (Best 1886, Della-Bianca 1990, Williams and Johnson 1992, Barden 1988, Williams 1998, Farjon and Frankis 2002, Brose and Waldrop 2006, Reeves 2007).

Wetland Indicator Status

Pinus pungens is not included on the National Wetlands Plant List (NWPL). Any species not on the NWPL is considered to be Upland (UPL) in all regions where it occurs. The UPL designation means that it almost never occurs in wetlands (U. S. Army Corps of Engineers 2020).

USDA Plants Code (USDA, NRCS 2024b)

PIPU5

Coefficient of Conservancy (Walz et al. 2020)

CoC = 7. 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 *Pinus pungens* is restricted to the eastern United States (POWO 2024). The species mainly occurs in the central and southern Appalachians but there are a number outlying populations east of the mountains and also a few to the west (McIntyre 1929, Della-Bianca 1990, Weakley et al. 2024). The map in Figure 1 depicts the extent of Table Mountain Pine in North America.

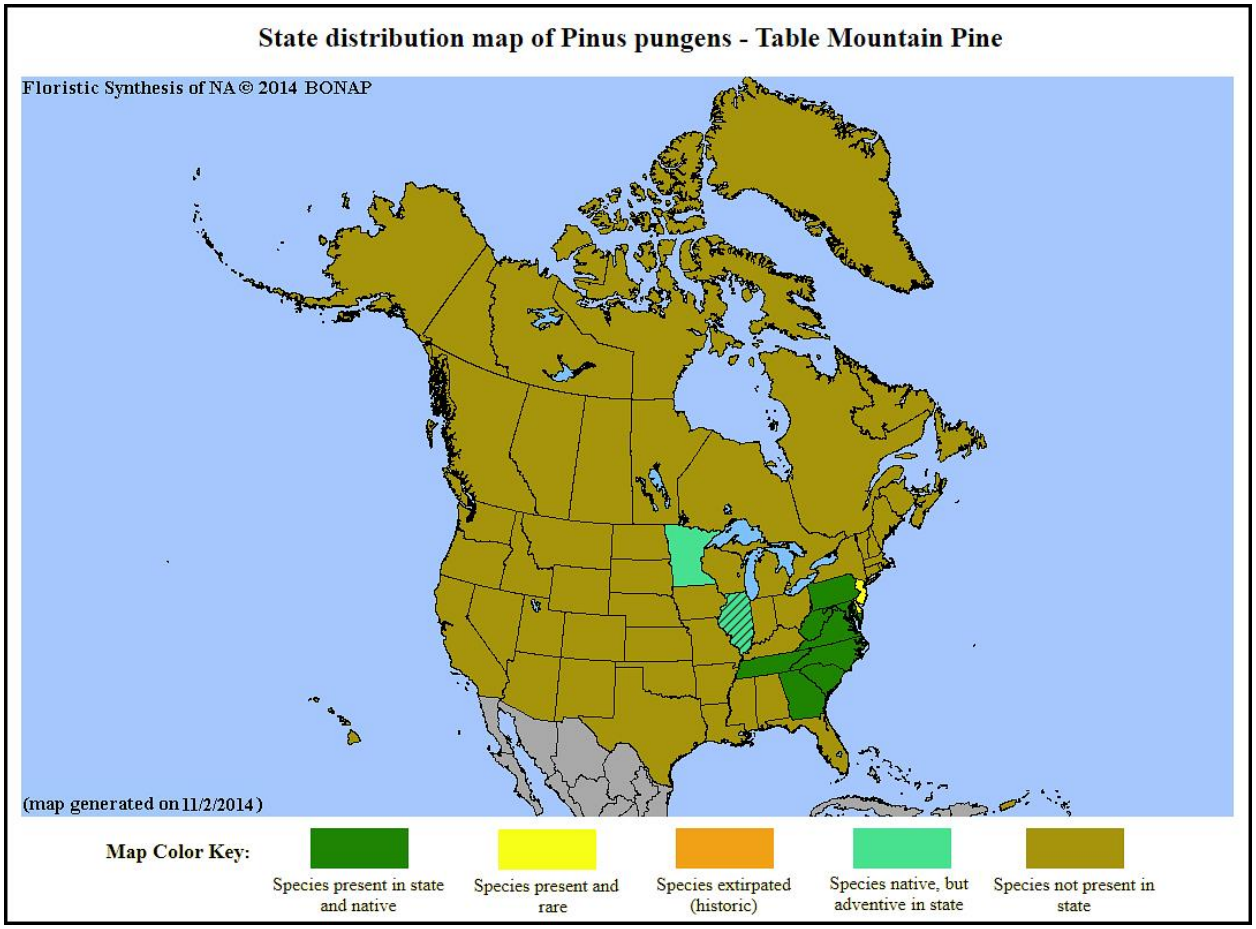


Figure 1. Distribution of P. pungens in North America, adapted from BONAP (Kartesz 2015). Cross hatching /// indicates a questionable presence.

The USDA PLANTS Database (2024b) shows records of *Pinus pungens* in three New Jersey counties: Burlington, Hunterdon, and Sussex (Figure 2). Specimens have also been collected in Ocean County (Mid-Atlantic Herbaria 2024). Hough (1983) noted that the native status of some stands was debatable, and only one Hunterdon County population has been accepted as a natural occurrence (NJNHP 2024).

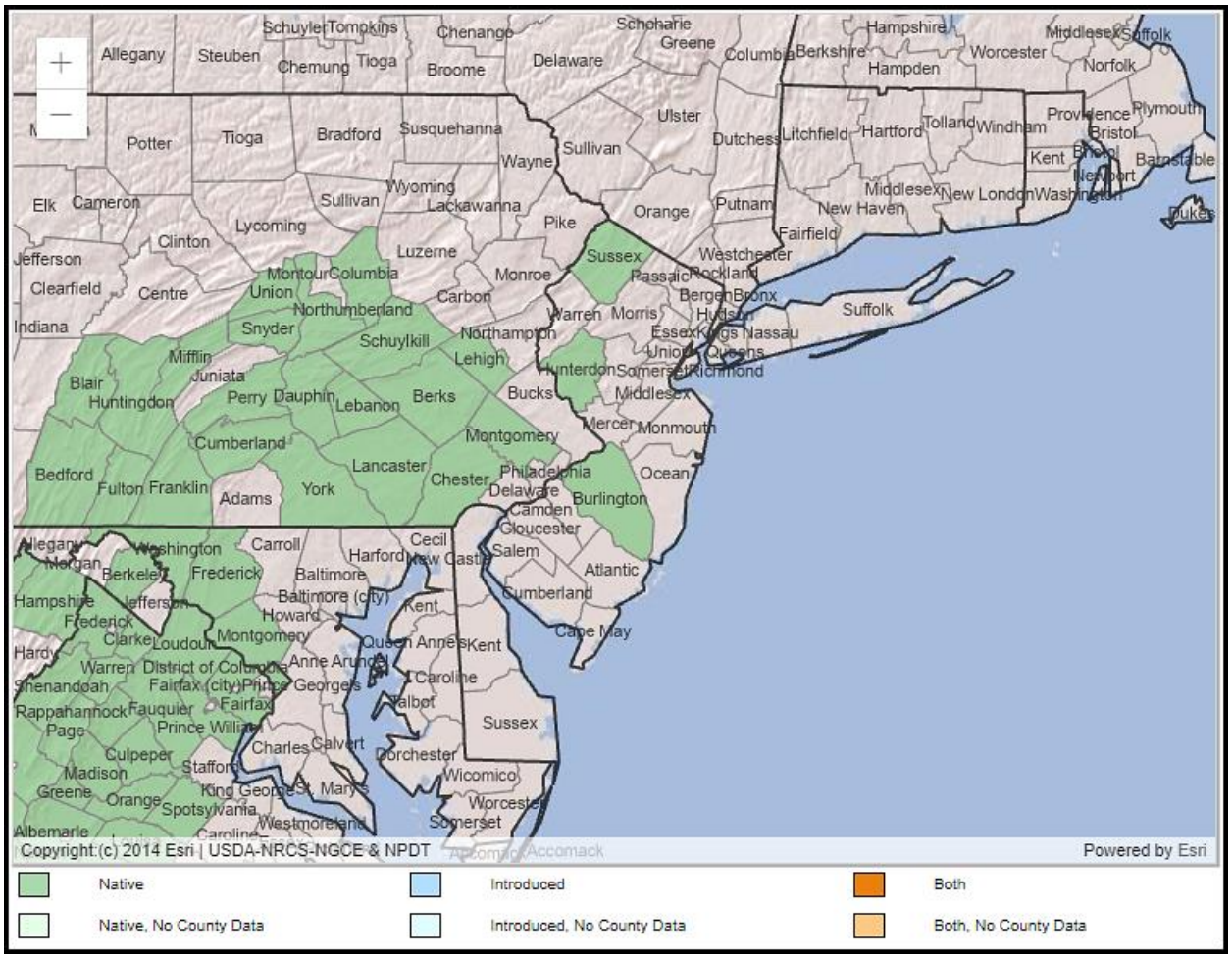


Figure 2. County records of P. pungens in New Jersey and vicinity (USDA NRCS 2024b).

Conservation Status

Pinus pungens is apparently secure at a global scale. The G4 rank means the species is at fairly low risk of extinction or collapse due to an extensive range and/or many populations or occurrences, although there is some cause for concern as a result of recent local declines, threats, or other factors (NatureServe 2024). The map below (Figure 3) illustrates the conservation status of Table Mountain Pine throughout its range. The species is secure, apparently secure, or unranked in most of the states where it occurs. It is vulnerable (moderate risk of extinction) in Georgia and critically imperiled (very high risk of extinction) in New Jersey and the District of Columbia. Populations in Illinois are not considered native.

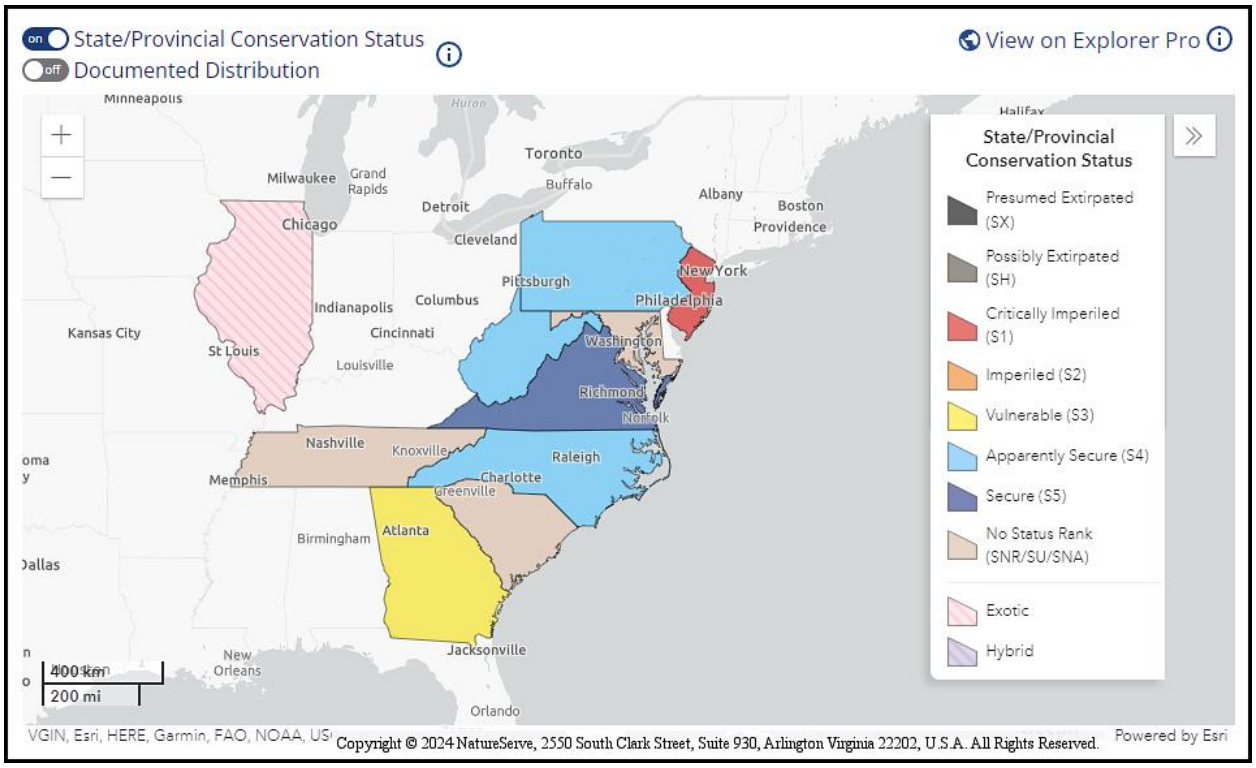


Figure 3. Conservation status of P. pungens in North America (NatureServe 2024).

Pinus pungens is ranked S1.1 in New Jersey (NJNHP 2024), meaning that it is critically imperiled due to extreme rarity. A species with a rank of S1.1 has only been documented at a single location in the state. *P. pungens* is also listed as an endangered species (E) in New Jersey, meaning that without intervention it has a high likelihood of extinction in the state. Although the presence of endangered flora may restrict development in certain communities, being listed does not currently provide broad statewide protection for plants. Additional regional status codes assigned to the tree signify that the species is eligible for protection under the jurisdictions of the Highlands Preservation Area (HL) and the New Jersey Pinelands (LP) (NJNHP 2010).

The New Jersey population of *Pinus pungens* was first documented by G. N. Best and R. E. Schuh in 1886. At the time, Best remarked that "*about one acre is densely covered with it, and an equal area with a scattering of trees*." It appeared that a single *P. pungens* tree had initially become established in an old field and the rest of the trees were its offspring. Realizing that the occurrence was outside of the species' normal range, Best initially questioned the origin of the population. He concluded that it was probably a natural occurrence after finding no evidence that *P. pungens* had been deliberately planted at the site and learning that earlier attempts to transplant young trees had consistently poor results (Best 1886). Taylor (1915) expressed some uncertainty regarding the native status of the population but Fairbrothers and Hough (1973) believed it to be natural based on the isolated location and that has continued to be the consensus. Eighty years after Best's discovery, Zobel (1969) visited the site and found a stand of several hundred trees. Noting that the *P. pungens* population was not reproducing and was slowly being replaced by hardwood trees, he predicted that the occurrence would not persist without deliberate human intervention. The Table Mountain Pine population experienced further decline in the latter part of the 1900s and it has continued to deteriorate despite active efforts to save the

occurrence during the current century. High rates of mortality have been observed during the past 15 years and it is not completely clear whether any living trees still remain at the site (NJNLT 2018, NJNHP 2024).

Threats

Community changes resulting from fire suppression during the 20th century have caused widespread declines in *Pinus pungens* populations throughout the species' range, and that continues to be the most frequently cited threat to the occurrences that remain. In the absence of regular disturbance Table Mountain Pine regeneration is inhibited by the establishment of deciduous trees and the development of a shrub layer. As deciduous hardwoods become more prevalent they can slowly alter site characteristics by increasing soil depth and nutrient levels, making the habitat accessible to a wider array of plant species. Lengthy periods of fire suppression typically facilitate the transition of pine-dominated communities into mixed oak forests (Hunter and Swisher 1983, Della-Bianca 1990, Groeschl et al. 1993, Sutherland et al. 1995, Harrod et al. 1998, Welch and Waldrop 2001, Armbrister 2002, Lafon and Kutac 2003, DeWeese 2007, Reeves 2007, Morgan 2008, Hessl et al. 2011, Silver et al. 2013, Brose 2017). Although the New Jersey population of *Pinus pungens* is not associated with a fire-adapted habitat a comparable trajectory of decline has been observed as a result of natural successional processes. The population established and expanded in an open field but as more hardwoods (eg. *Liriodendron tulipifera*, *Acer rubrum*, *Fraxinus* spp.) grew up at the site *P. pungens* seedling recruitment declined and the mortality of mature trees increased. Opportunities for *P. pungens* to reproduce at the site were further limited by the proliferation of invasive species such as *Microstegium vimineum* and *Rubus phoenicolasius* (NJNLT 2018 & 2024, NJNHP 2024).

The Southern Pine Beetle, *Dendroctonus frontalis*, has also contributed to the decline of many *Pinus pungens* populations (Armbrister 2002, Lafon and Kutac 2003, Knebel and Wentworth 2007, Morgan 2008). *P. pungens* appears to be a preferred host species for the beetles (Reeves 2007), which are more likely to attack pine trees in pure stands than those in stands that include hardwoods (Aoki et al. 2018). The beetles initially utilize injured or weakened trees but then spread into nearby healthy trees, often focusing on the largest individuals in a stand (Armbrister 2002, Lafon and Kutac 2003). Occasionally entire *P. pungens* occurrences are wiped out (Della-Bianca 1990). *Dendroctonus frontalis* has been expanding its range northward, and New Jersey has experienced more frequent outbreaks since 2001 (Aoki et al. 2018, NRCS 2019). It is not clear whether the beetle has played a part in reducing the size of the *P. pungens* occurrence in the state.

An assortment of other insects and diseases are also known to affect *Pinus pungens*. The European Pine Sawfly (*Neodiprion sertifer*) was first detected in Somerville, New Jersey in 1925 and it subsequently spread throughout the northeastern United States and Canada. The sawfly is a defoliator but seldom kills its host trees. Larvae of the Table Mountain Pine Coneworm (*Dioryctria yatesi*) bore into cones and destroy the seeds—in some years the insects have demolished entire seed crops. The Shield-backed Pine Seed Bug, *Tetyra bipunctata*, is also a seed predator. The Northern Pine Weevil, *Pissodes nemorensis*, is unlikely to have a serious impact on healthy *P. pungens* stands but can do severe damage in places where the trees have

already been weakened. Trees of all ages, but particularly young ones, are susceptible to Pine Twig Gall Scale, *Matsucoccus gallicola*. The scale insects deposit their eggs beneath the bark of trunks and branches, causing it to swell and crack, which typically kills foliage and occasionally results in the death of an entire tree (Baker 1972, Della-Bianca 1990, Reeves 2007). Extensive foliage losses can result from a fungus known as Hypoderma Needle Blight (*Hypoderma lethale*), while a canker rust (*Cronartium comandrae*) can have more serious consequences for the trees including growth reduction, top-kill, or mortality. Older pine trees are susceptible to rot associated with fungi such as *Phellinus pini* and *Phaeolus schweinitzii* (Boyce 1954, Della-Bianca 1990, Reeves 2007, USDAFS 2011).

Climate Change Vulnerability

Information from the references cited in this profile was used to evaluate the vulnerability of New Jersey's *Pinus pungens* 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 climactic 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 *P. pungens* was assessed as Moderately Vulnerable, meaning that it is likely to show some decrease in abundance or range extent in New Jersey by 2050. Assessments conducted in other parts of the species' range have concluded that Table Mountain Pine is one of the most vulnerable trees in the southern Appalachians (Erickson et al. 2012) but has the potential to increase in abundance in the east (Iverson et al. 2005).

Shifting climactic conditions in New Jersey are resulting in higher temperatures, a longer growing season, more frequent and intense precipitation events, and increasing periods of drought (Hill et al. 2020). Although *Pinus pungens* is generally considered drought-tolerant it is more sensitive to desiccation at the seedling stage and seed production can be reduced in mature trees following extended dry periods. *P. pungens* can take advantage of relatively small amounts of rainfall so precipitation frequency is a more reliable indicator of climactic effects on the species than the drought index (Barden 1988, 2000). The timing of precipitation events may be as important as the frequency. For example, unusually dry Septembers could interfere with the formation of buds for the following year's growth while excessively wet Februarys could disrupt associations with mycorrhizal fungi (DeWeese et al. 2010).

Pinus pungens is sensitive to freezing and the northern limit of its range might be defined by temperature. Low temperatures can reduce pollen viability and unusual climactic conditions may disrupt the synchrony of pollen release and female cone receptivity. Cooler conditions deter serotinous cones from releasing their seeds, and seedlings grow more slowly at lower soil temperatures (McIntyre 1929, Zobel 1969 & 1970). Mature *P. pungens* trees are also highly susceptible to damage from ice storms (Whitney and Johnson 1984, Lafon and Kutac 2003). Unfortunately, any potential advantage that *Pinus pungens* might gain from rising temperatures in New Jersey is likely to be offset by an increase in the abundance of invasive plants, which are expected to become an even greater threat to native communities in the northeast as a result of climate change (Bellard et al. 2013, Salva and Bradley 2023).

Management Summary and Recommendations

Attempts to preserve and rejuvenate New Jersey's single *Pinus pungens* population have been largely unsuccessful to date. The acquisition of several parcels during the period from 2003–2007 resulted in full protection of the land supporting the occurrence. Cones were collected from the site on a number of occasions between 2003 and 2017 for preservation of genetic material and use in propagation. The seeds were stored and planted by two different organizations: The New Jersey Forest Service's Forest Tree Nursery and Duke Farms. After large hardwood trees were removed in order to reduce canopy cover some nursery grown two-year-old *P. pungens* seedlings were planted on the site and protected from herbivores; unfortunately a lengthy drought followed the outplanting and likely played a part in their failure to flourish. A single prescribed burn was implemented in an endeavor to restore the understory in the stand but the fire was not sufficient to remove the dense cover of invasive shrubs (NJNLT 2018 & 2024; Hafstad, pers. comm.). New Jersey's Table Mountain Pine occurrence was also identified as a candidate site for seed collection as part of a range-wide genetic resource conservation effort but it did not make the final cut (Jetton et al. 2015).

Fire is the predominant management tool for *Pinus pungens* populations in other locations. Restorative fires must be hot enough to remove accumulated leaf litter, open up the understory, destroy the regenerative buds of competitive woody species, and stimulate the release of seeds from serotinous cones. Logging or canopy thinning followed by the burning of woody debris is often appropriate. The alternation of high and low intensity fires may be an effective way of maintaining Table Mountain Pine populations once they have been restored (McIntyre 1928, Della-Bianca 1990, Williams and Johnson 1990, Groeschl et al. 1992, Harrod et al. 1998, Williams 1998, Waldrop and Brose 1999, Welch et al. 2000, Welch and Waldrop 2001, Armbrister 2002, Reeves 2007, Wimberly and Reilly 2007).

Synonyms

The accepted botanical name of the species is *Pinus pungens* Lamb. Orthographic variants, synonyms, and common names are listed below (ITIS 2024, POWO 2024, USDA NRCS 2024b).

Botanical Synonyms	Common Names
	Table Mountain Pine
	Prickly Pine
	Bur Pine
	Hickory Pine
	Mountain Pine

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