

What are the Genetic Risks Associated With Planting Decisions?

Why We Care About Genetics Vol. 9

When we revegetate or restore an area rather than allow or rely on natural regeneration, there are potential genetic consequences because of first, the amount, and second, the type, of genetic diversity in the plants we are installing. In the first case, if we have introduced plants that have much lower genetic diversity (for example, by using just a few plants for seed sources) there could be negative consequences from genetic erosion (see Volume 11) and inbreeding depression. In the second case, using

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inappropriate seed sources can have the negative consequences of loss of local adaptations or lead to outbreeding depression if those plants hybridize with local plants. These effects vary in probability and in consequences. By learning as much as possible about the species and its pattern of genetic diversity, one can best navigate these potential consequences.

Potential for Inbreeding Depression

If a small sample of plants is used to produce planting materials and the species is largely outcrossing, this may lead to unnatural levels of breeding among relatives. This is more likely when gene flow is limited (from resident plants of the same species) in the new environment. Inbreeding depression (ID) is the lowered fitness among inbred individuals. In extreme cases, this can eventually

lead to local extinction. One mechanism for ID is the increase in homozygosity from breeding among relatives, and thus traits that were 'masked' by heterozygosity are increasingly exposed. So this is generally undesirable. In theory, it is also possible that the 'bad alleles' are exposed, the plants carrying them die, and the remaining population is healthier than before — an effect called 'purging the genetic load'. However, there are few empirical examples of this positive effect, and it would typically happen over a long period of low levels of inbreeding. The risk and consequences of ID depend on the plant species itself and the specific features of the planting activity. In general, it is good practice to avoid increased inbreeding — particularly in outcrossing plants — by collecting source materials from an adequate number of (and well-spaced, thus probably less related) donor plants. Adequate genetic diversity within the plant materials will reduce the potential for ID.

Loss of Local Adaptations

When seeds collected in one area are used to produce plants that are then planted elsewhere, there is a question of how well adapted the plants will be to the new environment. If they are not well adapted, the planting project may fail — directly, or over the course of several generations — and the plants may even negatively affect neighboring populations of the same species if they contribute pollen or seeds to them. Most plant species show adaptations over large spatial distances or environmental extremes (such as high and low elevations or extreme north and south latitudes). Beyond that, plant species vary greatly in the spatial



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scale and environmental conditions to which they show adaptation. Also, adaptations to climate may only be occasionally expressed and noticed, as in adaptation to rare events (such as an extreme drought or infrequent frost). In the absence of any specific information about adaptations of the plant species, it is reasonable to assume that there may be adaptations to the most distinctive environmental conditions (such as major differences in elevation or climate — particularly those related to

[select donor plants from an area that match the restoration site conditions as closely as possible]

moisture availability or low temperatures or special soil types). Following this assumption, one would collect material for restoration purposes from the local (to the restoration site) area, if possible. If the most locally available donor plants differ in their environment from the restoration site environment, or there simply aren't any populations that could reasonably be considered local, a good practice is to select donor



plants from an area that matches the restoration site in climate and other environmental conditions, as closely as possible.

Potential for Outbreeding Depression

If the introduced plants are very different genetically from plants of the same species that are adjacent to the restoration area, then hybridization between the two types of plants may produce progeny that are not well adapted. The resulting lower fitness of these hybrids, called outbreeding depression, can occur for several reasons. If the progeny are 'averages' or intermediate to the parents, and yet there are just two different environments (that of each parent) the progeny are, in effect, adapted to an environment that doesn't exist, and not well adapted to either parental environment. A second mechanism for outbreeding depression is breaking up allelic associations (called linkage disequilibrium) in the adapted plants by crossing. So there are different mixtures of alleles in the progeny, and the mixtures do not work together as favorably as the original sets.

In conclusion, in the pursuit of *locally adapted* plant material for planting projects, there are countervailing risks of incurring inbreeding versus outbreeding depression. However, much can be inferred about the relative risks of each from plant characteristics. For example, the morning glory (*Ipomoea purpurea*) is self-compatible. In populations of this species in the southeastern U.S., bumble bees account for most of the pollination between plants and keep the pollen fairly local. That is, plants that are closer together are much more likely to be related than those further apart. Under these conditions, we would expect considerable inbreeding naturally in morning glory and that it is



Photo credits: (above) Ted Bodner, Morning Glory; (lower left) Dave Powell USDA Forest Service, Cone Collecting www.forestryimages.org.

less vulnerable to inbreeding depression. In contrast, natural populations of largely outcrossing species such as ponderosa pine (*Pinus ponderosa*) or coast redwood (*Sequoia sempervirens*) may exhibit inbreeding depression if a small sample of highly related plants is used as the donor population for restoration. ■

More Information

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