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The Importance of Preserving Genetic Uniqueness in Pitch Pine Restoration (Vermont)

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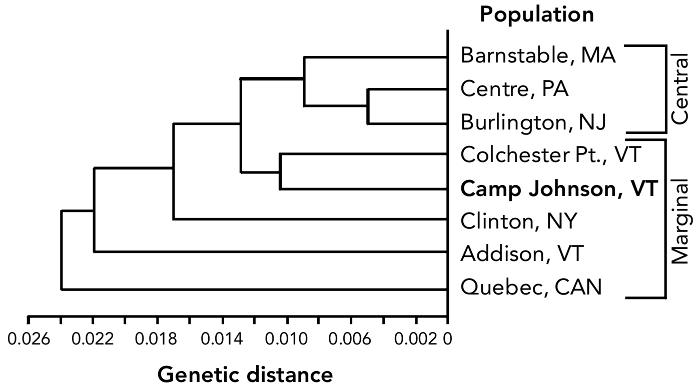

Figure 1. Clustering of genetic distance measures for populations of pitch pine (*Pinus rigida*). Populations connected with vertical lines closer to zero are more genetically similar than populations connected further to the left.

One of the few remaining populations of pitch pine (*Pinus rigida*) in Vermont is found at the northern extreme of its range at the Army National Guards' Camp Johnson in Colchester, where about 200-300 mature trees grow with very little natural regeneration. We believe this lack of regeneration is likely due to poor establishment conditions, most notably the suppression during the past 100 years of periodic fires that historically removed competition and prepared beds for seed germination and seedling establishment. We have also considered the possibility that high levels of inbreeding (common in small, isolated populations) have reduced fertility, growth, and survival within the stands.

The drastic loss of pitch pine habitat in Vermont to development, coupled with lack of natural regeneration at Camp Johnson, prompted us to attempt a restoration of this population through planting. We were concerned, however, that commercially available seedlings might not be well adapted to surviving on this site, especially if they originated from a southern location with a warmer climate. Moreover, we wondered whether the Camp Johnson population was genetically unique and should be protected from introduction of foreign germ plasm. In this note, we provide convincing evidence that restoration ecologists should consider the potential, long-term genetic impacts of using plant material from outside the study site when attempting to restore unique marginal populations.

We used starch gel electrophoresis to evaluate the genetics of 35 randomly selected Camp Johnson pitch pine and assess the genetic uniqueness of this population relative to three populations from the central part of the species' range and four other marginal populations. We also estimated current inbreeding levels and germination success.

Individuals and populations can differ genetically either in their level of genetic variability or by possessing different forms of genes (alleles) or having different allele frequencies. We found that Camp Johnson pitch pine was very similar to central populations in their level of genetic variability. The mean level of genetic variability of the pitch pine at Camp Johnson was 22.6 percent (expected heterozygosity) compared to the central population's mean of 23.3 percent (range of 22.9-23.5 percent expected heterozygosity) and to other marginal populations that averaged 20.1 percent (range of 17.3 to 22.3 percent). Although all populations generally possessed the same alleles, we noted substantial differences among populations in allele frequencies. We used clustering of genetic distance measures (Figure 1) to summarize allele frequency differences among populations. Marginal populations, including Camp Johnson, were not only genetically distinct from central populations, but they were also different from each other in allele frequencies. Significant differences in allele frequencies among populations indicated that moving seedlings into Camp Johnson from another population would likely alter the genetic structure of the future breeding pool, which could jeopardize future adaptation and evolution of Camp Johnson pitch pine.

Although pitch pine from Camp Johnson had slightly lower germination success than two other populations (54 percent compared to 77 percent for Colchester Point, Vermont, and 76 percent for Clinton County, New York), the population average was within the range of means reported by others (Heit 1958, Young and Young 1992, Association of Official Seed Analysts 1965). Thus, low seed viability did not appear to be responsible for the lack of natural regeneration at Camp Johnson. Our data also indicated that Camp Johnson pitch pine did not have higher than expected levels of inbreeding. Apparently this population is large enough and experiences enough gene migration to minimize inbreeding.

Considering evidence indicating that the Camp Johnson population is genetically unique, along with data showing that genetic variability, seed viability, and inbreeding were not problems, we recommended using indigenous seed to foster regeneration.

We germinated seed collected from the Camp Johnson pitch pine population in 1995 and grew seedlings in a greenhouse at the USDA Forest Service in Burlington for two years. Prior to planting, we burned the site to reduce competition and increase planting success. In spring 1998 and 2000, we planted more than 300 seedlings. We watered newly planted seedlings and installed permeable fiber mats to reduce competition and enhance establishment success. In addition, we mapped and labeled all seedlings so that we can examine relationships among seedling genetics, growth, and survival in the future. Initial seedling survival exceeded 90 percent. Following future prescribed burns, we plant to install additional plantings to complete the restocking process.

Acknowledgments

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Restoring New Mexico's Ponderosa Pine Forests: Restoring Clean Water. 2002. Anon. **Nonpoint Source News-Notes** 67:18-20.

The New Mexico Surface Water Quality Bureau, working with the U.S. Forest Service and other organizations, is undertaking a number of forest thinning and burning projects to restore ponderosa pine (*Pinus ponderosa*) areas, which, the author argues, will ultimately increase the water quality. Studies have shown that wildfires can negatively affect water quality by allowing a dramatic increase in run-off and erosion, with resulting floods damaging the streams. Other studies indicate that forest restoration can indirectly benefit water quality by reducing evapotranspiration, which indirectly increases the amount of water that reaches a stream and consequently increases the amount of water a stream can hold. The author notes that thinning without prescribed burning is not enough to restore the pine forests of New Mexico.

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Effects of Fire on Bark Beetle Presence on Jeffrey Pine in the Lake Tahoe Basin. 2001. Bradley, T. and P. Tueller, Dept. of Environmental and Resource Sciences, University of Nevada Reno, 1000 Valley Rd., Reno, NV 89512-0013, 775/784-4053, Fax: 775/784-4583, ptt@equniox.unr.edu. **Forest Ecology and Management** 142(1-3):205-214.

The authors studied the effect of bark beetles of the family Scolytidae on Jeffrey pine (*Pinus jeffreyi*) after low-intensity, late-season prescribed fire in forests on the north edge of Lake Tahoe, Nevada. They found a significant correlation between burning and the presence of bark beetles. About one-quarter of trees on the prescription burn plots were attacked by one or more species of bark beetles, while less than 1 percent of nonburned trees were attacked. Significant burn severity variables included crown scorch, duff consumption, and bole scorch. The authors recommend that future studies expand on fire-stress questions, including mortality threshold and bark beetle resistance, in order to provide more information on the effect of prescription burning on mature Jeffrey pine.

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The Relentless Spread of Sudden Oak Death: Tracking a Mysterious Killer. 2001-2002. Cole, E.F. **California Coast and Ocean** 17(3):3-10.

Cole reviews the current knowledge about the pathogen *Phytophthora ramorum*, which has caused Sudden Oak Death (SOD) in thousands of native oaks (*Quercus*) in California and southern Oregon. Thus far, tests have revealed no widespread treatment. Current activity is focused on understanding how the pathogen functions, removing infected dead trees, educating the public, and monitoring. California, Oregon, Canada, and South Korea have imposed quarantines on woody materials from counties in which SOD has been found. Current information is available at the California Oak Mortality Task Force Web site, www.suddenoakdeath.org.

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The Missouri River Floodplain: History of Oak Forests and Current Restoration Efforts. 2000. Dey, D., U.S. Forest Service, North Central Research Station, 202 ABNR Bldg., Columbia, MO 65211, ddey@fs.fed.us; D. Burhans, J. Kabrick, B. Root, J. Grabner and M. Gold. **The Glade** 3(2):2-4.

In a study of oak regeneration in floodplain areas and abandoned agricultural lands along the Missouri River, the authors planted pin oak (*Quercus palustris*) and swamp white oak (*Q. bicolor*) seedlings at two sites owned by the Missouri Department of Conservation: Smokey Waters and Plowboy Bend Conservation Areas. Workers planted 1-0 bareroot seedlings or seedlings produced by RPM™ (Root Production Method, an air-root pruning process developed by Forrest Keeling Nursery that produces larger plant stock with higher-than-normal growth patterns) on either mounded or nonmounded soil. They planted some seedlings with a cover crop of redtop grass (*Agrostis alba*) and left others to compete with natural vegetation. One area at each site was left untreated. The authors are monitoring the trees for survival and growth, soil characteristics, vegetation succession and competition with weeds, and songbird abundance and breeding success. They will compare the results with other regeneration methods.

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History and Management of Crown-Fire Ecosystems: A Summary and Response. 2001. Keeley, J.E., U.S. Geological Survey, Western Ecological Research Center, Sequoia-Kings Canyon National Parks, Three Rivers, CA 93271-9651, jon_keeley@usgs.gov; and C.J. Fotheringham. **Conservation Biology** 15(6):1561-1567.

In this last of a set of articles in an issue of *Conservation Biology* that addresses the role of fire regimes in western North American forests, Keeley and Fotheringham discuss the potential dangers of applying fire models from one system to other ecosystems. For example, managers have used prescribed burning to prevent catastrophic crown fires in yellow-pine forests. However, the authors note that applying this model to Canadian boreal forests, where crown fires seem to be a natural occurrence, is misguided. Similarly, the fuel-age/mosaic model, in which prescribed burning is used to produce patches of vegetation of varying ages within a landscape, may be sound policy in certain areas but should not be used in places where such a mosaic of age classes apparently was not the norm prior to fire suppression policies. In particular, the authors argue against applying the model of burning for Baja California, Mexico to California shrublands.

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Attempting Restoration of Wet Tropical Forests in Costa Rica. 2001. Leopold, A.C., Boyce Thompson Institute for Plant Research, Tropical Forestry Initiative, Cornell University, Ithaca, NY 14853, 607/254-1327, Fax: 607/254-2958, ac19@cornell.edu; R. Andrus, A. Finkeldey and D. Knowles. **Forest Ecology and Management** 142(1-3):243-249.

This article describes the preliminary results of work done by the nonprofit Tropical Forestry Initiative (TFI) to restore forests in Costa Rican pasturelands and promote local restoration efforts. In 1993 TFI members planted about 12 acres (5 ha) of old pastureland in southwestern Costa Rica with mixed native hardwood tree species (see *Restoration & Management Notes* 13(2):215-216). Three years after planting, some stands had near crown closure, and most species showed more than 90 percent survival after five years. The authors argue that the native species' rapid growth rates indicate that such mixed plantings may pro-