III. CONSERVATION

It is now widely known that many of our crop genetic resources, particularly in the Old World and in the areas in which crop plants originated, are endangered. Collective, scientific conservation efforts will be required to ensure that the future needs of mankind are met. California is an 'island', with unique physiography, climate, and agricultural species; and the need to conserve California crop resources is emphasized throughout these articles.

Gene conservation of commercial forest trees

David L. Kafton

Forests with commercial potential for wood products cover 17 percent of California (17 million acres). Nearly two-thirds of this acreage is along the north coast and in the north coast ranges, while over 20 percent is in the Sierra Nevada. In contrast to its field crops, all of California's commercial timber species are native. Coniferous species comprise 99 percent of the growing stock volume.

In 1975 the estimated value for forest products in California was $1.3 billion, and the industry paid $1 billion to about 90,000 workers. California is second only to Oregon in softwood timber production.

Forest tree gene conservation helps to perpetuate the genetic variability that has been the basis for the survival of the commercial forests; but, unfortunately, the irreplaceable gene resources of these forests are being continuously eroded.

Species are composed of one or more populations that are adapted to different environments, and it is the genetic variability that determines the extent to which a population can adapt to its constantly changing environment. Most of the recently investigated natural populations contain considerable genetic diversity, which provides them with an overall resistance to disasters such as epidemics and insect infestations.

The trend in forestry toward planting the offspring of selected trees on clearcut areas will hopefully lead to faster, good quality growth. However, the long-term consequences of this type of forestry are unknown. These domesticated forests, with less genetic diversity and a different genetic composition than their well-adapted predecessors, may be more vulnerable to natural disasters than the native forests they replace. To prepare for this uncertain future, it is important that we conserve as much of the available genetic variability as possible.

Reserves such as parks and wilderness areas are important for gene conservation because (1) the natural evolution of reserve species can continue, and new adaptations may develop in response to changes in the environment; and (2) gene conservation research requires natural, relatively undisturbed populations.

Unfortunately, reserves alone cannot be relied upon for gene conservation:

- Reserves can contain only a small portion of the total genetic variability that is found in a commercial species.
- Samples of commercial populations in reserves are likely to be contaminated by pollen from nearby commercial trees. (The genetic composition of populations that are harvested or planted is usually very different from that of undisturbed populations.)
- Supression of natural burning has led to the genetic alteration of previously undisturbed populations in reserves.

Thus, gene conservation requires germplasm banks—valuable as a safeguard against biological and economic disaster in the future, and in reforestation and research. Since conifer seeds store well for years at cold temperatures, seed banks are more practical than plantations alone. An ideal seed collection for gene conservation consists of a random (unselected) and comprehensive sampling of the genetic variability of a group of trees.

As the viability of stored seed samples diminishes, plantations are established, controlled crosses are made, and the gene combinations are again stored as seeds. If seeds are unavailable, cuttings may be collected, placed in plantations, and then either vegetatively propagated or eventually stored as seeds. One of the main shortcomings of germplasm banks is that they cannot evolve in response to changes in the natural environment.

Current reserves are probably in-

adequate, since they do not contain significant portions of some important commercial populations, and they are likely to be contaminated with pollen from nearby reforested or harvested areas.

Old-growth stands of white fir, ponderosa pine, Douglas-fir, and redwood have been extensively harvested in California without gene conservation seed collections having been made. In addition, a 1965 report stated that about 25 percent of California's formerly productive commercial forest land was covered with brush and unmarketable trees after logging and fires. Taken together, this has resulted in serious genetic losses for some populations.

There is a question about the gene distortion of redwood because it is not known whether sprouting from stumps has been adequate to preserve the gene pools of harvested populations; the ability to sprout declines after 200 years of age, and mostly old-growth was cut.

The southern California populations of ponderosa pine and Jeffrey pine, which have suffered heavy damage and mortality from the smog, face extinction. Gene conservation collections would provide a broad genetic base to be used for reforestation after the smog is eliminated.

The genetic composition of unharvested, commercial populations can be significantly changed by pollen received from nearby harvested or reforested areas. Pollen from heavily harvested populations of white fir, ponderosa pine, and Douglas-fir has been contaminating relatively undisturbed neighboring populations. For reforestation in California, Douglas-fir, ponderosa pine, Jeffrey pine, and sugar pine are the species most often used; they are also the current contaminators because selected and nonlocally adapted seeds and seedlings are usually used. The other commercial species remain potential contaminators because they have seldom been used in reforestation.

Current gene conservation activities

Organizations affiliated with the United Nations, such as the Food and Agriculture Organization and UNESCO, are leading some forest tree gene conservation activities. A serious lack of funds has limited them mostly to sponsoring meetings and producing useful publications.

The U.S. Forest Service has established seed zones in California. Eventually, reforestation in a seed zone will have to be done with seeds or seedlings that originated within the same zone. This does not guarantee, however, that seed collections originating within a zone will be either extensive or made from unselected seed-parents.

At the Forestry and Genetics departments of the University of California, Berkeley, representative collections have been made of seeds and cuttings from the five existing native *Pinus radiata* (Monterey pine) populations; gene conservation collections have been made from about half of the groves of *Sequoiadendron giganteum* (giant sequoia); and random, extensive samples have been collected from both native populations of *Cupressus macrocarpa* (Monterey cypress).

Although hundreds of other seed collections have been made from California's timber species, most are inappropriate for gene conservation. Furthermore, there is no comprehensive catalog of these collections, and adequate facilities for their perpetuation are lacking. In general, very little forest tree gene conservation work is being done in California or elsewhere.

Conservation of Commercial Timber Species in California.

Timber Species		Adequate reserves	Significant distortion	Danger of extinction—important populations	Contamination by distorted populations	Current contamination by reforestation	Potential contamination by reforestation
Scientific name	Common name						
Abies concolor	white fir	?	X	—	X	—	X
Abies magnifica	red fir	?	—	—	—	—	X
Libocedrus decurrens	incense-cedar	?	—	—	—	—	X
Pinus jeffreyi	Jeffrey pine	?	—	X	—	X	—
Pinus lambertiana	sugar pine	?	—	—	—	X	—
Pinus ponderosa	ponderosa pine	?	X	X	X	X	—
Pseudotsuga menziesii	Douglas-fir	?	X	—	X	X	—
Sequoia sempervirens	redwood	?	?	—	—	—	X

Adapted from Libby, W.J., D. Kafton, and L. Fins. 1975. Chapter 4. California conifers. In *The Methodology of Conservation of Forest Genetic Resources.* Food and Agriculture Organization of the United Nations. Rome, Italy.

Proposed activities

Conditions in California make it both possible and worthwhile to conserve commercial forest tree gene resources: all the commercial timber species are native; there are still considerable numbers of old-growth timber stands; and reforestation has not been extensive in many areas.

- It is imperative that unselected and extensive seed collections be made as soon as possible from the most endangered populations of Douglas-fir on the north coast, ponderosa pine in the Sierra Nevada and southern California, and Jeffrey pine in southern California.
- Then collections have to be made from all the commercial timber populations that have remained relatively unaltered by forestry activities (mostly old-growth stands).
- In addition, better production has to be provided for commercial populations in reserves.

An effective organization is needed to take responsibility for gene conservation work in California. Perpetuating intact gene pools of unselected samples of populations requires a commitment beyond the lifetime of an individual. Federal and state governments, private industry, and the University of California could cooperate in such a group.

This organization could:

- conduct, supervise, and coordinate gene conservation activities
- accurately assess and inventory commercial forest genetic resources
- plan and set priorities for germplasm conservation
- solicit, coordinate, and disseminate funds
- obtain facilities and train personnel
- seek alterations in laws and regulations so that forestry practices are integrated as much as possible with gene conservation work
- catalog and disseminate seed collections for reforestation and research
- support scientific research related to gene conservation.

David L. Kafton was Teaching Associate, Department of Genetics, University of California, Berkeley.