AN ECOSYSTEM APPROACH TO MANAGEMENT: A CONTEXT FOR RESTORATION AND RECLAMATION

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ABSTRACT

Recognition that the cumulative effects of human activity require mitigation is one of many factors contributing to a global call to change the ways people think about and work the Earth – a call to repair what is broken and degraded and to maintain and/or protect what works. Accordingly, societies around the world are exploring the type of change required and the ways of implementing it. Routinely, this change is expressed through the lofty concepts of sustainable development, ecosystem management, and ecosystem health – three prominent catch phrases that now permeate the scientific and popular media, and form the basis of a growing number of private sector, government, and academic programs. In a state of constant redefinition and reconfiguration, these words generate a variety of responses (e.g., inspiration, anger, enlightenment, and confusion) from people who must interpret their meaning and translate their intent into tangible action in, on, and above Earth's landscapes and waterscapes. Can the concepts denoted by these words be described in practical terms and usefully applied? If so, how are they related? This discussion paper briefly explores the definition and application of these concepts as a context for programs (e.g., restoration and reclamation) designed and implemented in support of efforts to keep Earth's landscapes and waterscapes working.

Introduction

Organisms derive their existence from the Ecosphere, and humans are no exception. People depend on Earth, her processes and resources to survive. But unlike the other 10-30 million species, humans have evolved the ability to transform unprecedented numbers and amounts of ecosystem services, products, and experiences. Insignificant and isolated at first, human endeavour had little influence on the Ecosphere, but the rates at which, and methods by which, people currently consume resources are jeopardizing ecospheric health and the long-term future of humankind. In fact, the transformation of ecosystem services and products (energy and matter) has been the single defining objective of human existence. For example, we now co-opt the organic equivalent of about 40% of the present net primary production in terrestrial ecosystems each year (Vitousek et al., 1986). It appears that we have begun to eclipse the finite capacity of ecosystems to cope with human-induced change (Rees, 1990).

Many agree with the need to recast the ecospheric-human relationship. And over the last 20 years, jurisdictions around the world have acknowledged that the altering power of unchecked human endeavour needs to be brought into balance with Earth's metabolism. For example, global reciprocity was provided some tenure as an element in the controversial and much debated concept of sustainable development that was articulated by the World Commission on Economic Development in its report, "Our Common Future" (WCED, 1987). Predictably, the popular, scientific, and agency literature has exploded with ideas, guidelines, and recommendations proposed to assist in the quest for initiatives (e.g., ecosystem management) that will lead to a

new ecospheric-human relationship. This discussion paper briefly examines the definition and application of sustainable development, ecosystem management, and ecosystem health as a context for programs (e.g., restoration and reclamation) designed and implemented to attain and/or maintain ecospheric-human balance.

Sustainable Development [Sustainable Living]

Sustainable development is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). It is an unfortunate catch-phrase. To sustain is to keep, to preserve, to continue to maintain something (Shields et al., 1993). Generically, the word is linked to the idea of well-being, but carries a different meaning for each person, a function of individual values, perspectives, education, and life-experiences. And when linked with "development" in reference to ecospheric well-being, its meaning is further clouded by the conflicting concepts and paradoxes that result.

Some people identify more with the "sustainable" part and work in support of efforts devoted to ecological and social transformation. Others identify with "development" and interpret it to mean a redefined version of the *status quo* (Wackernagel and Rees, 1996). From this perspective, the WCED's definition (and its derivatives) has been challenged because, among other concerns, it advances the age-old anthropocentric and utilitarian perspective that underwrites a recipe for perpetual growth (e.g., industrial development), continued deterioration of ecosystems, and loss of constituent biological assets (Dovers and Handmer, 1993; Pearce et al., 1989; Robinson, 1993; Robinson et al., 1990; Willers, 1994). But is it really a question of definition? Costanza and Patten (1995) suggest that much discussion and debate is misdirected because people continue to cast the problem as a definitional one when in fact it is more an issue of prediction – a prediction about what will last (given a prescribed suite of human activities) and achieving consensus (reconciling the values that make sustainable action possible) on what we want to last.

Many of the questions that have emerged from the examination of, and associated debates over, sustainable development are about values and beliefs that ultimately guide human behaviour in the finite ecosystems that provide the products, services, and experiences required for life – sustained life. While admittedly anthropocentric, the idea of "sustainable living" is more tenable than "sustainable development" if for no other reason than the fact that it does not carry a connotation of "development" as the principal driving force. Under the auspices of a reconfigured suite of values, it signifies balance – balance between the people who draw from and use Earth's processes and resources to survive and the ecosystems of which they are a part. Accordingly, sustainable living is envisioned as an Ecosphere filled with healthy ecosystems and healthy people -- a condition or state of ecospheric-human balance that society predicts can be attained and maintained.

While the concept of sustainable living can serve as the basis for a vision of (a prediction about) the future, it does not provide us the means or the path to get there. Despite the limitations of the original concept(s) of "sustainable development," the associated debates have highlighted the need to intensively and extensively examine human conduct in the Ecosphere. For example, in the decade following publication of "Our Common Future," the literature has been populated with reports on initiatives that examine the notion of culture as the primary cause and possible cure for Earth's ecological ills (one of the paradoxes), managing for uncertainty, intergenerational and intragenerational equity, individual versus collective interests, empowerment, the adaptive ability of humans and their institutions to cope with change, and the sustainable scale of the human economy relative to the life-support system(s) upon which that economy relies (i.e., what are the ecospheric limits to growth?). But how do we transform these issues and ideas, and any decisions about them into tangible action in,

on, and above Earth's landscapes and waterscapes? An ecosystem approach to management is one path available to us.

The Concept of an Ecosystem Approach to Management

Fundamentally, an "ecosystem approach" is based on the idea that if humans subscribe to and apply an appropriate set of values and are equipped with the required knowledge and tools, they can protect and maintain ecosystems, derive a quality existence from them and simultaneously ensure that opportunities for future generations are retained (Gray et al., 1996). An ecosystem approach is an adaptive process that employs a suite of integrated programs to care for Earth's natural assets by managing our relationship with the other components of ecosystems and ensuring that our perceptions, values, and behaviours work in support of ecosystem function. It is an encompassing process that captures the range of cultural, social, economic and ecological values that ultimately define human-ecosystem relationships (Fig. 1). An ecosystem approach to management is a method that can assist committed people in their efforts to keep the landscapes and the waterscapes working (Merriam, 1994) – an absolute requirement for the attainment and maintenance of healthy ecosystems and healthy people.

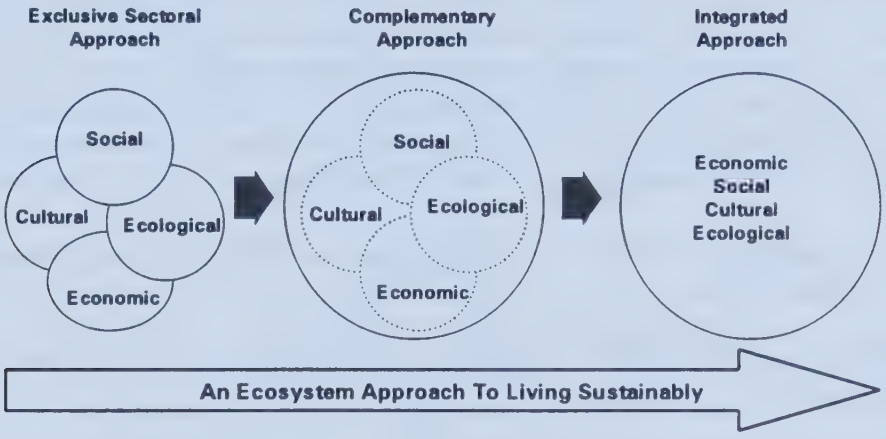


Figure 1. Sustainable living requires that society move from an exclusive sectoral approach to valuing and using natural assets to an integrated approach.

"Management" is a sweeping, generic term for the cadre of tools and techniques we use to meet our objectives and attain our goals. It is a controversial aspect of human endeavour, often a focal point of conflict, because as traditionally applied it has failed to account for the range of values and philosophies held by the variety of peoples who comprise Earth's cultures and societies. For example, the neo-classical utilitarian's approach to management is radically different from that of the emergent eco-centrist's perspective. In addition, the term often is used to imply that people understand the complex nature of ecosystem composition, structure, and function when, in fact, we do not. Is ecosystem management possible? No, not now, or in the near future. But an ecosystem approach to management is -- an encompassing endeavour that:

- captures the range of cultural, social, economic, and ecological values that ultimately define ecosystem-human relationships;

- requires decisions be made in the context of ecosystems as holistic entities with many natural assets, not individual resources;

- is sponsored by flexible, adaptive, accountable, and learning-oriented institutions;
- is participatory and knowledge-based;
- is dynamic and adaptive whereby the impacts (positive-neutral-negative) of human actions are identified, monitored, and constantly evaluated against prescribed measures of healthy ecosystems and healthy people; and
- results in a balanced spectrum of human activities (ranging from complete protection to active manipulation of natural assets) that are at least impact-neutral.

How do we organize ourselves to embrace and employ an ecosystem approach to management? Strategic, tactical, and "on-site" management plans developed in support of an ecosystem approach fill our bookshelves and our hard drives. They provide thousands of useful ideas and recommendations that implicate all sectors of society. But many are limited by organizational frameworks that constrain a society's ability to adequately cast natural assets (including humans) within an ecological context, and identify, explore, and wisely employ the full spectrum of social conditions and forces that determine human behaviour and impact ecospheric function. Building on the work of others (e.g., Christie et al., 1986; Gerlach and Bengston, 1994; Great Lakes Research Advisory Board, 1978; Grumbine, 1994; Kaufman et al, 1994; Lee, 1993; Robinson et al., 1990; Rowe, 1991, 1994), Gray et al. (1995) suggest that effective natural asset planning can be accomplished by commitment to, and application of, a unifying framework comprised of three themes and nine interrelated modules (Fig. 2):

A. An ecologically meaningful spatial and temporal context in which to manage human activity in the ecosphere. It requires that we:

1. define and describe Earth's ecosystems in-space-in-time and align our decisions and actions accordingly.

B. The appropriate enabling mechanisms, including:

2. a philosophy and corresponding suite of societal values that enable natural asset managers to take effective action;
3. institutional cultures and structures that sponsor proactive and integrated programs; and
4. programs involving all sectors of society as partners and participants in decision-making processes.

C. The appropriate suite of tools to help us understand Earth and to guide human behaviour in, on, and above her landscapes and waterscapes. Accordingly, society must sponsor:

5. useful data and information gathering and management programs (e.g., research, inventory, monitoring, and assessment) to advance our knowledge of ecospheric function and human impacts;
6. knowledge dissemination through life-long learning opportunities that are accessible and current (i.e., education, extension, and training programs);
7. strategic thinking and planning to identify, establish, and modify short- and long-term direction;

8. policy, legislation, and regulation to guide society in adoption and attainment of sustainable lifestyles; and

9. in-situ and ex-situ planning and management techniques designed to protect the pieces, the patterns, and the processes.

The importance of a commitment to care for Earth's natural assets can not be overstated – it is a critical element of any successful initiative. But commitment is meaningless in the absence of an integrated, unified, and practical protocol for action. The modules provide a basis to identify the appropriate questions and organize the suite of programs (e.g., ecosystem description, research, inventory, policy development, and restoration and reclamation) required for implementation. Given the space limitations of this paper, description and analysis of each module is not possible. While all modules are important, establishment of an ecologically-meaning spatial framework (a context) is a fundamental requirement for successful implementation of an ecosystem approach to management. Accordingly, the following section is devoted to the definition and description of ecosystems.

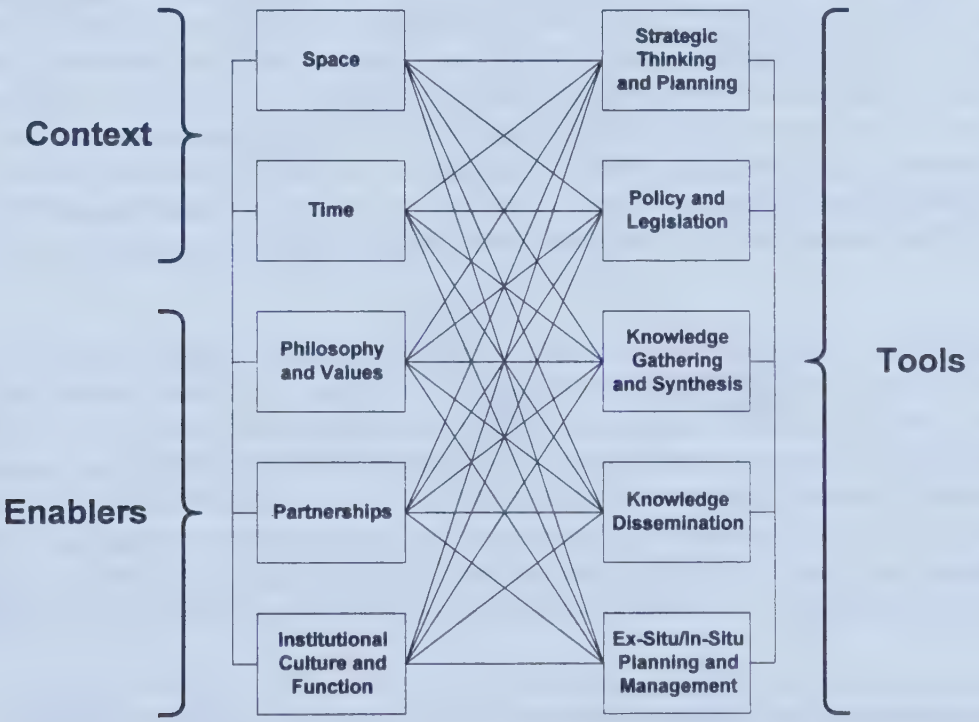


Figure 2. An ecosystem approach to management framework. The modules are linked and often employed simultaneously or in unison to develop and deliver ecologically-based programs (e.g., restoration and reclamation projects).

Ecosystem Defined

An ecosystem approach to management is based on the fact that Earth operates as a series of interrelated systems, within which all components are linked (Bailey, 1996). Rowe (1961) defines ecosystem as a "topographic unit, a volume of land and air plus organic contents extended areally over a particular part of the earth's surface for a certain time." And as the fundamental context for natural asset management, ecosystems

are used as bounded, geographic units of the landscape, waterscape, and airscape that include all natural phenomena. Rowe, Bailey, and many others, argue that an ecosystem is a definable entity that has currency as a context in which to pursue sustainable living objectives – it is a recognizable chunk of Earth space in which the flow of energy and the transformation of matter in-space-in-time creates networks of organisms (such as plants and animals, including humans), atmosphere, rock, soil, and water, interacting with each other and with other ecosystems.

Why use an ecological perspective, a relatively new and little tested technique, as the spatial context within which to pursue sustainable living objectives? After all, over the last few thousand years, societies throughout the world have invested significant resources (and spilled much blood) in the creation of spatially-based jurisdictional/administrative (e.g. country, province, district, and township) and thematic (e.g., mineral resources, species habitat, protected areas, and forested land) units to define their relationships with other societies and Earth's natural assets. The simple fact is that ecosystems have sponsored life for 4.6 billion years. And no society, however well endowed with knowledge and technology, can escape the fact that life derives from the Ecosphere and her constituent ecosystems – life does not equal organisms; life equals organisms plus the ecosystem(s) upon which they depend (Rowe, 1992a). And sustained life, through appropriate long-term management of human activities in, on, and above Earth's landscapes and waterscapes, depends on our success at identifying the inter-relationships between the natural assets that comprise each ecosystem – understanding ecosystem composition, structure and function (Fig. 3). In contrast to jurisdictional and thematic units, the ecosystem provides an integrating framework within which natural asset managers can work to address the spectrum of cultural, social, economic, and ecological factors and forces. And now that human actions have created significant impacts of continental and global proportions, an ecological context is increasingly required to scope out and understand the issues, establish partnerships, and design appropriate management programs.

Ecosystems can be very large (e.g., the Ecosphere is the largest earthly ecosystem) and very small (e.g., a pond), where the smaller ecosystems fit into the larger ecosystems. This hierarchical organization has been described as "successively encompassing levels of interacting components or units" (Grobstein, 1974) that constitute a system of "discrete interactive levels" (Pattee, 1973). An hierarchical approach helps us perceive complex systems by dividing them into understandable levels. Natural asset managers must be able to make decisions about human activities in ecosystems of all sizes, which requires that they know the location of ecosystem boundaries. The task of spatially and temporally delineating and describing ecosystems is called ecosystem classification (e.g., in Canada, the national program is referred to as Ecological Land Classification).

Each ecosystem is unique and complex, the boundaries of which exist as a gradient between neighbouring systems. This presents natural asset managers and users with a problem. How can we hope to understand ecosystems in all their complexity and diverse shapes and sizes if they are all different? Fortunately, advances in ecological theory, analytical techniques, and spatial technologies now permit managers to apply integrated and interactive ecosystem delineation tools and techniques (see Rubec [1992] and Sims and Uhlig [1992] for a summary of some programs). While not perfect by any means, scientists and managers have identified criteria and rules with which to draw lines on maps and photographs, build scale models, and draw pictures – to define and describe ecosystems as recognizable chunks of space-in-time (Fig. 4). The criteria are based on the factors and forces that create and shape ecosystems (see Fig. 3). For example, the boundaries of large ecosystems can be delineated by integrating climate and landform patterns while smaller ecosystems can be identified through examination of soils and vegetation patterns.

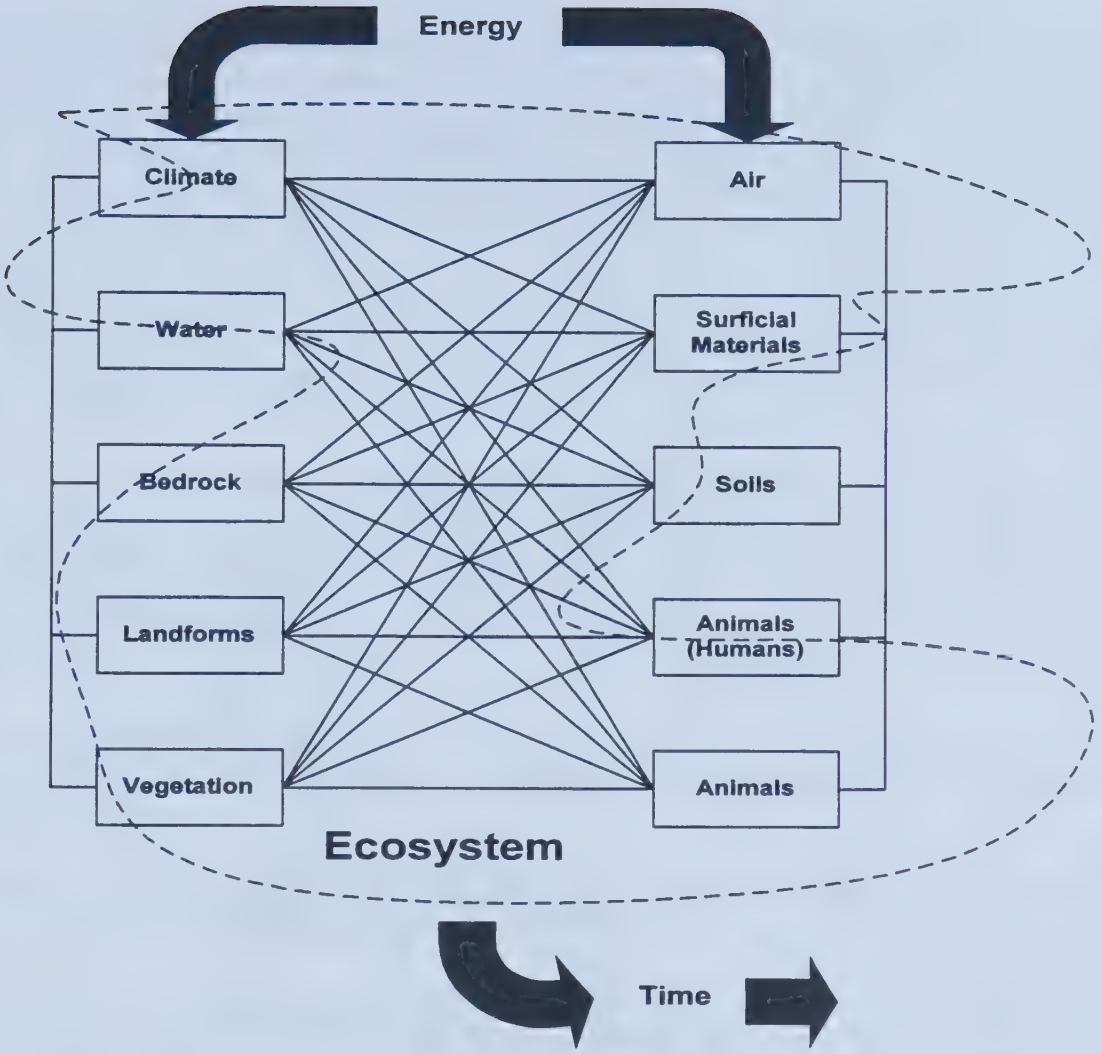


Figure. 3. The forces and factors that create and shape ecosystems.

The Concept of Ecosystem Health

A principal indicator of sustainable living is ecosystem health. But what is it? In its simplest terms, health measures system performance through the behaviour (function) of its parts (composition and structure) (Costanza et al., 1992). Costanza and Patten (1995) suggest that a system is sustainable if and only if it persists in a nominal behavioural state as long or longer than its expected existence time -- that it attains its full expected life span within the nested hierarchy of systems in which it is embedded. While most people immediately and correctly equate ecosystem health to lots of indigenous plants and animals relative to the ecosystem(s) in which they evolved, abundant clean water, forests, and wetlands, there is more. Humans are an important part of the Ecosphere. Rapport (1995) characterizes ecosystem health as a measure of the level of distress in the ecosystem, the ecosystem's resilience to perturbation, the ecosystem's ability to sustain itself, the degree to which an ecosystem's function does or does not impair the healthy functioning of adjacent ecosystems, and the extent to which the ecosystem supports healthy human communities. From this perspective, ecosystem health is an integrated combination of cultural health, social health, economic health, and ecological health.

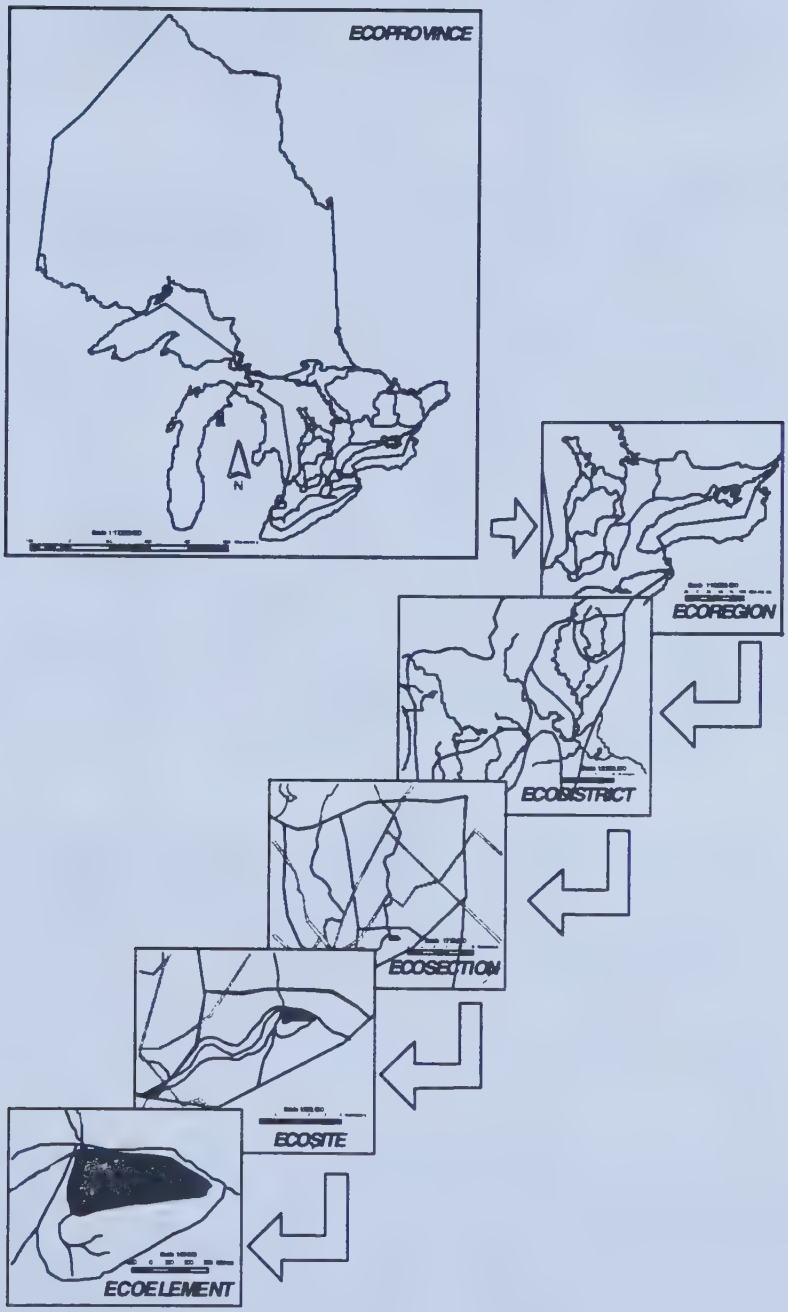


Figure 4. Using the federal Ecological Land Classification terminology, this spatial simulation model demonstrates how ecosystems of varying size and shape are related to each other in ladder-like levels. Use of this type of classification system allows natural asset managers to design and deliver programs within an ecologically meaningful spatial framework.

To what state or condition of ecosystem health do we aspire? Ecosystem health has no operational meaning unless it is defined in terms of a desired state or condition for that ecosystem (Lackey, 1994) – a condition or state that we predict can be achieved and sustained. For example, society may elect to maximize opportunities for ecotourism, or sustained yield of timber, or agricultural products, or all of these. Each prescription results in a unique ecosystem (Lackey, 1994). Similarly, Rowe (1992b) asks to what extent should we maintain natural (areas designated for preservation), semi-natural (areas in which resources are managed for sustained use), artificial (devoted to high input, intensive use such as farming and forestry) ecosystems, and to what extent do we establish restoration and rehabilitation programs for entire ecosystems? These questions are, of course, critical to visioning, establishing goals (e.g., healthy ecosystems and healthy people), and setting management targets. And the answers are, in large part, based on a commitment to, and decisions respecting attainment of, a prescribed level of ecosystem health.

Societies in many jurisdictions have devoted considerable effort (has it been enough?) to the study and application of ecosystem health in the last decade (e.g., Cairns, 1994; Costanza et al., 1992; Gray, 1992; Gray et al., 1992; Rapport, 1989, 1992, 1995; Regier, 1993; Schindler, 1987; Steedman, 1994; and Woodley et al., 1993). And while integrated programs to measure and monitor cultural, social, economic, and ecological health have begun to emerge, this discipline is in its formative stages. Steedman (1994) maintains that we can not expect the discipline to:

- specify unambiguous, routine criteria for interpretation of observations, because benchmarks for high and low ecosystem health are based on a complex mix of quantitative and qualitative data and information in a scientific and cultural context;

- provide a direct measure of ecosystem health because managers always will be required to choose and justify surrogate measures to index ecosystem health; and

- substitute for detailed information about specific ecosystem features because as consumers of natural resources, we always will need to collect, interpret, and communicate knowledge and information describing things that are important to us.

Given that simple, heuristic methods to measure and monitor ecosystem health are not likely to emerge as management tools in the near future, what do we do? First, we must recognize that the unique nature of ecosystem composition, structure, and function, and the variety of human activities in each ecosystem requires that health assessments and associated management prescriptions (including restoration and reclamation projects) be unique as well. Second, we must use the knowledge and the tools available to us. Through past and ongoing (cumulative) knowledge-gathering and syntheses (ecological espionage), we have access to a variety of indicators (e.g., presence/absence, abundance, and/or distribution of species and habitats of selected species; soil loss; soil compaction; air quality; toxic chemicals and their impacts; and human health conditions) that provide us some ability to establish targets and recognize existing and potential problems. Third, societies must support the required research and knowledge/technology transfer needed to advance ecosystem health as an important aspect of an ecosystem approach to management.

Summary

Human societies have elected to intensively and extensively use the products, services, and experiences provided by Earth's ecosystems. Through conscious and/or accidental decisions, we have significantly modified, and continue to modify these landscapes, waterscapes, and airscapes. Most people now live in

ecosystems that have been degraded and impaired to some degree. And societies throughout the world continue to accumulate natural debt to which the Ecosphere has begun to respond. Are we listening? Ecospheric-human balance is inevitable, one way or the other. We can elect to follow the difficult and perilous path by maintaining the *status quo*, or we can pursue sustainable lifestyles that at minimum support efforts to ensure protection and repair balances degradation and destruction.

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