9. Which Trees Should I Plant?

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Planting seedlings with proven potential for fast growth and disease resistance increases productivity and carbon sequestration; however, balancing growth potential with adaptability to future climate is not as well understood. Here, forest geneticists are collaborating with climate scientists to identify key climate variables most important for deployment of pine germplasm. Together they are creating a tool to guide planting decisions and to provide resources for an engaged and literate public.

One of the most important management decisions a landowner makes over the lifespan of a pine plantation is the choice of seedlings to plant, including species, seed source, and level of genetic improvement. This decision is made once, at the beginning of a rotation, and very little can be done to mitigate a poor selection. Most landowners understand that the decision is a tradeoff between seedling costs and financial returns. Generally less well understood is that seedling choices balance factors that favor productive potential with those that favor adaptability and survival. One of the aims of PINEMAP is to provide landowners with new tools to more explicitly explore this second set of tradeoffs.

To this end, the three southern tree improvement cooperatives have evaluated common garden experiments with families (trees sharing one or both parents in common) from multiple seed sources established in plantings spanning a range of environmental conditions (Figures 9.1 and 9.2). Researchers are using relative performance as an indicator of local adaptation, and from this information, they are predicting the optimal distance a loblolly pine seed source can be planted away from the location from which it was derived (transfer distance). Historical weather patterns at the test sites can also be used as a basis to extrapolate performance predictions to future climates. Using a similar approach, Schmidtling (2001) recommended that the optimal transfer from warmer to colder climates was a distance of 150 to 200 miles, a distance equivalent to a 5° F reduction in average minimum winter temperature. Trees have also been moved long distances east to west, but with caution required where trees are moved to areas with limited average summer rainfall. Researchers from the three southern tree improvement cooperatives have confirmed Schmidtling's recommendations for seed sources with two caveats and one important caution.

The first caveat is that as average minimum winter temperature increases, the transfer distance of 150 to 200 miles recommended by Schmidtling may also increase. The proposed PINEMAP Decision Support System seed deployment tool will enable landowners to view historical weather conditions and seed source zones for planting sites as well as predicted weather conditions and shifts in suitable seed source zones under different future climate scenarios. The second caveat is that transfer distances for loblolly pine derived from common garden experiments apply broadly to seed sources but are much more difficult to generalize to specific families (trees that share one or both parents in common) because of the species' tremendous tree-to-tree genetic variation. Growing season rainfall or aridity is an important factor in all of the recently developed models. Historically, water availability has limited the distribution and productivity of loblolly pine at the westernmost edge of its range. Water availability may become more important across a broader area of the loblolly pine range if rainfall decreases due to climate change, or if water demand increases because of longer growing seasons. Fortunately, other studies in the PINEMAP project are showing that trees

Table 9.1. Average number of loblolly pine seedlings grown across the South over the last three years and average number of families available to the public by vendor and region.

	Bulked seedlots	Open pollinated	Full-sibs	Clones	Total
Seedlings (millions)	39.4	619.4	58.8	16.9	734.5
Families by vendor per deployment zone		15	7	not reported	

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are flexible in response to water availability and are well placed to have "first dibs" on available water. In addition, studies are showing that silviculture can play an important role in impacting site quality.

So, what seed source choices are currently available to the landowner? A survey reported by McKeand et al. (2003) examining southern pine deployment strategies was repeated as part of PINEMAP's benchmarking effort. Two trends are evident (Table 9.1). First, planting is overwhelmingly done in family blocks today, either open-pollinated families (where all trees in a block share one parent in common) or full-sib families produced through controlled pollination (where all trees in a block share both parents in common). Second, the number of loblolly families available in any given region is limited and highly selected based on predicted performance estimated from local field trials regardless of the original seed source. Given the current state of our knowledge about the genetic basis for adaptability, this deployment strategy is not surprising—field testing is the gold standard.

The common garden analysis described previously complements the PINEMAP genotyping project, which quantifies how gene markers change across the region as an alternative method to find signs of selection for local adaptation. The promise of PINEMAP is that a better understanding of tree growth and its impact on stand dynamics will identify specific physiological traits essential for adaptability and growth, and specific genetic characteristics associated with those traits. This information, when combined with the gene markers from the genotyping effort and knowledge of the underlying genes from the companion USDA National Institute of Food and Agriculture funded pine genome project, PineRefSeq, will enable more precise and efficient selection, breeding, and deployment in the future. With this knowledge, our response to changing climates can be both more rapid and more effective.

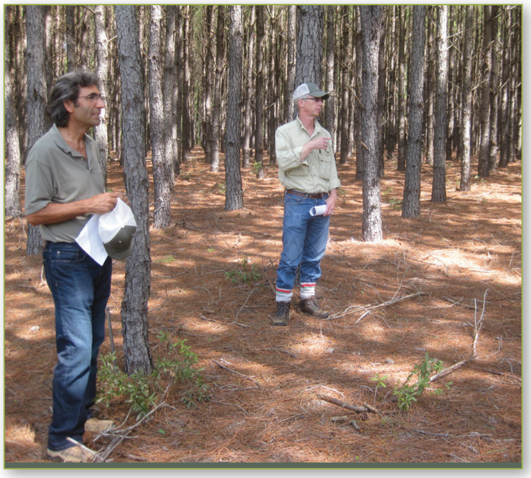

Figure 9.1. PINEMAP researchers Fikret Isik (left) and Ross Whetten examining an 18-year-old progeny test of plantation selections used in this study. The test is located in Oliver, Georgia, and is owned and maintained by Plum Creek Timber Company, Inc. Photo by Steve McKeand.

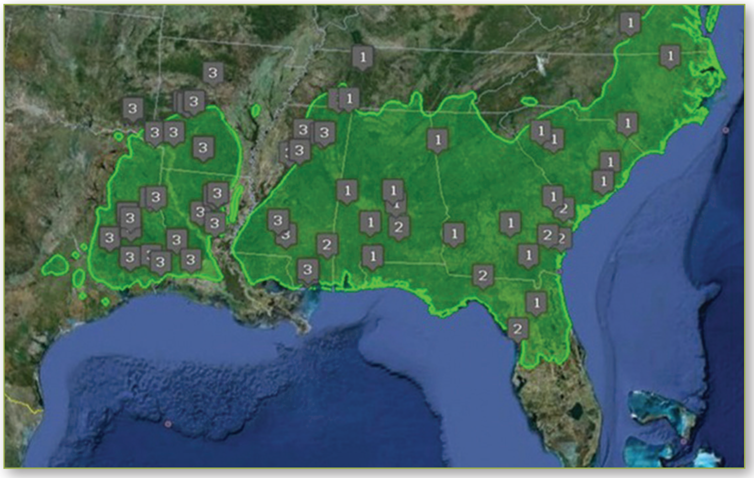

Figure 9.2. Common garden experiment locations analyzed to refine transfer methods. (1) North Carolina State University Cooperative Tree Improvement Program plantings, (2) Cooperative Forest Genetics Research Program plantings, and (3) Western Gulf Forest Tree Improvement Program plantings.