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Reintroduction of rare and endangered plants: common factors, questions and approaches

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Abstract. The science of reintroduction for conservation purposes is young, and there is still much to learn about the practice. As a means to achieving biological goals of successfully establishing new populations to enhance a species survival prospects, and project goals, such as learning how to go about establishing new populations, reintroduction projects are best done as well designed scientific experiments that test explicit hypotheses. Focusing on a range of factors common to any reintroduction, we review several empirical reintroduction projects with respect to hypotheses tested, experimental materials and methods employed, and evaluate their success in both biological and project terms.

Introduction

The central biological goal of rare-plant reintroduction is to establish resilient, self-sustaining populations that have sufficient genetic resources to undergo adaptive evolutionary change (Guerrant 1996*a*). In other words, the purpose is to enhance the species survival prospects in the wild. Reintroduction is used here as a general term that includes the establishment of new populations and re-establishment of extirpated populations from *ex situ* material, and the enhancement or augmentation of existing populations. It does not include the translocation (by removal and transplantation) of naturally occurring plants from one location to another, which involves a different set of strategic, procedural and ethical considerations.

In an insightful discussion of how to measure and define success in rare-plant reintroduction, Pavlik (1996) distinguished biological purposes and project purposes. Biological purposes revolve around the desire to establish new or augment existing populations and thus increase a species survival prospects. Project purposes have to do with evaluating the means by which the desired biological ends are pursued. Strategically, and as a practical matter, we agree with Falk *et al*. (1996) that the most efficient way to achieve the biological and project purposes is to conduct reintroduction projects as scientific experiments, carefully crafted to test explicit hypotheses about how best to go about the practice of reintroduction. In that way, whether or not the project is biologically successful, methods and protocols are most likely to be improved by information gained from the effort.

Reintroduction projects typically have multiple purposes. In addition to the basic biological purpose of establishing new or increasing the size or diversity of existing populations, project goals may include evaluations of practical greenhouse or field methods to theory-driven hypotheses about demography, population genetics or ecological interactions. By designing reintroduction projects as controlled scientific experiments, the effects of particular factors can be elucidated. Through careful observation and monitoring, additional, supplementary information can often be gleaned opportunistically. Reintroduction projects can also serve public education and policy purposes, both to provide the public with a focal point for what otherwise can be abstract discussions about the plight of rare species, and to give policy makers information with which to make better, more informed choices.

Different legitimate purposes can conflict with one another (Guerrant *et al*. 2004). What may seem important to address as a matter of scientific interest may not be in the best conservation interest of the species in that place and time. For example, the results of a common-garden experiment, in which material collected across a species range are compared, might be interesting theoretically and have significant practical implications, but could degrade the survival prospects of the resulting population through outbreeding depression or introduction of genes maladapted to local conditions. It is important, therefore, not only to be clear about the various purposes served by any reintroduction attempt, but also about their relative priority, and to anticipate potential unintended consequences, such that critical values are not compromised.

Each reintroduction project is unique with regard to the species involved, questions asked, intended purposes and external circumstances in which the work is conducted. Nevertheless, a large number of basic and important factors or elements are common to many if not all reintroduction attempts, and are thus incorporated into projects, either explicitly or implicitly.

The central focus ofthis paper is on a set of elements common to many if not all reintroduction projects, and how we have addressed them as research questions into our work. Table 1 lists some of these, and how they were incorporated into seven

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