Resilience Theory in Ocean Management: Finding New Bridges, Avoiding Barrier Reefs (1)

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Background

Over the last 25 years the linkages between ecological and social systems have been broadly recognized (Odum 1977; Gunderson et al. 1995; Berkes and Folke 1998; Berkes et al. 2003). Theories of how such complex systems function (Holling 1973; Gunderson et al. 1995; Gunderson 2000; Gunderson et al. 2002; Gunderson and Pritchard 2002) and how to confront uncertainty and manage them adaptively (Holling 1978; Walters 1986; Lee 1993; Functowicz and Ravetz 1994; Hilborn et al. 1995; Kay et al. 1999) have significantly influenced the philosophies of natural resource management (Lee 1999; Ludwig et. al 1993; Ludwig 2001; Ludwig et al. 2001). Change and surprise are inherent properties of complex systems: change in such systems is described through adaptive cycles of construction and creative destruction (Gunderson et al. 1995; Gunderson and Holling 2002). Adaptive cycles (Figure 1) exist in connected, nested hierarchies- termed "panarchies"- across scales of time and space (Figure 2) and both large, slow cycles and smaller, faster cycles can influence each other. Timing and resilience determine the outcomes of cycles. Resilience is defined as the capacity of a system to undergo disturbance and maintain both its existing functions and controls and its capacity for future change. An alternative definition of resilience is recognized, a combination of the resistance to disturbance and speed of return of a system to equilibrium state: termed *engineering resilience*, to differentiate it from the above-mentioned *ecosystem resilience* (2). Resilience is determined not only by a system's ability to buffer or absorb shocks, but also its capacity for learning and self-organization to adapt to change (Holling 1973; Gunderson 2000; Carpenter et al. 2001; Gunderson and Holling 2002).

1 Adapted from Clark, D. (in prep.) Adaptive Cycles and the Resilience of the Parks Canada Agency. For submission to *Conservation Ecology*.

2 Subsequent discussion refers only to ecosystem resilience.

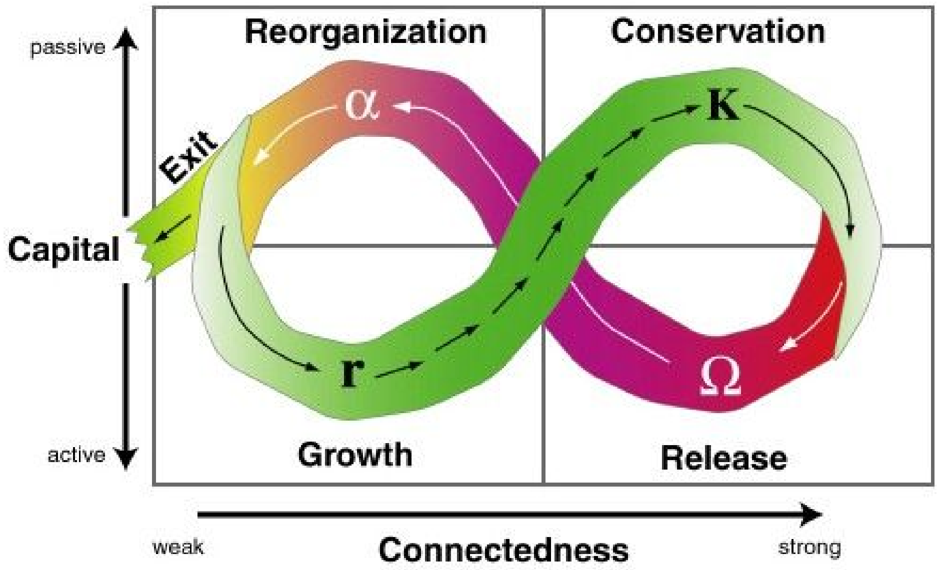

Figure 1. The adaptive cycle. (source: www.sustainablefutures.net)

During the r-phase of growth in the adaptive cycle, capital (actual and potential resources, and information) is mobilized. The K-phase follows and involves increasing organization and internal connectivity; conserving capital. If too many connections create an excessively rigid system, the system can enter a sudden omega-phase of disconnection and capital loss, followed by an alpha-phase of re-organization, during which innovation and experiment flourish, though potential capital may be lost here as a single new course of growth begins. It is important to note that though these cycles may be ubiquitous they are not necessarily deterministic: many influences can shape final outcomes. In particular, foresight is a unique property of human systems and can allow anticipation of and intervention in adaptive cycles in order to attain societal goals such as sustainability. Unfortunately this outcome is rare in practice (Gunderson and Holling 2002).

Figure 2 illustrates two dynamics between adaptive cycles in a panarchical relationship. Larger, slower cycles may stabilize smaller, faster cycles through a "remember" effect. Omega-phases in smaller and faster cycles may disrupt stable phases in slower, larger cycles, precipitating "revolt". Coinciding omega-phases can precipitate catastrophic collapse across multiple scales (Gunderson and Holling 2002).

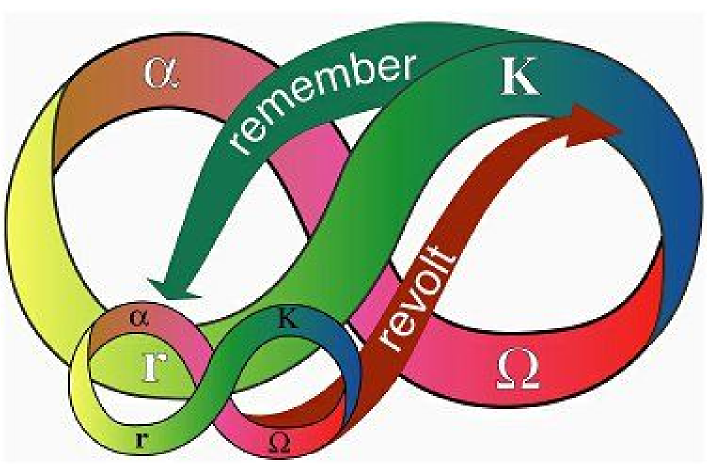

Figure 2. The panarchical cycle, illustrating two ways connected cycles at different scales may affect each other.
(source: www.sustainablefutures.net).

Current research

This theory of change contrasts markedly with the efforts of most resource management agencies to reduce variability in natural systems (Holling and Meffe 1996). Numerous authors argue that this approach is a fundamental flaw of modern resource management policy worldwide (Folke et al. 2002), and much current research now focuses on how resilience theory can be applied to real resource management issues.

An alternative management paradigm has been suggested: resilience management, which promotes sustainable management of social-ecological systems by enhancing their adaptive capacity and resilience in the face of change (Walker et al. 2002). This proposed approach, which parallels the ecosystem management heuristic developed by Kay et al. (1999), is a participatory process that involves four main steps:

1. modeling a social-ecological system, including its history, and identifying possible system drivers,
2. identifying drivers, stakeholder visions and contrasting policies to generate possible future scenarios,
3. exploring the system's resilience,
4. stakeholder evaluation of the process and outcomes in terms of policy and management implications.

In a more general approach, Berkes et al. (2003) have identified 4 main strategies for building resilience in social-ecological systems:

1. learning to live with change and uncertainty,
2. nurturing diversity for reorganization and renewal,
3. combining different types of knowledge for learning,
4. creating opportunity for self-organization.

Future research

A central argument of resilience theory is that resource management agencies must apply such new approaches if they are to function effectively in a rapidly-changing and increasingly interconnected world (Folke et al. 2002). Most recently, Holling (2003) reflects very thoughtfully and personally on the application of resilience theory to global concerns post-9/11; an era which, in adaptive cycle terminology, he describes as "a big back loop", referring to the omega-to-alpha portion of the cycle. Holling proposes that the resilience theory developed from regional case studies can indeed be scaled upwards, as part of "the foundation to understand and manage our complex transforming world".

However, despite the compelling arguments and appeals of those voices, evidence of resilience theory's application is scarce and its influence on practice to date appears limited. Why is this so? A preliminary response to this important question is that resilience theory in particular faces challenges related (but likely not limited) to the following:

1. its explicit criticism of existing resource management institutions, and implicit threat to their established institutional and political interests,

2. its newness, relatively untried methodology, and consequent lack of substantive guidance for practitioners (and perhaps such practitioners' expectations of direction),

3. its equating of paradigm shifts in management with paradigm shifts in science, arguably leading to ineffective policy interventions.

Questions for workshop discussion

Specific questions can also be asked about the Canadian experience in managing social-ecological systems for resilience: Does experience to date with the *Canada Oceans Act, 1997* (or indeed other relevant legislation) reflect the above identified resilience-building principles? Are there cases in Canada or elsewhere where resilience theory is being deliberately applied to resource management? If so, what can be learned from them? If not, are there situations where participants might be willing to try such an approach?

Our challenge to workshop participants is to bring their own research and experiences to respond to these specific challenges, identify others that may exist, and share potential strategies and tactics to overcome them and operationalize resilience theory in oceans management.

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Backgrounder author(s)

Doug Clark is a PhD candidate at Wilfrid Laurier University, and is researching local and regional-scale societal dynamics in grizzly bear management. His research interests broadly include institutions and governance for wildlife and ecosystems, with particular interest in Canada's north. He has 12 years of professional experience with Parks Canada in a variety of positions and locations, including Chief Park Warden of Wapusk and Kluane National Parks. He holds a B.Sc. in biology (Hons., Co-op) from the University of Victoria, and a M.Sc. in zoology from the University of Alberta, where he studied habitat selection by polar bears.

Nancy Doubleday is Associate Chair, Department of Geography and Environmental Studies, Carleton University. Nancy holds a Ph.D. (Queen's University) where she looked at combustion in sediments in the Eastern Arctic. Previously, she worked for Inuit organizations at local, national and international levels for over 20 years on legal, environmental and human rights issues. Nancy is a lawyer and ecologist holding LL.B. (Osgoode Hall, York), M.E.S. (York), B.Ed. (Toronto) and B.Sc. (Hons.) (Brock). Her research has included reconstruction of fire history and climate, wildlife management and traditional knowledge, international law of environment and human rights, and contaminants, as processes of change.