Relevance of Natural Recovery to Ecological Restoration

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Incorporation of natural recovery in the design of ecological restoration is a valid and important strategy. Ecological restoration is not akin to civil engineering, where all materials are assembled and all processes are controlled from start to finish. Instead, practitioners depend on natural processes to fulfill at least some restoration tasks, even in the most technically consummate projects. In this respect, well-informed projects maximize opportunities for natural processes in order to reduce expenditures of labor and budget and to assure a restoration "product" that is as faithful to the site and as natural as possible. These processes include resilience (the capacity for communities to recover directly from disturbance; Westman 1978) and succession.

Prach and Hobbs (2008) elegantly modeled the relationship between technical solutions and natural regeneration when attempting restoration on bare substrates such as mined lands. They prefaced their model by stating, "Basically, there are three approaches to restore a disturbed site: 1) to rely completely upon spontaneous succession, 2) to exclusively adopt technical measures of reclamation, and 3) to combine both previous approaches by manipulating spontaneous succession toward a target" (p. 363). Although they advocated combining technical solutions and natural regeneration in ways that were appropriate for site conditions and that favored the attainment of project goals, they gave the impression, perhaps unintentionally, that restoration could be achieved by leaving the task entirely to nature or by entirely technical solutions. The implication that restoration is achievable by nonengagement reveals a misconception that is pervasive among professionals with interests in ecological restoration.

The Society for Ecological Restoration International (SER) has consistently characterized ecological restoration as an intentional activity that facilitates recovery of an impacted ecosystem (SER 2002). The practitioner purposefully intervenes, manipulates, or provides subsidies to the biota and its physical environment as necessary to facilitate restoration. In other words, ecological restoration requires premeditated intent and some kind of purposeful step or action to facilitate recovery. However, numerous papers have been published that describe instances of resilience or succession with the tacit and possibly unfounded assumption that their recovery represented ecological restoration. Aronson and others (2009) determined that ten percent of all papers published in *Restoration Ecology* since 2000 fall into this category, and so do many entries to the database of case studies that appear online in the Global Restoration Network (www.globalrestorationnetwork.org). This practice erroneously suggests that natural recovery without any intent or engagement whatsoever constitutes a form of ecological restoration. The occasional use by authors of vague terms like *passive restoration* reinforces this misconception.

Interventions in an ecological restoration project need not be invasive in a technical sense, whereby trees are planted or seeds sown over wide areas following extensive site preparation and sometimes major repairs to the physical environment. Instead, the minimal interventions of what has been called *assisted regeneration* (McDonald 2000) are sufficient to reinitiate arrested ecological processes. Examples of assisted regeneration include releasing desirable natives from competition (Shono et al. 2007), fire regime alteration, nucleation plantings, deposition of debris mounds, artificial disturbances mimicking those of animals in order to increase niche diversity, creation of microcatchments to capture water and nutrients, and placement of perches for frugivorous birds. These interventions have also been referred to as triggers, because they represent minimal subsidizations with high returns by removing obstacles to ecological recovery (McDonald 1996).

Restoration has also been accomplished without the use of any manipulations of the biota or the physical environment in a process that we call *prescribed natural regeneration*. The most celebrated example of prescribed natural regeneration is the excellent tropical dry forest restoration on 110,000 hectares of marginal farmland in the Guanacaste region of Costa Rica by Daniel Janzen (2002). Restoration consisted of purchasing the land and then letting "nature take back its original terrain" (Janzen 2002, 559). Although intentional tree planting and soil

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conditioning were attempted in limited areas, the project generally lacked manipulations of any sort. We could argue that what occurred in Guanacaste was unassisted long-term forest succession rather than restoration. But dismissal of Janzen's restoration efforts would be disingenuous, because the restoration was carefully planned and implemented with superlative results.

If it were to conform to the SER (2002) definition of ecological restoration, what was the active intervention at Guanacaste, disregarding the few places where native trees were planted or soils amended? It was the intentional act of protecting land from ranching, subsistence agriculture, irrigation, heterogeneous hunting, sporadic logging, and anthropogenic fires with prior knowledge that spontaneous forest reseeding would follow. The operative word here is *intent*. Janzen developed a restoration plan based on a well-conceived strategy backed by observations on natural reseeding, whereby protection allowed the recovery of tropical dry forest in a manner that considered reference conditions.

Intent in prescribed natural regeneration is predicated upon three prerequisites (and it was, at Guanacaste):

1) understanding of the causes and ecological consequences of degradation
2) ecological knowledge of recovery processes
3) designation of reference ecosystems and an understanding of their biodiversity

Ecological knowledge that recovery is possible requires an appreciation of the capacity and limits of characteristic species to recover owing to their inherent resilience, a property then conferred to communities. Intent assumes that the restoration practitioner has the requisite authorizations, budget, and other capabilities to carry out the project; it is not just wishful thinking but the capacity to act on the intention. Janzen had that capacity.

Other examples of prescribed natural regeneration come from case studies in central Europe, where forests have regenerated without assistance on former mined lands. Regeneration was intentional and was predicated on knowledge of seed dispersal from nearby natural forests that served as reference models and also from knowledge that a substrate suitable for soil formation had been prepared during physical mine reclamation (Prach and Pyšek 1994, Řehounková and Prach 2008).

The occurrence of natural regeneration does not always signal ecological restoration. Even if there were no intent to restore an ecosystem, fortuitous circumstances can still conspire to provide the appropriate conditions for its recovery. We contend, however, that such recovery should not be designated as ecological restoration. Without prior intent for restoration, natural recovery is simply that—natural recovery. The results may have been the same, at least over the long term; it would be a welcome windfall for conservation; and it can provide restorationists with invaluable insights into how to harness this capacity in sites where restoration is intended. It is not a case of one being intrinsically better or worse; it is simply that natural recovery (in and of itself) is not restoration.

Why is it worthwhile to identify boundaries between natural recovery that occurs outside restoration and that which occurs within it, and how can this distinction contribute to our understanding of ecological restoration? We see two benefits. First, as restorationists we can learn from examples of resilience and succession, which teach us how to understand, anticipate, and harness natural recovery potential in restoration. With this awareness we can avoid underestimating natural recovery potential on a restoration site and appropriately design our interventions to harness it rather than dismissing it as unimportant.

Second, the distinction allows us to more critically assess the quality of the natural recovery that ensues, rather than assuming that it will necessarily lead to an appropriate reference state (Clewell and Aronson 2007). In other words, it protects us from the alluring self-deception that all natural recovery necessarily exhibits full ecological functioning and superior biodiversity. Consequently, we can avoid the temptation to overestimate the potential for natural recovery and compensate for its inadequacies in restoration plans. For example, dos Santos and others (2007) recommended assisted regeneration for otherwise spontaneously developing vegetation on recently deposited coal mine spoils in order to attain improved soil structure, fertility, and biodiversity.

If an inadequacy in natural recovery is not recognized, the error can lead to what could be called underrestoration, where functionally incomplete assemblages of species lead succession away from the appropriate reference state. The antithesis of underrestoration is what might be called overrestoration, particularly in technical projects, where needless interventions overwhelm an ecosystem's inherent recovery capacity. Such technical overshoot can deflect the trajectory of restoration toward an undesirably altered state. Both errors arise from insufficient familiarity with natural resilience potential and the limits and capacity of restoration to dovetail with them.

To a large extent, the problems we have addressed in this paper could be attributable to unsettled terminology rather than to conceptual differences. We urge restorationists to work assiduously toward developing a common use of terms with precise and unambiguous meanings. Our hope is that authors will then adopt these terms and that editors will insist on their proper application.

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