Restoration Ecology to the Future: A Call for New Paradigm

Young D. Choi[1,2]

Abstract

The discipline of restoration ecology has grown remarkably in the past decades, providing new ideas and opportunities for conserving biological diversity, managing ecosystems, and testing ecological theories. On the other side, its past-oriented, static, and idealistic approach has been criticized for subjectivity in determining restoration goals, inapplicability to dynamic ecosystems, and inability for restoring certain irreversible losses. Moreover, unpredictable sustainability of the restored ecosystems, which were modeled after its historical fidelity, adds our skepticism under the changing environment. This paper calls for a new paradigm of ecological restoration to the future. A future-oriented restoration should (1) establish the ecosystems that are able to sustain in the future, not the past, environment; (2) have multiple alternative goals and trajectories for unpredictable endpoints; (3) focus on rehabilitation of ecosystem functions rather than recomposition of species or cosmetics of landscape surface; and (4) acknowledge its identity as a "value-laden" applied science within economically and socially acceptable framework. Applicability of ecological theories to restoration practice is also discussed in this paper.

Key words: ecology, future, paradigm, rehabilitation, restoration, sustainability.

The discipline of restoration ecology has grown astoundingly in the past decades, providing new ideas and opportunities (Choi 2004; Davis & Slobodkin 2004*a*, 2004*b*). It has been regarded as a new strategy for conserving biological diversity (Jordan et al. 1988) and ecosystem integrity (Cairns & Heckman 1996), a litmus test for applicability of ecological theories to practice (Bradshaw 1983, 1987, 2002), and a hope for the future (Dobson et al. 1997). At the same time, restoration ecology is a subject of skepticism as an emerging science. Kirby (1994) labeled ecological restoration as "an expensive self-indulgence for the upper classes" and "New Age substitute for psychiatry" that "distract intelligent and persuasive people from systemic initiatives." Davis (2000) even went further arguing to retire the word "restoration" for its subjectivity in determining restoration goals, inapplicability because of a static approach to dynamic ecosystems, and impracticality because of certain irreplaceable losses (e.g., keystone species). Nonetheless, major dilemmas lie in our contemporary paradigm of past-oriented and idealistic restoration. In this article, I attempt to address these dilemmas and a need for changing our restoration paradigm from past- to future-oriented for its applicability of ecological theories to restoration practice, predictability of restoration outcome, and sustainability of restored ecosystems.

As Davis (2000) noted, our first dilemma was setting target ecosystems of the past. Which time period in the past should be the target of restoration? Should we go back to 200 years ago, 300 years ago, or ice ages? Determination of target ecosystems is highly arbitrary and subjective. Second, to what magnitude and scale do we want to restore? Over eight million people live in Chicago and its suburbs where mostly wetlands existed prior to European settlement (Choi & Bury 2003; Choi 2004). Would the people of Chicago area be willing to abandon their city and homes for "noble" wetland restoration? Not likely! Economic and social costs of restoration are often prohibitive. Therefore, goals and scopes of restoration are largely determined by social acceptance (Jackson et al. 1995; Hobbs & Norton 1996; Choi 2004; Davis & Slobodkin 2004*a*). This is subjective too. Third, would it be possible to restore the past? In North America, landscapes before arrival of European settlement (200–300 years ago) have typically been the targets (Davis 2000). Can we restore the ecosystems of seventieth and eightieth centuries? Restoration of past ecosystems is possible when climatic conditions suit the species that once were present (Cairns 2002). However, the IPCC (2001) report concluded that the Earth's surface temperature increased by 0.6°C during the twentieth century; there is no sign of reversing this trend. Moreover, much of the original characteristics of ecosystems that existed in the eightieth century or earlier were altered irreparably (Wali 1999; Choi 2004) and many key species were lost permanently (Davis 2000) during the courses of cultivation, industrialization, and urbanization. We need to admit our inability to restore an ecosystem to its very original state. We cannot go back to our nostalgic past! Last, would it be possible for restored ecosystems to be sustainable in the future environment? IPCC (2001)

[1] Department of Biological Sciences, Purdue University Calumet Hammond, IN 46323, U.S.A.
[2] Address correspondence to Y. D. Choi, email ydchoi@calumet.purdue.edu

projected that the Earth's surface temperature would increase 1.4–5.8°C at a 90–95% chance. The Earth's soil and water are continually enriched by atmospheric depositions of nitrogen (Galloway et al. 2004) and other nutrients. Intercontinental species invasions, mostly through transportation by humans, are faster than ever (Lonsdale 1999). Sustainability of restored ecosystems that were constructed for the past environment is very unlikely in the future environment (Vitousek et al. 1997).

Our capacity for ecological restoration is limited; however, our limitation is not a justification for "irrestoration." Ecological restoration is essential for mutual survival of both human and nature (Cairns 2002) and becoming an increasingly important tool in our attempt to manage, conserve, and repair (or enhance) the world's ecosystems (Hobbs 2004). Meanwhile, efforts to rigidly preserve a limited mission, such as restoration of past environments without social values, would probably lead to ossification within the field, a decline in its scientific credibility, and loss of public support (Davis & Slobodkin 2004*b*). Although it is undoubtedly valid to learn from the past (Choi 2004), our restoration efforts for the future need not to be constrained by "historical-fidelity" (Higgs 2003; Halvorson 2004; Throop 2004). A future-oriented restoration should aim to establish ecosystems that are able to persist in future environment (Cairns 2002; Choi 2004).

In addition, as Bradshaw (1983) noted, ecological restoration would continue to be a testing ground for applications of ecological theories. Particularly, succession theories may provide conceptual trajectories of restoration outcomes (Dobson et al. 1997; Wali 1999; Walker & del Moral 2003; Choi 2004; Temperton & Hobbs 2004). Ecosystem processes are dynamic, not static; they do not necessarily undergo an ordered development toward a single endpoint, but instead more likely undergo rapid transitions between different metastable states toward multiple endpoints (Hobbs & Norton 1996; Hobbs 2002); and the endpoints are often unpredictable (Temperton & Hobbs 2004). Therefore, we need to set alternative multiple, instead of single, goals for restoration; multiple trajectories are essential for the unpredictable nature of our future environment (Choi 2004). A broader consideration of ecosystem- or landscape-approaches (Hobbs & Norton 1996; Hobbs 2002, 2004) is also needed because ad hoc or situation-specific sorts of gardening (Allen & Hoekstra 1992) are not conducive to cross-fertilization of ideas between different localities (Majer & Recher 1994; Choi 2004). Moreover, we need to acknowledge that restoration ecology is an applied science, like engineering, that has a direct link to human interests. Goals of our restoration efforts are indeed value-laden social enterprises (Davis & Slobodkin 2004*a*). We, not nature (although we make a significant reference of it), set the goals and scopes of restoration based on our own judgment. Therefore, the goals of restoration should be within an economically and socially acceptable framework (Jackson et al. 1995; Hobbs & Norton 1996; Choi 2004).

Future-oriented restoration should focus on ecosystem functions rather than recomposition of species or the cosmetics of landscape surface. If a person lost one of her or his legs, the physician would put a prosthetic leg. The primary purpose of the prosthetic is to rehabilitate the function of leg rather than to recompose original flesh and bones. Physicians call this process rehabilitation, not restoration. Taking this analogy to our profession, a complete replica of the predisturbance ecosystem is not realistic because much of the damages in our environment are irreversible (Choi 2004). All we can do for now is to rehabilitate certain ecological functions, through reconstruction of ecological structures on a limited basis, which were lost by environmental degradations. The reconstructed structures are often made of alternative materials, not necessarily the original bones and flesh. Box (1978) and Wali (1992) defined "rehabilitation" as an act of improvement from a degraded state. Bradshaw (2002) elaborated this definition as an action of restoring degraded ecosystems but with little or no implication of perfection. The Society for Ecological Restoration (SER) defined restoration as the process of assisting the recovery of damaged, degraded, or destroyed ecosystems (SER 2002 as cited by Hobbs 2004). This SER definition seems to reiterate the concept of rehabilitation that was synthesized by Box (1978), Wali (1992), and Bradshaw (2002). Nearly all of our actions of restoration, in my opinion, fall into the definition of "rehabilitation." Therefore, our paradigm of ecological restoration needs to be redefined with functional rehabilitations for the future, not nostalgic recompositions of the past.

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