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Ecological Restoration in an Era of Ecological Disequilibrium

John Cairns, Jr.
Department of Biological Sciences,
Virginia Polytechnic Institute and State University,
Blacksburg, Virginia 24061, USA

Abstract : The current rate of ecological destruction greatly exceeds the rate of ecological repair, a situation that obviously cannot continue indefinitely. In addition, the rate of biotic impoverishment makes finding suitable species for recolonization extremely difficult. Furthermore, for the first time in human history, humankind is confronted with two global, ecological problems : (1) climate change, including global warming, which makes return to antecedent conditions extremely difficult, and (2) acidification of the world's oceans, which raises the threat of ecological disequilibrium in these vast systems. The biospheric life support system is probably approaching a number of ecological tipping points, which means the conditions so favorable to humankind may be impaired or even made unfavorable. Measures could be taken at local, regional, and global levels to reduce these risks, but the time for implementing them is shortened every year.

Keywords : Ecological restoration, Landscape disequilibrium, Biospheric life support system, Climate change, Acidification, Global ecological problems.

Introduction :

Shakespeare is rumored to have said that all literature is about loss—a concept I struggled with and wanted to reject, upon first hearing. Preferring to write out of joy—indeed ideally, out of exaltation, bearing witness to the things I love during this brief life—it took me a while to realize that even the act of celebrating is an acknowledgement of loss, for it is the temporal nature of celebration—the awareness that a thing has not always been one certain way before, and may not always be thereafter—which most sharpens the poet's and the reader's senses. Celebration and loss are shadows of one another in literature.

Rich Bass, "The Space Between"

The National Research Council (NRC, 1992) has defined *restoration* as the reestablishment of predisturbance aquatic functions and related physical, chemical, and biological characteristics (p. 17).

Furthermore, restoration is different from habitat creation, reclamation, and rehabilitation, since restoration is a holistic process not achieved through the isolated manipulation of individual elements. The holistic nature of restoration requires reintroduction of appropriate biotic assemblages, not just a few species. Both ecosystem structure and function must resemble the original natural system for the process to be true restoration. All restoration efforts are approximations, but they can be deemed successful if the system is self-maintaining in a way similar to the predisturbance condition.

However, ignoring the components of the larger system is foolish. For example, persuasive evidence indicates that key species act as "ecosystem engineers" and provide an important ecosystem function to the intertidal zone (Widdows and Brinsley, 2002). In addition, the algal biofilm is a major factor influencing the stability of intertidal cohesive sediments that form estuarine mudflats (Paterson and Black, 1999). The role of predators and other "keystone species" in determining community structure and function is too well known to justify further discussion here. Of course, it has been known for decades that increased temperatures can cause a shift in dominance of freshwater algal communities from diatoms at lower temperatures, to green algae at somewhat higher temperatures, and to bluegreen algae at even somewhat higher temperatures (Cairns, 1956). Diatoms are often the preferred food of many aquatic organisms, while bluegreen algae are not. This change can effectively reduce the complexity of a freshwater aquatic community. Finally, the cumulative (but seemingly insignificant individually) impact of human selection of wild species should never be ignored. The snow lotus is a rare plant that only grows at high levels in the Himalayas. Research investigators have concluded that the reason this one species has been shrinking over time is that people pick the largest specimens (Schmid, 2005). Such human interaction is undoubtedly happening more frequently than is realized, since skilled professionals must observe and validate what has happened.

The biospheric life support system is probably approaching a number of tipping points because the rate of ecological damage far exceeds the rate of repair (Figure 1). If society cannot, or will not, measure the nearness to ecological tipping points or even document the risks involved with doing nothing, it cannot effectively manage an ecosystem. If,

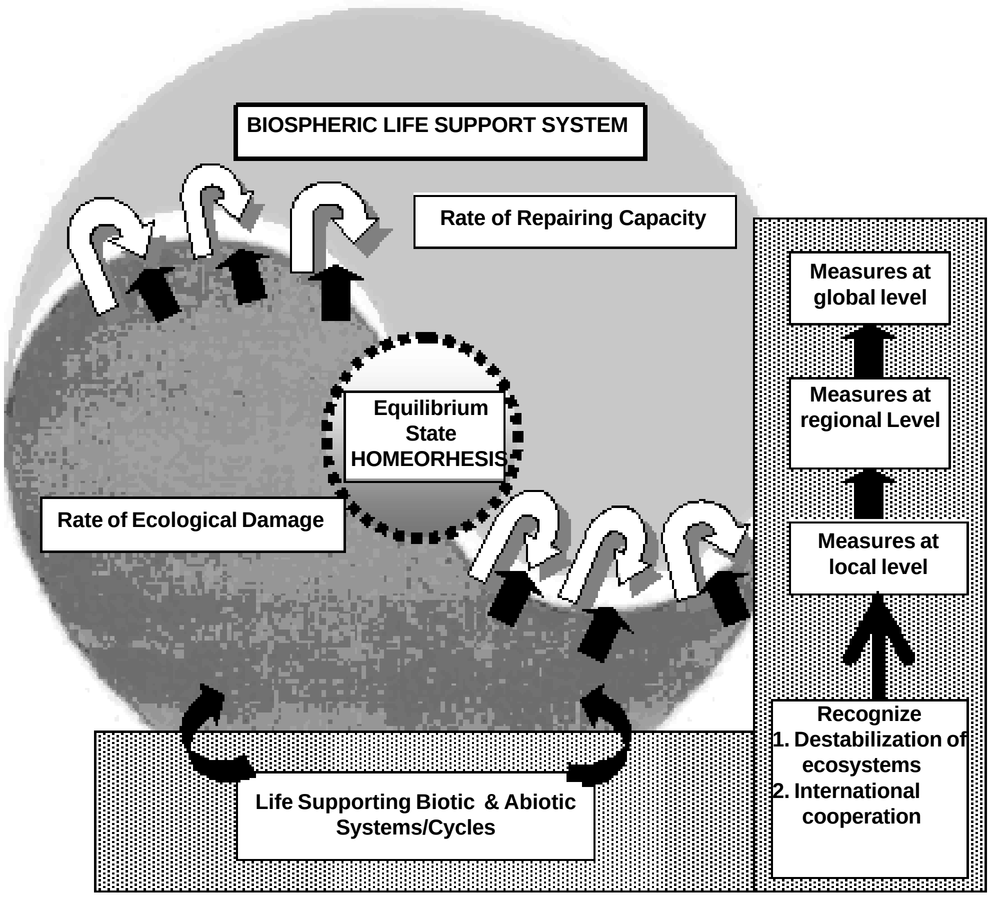
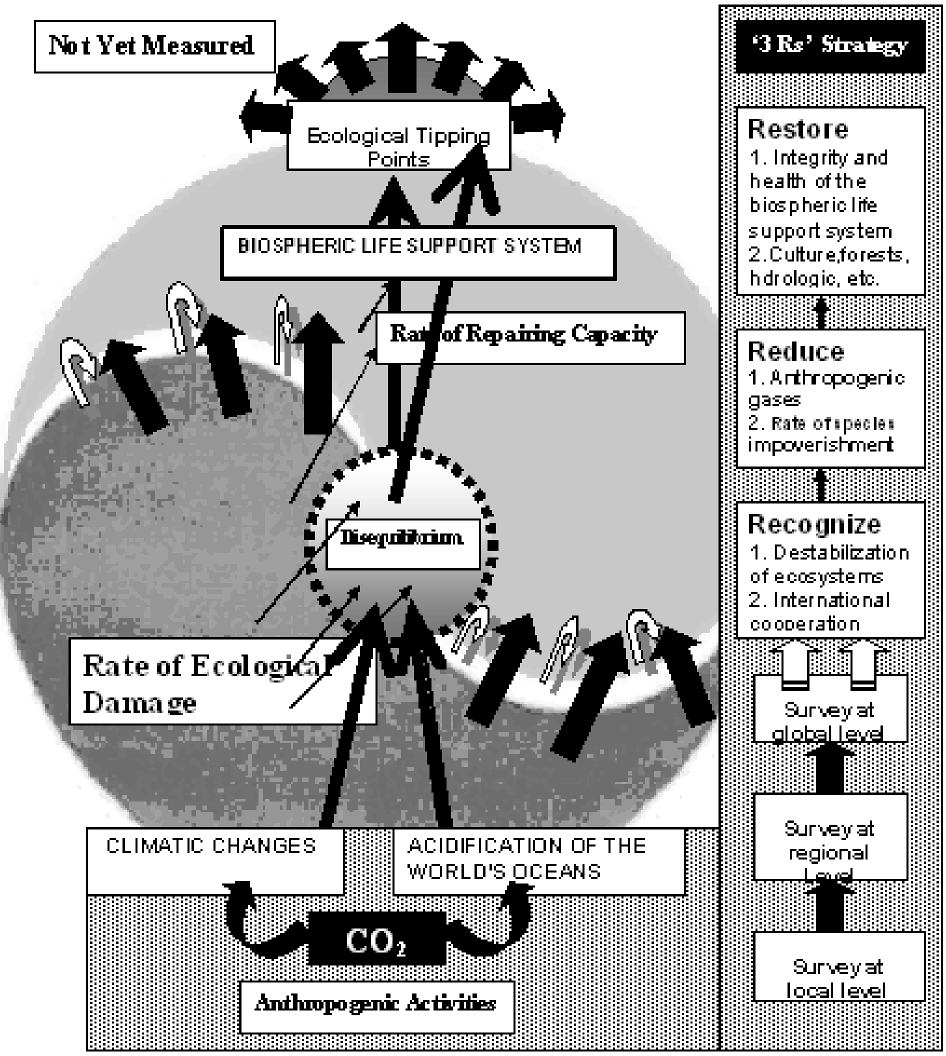


Fig. 1 : Ecological equilibrium retaining global ecological integrity with various life supporting biotic and abiotic system/cycles.

indeed, the major goals of ecological restoration are to replace lost natural capital and ecosystem services and to determine how far humankind needs to go to achieve this goal, data are essential. Increasing evidence continues to indicate an ecological overshoot at the global systems level (Meadows *et al*., 2004).

The overshoot appears to have occurred about 1980 and has increased substantially since then. Wackernagel *et al*. (2002) have produced robust data to support this view. One NRC (1992) committee has



restoration : The current rate of ...gical repair and the biospheric life ...ecological tipping points which need ...vey at 3 levels.

recommended that :

(1) national restoration goals and assessment strategies be developed for each ecoregion,

(2) principles be established for priority setting and decision making,

(3) redesign policies and programs for federal and state agencies to emphasize restoration, and

(4) innovation occurs in financing and use of land and water markets.

For freshwater ecosystems, the NRC (1992) committee recommended the following goals :

(1) a net gain over the next 20 years of 2 million acres of restored lakes, out of the current 4.3 million acres of degraded lakes.

(2) a national river and stream restoration target of 400,000 miles of river-riparian ecosystems be restored within the next 20 years. This target represents only about 12% of the total 3.2 million miles of US rivers and streams and is recommended because it is comparable to the miles of streams and rivers affected by point source (*e.g.*, industrial wastes) and nonpoint source (*e.g.*, agriculture runoff) pollution.

(3) inland and coastal wetlands be restored at a rate that offsets any further loss of wetlands and contributes to an overall gain of 10 million wetland acres by the year 2010, largely through reconverting crop and pastureland and modifying or removing existing water control structures.

Obviously, these recommendations are not being implemented and prospects for future remedial measures may be even worse, but the problem cannot be ignored.

Ecological Disequilibrium :

The list of ecological problems is long and includes species impoverishment (*e.g.*, extinction and population degradation; habitat fragmentation and destruction; and pollution, including acid rain). Arguably, two major threats exist to global ecological integrity:

(1) global warming, which was predicted well over a century ago and for which scientific evidence has been mounting ever since.

(2) acidification of the world's oceans to a level that may be irreversible in current lifetimes, as Britain's Royal Society—one of the world's most prestigious scientific societies—warns (ENS, 2005).

Too much carbon dioxide in the atmosphere, which is taken up by the oceans, causes the acidity in the oceans. The role of carbon dioxide and other greenhouse gases in causing global warming has been the consensus of mainstream science for many years. The simultaneous acidification of the oceans and warming of the planet will almost certainly result in an ecological disequilibrium unprecedented in human history. What if these two disasters, now increasingly probable, intensify or even continue over a significant time span? How would humankind cope with ecological restoration on such a grand scale?

The NRC's (1992) definition of restoration as the reestablishment of predisturbance functions and related physical, chemical, and biological characteristics seems an impossible dream on a global scale. The global impoverishment of species will not leave enough recolonizing species to replicate predisturbance community structure and function. In addition, antecedent chemical/physical conditions would be equally difficult to replicate on a global scale.

Do Not Despair !

In the preface of his book on climate change, Lynas (2004, pp. xvii- xviii) relates a story told by the Aleutian Eskimos in Alaska that illustrates a profound feature of the human condition. When the Russians arrived in Alaska, people went down to the beach to greet the strangers, mystified as to how these foreign seafarers had suddenly appeared as if from nowhere. The Russians pointed out into the bay where their big ship lay at anchor, but none of the Alaskans could see it. They looked left and right, but even if their eyes registered the huge vessel, their world view left no place for it and the people saw nothing. Only a single shaman, the wisest man in the community, stepped forward, consciously refocusing his eyes and opening his mind. He saw the ship, and just at that moment—as if by some sort of shared collective consciousness—so did everyone else. The story reminded Lynas of global warming. At first, no one can see it—the implications of this looming catastrophe are simply too huge to be easily comprehended. However, led by the modern shamans (the world's scientists), the issue begins to gather momentum. However, will enough of humankind realize the peril before it is too late to act?

Cairns and Wicks (2005) note that many disciplines, especially those of science and public health, have identified education as a key element for bridging the knowledge gap between the general public and professionals. If not too late, some obvious immediate steps to reduce risks follow (Figure 2).

(1) Drastically reduce anthropogenic gases that affect both climate change and ocean acidification.

(2) Drastically reduce the rate of species impoverishment so that as many species as possible are available to recolonize damaged ecosystems.

(3) Recognize that the destabilization of ecosystems and human society are closely linked.

(4) Be prepared for the collapse of systems, such as agriculture, forests, hydrologic, etc., which are of tremendous economic importance.

(5) Recognize that international cooperation and trust are essential to the resolution of global problems.

(6) The nation/state is no longer the primary provider of security. The primary source of security is the integrity and health of the biospheric life support system.

One major point is absolutely clear—however much humans destabilize the world's ecosystems, they will not eliminate evolutionary processes. What may happen, unless quick remedial action is taken, is the disruption of the ecosystem services that have favored the human species for many thousands of years. I have used the Rich Bass quote at the beginning of this manuscript because present unsustainable practices may adversely affect the biospheric life system so that it no longer favors humankind (Cairns, 2004a,b,c; 2005). Humankind cannot persist in the denial of the catastrophic consequences of unsustainable practices (Cairns, 2004c).

Species do come and go. Humans are presumptuous to expect *Homo sapiens* to be on the planet for the estimated 15 billion years Earth might last, but it could happen. Still, the quality of life is what matters, not the duration. Humankind could and should live in harmony with the other species with which it shares the planet. Humans must not produce an ecological overshoot by using resources faster than Earth can regenerate them. Finally, humans must live sustainably so that life on Earth is not endangered. This vision, coupled with local and regional ecological restoration will facilitate the transition to self-maintaining, dynamic ecosystems. This process could take well over a century, which is nothing in evolutionary time. Whatever happens, humankind will be following a vision far more spiritual than economic growth.

Diamond's (2005) superb, timely book discusses how societies choose to succeed or fail. The practices needed for success are clearly stated, as are the reasons for failure. What humankind could do and what it will do will determine the outcome.

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