John J. Ewel

Restoration is the ultimate test of ecological theory

Ecosystem restoration is an activity at which everyone wins: when successful, we are rewarded by having returned a fragment of the earth's surface to its former state; when we fail, we learn an immense amount about how ecosystems work, provided we are able to determine why the failure occurred.

The most commonly employed criterion for judging the success of an ecosystem reconstruction project is simply whether or not the reconstituted community resembles the original: does it contain the same dominant species and have similar physiognomy? But such superficial comparisons often prove deceptive when, in the longer term, the recreated community disintegrates. The success of ecosystem restoration can be judged by the five criteria described below. The ecologist capable of creating an ecosystem that passes this rigorous test earns high marks; the one who fails is sure to gain new insights into ecosystem structure and function.

Sustainability

Is the reconstructed community capable of perpetuating itself, or, like agricultural ecosystems and golf courses, can it be sustained only if

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managed by people? Germination and ecesis are the most precarious phases of plant-community development, but these stages can be bypassed during restoration by planting seedlings rather than seeds. The failure of the community to regenerate thereafter means either that the environment changed, that the restored community was a seral stage, or that the ecologist did not understand the regeneration requirements of the species.

Invasibility

Does the reconstruction yield a community that resists invasions by new species? Intact, natural communities are, in general, less easily invaded than ones that have been damaged or ones that lack one or more of their key species. Invasions can be symptoms of incomplete use of light, water, and nutrients.

Productivity

Like invasibility, productivity is dependent upon efficacy of resource use by the community. A restored community should be as productive as the original. Net ecosystem productivity is an especially useful measure of community performance because it integrates many processes, including photosynthesis, respiration, herbivory, and death.

Nutrient retention

Although all ecosystems are open to nutrient fluxes, some are more open than others. A reconstructed community that loses greater amounts of nutrients than the original is a defective imitation. In the long run it will prove to be unsustainable because it will be invaded by new species and its productivity will decline.

Biotic interactions

Reassembly of formerly associated plant populations often – but not always – leads to reconstitution of the entire community. Animals and microbes usually colonize spontaneously because of their mobility and ubiquity, respectively. Nevertheless, biology texts are packed with examples of communities whose functional integrity hinges on a pollinator, a microbe essential for nitrogen fixation or phosphorus uptake, or a key link in a food chain. The importance of key species is often best revealed by their absence.

Ecologists have learned much about ecosystem structure and function by dissecting communities and examining their parts and processes. The true test of our understanding of how ecosystems work, however, is our ability to recreate them.