Values and Science in Ecological Restoration—A Response to Davis and Slobodkin

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In “The Science and Values of Restoration Ecology” (Restoration Ecology, this issue), Davis and Slobodkin (henceforth D & S) present the view that the goals and objectives of ecological restoration can only be set in a social context, and that the science of ecology only becomes important during the implementation stage of a restoration project. In so doing, they adopt a perspective that is in direct contradiction to many of the key tenets of The SER (Society for Ecological Restoration) Primer on Ecological Restoration (SER Science & Policy Working Group 2002; henceforth the “Primer”). The Primer is a first attempt by nine members of SER International’s Science and Policy Working Group to describe the young and evolving field of ecological restoration, its principles and its strategies. The Primer conceptually describes how ecological restoration projects can be planned, conducted, monitored, and evaluated, and seeks to show how ecological restoration articulates with ecosystem management and nature conservation, and how it relates to allied activities like rehabilitation and ecological engineering. The Primer was posted on SER International’s website in April 2002, with the anticipation that feedback from around the world would stimulate and assist the preparation of a second edition that would respond to all constructive criticism. Fifteen months later, it is clear that the Primer is having an impact on restorationists and their clients, not to mention the World Conservation Union (IUCN) and other international organizations (Society for Ecological Restoration International News 2003). In the context that this first attempt can be improved upon, critical essays such as that of D & S are most welcome. As the three primary authors of the Primer, all of whom have put a great deal of thought and discussion into its content while carefully following the international literature on the related subjects, we felt that it would be of value to present an expanded explanation of the tenets of the Primer with which D & S disagree, providing support from recent ecological literature on the more controversial topics.

Davis and Slobodkin assert that “defining restoration goals and objectives is fundamentally a value-based, not scientific, activity”, while the science of ecology “plays a central and essential role in the implementation of restoration projects.” We consider their emphasis on value-based aspects of restoration to be a nonissue with which there is no disagreement in the Primer or generally among restorationists. However, we argue that ecological science has a much broader role in restoration than merely in its implementation. Furthermore, D & S dismiss as outmoded the term “ecosystem” which appears many times in the Primer, and also question the use of “integrity” and “health” as ecosystem attributes or desiderata for ecological restoration. They argue that “attributes such as ‘health’ and ‘integrity’ can (only) be meaningfully applied to entities that have been directly shaped by evolution, such as individual organisms.” However, “communities and ecosystems are not shaped as entities by evolution.” We find D & S’s critique of the Primer’s use of the terms ecosystem, health, and integrity to be unfounded. In addition, we object to the manner in which D & S relate restoration to architecture, engineering, and advocacy, and we express concern with their proposed definition of restoration.

Values Versus Science

The Primer maintains (Section 9) that the young and vigorous science of restoration ecology provides not only methods, but also key concepts, models, and evaluation techniques in support of restoration in practice. In other words, practitioners rely on the body of science that comprises restoration ecology to achieve restoration goals. In this respect, no disagreement exists between D & S and the Primer. However, in contrast to D & S’s contention to the contrary, restoration practitioners employ science from start to finish. The very determination that degradation has actually occurred requires sophisticated ecological knowledge and discrimination, as does its empirical rendering. The selection of a reference condition on which restoration can be modeled is largely an ecological enterprise. The definition of restoration goals requires a scientific basis to
select goals that are ecologically plausible and socially relevant, long term. Likewise, the selection of general restoration strategies and specific methodologies requires sound ecological judgment. At a more philosophical level, the word “implementation”, as used by D & S to refer to the practice of ecological restoration, is a misnomer, because all restoration projects at this early stage in the development of restoration as a discipline can be conceived as long-term experiments.

Davis and Slobodkin argue, without documentation, that restorationists often confuse science with their own values, and neglect the value-basis of social decisions concerning ecological restoration. We suggest that such confusion resides with D & S, not with the average restorationist. Curtis Prairie, which is widely considered a classic if not the very first documented ecological restoration project, offers a definitive example of how scientific and socioeconomic endeavors are complementary and inextricably intertwined (Jordan 1983; Cottam 1987). J. T. Curtis conceived this prairie restoration initiative in scientific terms. The project was consummated only because of the availability of labor provided by the Civilian Conservation Corps (CCC). The CCC was a socioeconomic enterprise devised by America’s President Roosevelt to give employment for many who had lost their jobs after the Great Depression of 1929. We find this no different from much so-called basic research today that is funded on the basis of socioeconomic imperatives.

The Primer makes it clear in Section 1 that the decision to initiate a restoration project should ideally be made by all concerned stakeholders and by consensus. Stakeholders, by definition, attempt to satisfy their own values and interests. We argue that the decision to restore can only be made wisely if ecologically as well as economically and socially tenable goals, and objectives are clearly presented to the stakeholders. In order to develop realistic and effective restoration goals and objectives, it appears to us self-evident that concerned parties must rely on expert scientific opinion in selecting goals that are attainable. The greater the practitioners’ ecological knowledge the greater will be the likelihood of developing goals and objectives that are feasible and that yield valuable and enduring results. We sympathize with the restoration ecologist who is charged with the implementation of a “restoration” project, the goals of which have been chosen on purely socioeconomic grounds. For example, we are personally aware of a project to create a wetland on top of a mine tailings stack and another to establish deciduous forest on a leached, acidic, sandy soil. As noted in the final Section of the Primer, we argue that restoration projects should intentionally be integrated into larger programs of a socioeconomic nature, including conservation, ecosystem management, and resource exploitation activities that have complementary restoration components.

Ecosystems: What are They?
Davis and Slobodkin consider the concept of the ecosystem to be outmoded or obsolete. They suggest that the Primer’s consideration of ecosystems as “ecological entities” is “reminiscent” of antiquated ideas tracing back to F. E. Clements and colleagues in the 1930s. D & S advance the view that ecosystems and “communities” (1) are not tightly organized and lack “coherence”, (2) do not have clear boundaries, (3) have no “mechanisms that have evolved to regulate particular processes”, and (4) “do not exhibit any kind of evolutionary imperative, such as reproduction, as do individual organisms. Although it is true that ecological thought has “moved on” since the time of Clements, there is still a great deal of evidence that biotic communities and ecological systems, at various scales of complexity and resolution, do show a very high degree of integration, or “coherency” in their responses to perturbations of various kinds. Ecologists generally agree, however, that communities and ecosystems should not be considered as “pseudo-organismal” as they were by some phytosociologists and ecologists two or three generations ago. Ecosystems may not evolve in the sense in which the word is used in population biology, but they certainly develop over time and appear to have emergent properties and coherent developmental dynamics. Although ecosystems may not reproduce in the usual sense, and their boundaries are not discrete like those of organisms, they do develop feedback loops that are reminiscent of homeostasis and resilience seen in organisms faced with external perturbations or trauma. Different approaches exist, but a large number of ecologists are, and have been, actively engaged in exciting and integrative or transdisciplinary research in these areas, including the late Eugene and Howard Odum and many of their former students. The interdisciplinary group known as the Resilience Alliance (available from: http://www.consecol.org; Carpenter et al. 2001), who work with a model of ecosystem development and dynamics (adaptive cycle; see Gunderson & Holling 2001) that is very different from those of the two Odums, not to mention that of Clements, firmly embraces the notion of ecosystems as “integrated entities.” We note that D & S misrepresent contemporary functional and applied ecosystems literature by prominently citing two evolutionary biologists, Jared Diamond and the late S. J. Gould, and an unbalanced sampling of ecologists, that is, Kapustka & Landis (1998) and Lackey (2001). Readers are, therefore, encouraged to explore this subject in more detail, starting with, for example, Pomeroy & Alberts (1988) and Golley (1993), and continuing with a more balanced sampling of the ecological literature including, for example, Carpenter et al. (2001)

The Primer also reflects many threads in contemporary ecological thought when it states in Section 1 that restoration aims to return an ecosystem to its historic trajectory, which has the potential for a broad range of ecological expressions (Section 4). The Primer never stipulates that a particular historic ecosystem could or should be restored to a pristine, baseline condition of some sort but rather, most often, to its former trajectory. Section 3 explains that restored ecosystems are not static, but instead are shaped
by, and may respond or adapt to, ongoing intrinsic and extrinsic influences, both human and nonhuman.

**Ecosystem Health and Integrity**

Davis and Slobodkin express discontent with the Primer’s (or anyone else’s) use of the terms ecological integrity and health. We understand their concern, but the Primer was written for a broad audience including land managers, policy makers, educators, and the concerned but not necessarily scientifically literate public for whom these terms can conveniently convey the broad ecological intent of restoration in a few words. Some professional ecologists reject these terms for their imprecision (Lackey 2001), whereas many others wholeheartedly embrace them and seek to develop them further in theoretical and practical terms, at the interface of scientific ecology, societal values, and public policy. The International Society for Ecosystem Health (Rapport et al. 1999) and the above-cited Resilience Alliance, as well as many other nonaffiliated scientists of various backgrounds, employ these notions and are working actively to go “from metaphor to measurement” in their approach to health, integrity, and resilience of ecosystems, including socioecosystems (Carpenter et al. 2001). Although acknowledging that the metaphors and analogies with organisms are essential tools for communication (Lackey 2001; cf. Aldo Leopold’s seminal use of the metaphor, Leopold 1999), they assert that “serious” scientific and practical, conservation/sustainability “harvests” are to be gained through their mathematical exploration as well as experimental or public policy applications (Rapport 1995; Cairns 1999; Costanza et al. 1999). Rapport et al. (1999) address this challenge in terms of “extending the concept of ‘health’ from its traditional domains of application at the individual and population levels to that of the whole ecosystem.” Harris & Hobbs (2001) neatly express the linkages between ecological restoration and ecosystem health.

Of course, D & S are not the first writers to criticize the notion of ecosystem health. The debate goes back at least 10 years (Calow 1992; Suter 1993; Wicklum & Davies 1995; Callicott et al. 1999; Lackey 2001). The conflict in fact is linked with the debate over the term “ecosystem” itself—some consider the term semimystical and unacceptable, whereas others, including ourselves, consider it the core concept in ecology. For that reason, these terms are specifically defined (Section 4) in the manner in which they are used in the Primer. Ecosystem integrity and health are both defined as referring to the state or condition of an ecosystem in which its dynamic attributes are expressed within the normal ranges of activity related to its ecological stage of development. D & S incorrectly argue that both terms, as used in the Primer, connote processes rather than states or conditions, and they build their objection to what they perceive as the Primer’s endorsement of “ecosystems as organisms” on this misconception.

The Primer distinguishes between these terms by defining integrity in terms of biodiversity—particularly species composition and community structure—whereas health is defined as an ecosystem’s overall dynamic state at a given time based on ecosystem functioning. Indeed, Ulanowicz (1997) and Mageau et al. (1995) argue that ecosystem “health” is something that can be measured at a given point in time, while integrity, which approaches the notion of resilience, can only be evaluated over a longer period. The relevant point here is that a number of ecologists do use these terms, in scientific as well as popular writings, and are working to refine these concepts and methods of analysis and measurement (Wu & Loucks 2000; Müller et al. 2000; Morgan Ernest & Brown 2001; Xu et al. 2001).

In dismissing the use of scientific ecological rationale in the establishment of restoration goals, D & S introduce the teleological concept of “intrinsic evolutionary or ecological purpose”, suggesting that they themselves endorse both ecological and nonscientific values. Furthermore, the statement cited by Jared Diamond that the goal of restoration is not a self-evident mandate, and that it is only one of the many possible choices, does not necessarily imply that ecological thought does not or cannot enter into the goal-setting process. The logic in D & S’ statement that “characterizing communities and ecosystems as ‘healthy’ or ‘damaged’ [is] a value-based, not scientific, assessment” is flawed, because the state of health of an ecosystem can only be effectively evaluated on the basis of ecological attributes (Aronson et al. 1993) or a combination of ecological and social values (e.g., Gunderson et al. 1995; Harwell et al. 1999). Sociocultural values alone might be used as a basis for decision-making, it is true, when the benefits of restoring a strictly cultural ecosystem are considered, as is commonly the case in Europe or the Mediterranean Basin. Bill Jordan and coworkers have explored, and continue to explore, this terrain with great penetration (e.g., Jordan et al. 1987; Jordan 1994, 2003; cf. Higgs 1997). But, in sum, as Higgs (1997) and many others have pointed out, ecological restoration works best as an integrative exercise, combining sciences of various sorts, and nonscience as well.

**Other Issues**

Davis and Slobodkin misrepresent ecological restoration when they equate it with architecture and engineering. These fields require fixed, predictable endpoints, and tend to ignore evolutionary or involutionary processes after delivery of the “product”. The SER International Primer (Section 10) explains that restoration “recognizes and accepts unpredictable development and addresses goals that reach beyond strict pragmatism...” If an ecosystem were to be restored to a particular historic state, then a comparison with architecture would be valid. Instead, ecosystems are ideally restored to their historic trajectories, after which a range of possibilities exist.

Davis and Slobodkin infer that SER is an advocacy group. SER’s bylaws specifically prohibit the advocacy of projects and programs. SER limits itself to the advocacy of
“good” restoration. This distinction was not conveyed by D & S and is, therefore, a potential source of confusion.

We challenge the alternative definition of ecological restoration offered by D & S on the basis of more than its syntactical limitations (“restoration is the process of restoring processes”). Despite their apparent rejection of the idea of a reference system, they speak of “valued processes or attributes”. In order to know the valued attributes and processes, the restorationist, in planning a restoration project, must have in mind an image (or more than an image) of the relevant ecosystems and landscapes before degradation or transformation. Furthermore, although the concept of degradation is absent from D & S’ proposed definition, it must be acknowledged that if a landscape is not recognized as being degraded, or somehow damaged, there is nothing to restore. We are also concerned by their implication that the piecemeal restoration of a landscape is valid. If so, then their definition could equally well be applied to many mitigation projects of limited scope and ecological consequence. Instead, the Primer contends that true ecological restoration is a holistic process. In the words of Jordan (2003), restoration “attempts…to make nature whole.”

In conclusion, although having no argument with D & S’ contention that the definition of the goals of ecological restoration is primarily a value-based social exercise, we reject their recommendation that the field of ecological restoration should “confine its scientific efforts to the implementation of restoration objectives.” What they propose is a step backward; the future of ecological restoration lies in its contentment of restoration objectives.” What they propose is a

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