Pinus resinosa

Red Pine

Pinaceae

Pinus resinosa by Steven Katovich, Bugwood.org

***Pinus resinosa* Rare Plant Profile**

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

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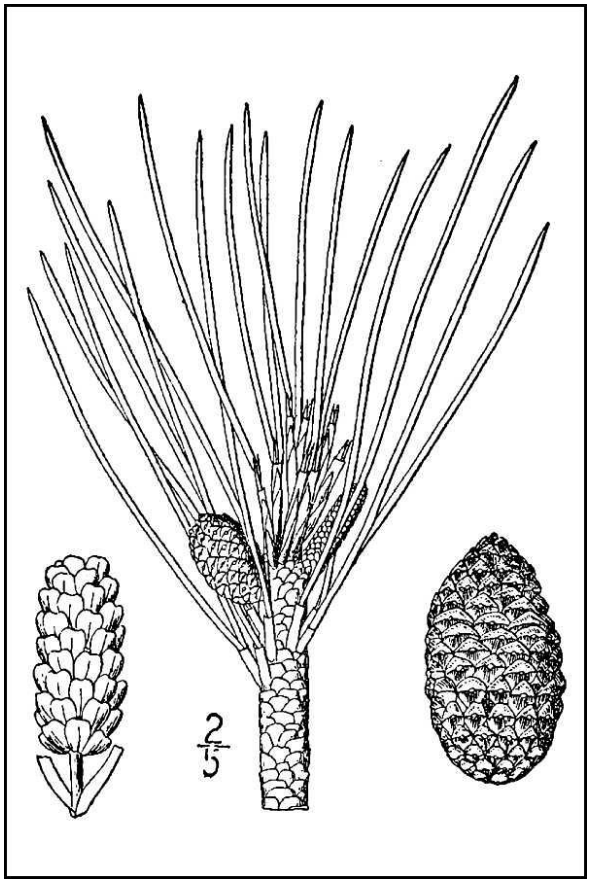
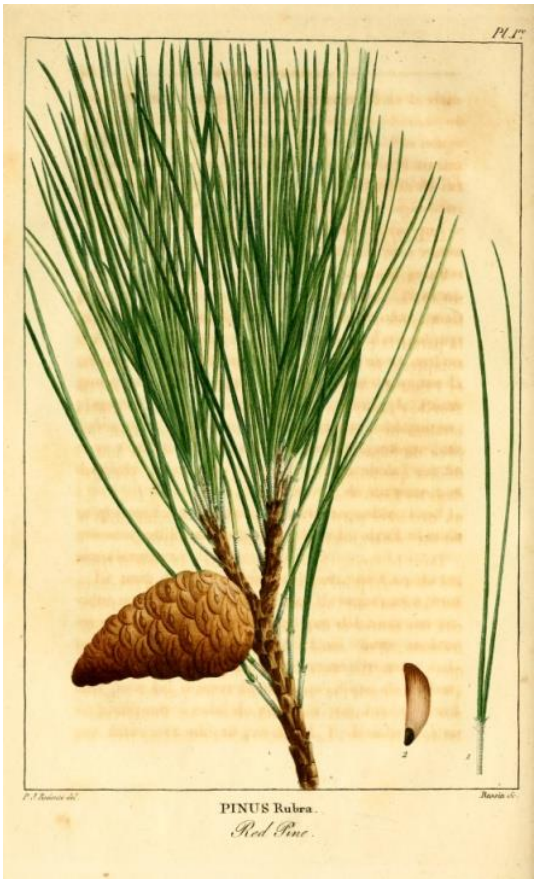
Life History

Pinus resinosa (Red Pine) was once the most important timber pine in the Great Lakes area, but aggressive logging during the 1800s nearly eliminated it from parts of the region (Kral 2020, Hauser 2008). Red Pine has since become one of the most widely planted trees in North America (Rudolph 1990), and even in states or provinces where it is native it may be more common in plantations (Weakley 2015, SSAC 2016). The tree's commercial value for both lumber and pulp has inspired a considerable amount of research on the species.

Pinus resinosa is an evergreen tree that can reach up to 40 meters in height and 1.5 meters in diameter. The trunk is straight and the bark features irregular scaly plates with a reddish-brown color. The branches are spreading to ascending, and on mature trees most are located near the top. The dark green needles are in bundles of two, range from 9–16 cm in length, and snap cleanly in half when fresh. Winter buds have red-brown scales with white fringed margins and are about 1.5 cm long. In the spring, both male and female cones are produced on the same tree. The male (pollen) cones are about 15 mm long and dark purple. Female cones are 3.5–6 cm and take two years to mature, ripening the second summer and then dispensing seeds for up to a year. The seed-bearing cones are ovoid when closed but nearly round when fully open and do not have spines on the scales. (See Britton and Brown 1913, Fernald 1950, Gleason and Cronquist 1991, Gilmore and Palik 2006, Hauser 2008, Kral 2020).

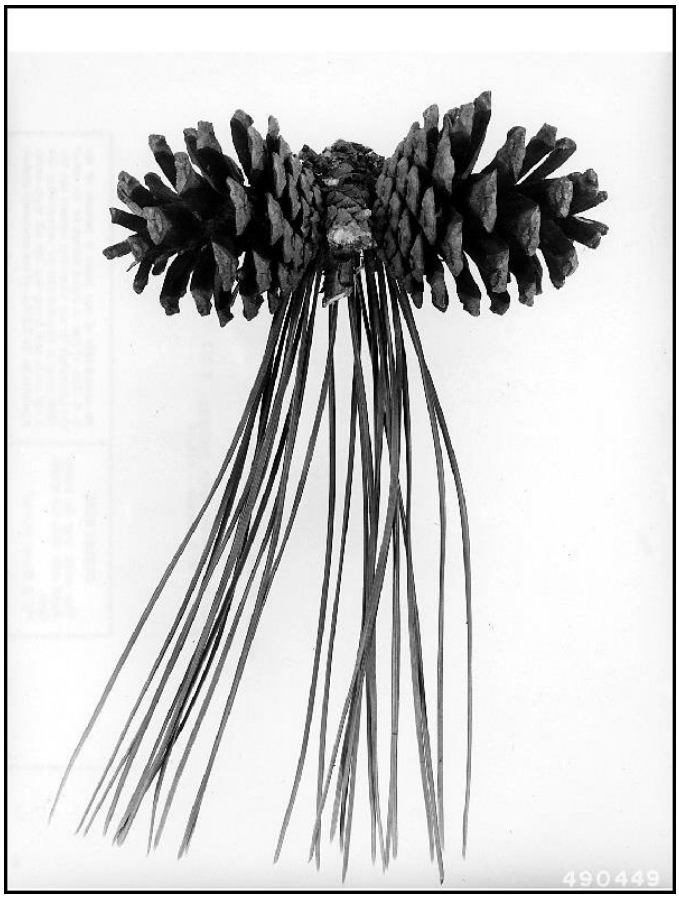




Left: Britton and Brown 1913, courtesy USDA NRCS 2022a. Right: Pierre-Joseph Redouté, public domain.

Pinus resinosa trees produce lateral roots that radiate outward like irregular wheel-spokes and remain within 10–45 cm of the surface. The lateral roots may be up to 11 meters long, and they in turn develop vertical sinker roots that can extend to depths of up to 5 meters. A short taproot of 3 meters or less may or may not also be present (Hauser 2008). Images and details concerning the fine root structure of *P. resinosa* are available in Pregitzer et al. (2002). Red Pine forms ectomycorrhizal fungal associations that do not penetrate the root cortex (Wang and Qiu 2006). *P. resinosa* grows better with mycorrhizae than without, and in habitats where phosphorous is limited the pine can compensate by forming more numerous mycorrhizae (MacFall et al. 1990, 1992). Koide and Kabir (2000) found that nutrient accumulation can also be enhanced by the presence of saprophytic soil microbes, and while either the fungi or the microbes on their own can be beneficial to *P. resinosa* together they have an additive effect.

P. resinosa seedlings usually grow slowly—often achieving less than 3 cm of height during their first year and taking as long as 10 years to exceed a meter—and seed production may not be initiated until the tree is 15–60 years old depending on site conditions (Rudolph 1990). An individual Red Pine tree can live for as long as 400 years, although most do not exceed 200 years in age (Gilmore and Palik 2006). A tree mortality study in Minnesota found that the average annual mortality of *Pinus resinosa* in a natural stand was less than 1%, which was comparable to results that had previously been reported for managed stands (Silver et al. 2013).



Left: Open cones, W. D. Brush, courtesy USDA NRCS 2022b. Right: Bark, J. S. Dodds, 2020.

Pollinator Dynamics

Wind is the primary pollination mechanism for *Pinus resinosa*. The species is also self-compatible, although cross-fertilization is facilitated by the position of the female cones which are usually located higher in the tree than male cones. In a typical Red Pine stand self-pollination is estimated at less than 10% but the frequency is likely to be higher in small or isolated stands (Hauser 2008). Despite the high likelihood of outcrossing, *P. resinosa* is one of the most genetically uniform tree species (Gilmore and Palik 2006). However, self-pollinated plants show only a minor reduction in survival and fertility, suggesting that the pine carries few harmful genes (Rudolph 1990).

Pollination takes place during late May or June when the female cones are only 4 mm long, but fertilization of the ovules does not occur until mid-summer of the following year after the cones have finished growing and the seed coats have hardened. Cone growth halts in late summer of the first year then resumes the following spring, and 60% of cones fail to develop due to damage by insects, weather, or other factors between their first and second year of development (Rudolph 1990).

Female cones have two ovules per scale and 50–110 scales per cone (Dickmann and Kozlowski 1971), but the ovules at either end of the cones are structurally incomplete so only those in the central section are able to develop into seeds (Lyons 1956). Lyons reported that the seed capacity of a Red Pine cone ranged from 30–100 and the outcome was influenced by cone size and position in the crown of the tree. Lack of pollination or ovule abortion in the productive region of cones was also noted to cause variation in the number of seeds (Dickmann and Kozlowski 1971. Sutton et al. (2002) found that light availability affected the number of cones produced in different parts of a tree's crown. They also examined seed capacity, observing that an average *P. resinosa* cone produced 53 seeds (minimum 7, maximum 88). Seed productivity varies between years, with good seed crops occurring about ever 3–7 years (Gilmore and Palik 2006).

Seed Dispersal and Establishment

Pinus resinosa seeds are ovoid and brown, with a body 3–5 mm long and a wing that extends up to 20 mm (Kral 2020). Dispersal generally begins a few days after ripening, which typically occurs between mid-August and October (Hauser 2008). Cool, wet weather may delay cone opening, but once it occurs the heaviest and most viable seed falls during the first month and seedfall continues throughout the winter and into the following summer (Rudolph 1990). Seeds of *P. resinosa* are dispersed by wind, most often within a radius equal to the height of the parent tree, although dispersal distances up to 300 meters have been reported (Hauser 2008).

Red Pine seeds have no dormancy requirements but they can remain viable in the soil for several years, and delayed germination for up to 10 years has been reported (Hauser 2008). No pre-treatment is required for germination (Leopold 2005). Seedling emergence typically occurs at temperatures between 16–30° C, most often during spring or summer but occasionally in the fall (Rudolph 1990, Hauser 2008). Sutton et al. (2002) found that seed size influences germination success up to a threshold beyond which additional mass does not appear to confer an advantage; they

also reported that the majority (89%) of *P. resinosa* seeds germinated under greenhouse conditions. In natural settings, however, habitat conditions significantly influence the frequency of germination and establishment.

Habitat

Pinus resinosa typically grows in well-drained sites at elevations between 200–800 meters, although it can sometimes be found as high as 1300 meters (Hauser 2008, Kral 2020). The substrate is usually coarse-textured sand or gravel (Roberts 1985) and the water table is generally 1–3 meters below the surface (Hauser 2008). Native occurrences in the Great Lakes area are often situated on sand plains or low ridges, and eastern populations may also be found on dry slopes or mountain tops (Rudolph 1990, Rhoads and Block 2007, Edinger 2021, NJNHP 2022). Red pine can grow in pure stands or be the dominant canopy species, but when it occurs in the understory it is most frequently associated with White Pine (*Pinus strobus*) or Jack Pine (*P. banksiana*) (Rudolph 1990, Hauser 2008). In New Jersey, *P. resinosa* could potentially occur as an associated canopy species in a *Pinus rigida* woodland alliance or as a minor component of a *Pinus strobus—Quercus alba/rubra/velutina* forest alliance (Breden et al. 2001).

Pinus resinosa seedlings require bare mineral soil and plentiful sunlight in order to become established, so a disturbance is often necessary to create suitable germination sites in a closed canopy forest (Engstrom and Mann 1991). Cook (1952) noted that *P. resinosa* seedlings were excluded by heavy soil or litter cover. Moist soil with a pH of 8.5 or lower is needed for seeds to germinate, and partial shade may be beneficial because more than four hours a day of sunlight can inhibit germination (Hauser 2008). However, too much shade limits seedling growth and the plants will not develop beneath dense brush (Cook 1952, Hauser 2008, Rudolph 1990).

Fire is generally cited as the natural disturbance best suited for creating favorable germination sites for *P. resinosa* (Rudolph 1990, Engstrom and Mann 1991, Gilmore and Palik 2006, Hauser 2008). Fire facilitates Red Pine germination by removing the thick duff layer, exposing mineral soil, and opening the canopy (Mallik and Roberts 1994, Gilmore and Palik 2006). *Pinus resinosa* seeds must be introduced after a site has burned, coming from nearby trees that were not damaged by the fire (Bergeron and Brisson 1990). Bergeron and Brisson observed that mature Red Pines have a thick bark that protects them from conflagrations that kill many of their competitors, and they sometimes even show enhanced growth following a fire that has released nutrients and reduced competition.

Wetland Indicator Status

Pinus resinosa is a facultative upland species, meaning that it usually occurs in nonwetlands but may occur in wetlands (U. S. Army Corps of Engineers 2020).

USDA Plants Code (USDA, NRCS 2022c)

PIRE

Coefficient of Conservatism (Walz et al. 2018)

CoC = 10. Criteria for a value of 9 to 10: Native with a narrow range of ecological tolerances, high fidelity to particular habitat conditions, and sensitive to anthropogenic disturbance (Faber-Langendoen 2018).

Distribution and Range

The global range of *Pinus resinosa* is restricted to North America (POWO 2022). The map in Figure 1 depicts the extent of Red Pine in the United States and Canada.

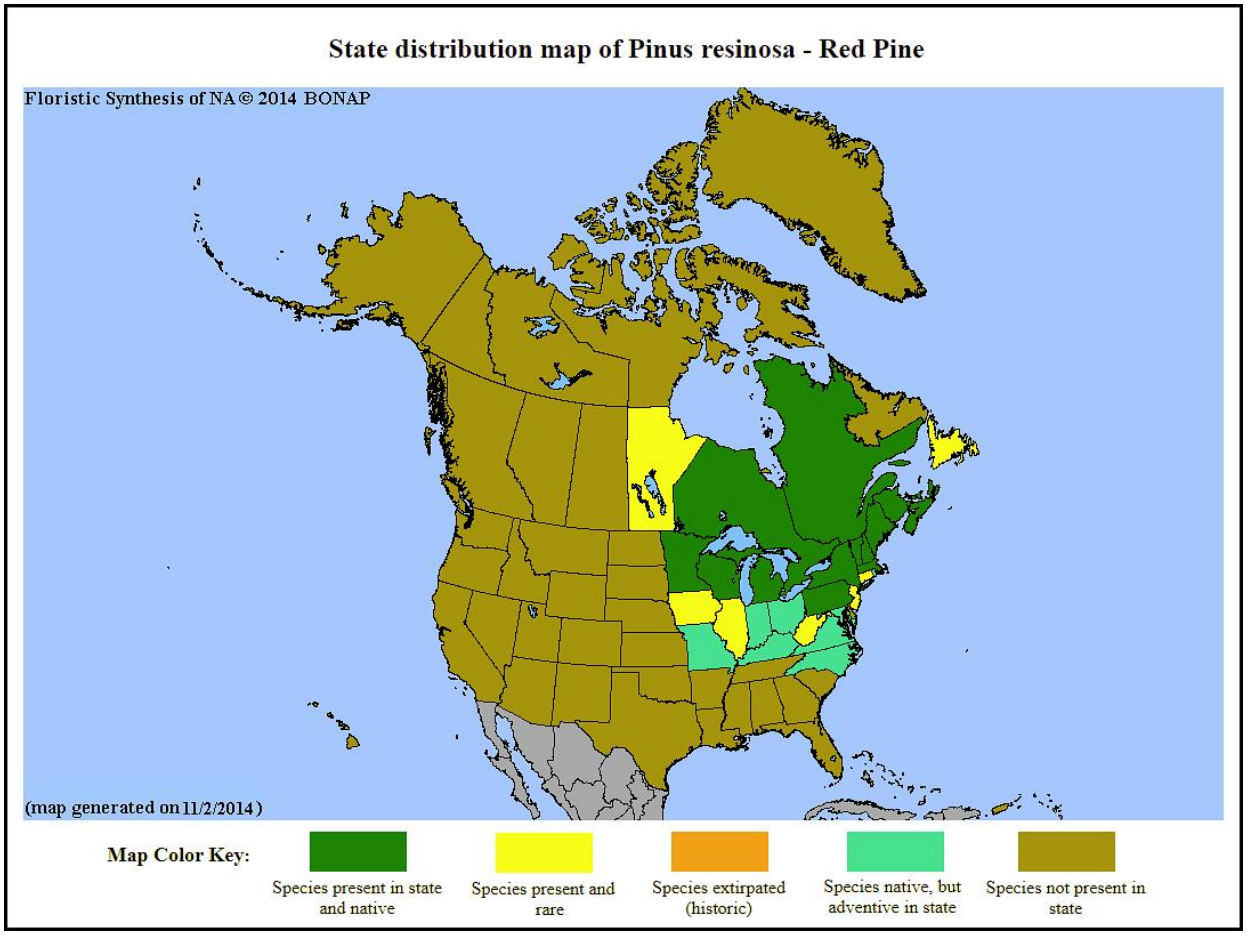


Figure 1. Distribution of P. resinosa in North America, adapted from BONAP (Kartesz 2015).

The USDA PLANTS Database (2022c) shows records of *Pinus resinosa* in six New Jersey counties: Bergen, Hunterdon, Middlesex, Morris, Sussex and Warren (Figure 2 below). Additional sites were documented in Cape May and Monmouth Counties (Mid-Atlantic Herbaria 2022). The data include historic observations and may not reflect the current distribution of the species.

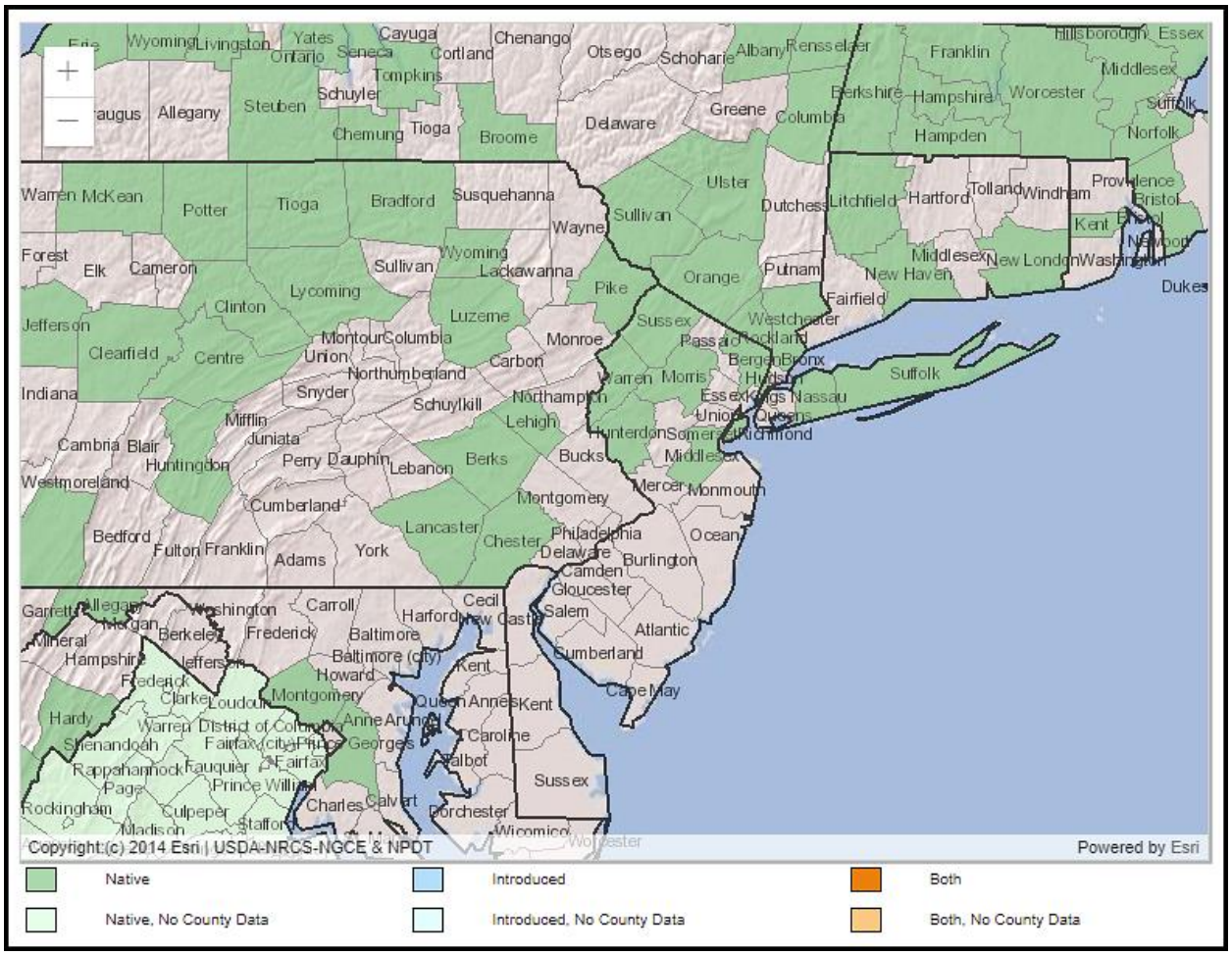


Figure 2. County records of P. resinosa in New Jersey and vicinity (USDA NRCS 2022c).

Conservation Status

Pinus resinosa is considered globally secure. The G5 rank means the species has a very low risk of extinction or collapse due to a very extensive range, abundant populations or occurrences, and little to no concern from declines or threats (NatureServe 2022). In fact, *P. resinosa* is reported to be increasing throughout its range following the centuries of logging. Both natural regeneration and reforestation efforts have contributed to its recovery (Farjon 2013). The map below (Figure 3) illustrates the conservation status of Red Pine throughout its range. *P. resinosa* is critically imperiled (very high risk of extinction) in four states and imperiled (high risk of extinction) in three provinces and one state. Throughout the rest of its range it is secure or apparently so, and it is present but introduced in North Carolina.

Red pine has been planted at numerous locations in New Jersey, but only one occurrence is considered native (Fairbrothers and Hough 1973). Consequently, *Pinus resinosa* is ranked S1.1 in New Jersey (NJNHP 2022), meaning that it is critically imperiled due to extreme rarity. A species with an S1.1 rank has only ever been documented at a single location in the state. *P. resinosa* 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 *P. resinosa* 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).

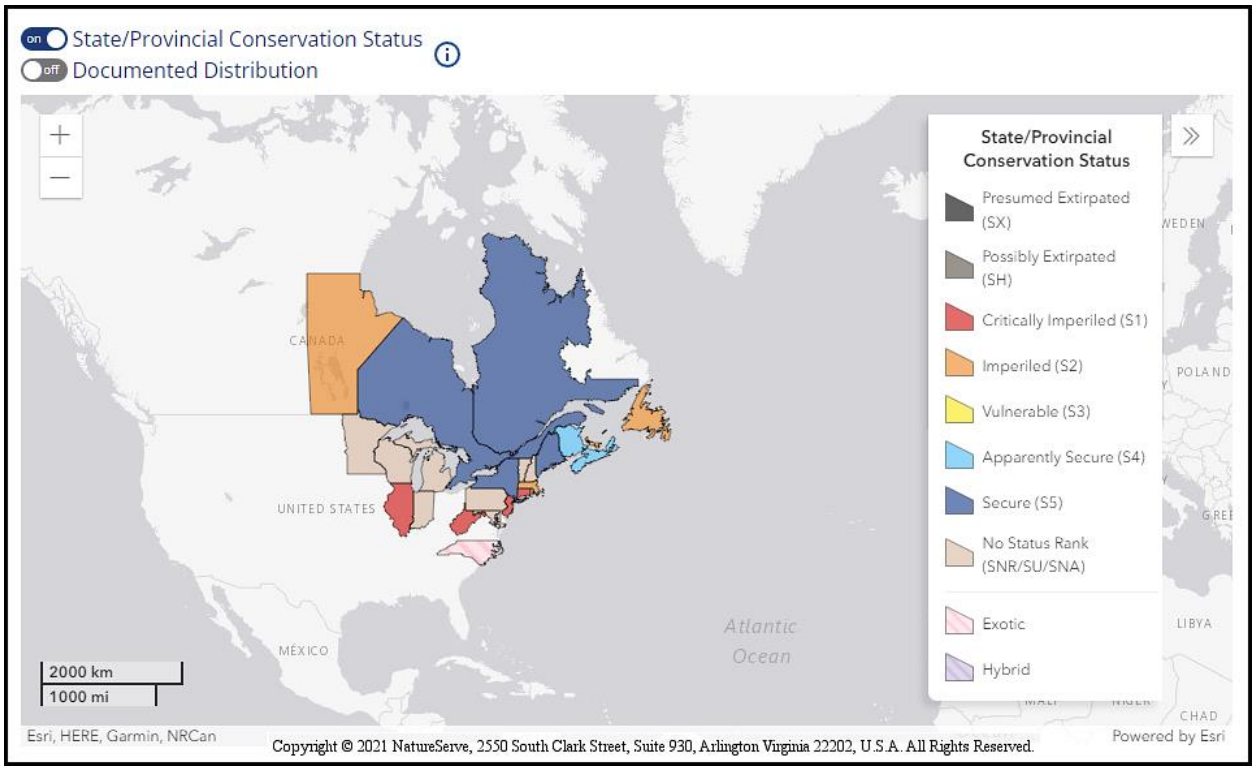


Figure 3. Conservation status of P. resinosa in North America (NatureServe 2022).

In his flora of the greater New York area, Taylor (1915) identified *Pinus resinosa* as a northern species that reached its limits in the region and was found exclusively north of the Wisconsin glacier's terminal moraine. He listed the species as present in New York, Connecticut, and Pennsylvania but not in New Jersey. A single population of Red Pine was found in Sussex County in 1936 (Clausen 1939) and that continues to be the sole natural occurrence known in the state. The site is still extant and recent records indicate that the population is healthy and reproducing (NJNHP 2022).

Threats

Habitat loss has historically taken a notable toll on *Pinus resinosa*. In the Great Lakes region of the U. S. an estimated 22 million acres of Red Pine has been reduced to approximately 1 million acres as a result of unfettered harvesting, land appropriation for agriculture and development, and fire (Gilmore and Palik 2006). The mining of gravel for railway and highway beds also contributed to the decline of the species in Newfoundland (Roberts 1985). Threats from development continue today as habitats on rocky summits are targeted for the construction of radio towers, cell phone towers, and windmills (Edinger 2021). Habitat damage from all-terrain

vehicles has also been noted as a threat, as well as clearing activities on adjacent land that provide access for invasive plants and alter community dynamics (SSAC 2016, Edinger 2021).

While fires can benefit *Pinus resinosa* populations they may also be damaging, depending on both intensity and frequency. Young plants are more susceptible to mortality (Hauser 2008). Because Red Pine regenerates slowly, short intervals between fires (< 36 years) do not permit the trees to achieve sufficient height and bark density to survive the next blaze, while a very high intensity burn that eliminates an entire stand can remove the potential seed source for the next generation (Bergeron and Brisson 1990). Certain types of fire can also trigger dense growth of understory species such as *Kalmia* or *Corylus*, inhibiting the germination and establishment of Red Pine (Mallik and Roberts 1994, Scherer et al. 2018).

Conversely, the suppression of natural fires may also threaten populations (Edinger 2021). One of the important ways that fire promotes establishment of *Pinus resinosa* seedlings is by reducing competition (Gilmore and Palik 2006, Hauser 2008). Red Pine has been reported as sensitive to competition from hardwood trees, shrubs, and herbaceous species for resources both above and below the ground. On a scale of 0 (extremely shade intolerant) to 10 (extremely shade tolerant), *P. resinosa* has been rated 2.4 (Rudolph 1990). Slow root development puts the species at a disadvantage to faster-growing species in obtaining water and nutrients (Hauser 2008).

Poor regeneration is often cited as a threat to natural populations of *Pinus resinosa*. Developing seeds may be consumed by Red Squirrels (*Tamiasciurus hudsonicus*) before they are even dispersed. For seeds that reach the ground, germination and establishment can be impeded by physical barriers such as dense lichen cover or biochemical barriers produced by dwarf ericaceous shrubs (SSAC 2016). *Pinus resinosa* seedlings that germinate beneath established stands are susceptible to fungal pathogens (*Diplodia pinea* and *Sirococcus conigenus*) that can persist without harm in mature trees but are lethal to the young plants (Scherer 2016).

Red Pine is particularly vulnerable to herbivory at the seedling and sapling stage. Browse by White-tailed Deer (*Odocoileus virginianus*) has been identified as the cause of regeneration failure for many kinds of slow-growing woody evergreens including *Abies*, *Pinus*, *Taxus*, *Thuja*, and *Tsuga* (Waller and Alverson 1997, Cornett et al. 2000, Côté et al. 2004). The use of a deer exclosure underscored the impacts of long-term browsing on Red Pine in Minnesota: No *P. resinosa* saplings were found outside of the exclosure during the initial period when deer where abundant but the trees slowly reestablished after the herd had been greatly reduced (Ross et al. 1970). Seedling herbivory by the Eastern Cottontail (*Sylvilagus floridanus*) and the Snowshoe Hare (*Lepus americanus*) has also been reported (Rudolph 1990).

Approximately 100 insect species are known to feed on Red Pine although few cause mortality (Rudolph1990). Hauser (2008) reported that *P. resinosa* seed production may be seriously reduced by insects that utilize the cones during their larval stage such as the Red Pine Cone Beetle (*Conophthorus resinosae*), Red Pine Cone Moth (*Eucopina monitorana*) and other coneworms (*Dioryctria spp*.). Severe outbreaks of defoliator species such as the redheaded pine sawfly (*Neodiprion lecontei*) or the pine tussock moth, (*Dasychira plagiata*) can lead to the death of mature trees (Gilmore and Palik 2006). Fahrner et al. (2016) found that another defoliating moth (*Choristoneura pinus*, Jack Pine Budworm) has recently transitioned to feeding

on Red Pine. *Pinus resinosa* trees in all age classes can be susceptible to Red Pine Scale (*Matsucoccus resinosae*) which is seldom fatal on its own but weakens the trees and makes them vulnerable to a secondary infestation by cerambycids (Rudolph 1990, NHFPB 2012). Cerambycids (longhorn beetles) are wood-boring insects, and *P. resinosa* is the host plant for about a dozen species (Gosling 1986). The beetles typically attack trees that are already stressed, hastening their demise (Ryall and Smith 2001). Two additional insects have been identified as emerging threats to *Pinus resinosa*. Both the European Woodwasp (*Sirex noctilio*) and the Southern Pine Beetle (*Dendroctonus frontalis*), unlike most native species, will attack healthy, living trees (NJDEP 2010, Edinger 2021, NJ Forest Service 2022).

The disease most frequently identified as a serious threat to *Pinus resinosa* is Scleroderris Canker, which is caused by the fungus *Gremmeniella abietiana*. Two races are known in the northeastern United States: The native type is mainly damaging to seedlings but occasionally causes mortality in older trees while the European strain poses a more extensive threat even to mature trees (SSAC 2016). Needle cast diseases such as *Lophodermium pinastri* and *Scirrhia acicola* that retard the growth of red pine can kill small trees, and death of trees can also occur as the result of root rot diseases including *Heterobasidion annosum* and *Armillaria mellea* (Rudolph 1990, Hauser 2008).

Pinus resinosa naturally occurs in areas with cool to warm summers, cold winters, and low to moderate precipitation (Hauser 2008). Throughout the course of a year, certain climactic conditions may hinder reproduction. Pollination may be impeded by extended periods of rainy weather during late spring, while germination and seedling survival can be limited by summer droughts and high soil temperatures, sudden drops in temperature in the early fall that last beyond 24 hours, or winter drying of foliage (Rudolph 1990). Shifting climactic conditions are likely to exacerbate existing challenges and may also foster new interactions between stressors (Handler et al. 2014). For example, rising temperatures can be expected to increase competition for water (Curzon et al. 2017) but wetter conditions may favor other species. Changes to weather patterns might also alter natural fire regimes or enhance impacts from herbivory and disease (SSAC 2016).

Gradual global warming is predicted to temporarily increase Red Pine abundance but ultimately lead to the species' decline (Hauser 2008). On a risk scale of 0 (low) to 1 (high), *Pinus resinosa* was ranked at 0.75, signifying a medium to high vulnerability to climate change in eastern Canada (SSAC 2016). Handler et al. (2014) evaluated potential climate change impacts separately for two Minnesota communities that included *Pinus resinosa*. Fire-dependent Forest included natural occurrences and was considered to have a moderate to low level of vulnerability, while the vulnerability of Managed Red Pine (plantations) was assessed as moderate to high.

Management Summary and Recommendations

Conservation of extant natural occurrences must be a key component of management for *Pinus resinosa* in regions where the species is imperiled. At the local level, protection may entail assuring that mature trees are not displaced by development, that seedlings and saplings are not

damaged by high-impact recreational activities, and that native community components are not replaced by invasive plants. Monitoring for the presence of damaging insects that have the capacity to kill mature trees could determine whether additional action is required to preserve a stand. At the landscape level, establishment of Red Pine plantations in the vicinity of natural populations should be avoided in order to limit the chances of outbreeding depression—a reduction in vigor and fitness that results from interbreeding between distantly related individuals (Machinski et al. 2012). Although *P. resinosa* is known to have low genetic diversity, some regional variation in chloroplast microsatellites has been detected and there is still much to be learned (Walter and Epperson 2005).

Pinus resinosa faces numerous threats during the period that extends from initial establishment to reproductive maturity. In places where Red Pine is imperiled, additional protection or intervention may be required during that vulnerable phase. For example, exclusion of herbivores at selected sites could help young pines to survive the sapling stage. Controlled burning may be used to facilitate *P. resinosa* reproduction by opening the canopy, removing duff, and reducing competition. Periodic surface fires of low intensity or infrequent high intensity fires can allow *P. resinosa* to reestablish between burns (Bergeron and Brisson 1990). However, the tool should be used with caution in order to avoid devastating crown fires that eliminate entire stands leaving no seed producers to establish new generations. In general, low intensity fires conducted during the spring months at intervals of sufficient length for young trees to develop a thick, protective bark layer are advised. Hauser (2008) provides specific recommendations regarding fire intervals and intensity, along with additional resources for the planning of prescribed burns in *P. resinosa* habitat.

Synonyms

The accepted botanical name of the species is *Pinus resinosa* Aiton. Orthographic variants, synonyms, and common names are listed below (ITIS 2021, USDA NRCS 2022c, POWO 2022).

Botanical Synonyms	**Common Names**
Pinus resinosa f. *globosa* Rehder	Red Pine
Pinus rubra Michx. f.	Norway Pine
	Northern Pine

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