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Appropriate Use of Genetic Manipulation for the Development of Restoration Plant Materials

T.A. Jones and J.G. Robins

Contents

Abstract The diversity of approaches for developing restoration plant material reflects a variety of philosophies that represent what can and should be accomplished by restoration. The "natural" approach emphasizes emulation of putative naturally occurring patterns of genetic variation. The "genetically manipulated" approach involves such techniques as artificial selection, hybridization, bulking, and chromosome doubling to create populations that are ostensibly as well or better equipped to restore ecosystem function than the extirpated natural populations that they are designed to replace. A number of caveats have been issued regarding manipulated plant materials, including concerns regarding improper genetic identity, outbreeding

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depression, maladaptation, and inappropriate amounts of genetic variation. Here we detail (1) when these concerns are likely to be valid or inconsequential, (2) how precautions may be taken to minimize these concerns, and (3) how to respect, as much as possible, the principles cherished by proponents of natural plant materials, yet still take advantage of the benefits of genetic manipulation.

1 Use of Natural and Genetically Manipulated Plant Materials

In recent years, the use of prevariety germplasm (Fig. 1) has become popular for restoration applications in the USA. Prevariety germplasm consists of released (termed "selected" or "tested" class) or unreleased (termed "source identified" class) plant material that qualifies for seed certification but lacks the field testing across multiple locations or years required for cultivar release. In lieu of this testing, the native plant material is presumed to be adapted to the locale from which it originates. The prevariety germplasm scheme supports two "tracks" for native plant materials, "natural-track" and "manipulated-track" (Young et al. 2004). Materials that are an "unrestricted representation of the intact wildland population on the original site" qualify for natural-track status. In addition, intentional genetic manipulation must be avoided when the material is being increased or tested. On the other hand, manipulated-track materials have been "purposefully or inadvertently hybridized with other accessions or selected for distinctive traits."

Based on the objectives for the plant material, the plant-material developer must decide whether a plant material's track should be natural or manipulated. The relative merit of the two tracks is the subject of much debate. Currently, both approaches are widely used, and each has its merits. By addressing the common objections to genetic manipulation in restoration plant materials, we attempt to show how the use of such materials is legitimate when environmental degradation is severe. Indeed, using genetic manipulation to develop plant materials that are able to resist biotic and abiotic stresses may be the best hope for the greatest restoration challenges (Jones and Monaco 2009; Jones et al. 2010).

Nevertheless, manipulated materials are often deemed inappropriate for restoration practice. For example, in 2001 we released P-7 germplasm of bluebunch wheatgrass (*Pseudoroegneria spicata* [Pursh] A. Löve), a multiple-origin polycross of 25 populations, based on its high genetic diversity (Larson et al. 2000; Sect. 3.6). But despite P-7's genetic similarity to other released bluebunch wheatgrass materials (Larson et al. 2004) and despite support in the restoration ecology literature for such an approach (Millar and Libby 1989; Burton and Burton 2002; Rice and Emery 2003), this material has been roundly criticized for its lack of a single point-of-origin. While some are ready and willing to implement such materials onto the landscape as the best hope for countering what they perceive to be a ferocious and overwhelming threat, others consider their use to be unacceptable. We contend that the desired approach is the one that maximizes the probability of success for a particular situation. Our personal plant material development efforts have entailed

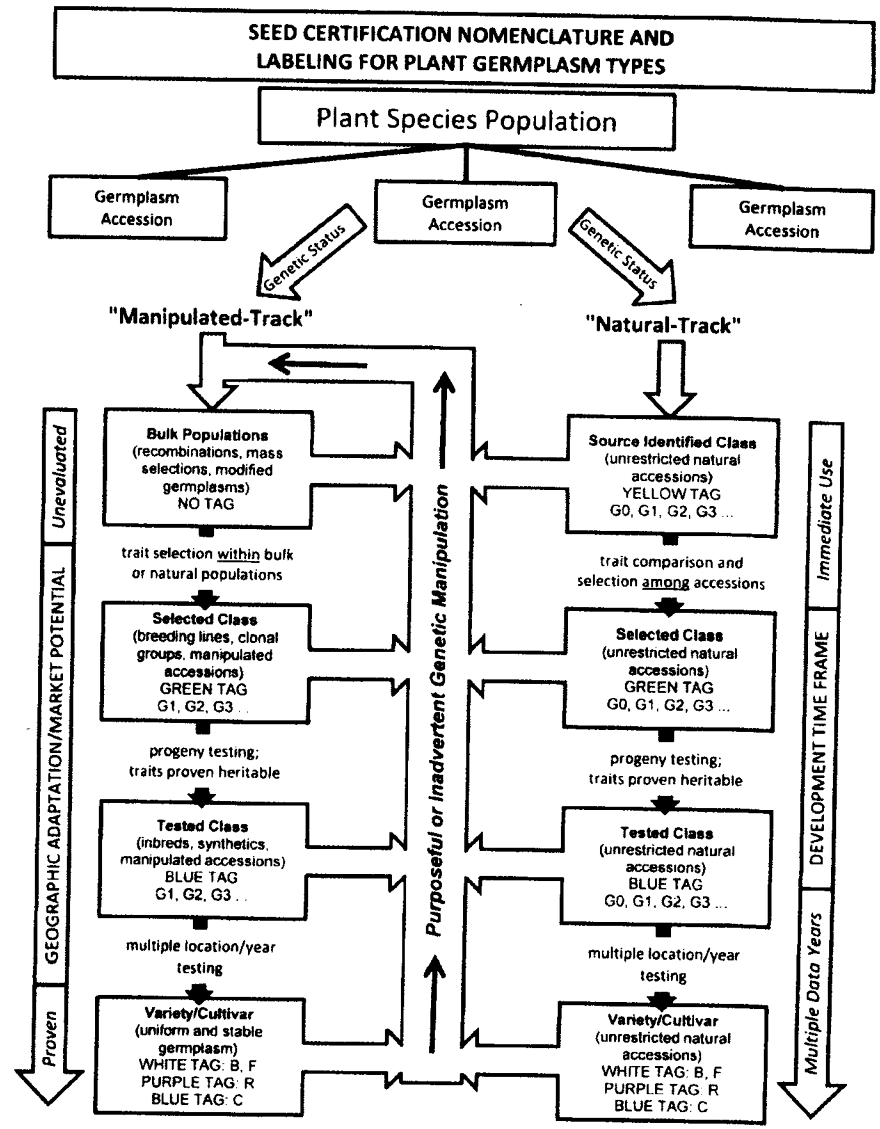

Fig. 1 Prevariety germplasm development flow chart as updated from Young et al. (2004). (With permission of the Association of Official Seed Certifying Agencies (AOSCA))

both approaches, and we see nothing to be gained by insistence on the exclusive use of one approach over the other regardless of the restoration challenge at hand.

The natural approach has been widely accepted because it appeals to restoration ecologists and practitioners trained in the evolutionary paradigm, which is