

Table Mountain Pine Five-Year Restoration Plan Abraitys Pine Stand Preserve, Hunterdon County

October 31, 2018

**New Jersey Department of Environmental Protection
New Jersey Forest Service
And
New Jersey Natural Lands Trust**

Objective

The New Jersey Natural Lands Trust and the New Jersey Forest Service seek to restore a viable population of New Jersey's only known occurrence of the State Endangered *Pinus pungens* (Table Mountain pine) at the Trust's Abraitys Pine Stand Preserve, Hunterdon County.

Background

Pinus pungens (Table Mountain pine (TMP); *Pinaceae*) occurs in upland woods of the central and southern Appalachian Mountains of the eastern United States. Although typically found on thin, rocky soils from northern Georgia to Pennsylvania, several outlier populations exist outside of this main range, including the sole population documented from New Jersey. This population of TMP has been known to exist in the Sergeantsville area of Delaware Township, Hunterdon County, since the early 1800s. Recorded information dates to an 1886 entry in the Bulletin of the Torrey Botanical Club in which G.N. Best describes a field trip to the one-acre site of an abandoned old field on June 14, 1886 (Best, 1886). The stand was rediscovered decades later by local botanist Vincent Abraitys, after whom the site is now named.

Preserve Description

The Abraitys Pine Stand Preserve is 59 acres located in the village of Sergeantsville, Delaware Township, Hunterdon County. Beginning in 2003, with the help of the New Jersey Green Acres Program, 30 acres containing some live but very old individuals of TMP came under ownership of the New Jersey Natural Lands Trust (Trust), a non-profit government agency whose mission is to preserve land in its natural state for enjoyment by the public and to protect natural diversity through the acquisition of open space. A second 29-acre parcel was acquired by the Trust in 2006, where as few as two surviving TMP trees currently exist.

Although formerly an upland field, habitat conditions have completely reverted to forest, with former field boundaries now indicated only by remnants of old stone walls. See Figure 1. The existing forest canopy is dominated by red maple (*Acer rubrum*), tulip poplar (*Liriodendron tulipifera*), ash (*Fraxinus* spp.), and pitch pine (*Pinus rigida*). Shrub and herbaceous layers are almost completely dominated by nonindigenous and invasive species. The closed canopy conditions have greatly reduced successful reproduction in the TMP population, with low cone production and limited to no seedling recruitment. Today, only two mature trees are believed to

remain approximately 50 yards apart on an eastern slope, with an increment bore dating one of the trees to approximately 75 years.

Species Description

TMP is a slow growing, limby conifer. While the tallest individual recorded was well over 90 feet, most do not exceed 66 feet (Zobel, 1969). The diameter at breast height of TMP is usually about 16 inches; the maximum recorded DBH was 34 inches (Zobel, 1969). The trunk of a mature TMP is usually crooked and gnarled. Older trees display a flat crown while younger trees can take on a variety of forms, from bushy individuals in open habitat to tall and slender when found in crowded stands. Long, thick limbs often remain alive for extended periods of time on over half of the bole, even in denser stands (Zobel, 1969). Branch stubs are also retained for lengthy periods. The bark is broken up into smooth, sometimes flaky plates and thickness increases linearly with diameter (Zobel, 1970). Needles are borne two per fascicle; size averages 2.7 inches across its range, the smallest being 1.3 inches and the largest 4.1 inches. Some fascicles may contain three needles, but they are rare. Needles are retained for 2-3 years.

TMP is monoecious and wind pollinated, with male cones 0.6 inches in length and female cones ranging from 1.7 to 4.1 inches and are borne in whorls of two to seven. Cones are typically serotinous and trees mature and produce cones 5-7 years after germination (Welch et al., 2000). Cones can persist on the stem for a decade or more whether they are open or remain closed (Barden, 1979). Cones are thought to open following fire, but a population in North Carolina maintained continuous reproduction in the complete absence of fire for nearly a century, suggesting that fire may not be crucial to reproduction in this species (Barden, 1977).

TMP is commonly found in upland pine/oak communities, occurring alongside chestnut oak (*Quercus montana*), pitch pine (*Pinus rigida*), white pine (*P. strobus*), and Virginia pine (*P. virginiana*). It is often found in pure stands, where it dominates the canopy (Golden, 1981). Other codominant and understory associates include eastern hemlock (*Tsuga canadensis*), black oak (*Quercus velutina*), bear oak (*Quercus ilicifolia*), eastern white oak (*Quercus alba*), hickory (*Carya* spp.), black gum (*Nyssa sylvatica*), black birch (*Betula lenta*), as well as various ericaceous shrubs such as mountain laurel (*Kalmia latifolia*), lowbush blueberry (*Vaccinium pallidum*), huckleberries (*Gaylussacia* spp.), and rhododendrons (*Rhododendron* spp.) (Brose and Waldrop, 2000).

TMP is placed in the pine family subsection *Australes* (Eastern North American, Central American and Caribbean pines) and is very closely related to pitch pine, loblolly pine (*P. taeda*), and pond pine (*P. serotina*) (Gernandt et al., 2005). TMP has been shown to possess a substantial amount of genetic diversity when compared to other coniferous species and even other woody species, with higher levels of genetic diversity being found in the northern and southern termini of its range (Gibson and Hamrick, 1991). Additionally, inter-population genetic analyses show a 13.6% difference between TMP populations, twice that of most conifer species (Gibson and Hamrick, 1991). Studies on genetic diversity suggest collecting seeds from 10-20 mother trees with at least 328 feet between each tree in sampled populations, but also recognize that this may not be feasible in extremely small populations (Jetton et al., 2015).

While a seemingly rare occurrence, there is evidence suggesting that TMP can hybridize with several other pine species. Several individuals in North Carolina displayed characteristics intermediate between TMP and pitch pine (Zobel, 1969). There is also evidence of natural hybridization between TMP and shortleaf pine (*P. echinata*) (Dorman, 1976).

Previous Management

On several occasions the Trust has collected cones as a seed source for future stand regeneration initiatives at Abraitys Pine Stand Preserve. In December 2003, when the preserve supported approximately 25 very mature TMP trees, the Trust collected cones from the forest floor and delivered them to the New Jersey Forest Service's (NJFS) Forest Tree Nursery in Jackson (NJ Forest Nursery) where approximately 1,000 viable seeds were extracted. From those seeds the NJ Forest Nursery successfully grew 50 seedlings. These progeny, consisting of two-year old seedlings, were planted back on-site in 2005 following selective removal of large hardwood canopy trees surrounding a healthy TMP and employing protection of the saplings from deer browse. However, this planting attempt failed potentially due to two consecutive years of drought, unsuitably shady planting location choice, lack of implementation of prescribed burning for site preparation, and rampant overgrowth by invasive plants including Japanese stiltgrass (*Microstegium vimineum*) and Japanese wineberry (*Rubus phoenicolasius*). In 2013, a second collection of cones resulted in several potted seedlings which did not survive at the NJ Forest Nursery. Some of this seed collected in 2013 was saved by Trust staff and was shared with the NJ Forest Nursery. Seeds stored under refrigeration at the NJ Forest Nursery failed to germinate, but those stored by Trust staff and later germinated by the NJ Forest Nursery produced 47 potted seedlings housed in the nursery as of July 2018. Average height is approximately five inches; seedlings range from two to seven inches in height and all are considered healthy. Seeds were again collected in December 2017.

Restoration Plan Components

Based on the status and history of management of TMP at Abraitys Pine Stand Preserve, the following is recommended for implementation by the NJFS in cooperation with the Trust during 2018 through 2022 to secure its continued existence at the Preserve. Results will be assessed periodically and at the conclusion of the fifth year of the plan in 2022, and the plan objective, plan components, partners and/or implementation schedule may be revised as needed.

Component 1: Extract remaining seed from preserve. The genetic material comprising TMP from this preserve is extremely limited and consists of 47 one-year greenhouse seedlings and an undetermined number of additional seed and cones collected from the site during 2017. It is critical that the forest formerly and currently supporting this species be thoroughly scoured at the earliest opportunity for any additional remaining viable genetic material for use in propagation and restoration. Collected cones and seed must be properly stored to maximize their long-term viability. To reduce the risk of catastrophic loss, seed collected in 2017 and during future collection events should be evenly divided and separately stored at NJ Forest Nursery and at the chosen Secondary Nursery (see Component 2). Further, consideration should be given to transferring a subset of seed to a reputable long-term seed storage facility, such as the UC Davis Seed Biotechnology Center.

Component 2: Establish and maintain *ex situ* seed tree orchards. When greenhouse seedlings at the NJ Forest Nursery reach appropriate maturity (two years minimum), a subset of the seedlings (20 trees—assuming 100 percent survival) should be used to create a seed tree orchard for *ex situ* conservation on the nursery grounds. These trees will serve as a source of trees, seed and cuttings for future and continuing restoration efforts. Another subset of seedlings (20 trees) should also be established in a seed tree orchard in at least one other botanical garden, academic institution or similar qualified facility where they would receive proper care and further secure the survival of this genetic material, should a catastrophic event befall both the preserve and the *ex situ* NJ Forest Nursery material. This Secondary Nursery should also store half of seed collected from the TMP site to reduce the risk of loss (see Component 1). Finally, the remaining seedlings (7 trees) should be retained in pots for initial experimental outplanting at the preserve (see Components 3 and 4).

Component 3: Prepare Abraitys Pine Stand Preserve for initial experimental outplanting. Both forested and active agricultural field habitat currently exists at the preserve. Fields currently in agriculture, once abandoned and properly prepared, may provide the most time and cost-effective locations for initial experimental outplanting of trees. Open fields also allow for simpler maintenance and monitoring. Access for vehicles and equipment will need to be addressed prior to any outplanting effort. Consideration should be given to amending soils in the selected outplanting location(s), potentially including incorporation of upper soil horizons removed from the adjacent forested habitat.

Component 4: Perform initial experimental outplanting. Once the seven seedlings retained in pots at the NJ Forest Nursery attain a minimum age of two years they should be outplanted in the fall to a properly prepared experimental location in one or two of the adjacent open fields near the existing population. Seedlings must be caged and otherwise protected from herbivory and will require regular watering. Plantings will be monitored on a bi-annual or more frequent basis, including but not limited to survival, height, crown diameter, basal trunk diameter and, eventually, DBH and reproductive output. Results will be used to inform subsequent management prescriptions for the site. Depending on the results of this initial experimental outplanting, additional outplantings may be pursued using material obtained from subsequent seed germination and cuttings (see Component 5).

Component 5: Maximize propagation through phased seed germination and cuttings. A phased approach to propagation from collected seed (see Component 1) and through clonal tip cuttings should proceed at the NJ Forest Nursery and Secondary Nursery. The resulting material will be used to augment the seed tree orchards as well as for use in additional outplanting events at the preserve (see Component 4). While germination of remaining seed collected from the preserve is likely to diminish or end during the five-year period of this plan, propagation through cuttings obtained from the seed tree orchards may continue until seed orchard trees achieve reproductive maturity.

Component 6: Forest Restoration. Rehabilitating conditions within the natural forested habitat that may stimulate germination of TMP seed and also prepare this location for future outplanting of TMP trees obtained through propagation will include prescribed burning, invasive

species control, creating canopy gaps, and deer management. The use of prescribed fire, preferably warm season application, alone or in combination with herbicide treatment, mechanical removal and deer exclusion, will be employed to increase canopy light, control non-natives, and facilitate the recolonization of native species. Fire is also expected to remove leaf litter and expose mineral soil, promoting seed germination of TMP and/or creating conditions for future TMP outplanting in created canopy gaps. The use of deer fencing will further promote the colonization of a native understory.

Component 7: Genetic Analysis. To guide efforts to conserve New Jersey genetics of this species, NJFS will explore involvement in ongoing studies of pine genetics. Camcore, an international program for tree breeding and genetic conservation, has developed a comprehensive resource for TMP genetics (Jetton et al., 2015). Based at North Carolina State University (NCSU), Camcore researchers had been in touch with Trust staff to include New Jersey's population in earlier research efforts but did not include NJ's population at that time. NJFS will contact staff affiliated with Camcore to replicate their protocols with what remains of the extant population to determine the uniqueness of NJ's population. This information should be used to verify species genetics and inform local breeding efforts. This may include conservation of unique genetics if NJ's population is distinct from neighboring populations or supplementation of planting stock if NJ's population is indistinguishable.

Five-Year Activity Schedule

Year 1 –Fall/Winter 2018

- Maintain existing TMP seedlings in the NJ Forest Nursery.
- Perform one or more cone collection events at Abraitys Pine Stand Preserve, concentrating search efforts at locations surrounding live and dead TMP trees.
- Extract seed from any collected cones and divide into two or more batches, one to be retained and stored at the NJ Forest Nursery and another to be stored at the selected Secondary Nursery. Consider transferring a subset of seed to a reputable long-term seed storage facility, such as the UC Davis Seed Biotechnology Center.
- Establish access for vehicles and equipment to potential experimental agricultural outplanting site(s) at Abraitys Pine Stand Preserve.
- Develop plans for future planting, watering, herbivory protection and monitoring of experimental outplanting site(s).
- Identify and establish relationship with selected Secondary Nursery.

Year 2 - 2019

- Consider/implement removal of seed from storage at NJ Forest Nursery and/or Secondary Nursery for germination and establishment of another seedling cohort in controlled

greenhouse environment. (Note: This is an annual activity, as determined necessary.)

- Plan and prepare *ex situ* seed tree orchard sites at NJ Forest Nursery and Secondary Nursery, taking into consideration possible future expansion to accommodate additional trees propagated from seed and cuttings.
- Consider/implement outplanting all or portion of two-year seedlings (approximately 20 trees) at *ex situ* seed tree orchards at NJ Forest Nursery and Secondary Nursery in fall 2019.
- Consider/implement outplanting remaining two-year seedlings (approximately 7 trees) at selected and properly prepared experimental agricultural outplanting location(s) on preserve.
- Consider/implement initial forest habitat restoration through application of warm season prescribed burn.
- Design/implement additional experimental invasive species control techniques (herbicide treatment, mechanical removal, deer exclusion) in combination with warm season prescribed burn. The treatment plan may include plots for monitoring different treatments (e.g., prescribed burn with/without deer exclusion, prescribed burn with herbicide treatment and deer exclusion, etc.)
- Seek/enter four-year contract for annual seedling maintenance (watering, weeding, fence/cage management, etc.) and monitoring (morphometrics and environmental conditions) at preserve experimental agricultural outplanting location(s).
- Contact Robert Jetton and Andrew Whittier from NCSU to determine whether and how to include NJ genetic material in Camcore's *Pinus pungens* project. This will likely include collection of cones/seed and/or branch clippings from established seed tree orchards.

Year 3 – 2020

- Consider/implement removal of seed from storage at NJ Forest Nursery and/or Secondary Nursery for germination and establishment of another seedling cohort in controlled greenhouse environment.
- If not implemented in 2019, outplant all or portion of three-year seedlings (approximately 20 trees) at NJ Forest Nursery and Secondary Nursery seed tree orchards.
- If not implemented in 2019, outplant remaining three-year seedlings (approximately 7 trees) at selected and properly prepared experimental agricultural outplanting location(s) on preserve.
- If not implemented in 2019, implement forest habitat restoration through application of warm season prescribed burn alone or in combination with additional experimental invasive species control techniques (herbicide treatment, mechanical removal, deer exclusion).

- If not implemented in 2019, enter contract for seedling maintenance (watering, weeding, fence/cage management, etc.) and monitoring (morphometrics and environmental conditions) at preserve experimental agricultural outplanting location(s).
- Based on assessment of seedling maturity at seed tree orchards in NJ Forest Nursery and Secondary Nursery, implement propagation from cuttings and establish in controlled greenhouse environment.
- Consider/implement outplanting of additional two-year seedlings at selected experimental agricultural outplanting location(s) on preserve.

Year 4 – 2021

- Consider/implement removal of seed from storage at NJ Forest Nursery and/or Secondary Nursery for germination and establishment of another seedling cohort in controlled greenhouse environment.
- Assess other site management needs at experimental agricultural outplanting site(s) based on monitoring data.
- Consider/implement outplanting of additional two-year seedlings at selected agricultural outplanting location(s) on preserve.

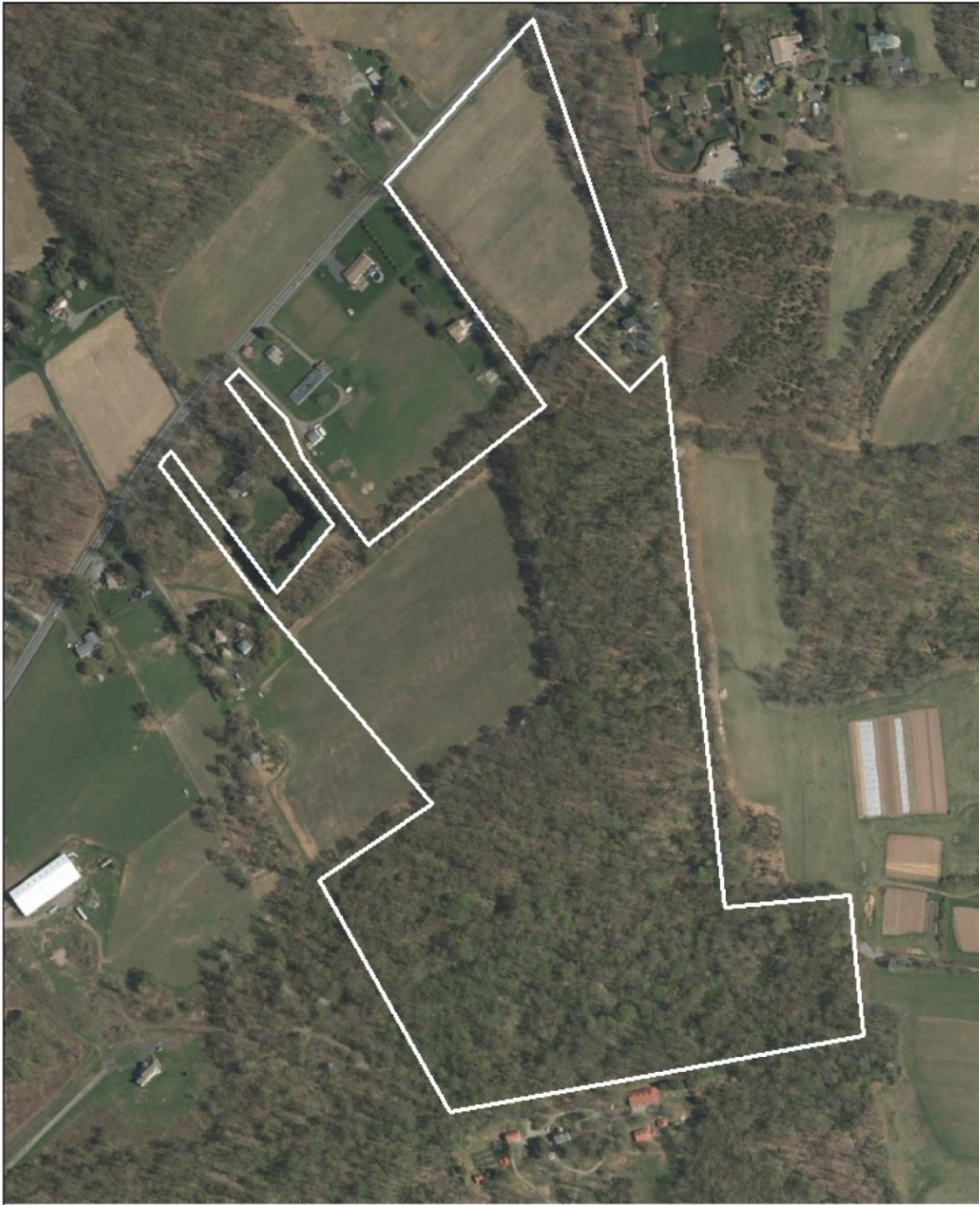
Year 5 – 2022

- Consider/implement removal of seed from storage at NJ Forest Nursery and/or Secondary Nursery for germination and establishment of another seedling cohort in controlled greenhouse environment.
- Consider/implement outplanting of additional seedlings as well as seedlings propagated from cuttings at selected experimental agricultural outplanting location(s) on preserve.
- Assess/implement forest habitat restoration through second application of warm season prescribed burn alone or in combination with additional experimental invasive species control techniques (herbicide treatment, mechanical removal, deer exclusion).
- Assess other site management needs at experimental agricultural outplanting site(s) based on monitoring data.
- Based on degree of success of outplanting at experimental agricultural location(s) and results of forested habitat restoration through prescribed fire and other methods, consider option of outplanting seedlings into forested portions of preserve.
- Assess results of annual monitoring and overall TMP restoration success and perform planning for 2023-2027

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Figure 1



New Jersey Natural Lands Trust
Abraitys Pine Stand Preserve

Delaware Township, Hunterdon County, New Jersey

