# A PROPOSAL FOR A

# SOUTHERN FOREST GENE CONSERVATION PLAN

J. R. Barbour 1/

The conservation of our nation's forest genetic resources has lagged behind that of agricultural species. The practice of scientific forestry has maintained the genetic diversity of the economically valuable forest tree species. Because of this the forestry community has become complacent about ensuring the long term conservation of our forest genetic resources. If forest genetic resource managers do not take an active role in developing tree gene conservation strategies, someone with opposing views will step in and do it for us.

The Southern region is blessed with an abundance of forest genetic resources and the trained personnel to direct their future use. The members of the Southern Tree Improvement Conference are sufficiently organized to develop a Southern Forest Gene conservation Plan for southern tree species. This proposal involves developing management strategies for long term in situ and ex situ gene conservation with an accompanied database management system. This regional gene conservation plan could integrate with other gene conservation networks to effectively conserve and maintain the total tree gene pool.

Keywords:gene conservation, forest genetic resources, in situ, ex situ

## INTRODUCTION

The forested areas of the North American continent comprise about 734 million hectares or 40% of its land area.(World Resources Institute,1988). The practice of forestry has maintained the gene pool of our economically valuable forest tree species, therefore many native tree species are not close to extinction. Because of this the forestry community has become complacent about ensuring the long term conservation of our forest genetic resources. Tree seed collections have primarily been for short-or-medium term storage for use in afforestation or reforestation activities. Few programs have long term objectives.

1/ Germination Specialist, National Tree Seed Laboratory, Rt. 1 Box 182B, Dry Branch, Georgia 31020

## Genetic Variation

Forest genetic resources refer not to the seed itself but to the genetic information found in the chromosomes and associated subcellular structures(Kloppenberg, Jr. , 1988). To ensure the conservation of these forest genetic resources, knowledge of the diversity and distribution of genes in a species' population is crucial to genetic management(National Research Council, 1991). Gene flow determines the geographic scale over which species' populations may be differentiated from each other. Mating systems and the geographical range of species have significant effects on the level of genetic variation among species' population. Differences between pollen and seed migration often coincide with selective differences which affects genetic diversity, genetic drift and the probability distributions of unique alleles(Namkoong and Gregorius, 1985).

These nonrandom arrangements of genotypes impose a structure on a population. Understanding genetic structure in a tree species will make it possible to sample the genetic diversity of populations correctly.

Man's intervention can also increase genetic diversity through forest management, breeding, and biotechnology. Reforestation and afforestation can extend the range of species into areas where different selection pressures favor unique alleles. Breeding can create greater diversity among populations within species(National Research Council, 1991). Biotechnology does not replace traditional plant breeding, rather it extends the gene pools of species by overcoming incompatibility barriers of reproduction(Kloppenburg, Jr., 1988).

## Managing Forest Genetic Resources

Managing forest genetic resources involves developing overall strategies, applying methodologies, developing new technologies, and coordinating organizational efforts(National Research Council, 1991). The forestry community is fortunate in that we can tie into the networks already established by agricultural research. The advantage of using the networks in place is that existing facilities and staff can be used rather than erecting new structures and adding more bureaucracy.

The Southern forest genetics managers already have a network in place and it is called the Southern Forest Tree Improvement Conference(SFTIC). SFTIC is classified as an information exchange network which is used as a forum to exchange information among the collaborative forest genetics research networks and state and federal forestry agencies( Plucknett et. al. 1990). As a network, SFTIC has already developed the rules of governance, leadership, and management(Plucknett et. al., 1990). SFTIC is ideally suited to interact with other agricultural networks in developing and implementing a Southern Forest Gene Conservation Plan.

# SOUTHERN FOREST GENE CONSERVATION PLAN

The main purpose of this proposal for a Southern Forest Gene Conservation Plan is to preserve the excellent work on the genetic management of Southern pines by the collaborative forest genetics research networks, and the state and federal forestry agencies. This regional gene conservation plan is being proposed because the southern forest genetics managers are well organized and the opportunity is strong for establishing leadership in developing regional and national systems of forest tree gene conservation. The proposal is not meant to create more work for everyone, but to organize and preserve the legacy of the southern forest genetics managers. The major objective of forest tree improvement has been to provide genetically improved material for reforestation. In the short term, this objective has been met. I am only suggesting that a sample of the southern pines' genetic base be conserved in the event that the southern forest genetics managers need to use it in the future.

## In situ conservation

There are 2 ways to conserve genetic material: in situ and ex situ(National Research Council, 1991). In situ conservation and ex situ conservation are complementary strategies. In situ conservation preserves the population and the evolutionary processes that enable the population to adapt(National Research Council, 1990). Good examples of in situ conservation are national parks, state parks, nature conservancy landholdings, wildlife refuges, wilderness areas, and multiple-use management areas. The problem with in situ conservation of forest genetic resources is that genetic variation and determining an effective population size for a viable gene pool must be considered rather than the size of the area.(Roche, 1975). Designing tree reserves and managing natural or artificial stands requires an understanding of the reproductive systems of the trees being conserved(National Research Council, 1991). In my opinion, in situ conservation is beyond the scope of SFTIC, because the organization's membership is more geared to scientific advancements than legislative and managerial processes.

## Ex situ conservation

In contrast, ex situ conservation preserves the genetic material as samples of the population that are readily available for use. Examples of ex situ conservation are seed, pollen, tissue culture, DNA fragments, clone banks, seed orchards, seed production areas, provenance studies, and progeny tests. Ex situ conservation is within the scope of SFTIC, because SFTIC's members do have direct control over the ex situ elements of conservation. Therefore, the proposal for a Southern Forest Gene Conservation Plan is exclusively concentrated on ex situ conservation(Figure 1). The ex situ genetic material is already available and could easily be organized for conservation.

## Collections

Ex situ conservation in agricultural crops is usually organized into 3 kinds of collections according to their function: active collections, breeders' collections, and base collections( National Research Council, 1991). Active collections include the genetic material in seed orchards, clone banks, progeny tests, and provenance tests. These are the primary sites for distribution, evaluation, and general management. Active collections are usually maintained until they outlive their usefulness.

Breeders' collections consist of inbred lines, superior varieties, elite lines, and hybrids mostly found in agricultural crops(National Research Council, 1991). It denotes the germplasm used most frequently by plant breeders. In forestry, breeders' collections would consist of the breeding population of the species. The breeders' collections are a subset of the active collections(National Research Council, 1991).

Base collections are backup reserves of active collections held under condition of long term storage(National Research Council, 1991). Long term storage is defined as spanning a period of time longer than one rotation (Anonymous, 1984). Base collections insure against total loss in the event the active collections are destroyed(Kloppenburg,Jr.. 1988). Base collections can encompass the range of genetic diversity within a species or just be a subset of its range.(National Research Council, 1991).

Since long term preservation is the objective of base collections, they are usually kept of species with true orthodox seeds(Roche, 1975). Pine seed are classifed as orthodox(Schopmeyer, 1974). True orthodox seeds can be stored for relatively long periods at sub-freezing temperatures if their moisture contents are reduced to below 10%(Bonner, 1990). This storage environment is the preferred standard for long term storage for genetic resources conservation , because it is technically achievable at a reasonable cost while insuring the reduction in viability of orthodox seeds occurs very slowly(IBPGR. 1985).

## Long Term Storage

There are a few studies on the effects of long term storage of forest tree species. Pinus resinosa seed maintained high germination stored for 42 years and Pinus elliottii seed had 66% germination after 50 years in cold storage( Bonner, 1990). Samples of true orthodox tree seeds, including some firs and pines, have been stored up to 6 months in liquid nitrogen(LN2) without adverse effects(Bonner, 1990). There is no evidence to suggest that long term storage of true orthodox tree seeds will not be just as successful as it has been with agricultural seeds.

Genetic changes during long term seed storage are possible, because the loss of vigor could lead to genetic drift(Bonner, 1990). It is important at the onset of storage to provide enough seed for each accession to reduce the effects of genetic drift. Seed can be replenished in a base collection when the viability begins to decrease. Genetic change may occur during replenishment through inadvertent selection and seed aging(National Research Council, 1991). Gene frequency comparisons before and after seed replenishment of the base collection could be measured using electrophoresis or restriction fragment length polymorphisms(RFLP).

Methods of storage that reduce the frequency of seed replenishment are very important. For long term seed storage, the seed storage facility needs good environmental controls to keep the temperature and moisture constant(Bonner, 1990). Most organizations do not have up-to-date seed storage facilities or the storage capacity to store seed at low temperatures for long periods of time. One such facility does exist within the Department of Agriculture. It is called the National Seed Storage Laboratory(NSSL) and it is located in Ft. Collins, Colorado. A new 66,000 square foot addition was recently built to address the future demand of seed conservation. A portion of the facility has been designated for forestry tree seed(personal communications with Henry L. Shands, Associate Deputy Administrator, Genetic Resources of USDA).

**National Seed Storage Laboratory**

I would like to propose as part of the Southern Forest Gene Conservation Plan that seed samples be stored at the National Seed Storage Laboratory(NSSL)as base collections. These base collections would be placed in heat sealed packets and serve as a backup to active collections stored or planted at another location. The Center for Plant Conservation (CPC), an association of U.S. botanical gardens, maintains rare and endangered U.S. plant species(National Research Council, 1991). The National Plant Germplasm System, a part of the USDA, provides backup storage of seeds for CPC's collections at its western agricultural research station and at the National Seed Storage Laboratory(National Research Council, 1991). Just like the CPC, SFTIC members could set up a memorandum of understanding with the USDA to house southern forest tree seed at the National Seed Storage Laboratory. There is no monetary charge for storing seed at NSSL(personal communications with Henry L. Shands, Associate Deputy Administrator, Genetic Resources of USDA).

The NSSL does not replenish, evaluate, enhance, or distribute germplasm as part of its mandate(National Research Council, 1991). Eventhough, the NSSL may have the capacity to store seed, the facility does not have the personnel or expertise to prepare the tree seed for storage, to test tree seeds, and maintain a record keeping system. The National Tree Seed Laboratory(NTSL) could act as a clearinghouse by providing their expertise and services in preparing the seed for storage. The Southern forest genetics managers could send the seed for the base collections to the seedlab. The NTSL personnel would check the moisture content before packaging the seed in the heat sealed packets, and log the seed samples into a database. Periodic germination tests on the base collections could also be performed by seedlab personnel. The documentation of the active and breeders' collections could be combined with the base collections' database or kept in separate databases.

It would be the responsibility of the SFTIC membership to establish the protocols on the amount of seed in each sample needed to maintain genetic integrity, establish viability standards, parameters of storage, timing of germination retesting, and database maintenance. An ad hoc committee within SFTIC could be formed to iron out the details of a Southern Forest Gene Conservation Plan. Once the conservation of the southern pines was underway, more southern tree species could be included in the conservation plan if desired by the group. Individual organizations could formulate their own germplasm conservation plan if there were no consensus within the SFTIC membership. Each organization would have to negotiate with the National Seed Storage Laboratory for seed storage.

## Why bother?

The purpose of this proposal is to preserve the legacy of the southern forest genetics managers for future use. Seeds are just seeds when produced by trees, but they become germplasm when gathered to conserve genetic diversity, develop a breeding program, or preserve specific genetically controlled traits(National Research Council, 1991). The phenomenal agricultural productivity of the U.S. has come from using germplasm to improve crops genetically(National Research Council, 1991). The National Plant Germplasm System, developed by the USDA, insures that agricultural scientists have genetic material to work with in the future(National Research Council, 1991).

Similarly, the practice of forestry has conserved the major forest tree species by regenerating tree species after timber harvesting. This in situ conservation has insured a ready supply of timber for products that have fueled U.S. economic expansion and stability.

Society will continue to need the services and products from the forest. As other countries deforest their landholdings, there will be more pressure on the U.S. forests to meet not just the nation's demand for forest products, but a global demand for wood products. With the environmental controversy concerning western forests, more attention will be focused on the southern region to provide more of the wood supply. Sustaining forest productivity will require continued use and access to a broad diversity of germplasm. Managing forest genetics resources will become a strategic necessity for the U.S.(National Research Council, 1991).

An ex situ germplasm management plan may provide a buffer against the loss of genetic management through personnel and organizational changes. New personnel may lose interest in past efforts and abandon projects in pursuit of their own ideas. Some of the collaborative research networks may be disbanded due to fiscal problems or loss of interest. Forestry schools could be closed in the future due to lack of funding and decreasing enrollments.. Genetic material could be lost, misplaced, or abandoned.

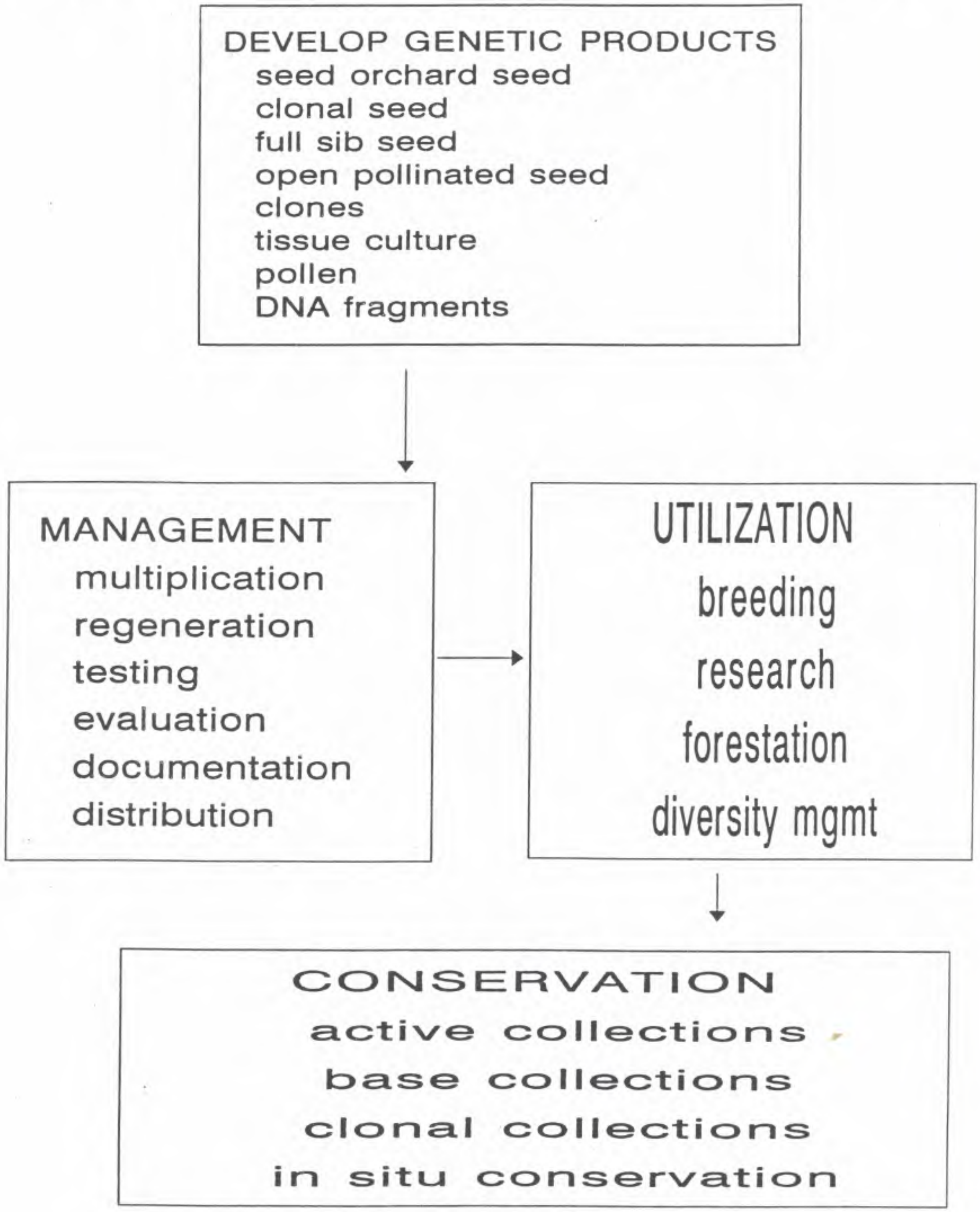
The genetic material could also be destroyed without the proper storage or correct seed conditioning. Proper environmental controls and monitoring equipment of a storage facility are needed to store seed without loss of viability. Storing southern pine species' base collections at a facility, such as the National Seed Storage Laboratory, would make it easier to track the seed's viability over a long time period, so that the base collections could be replenished when their viability fell below set parameters.

## Conclusion

If forest genetic resource managers do not develop a germplasm system to conserve the forest tree resources, who will? They are the most knowledgeable concerning the conservation of the region's forest genetic resources, and have the most access to the collection within an ex situ germplasm management plan.

It is my hope that such a plan will be developed and implemented within the southern region. The southern region could lead the way for the rest of the nation in gene conservation. The southern forest gene conservation plan could be expanded or duplicated to include the other regions of the U.S.

# EX SITU GERMPLASM MANAGEMENT PROGRAM



## LITERATURE CITED


Anonymous, 1984. Report of the fifth Session of the FAO Panel of Experts on Forest Gene Resources, United States, FAO, Rome, 101pp.

Bonner, F. T. 1990. Storage of seeds: Potential and limitations for germplasm collection. For. Ecol. Manage., 35:35-43.

IBPGR. 1985. Cost-effective Long-term Seed Stores. International Board for Plant Genetic Resources, Rome.

Kloppenburg, Jr., J. R., ed. 1988. Seeds and Sovereignty: The Use and Control of Plant Genetic Resources. Durham, N. C.: Duke University Press.

Namkoong, G., and H. R. Gregorius. 1985. Conditions for protected polymorphism in subdivided plant populations. 2. Seed versus pollen migration. Amer. Nat. 125:521-534.

National Research Council. 1991. Managing Global Genetic Resources: Forest Trees. Washington, D. C. National Academy Press. 228pp.

National Research Council. 1991. Managing Global Genetic Resources: The U. S. National Plant Germplasm System. Washington, D. C. National Academy Press. 174pp.

Plucknett, D. L., N. J. H. Smith, and J. Ozgediz. 1990. International Agricultural Research: A database of Networks. Washington, D. C.: World Bank.

Roche, L. R. ed. 1975. Methodology of Conservation of Forest Genetic Resources. Rome, Italy: Food and Agricultural Organization.

Schopmeyer, C. S., ed., 1974. U. S. Department of Agriculture, Forest Service. Seeds of woody plants in the United States. U. S. Dep. Agric., Agric. Handb. 450.

World Resources Institute, International Institute for Environment and Development, and United Nations Environment Program. 1988. World Resources, 1988-89. New York: Basic Books.