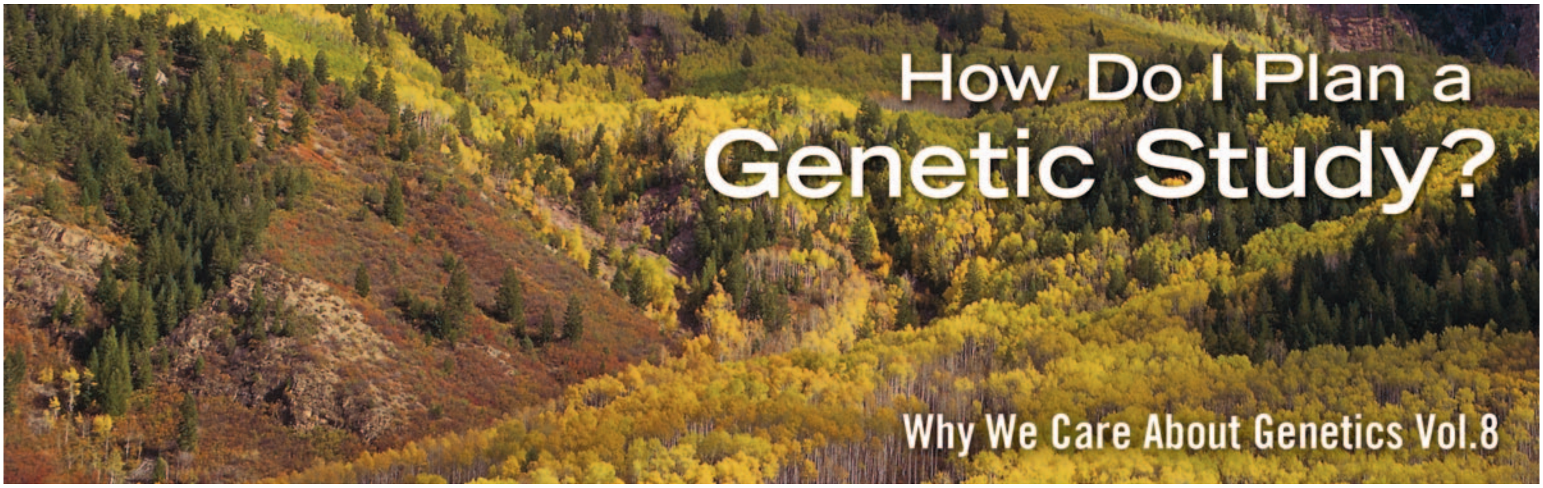

A genetic study can often assist in making a critical management decision or preparing an effective restoration or management plan. However, whether the genetic study is a quick assessment of samples of plant material, or a longer-term and more elaborate project, attention to some basic principles can mean the difference between acquiring useful information or simply wasting time and other resources. Before commencing any genetic study or investigation, three issues should be addressed:

- What is the specific objective of the study?
- What is the likelihood that a genetic study will provide the desired information?
- What is the most appropriate design (including sampling, laboratory methods, and analysis) for the study context and objective?

Study objective: There should be a clear understanding of the study objectives — both to determine the appropriate sampling design and to evaluate the likelihood of achieving the desired information. There is a wide range of possible study objectives that can be served by genetic tools, including: determining whether plants have hybridized, deciding on appropriate (source) plant materials for restoration, determining the ploidy level of certain plants or populations, monitoring changes in genetic diversity over time, identifying plants as belonging to the same or different clone or population, and so on (see, for example, Volume 2).

Likelihood of success: There may be a range of possible outcomes for a genetic study, depending on the context and the amount of information already available for the species. For example, if the objective is to identify the origin of plants in a plantation or restoration project, the chances of a definitive result are increased when: there are good planting or nursery records that limit the number of possible sources; and there are plant samples available from all of the possible sources; there are genetic markers already developed that can distinguish one source population from another. Although there are usually genetic differences of some sort among populations, the ability to detect them varies widely with the type of genetic marker developed and used and the number of loci that can be considered. Sometimes genetic differences among populations are quantitative (for example, the frequencies of certain alleles differ among populations) rather than qualitative (for example, there are alleles that are specific to a population and thus are diagnostic; these are called 'private alleles'). So in the former situation, the result of a genetic study may be expressed in terms of probability rather than definitively. The value to management of such a result should be considered prior to investment in a genetic study. Sometimes the result will be related to the financial

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resources available for the study: if genetic markers are not already available, their development can be expensive, and often the more markers available, the better the resolution of the study. In forensic studies, it is always easier to prove a negative (that is, that the plant did not come from a certain source, or two plants are not the same) rather than the positive. In genetic monitoring studies, the ability to detect changes in genetic diversity over time will depend on the timespan of generations for that species, whether multiple or few generations overlap (and are thus available for sampling), the rate of change in the environment (that is, the strength of the influence that is suspected to have a genetic impact), and other factors.

Appropriate study design: To achieve the most useful and credible result, genetic studies require consideration of the sample size of the focus plant or population, the appropriate spatial distribution of samples, and the type of material (for example, seeds or foliage) to be sampled. The number of samples needed will vary according to the study objectives (for example, whether the goal is to distinguish plant

populations genetically, determine whether two plants come from the same clone, investigate genetic variation in relation to an environmental gradient, or other objective) and the characteristics of the species. Species characteristics such as mode of reproduction (that is, asexual or only sexual) and mating system will influence the number of samples needed. The appropriate spatial distribution of the samples (for example:

[talking with a geneticist prior to initiating a study will ensure your efforts are productive]

Multiple seeds per individual? Number of individuals per population or per unit area? Random or structured distribution?) will depend on the objectives, the spatial range that is considered relevant to the study, and species characteristics. Seeds and leaves (or needles) are the materials commonly used for genetic analysis, but each provides different kinds of genetic information: leaves represent the genetic identity of the sampled plant; seeds provide some information on the sampled plant and the plant which provided the pollen. In some cases (for example, conifers), seeds can provide even more specific information on the genetic contribution from the two parents. Some study objectives may require additional samples from other populations, subspecies, or even species to serve as reference groups or comparisons. Finally, the type of genetic marker

Photo credit: (all above) USDA Forest Service, Genetic Resource Program. (below) US Forest Service; Connie Millar sampling whitebark pine in the eastern Sierra Nevada.

chosen for the analysis will depend on the objective, species characteristics, and characteristics of the marker itself — including the current cost of working with that marker type (see Volume 5).

All of these considerations underscore the importance of talking with a geneticist prior to making investments in a study or collecting samples. This will help to ensure that the sampling effort is effective and doesn't waste your time or other resources, and to get an idea of the type of information that could be gained. The description here has been focused on molecular studies involving field sampling and laboratory analysis, but some objectives would require field-based studies (see Volume 6) or taking samples over time (monitoring) and thus require thoughtful planning and additional considerations. ■