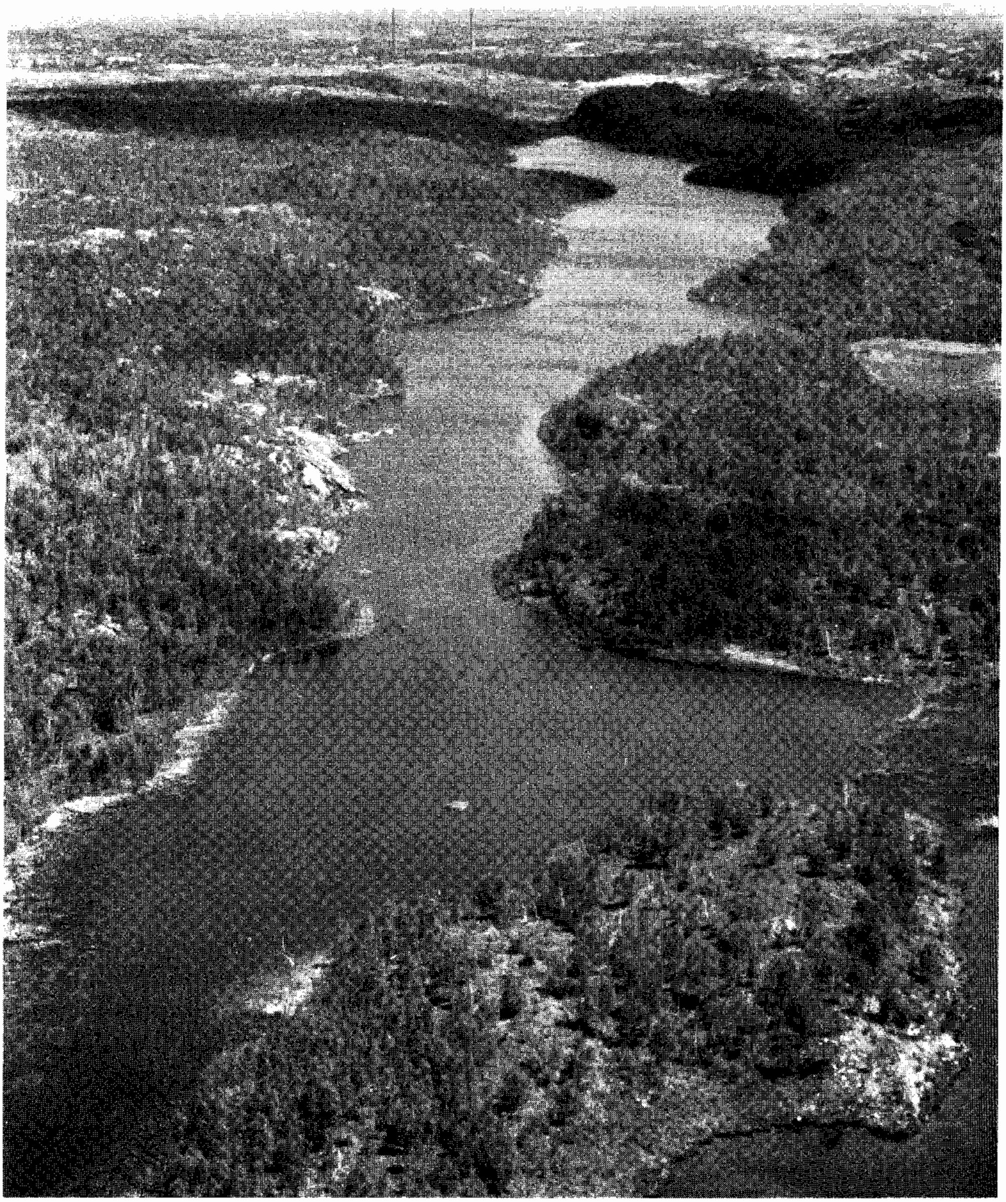


Section D

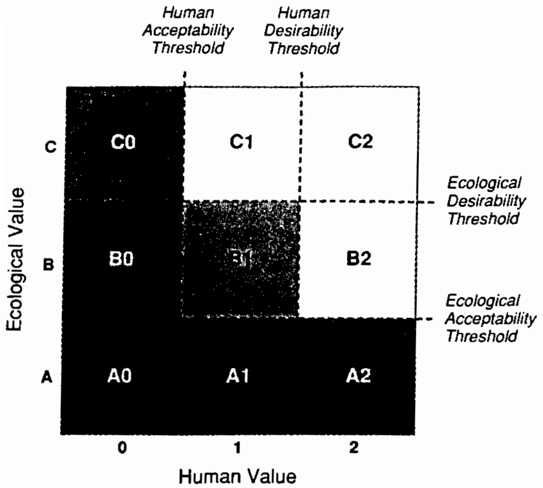
Research Topics in Restoration Ecology

John Cairns, Jr.

Since the beginning of the agricultural revolution, the rate of ecological destruction has markedly exceeded the rate of ecological recovery. Natural ecosystems have suffered perturbations that have resulted in displacement of species, loss of ecological function and structure, and diminution of ecological integrity. The newly developing field of restoration ecology is, in a very real sense, an attempt to accelerate and enhance the natural recovery processes so that the integrity of a damaged ecosystem can be fully or partially restored. Because each ecosystem is the product of a sequence of biological, climatological, and other processes, precise replication of the predamaged condition is highly improbable (Cairns 1989). Therefore, most restoration will be an attempt to re-establish a naturalistic assemblage of organisms compatible with the chemical/physical environment that exists.

Current evidence suggests that ecological restoration will be most effective when carried out at the landscape level (NRC 1992). Restoration efforts are also more likely to be successful and endure once completed if human society is sufficiently environmentally literate to understand both the ecological values and the human values resulting from restoration. Figure D.1 provides an illustrative matrix showing a number of choices that reflect both ecological and societal values.

Design criteria for ecological restoration and maintenance projects should reflect both human behavior and needs as well as the ecological needs of project species and habitat. Estimating these is a formidable undertaking, far beyond the capabilities of a single individual or single discipline. However, if the present rates of ecological destruction and human population continue to increase, for even a few additional decades, ecosystem services per capita will almost certainly be below the level necessary for sustained long-term use. Illustrative ecosystem services are regulation of the atmospheric gas balance, improvement of water



Cell	Ecological Value	Human Value
A0	Unacceptable	Unacceptable
A1	Unacceptable	Acceptable
A2	Unacceptable	Desirable
B0	Acceptable	Unacceptable
B1	Acceptable	Acceptable
B2	Acceptable	Desirable
C0	Desirable	Unacceptable
C1	Desirable	Acceptable
C2	Desirable	Desirable

FIGURE D.1. (From National Research Council 1992.)

quality, provision of models for new drugs and medicines, provision of genetic pools for agricultural crops (especially those that will be necessary if global climate change occurs), and that feeling of well-being so difficult to quantify but which large numbers of people seek on their vacations and free time by associating with natural systems.

Communicating effectively about ecological and societal value systems and reaching compromises will indeed be a challenge. Success at achieving this environmental literacy will occur if ecological values are given the same attention as human values. At present, most humans consider themselves apart from ecosystems rather than a part of ecosystems.

As a number of chapters in this book have shown, eliminating or markedly reducing the source of the problem (e.g., emission controls) may result in remarkable recovery, as was the case for the River Thames in England (Gameson and Wheeler 1977). However, I have personally encountered a number of ecosystems (as remote from my home institute as Hobart, Tasmania, and as close as the surface mining in my home state of Virginia) where ecosystem recovery has not occurred long after the stress had been eliminated or markedly reduced. Clearly, for the latter instances, the ecosystem "medicine" of Rapport (1984) will be necessary if the "patient" is to recover.

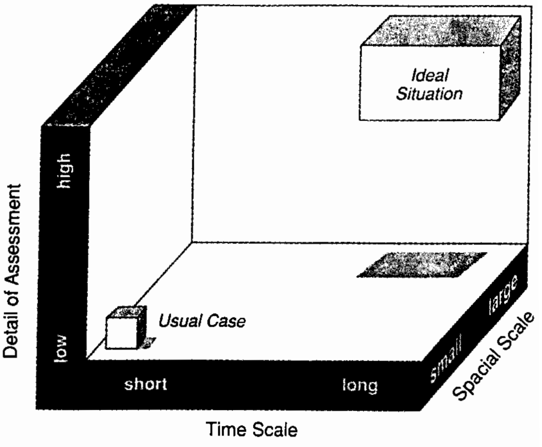


FIGURE D.2. (From National Research Council 1992.)

As Kauffman (1993) noted, a new science, the science of complexity, is emerging. This particular science, together with the dawning of the information age, will certainly result in major transformations of the social, economic, and ecological systems in the next century and perhaps at the end of this one. The science of complexity and the information age are inextricably linked, but they are phenomena deserving individual attention. Complex adaptive systems achieve, in a lawlike way, the edge of chaos (Kauffman 1993). This is a consequence of the fact that organisms, economic entities, nations, and ecosystems do not merely evolve but rather coevolve.

One of Kauffman's (1993) hypotheses that strikes me as particularly relevant to restoration ecology is that a coevolving individual does not benefit, but in fact does worse, by calculating too far into the future. My own interpretation of this is that if we are to develop a partnership with nature as an alternative to exploiting natural systems, our coevolution must begin with preventing damage and repairing damage wherever possible. Included in this "wherever possible" are economic considerations that may use opportunity–cost analysis rather than the traditional cost–benefit analysis. This entails repairing ecosystems so that money spent in such activities will generate the greatest social good rather than fixing blame for the destruction and assigning the costs of repair to the "guilty." Figure D.2 illustrates this point. If Kauffman's speculation is correct, society could move gradually from the box in the lower left-hand corner of the figure (usual case) to the box in the upper right-hand corner (ideal situation). Trying to leap immediately to the ideal situation would almost certainly be counterproductive.

The good news about ecological restoration is that, despite the fact that it is a new field (as scientific fields go), practically all attempts at ecological restoration result in significant improvement in ecological integrity and condition. In fact, the field is too new to have a long history that will determine whether the systems return to predisturbance condition or some approximation thereof or, more important, whether they ultimately become self-maintaining. Monitoring recovery rates and trajectories at landscape damage sites such as Sudbury provide important opportunities to track this process. However, despite uncertainties about the future condition of "restored ecosystems," the fact that they are vastly better than the damaged condition is comforting. What is less comforting is the fact that restoration may cost an order of magnitude or more than the cost of preservation, something that is true of health and a variety of other factors affecting the human condition.

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