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Resilient Management: Comments on "Ecological and Social Dynamics in Simple Models of Ecosystem Management" by S. R. Carpenter, W. A. Brock, and P. Hanson.

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INTRODUCTION

People who are engaged in understanding and managing environmental resources live in a strange world, a sort of terra incognito, that exists between theory and practice. That is, we don't have sufficient theory to explain the unpredictable behavior of resource systems, but rather we struggle with partial, disciplinary-bound concepts and methods. We also struggle with limitations in data to sort among multiple hypotheses, each of which may have alternative policy implications. Nor do we have sufficient experience or ways of accelerating learning about the effects of policies in the real world. The paper by Carpenter, Brock, and Hanson (1999) sheds light in this strange world, because it advances both the theoretical underpinnings of resource policies and provides sound guidance on ways to structure more thoughtful practice, as described in the following sections.

PRACTICAL THEORIES

The theoretical premises of most current resource management actions are explicit and partial or implicit and tacit. Partial theories are developed and maintained by disciplinary hubris and lead to a remarkable naivete. For instance, ecologists recognize the inherent complexity of nature and develop sophisticated models and understanding of ecosystems, but often have an oversimplified sense of political or social dimensions around resource issues. Witness the recent statements by nationally recognized U.S. scientists for an "independent review" of ongoing ecological restoration plans in the Everglades. Although narrowly correct (what scientist

wouldn't want independent peer review?), they appear hopelessly naïve of the social, political, and power relationships in the region. That is, by continuing a discussion on the uncertainties of the ecology (which is unlikely to be resolved by blue ribbon panels, but rather by field tests), they are perpetuating a long-standing policy gridlock. Moreover, such moves have a dismal history; over the past 20 years, few if any, technical committees or scientific review panels have made any difference in policy (Light et al. 1995). The paper by Carpenter et al. (1999) shows ways out of such traps by building a robust bridge among theories from three disciplines (ecology, economics, and cultural theory). In doing so, the authors go a long way in developing an integrative theory of change around two key concepts for dealing nonlinear dynamics in systems of people and nature.

The paper addresses two properties of complex resource systems: resilience and panarchy. Resilience in ecological systems is the amount of disturbance that a system can absorb without changing stability domains (Holling 1973). Fig. 1 of Carpenter et al. (1999) is an excellent depiction of the transitions between alternative stability domains in the lake system, and it demonstrates how resilience is a function of interactions between key "slow" variables (e.g., phosphorus in sediments) and fast variables (e.g., weather variation). This interaction is also embedded in the concept of a panarchy, a construct that combines the adaptive cycle of Holling (1986) with cross-scale theory. Panarchy was developed as an alternative explanation to the top-down, slow-variable entrainment of hierarchy theory used by many ecologists (O'Neill et al. 1986). By incorporating these concepts into user-interactive models, Carpenter et al. (1999) are helping to chisel away some of the cross-scale and modeling obstacles outlined by Walters (1997) in his review of assessment and management.

THEORETICAL PRACTICE

A growing body of literature has documented a pattern of ecological surprise and policy response in managed resource systems. Walters (1986) first described a rhythm of crisis and opportunities in resource systems. The six ecological histories of regional-scale systems in Gunderson et al. (1995) all follow the model of a resource crisis followed by policy reformation and renewal. Similar patterns are described in traditional resource systems (Berkes and Folke 1998) and in large, North American bureaucratic management systems (Johnson et al. 1999). This pattern has also been described more generally in technological applications in social systems as a "bite-back" effect (Tenner 1997). It is also described as a pathology of resource management (Holling 1996), in which management actions are initially successful, leading to a myopia of research and management and eventual reduction in the resilience of the ecosystem.

The models of Carpenter et al. (1999) move beyond pattern recognition or qualitative descriptions into a framework that allows managers to more robustly understand the types of nonlinear dynamics of these systems. In most of the cases noted here (Gunderson et al. 1995, Johnson et al. 1999), the resource "surprise" is an indication of a shift in stability domain in the ecosystem. In the Carpenter example, it is the trophic state of the lake. The model framework allows thoughtful managers to assess alternatives in terms of recovery and restoration. In these cases, the options include: (1) restoring the system to a desirable domain, (2) allowing the system to return to a desirable domain by itself, or (3) adapting to the changed system because changes are irreversible. By probing the uncertainties of the resource system, a manager is able to learn while doing and to make inevitable mistakes more reversible and less costly. The point here is that this framework changes the fundamental way in which most managers think about and attempt to understand the systems that they are charged with "managing."

This paper contains a few lessons on sustainability and how it might be achieved. It is clear that sustainability is not a product but a process. It is also clear that the process of seeking sustainability requires focusing on ecosystem processes of resilience, renewal, and adaptive capacity. Those processes are constantly changing and, hence, must be constantly probed. It is also clear that we must seek more integrative approaches, because focusing on one scale and narrow goal-seeking (such as optimizing economic activities) are likely to be

maladaptive. Or in the worst case, such myopic practices lead to a loss of resilience so that actions are irreversible and options dwindle.

Success and failures of resource polices are not revealed in journals such as this one, but rather by putting those policies at risk in the real world. The simplified models by Carpenter et al. (1999) help move out of a pathologic process of seeking a "best" management practice to implement, with subsequent larger and more unmanageable crises, to a process that allows asking better questions to pose and test in the real world. Although this message is not new, this paper illuminates new paths in theory and practice to pursue on the quest called sustainability.

RESPONSES TO THIS ARTICLE

Responses to this article are invited. If accepted for publication, your response will be hyperlinked to the article. To submit a comment, follow [this link](#). To read comments already accepted, follow [this link](#).

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