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# An interdisciplinary research agenda for the study of ecological-economic systems in the American West

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## Abstract

Increased public awareness of resource management issues and new attitudes toward resource conservation have led to great interest in the subject of the apposite use and management of natural and environmental resources in the American West. This paper analyzes this subject from an interdisciplinary ecological-economic perspective. Four salient issues concerning the study of the West's ecological-economic systems that remain inadequately understood are identified and then discussed. A research agenda is proposed to answer some key questions concerning the functioning, health, and management of the West's ecological-economic systems. © 2000 Elsevier Science Ltd. All rights reserved.

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## Introduction

There is no gainsaying the fact that natural and environmental resources are an important part of life in the American West. Grazing, ranching, mining, and recreational activities such as camping, fishing, and hunting have all been and are a salient part of the lives of people residing in the states comprising the American West. With increasing use of these resources, federal and state governments have established a plethora of rules and regulations governing the use and the management of western natural and environmental resources. As a result, the *nature* of the regulatory relationship between the regulating and the regulated parties has changed substantially over time (Clawson, 1983, p. 2). Further, as Cawley (1993) has noted, increased public awareness of resource management issues and new attitudes toward resource conservation have combined to dramatically alter the character of this regulatory relationship.

This increased public awareness and the rise of new attitudes toward resource conservation have been

accompanied by a remarkable convergence in the views of biological and social scientists regarding the appropriate way in which natural and environmental resources should be viewed, studied, and managed. Today, most ecologists and economists agree that natural and environmental resources should be thought of as *ecological-economic systems* that are *jointly determined*. Hence, in the rest of this paper, we shall refer to natural and environmental resources as ecological-economic systems. Once it is recognized that ecological-economic systems are jointly determined, it seems obvious that these systems should be studied as one system (see Perring et al. (1995a), Dasgupta (1996), Dasgupta and Maler (1997), and Batabyal (1999a,b)). However, because this recognition has been recent, important issues pertaining to the functioning, the health, and the management of jointly determined ecological-economic systems remain inadequately understood. Given this state of affairs, this paper has three objectives. First, we discuss four of these issues in the context of the extant literature. Next, we propose an interdisciplinary research agenda for studying these four issues. Finally, we show how specific aspects of this research agenda might be accomplished.

The four issues of this paper are (i) the substitutability

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between different types of natural capital, (ii) the effects of economic activities on the health of an ecological-economic system, (iii) the relationship between human activities and the keystone species of an ecological-economic system, and (iv) the optimal management of ecological-economic systems. We now discuss these issues in greater detail.

#### Four issues and the related literature

##### *Substitutability between different kinds of natural capital*

Two kinds of substitutability are relevant. The first kind concerns the substitutability between natural and produced capital. The second kind relates to the substitutability between different types of natural capital. The substitutability between natural and produced capital has been studied by economists in considerable detail (see Solow (1974), Hartwick (1977, 1978), Dixit et al. (1980), Daly and Cobb (1989), Daly (1991), and Turner (1992)). In contrast, the substitutability between different types of *natural* capital has received very little attention from ecologists and economists. This has led Perrings (1996, p. 232) to note that “the complementarity between species in many [ecological-economic systems] is still very imperfectly understood.” Why is it important to understand the substitutability between different types of natural capital? This is because the *resilience*<sup>1</sup> of ecological-economic systems is typically a function of this substitutability (see Schindler (1990) and Costanza et al. (1995)).

Consequently, in raising this issue of substitutability, our objective is to point to the questions that require additional research attention. Here are three examples of such questions. What is the relationship between the resilience of an ecological-economic system and the number of substitute species in this system that can perform a given set of ecological functions? What is the minimum combination of resources that will permit an ecological-economic system to function under the expected range of economic and ecological conditions? Finally, what is the effect of incomplete—and possibly incorrect—knowledge about inter-species substitutability on the decision to conserve biological diversity?

##### *Effects of economic activities on the health of an ecological-economic system*

It is no surprise that the level of economic activity tends to have an impact on the health of an ecological-

economic system. Population ecologists and resource economists—see Dasgupta (1982), Clark (1990), and Walker (1993)—now agree that excessive levels of economic activity can have a detrimental impact on the health of an ecological-economic system. Given this situation, it is important to examine the impact of the *level* of economic activity on the health of an ecological-economic system.

Put differently, research is needed to analyze the impacts of *livelihood-based* economic activities on the health of an ecological-economic system. From a practical perspective, what this means is that we need to know the answers to three specific questions. First, how does the health of an ecological-economic system evolve when the services that this system provides are utilized at a constant rate over time? Second, how do changes in the pattern of economic activities—associated with changing livelihoods—affect the health of an ecological-economic system? Third, what impacts do economic policies that apply fixed rules in order to achieve constant yields have on the health of an ecological-economic system?

##### *Relationship between keystone species and human activities*

As Paine (1969, 1974) and Krebs (1985) have noted, the activities of keystone species determine the structure of ecological-economic systems. Unfortunately, economists have contributed very little to our understanding of the nexuses between human activities and keystone species. Consequently, a number of questions involving the *link* between human activities and keystone species present themselves. In particular, two questions warrant early research attention.

Because the health of an ecological-economic system depends on the welfare of the keystone species in that system, the design of measures of the health of an ecological-economic system should incorporate the activities of keystone species into these measures. This will be a salient task for future researchers. Second, we know from Holling et al. (1995) that in some ecological-economic systems, environmental disturbances can perform the same role as keystone species in maintaining species diversity. Consequently, it will be necessary to study the extent to which human activities can mimic the role played by environmental disturbances. An answer to this question will provide useful insights into the ability of humans to replicate the role played by the keystone species of an ecological-economic system.

##### *The optimal management of ecological-economic systems*

As noted by Dasgupta (1996) and Batabyal (1999b,c), for too many years ecologists and economists have gone

<sup>1</sup> Resilience refers to “the amount of disturbance that can be sustained [by an ecological-economic system] before a change in system control or structure occurs.” (Holling et al., 1995, p. 50).

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