

Reserves and resilience—from single equilibrium to complex systems

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Reserves and resilience—from single equilibrium to complex systems

It is no longer a provocative statement to argue that human activities impact ecosystem dynamics at all scales, and across scales; that there are no pristine areas free from human influence or social systems independent of nature's subsidies. Throughout history humanity has shaped nature and nature has shaped the development of human society. We are currently living in the Anthropocene era where most aspects of the functioning of the Earth system cannot be understood without accounting for the strong influence of humanity. A major challenge in this era of extensive transformations is to actively strengthen and enhance the capacity of the biosphere, from local to global levels, to support and sustain social and economic development.

Human progress rests on this capacity. It is time to abandon naïve perceptions of environmental independence and instead reconnect human perception and action to the processes of the biosphere. It will require a shift in thinking from focusing on controlling change in an engineering fashion for optimal solutions to accept that change is the rule rather than the exception. The old way of thinking implicitly assumes a stable and infinitely resilient environment. The new perspective recognizes that resilience can and has been eroded and that the luxury of living with a self-repairing and forgiving biosphere seems to be history.

A major task for prosperity is to try to sustain desirable pathways for development in the face of change. The concept of resilience shifts perspective from the aspiration to control change in systems assumed to be stable, to sustain and enhance the capacity of social-ecological systems to deal with change. It implies accepting uncertainty and surprise and learning to live with it.

Protected areas and reserves are common measures in current resource and environmental management and conservation. To what extent do such measures contribute to resilience and to what extent do they actually help conserve biodiversity in a human dominated world? The article 'Reserves, Resilience and Dynamic

Landscapes' by Bengtsson et al. in the current issue of *Ambio* (pp 389–396) addresses such questions from a landscape/seascape ecology perspective. The role of reserves as a management tool for ecosystem services in complex adaptive ecosystems is their focus. Protected areas and reserves are open systems that will sooner or later be affected by large-scale disturbances and disturbance regimes are a part of ecosystem dynamics within as well as outside reserves. Humans have fundamentally altered natural disturbance regimes, adding new types and changing frequency, intensity and spatial patterns of disturbances. These changes have been rapid, which means that many organisms have become maladapted to present conditions. These disturbances may challenge the existence of a protected area unless the processes that sustain it are connected to the dynamics of the surrounding landscape. There is an increased focus on protected areas and reserve networks as a significant management tool in both terrestrial and marine systems. Implication of altered disturbance regimes and loss of resilience are issues that need to be addressed in the selection and combination of reserve networks in any system.

Bengtsson et al. propose new types of reserves to conserve biodiversity and sustain ecosystem services in managed landscapes, namely 'ecological fallows', 'ephemeral reserves', 'mid-succession reserves' and 'dynamic successional reserves'. These reserves focus on supporting ecosystem processes, keystone species and functional diversity that are essential parts of the capacity of ecosystems to generate and sustain ecosystem services. The landscape matrix of dynamic reserves combined with protected areas would be important insurance in adaptive landscape management and contribute to long-term sustainability, ecosystem resilience, and biodiversity conservation.

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Origins and Biological Accumulation of Small Plastic Particles in Fur Seals from Macquarie Island Cecilia Eriksson and Harry Burton	380–384	The Impact of an Urban-Industrial Region on the Magnitude and Variability of Persistent Organic Pollutant Deposition to Lake Michigan Keri C. Hornbuckle and Mark L. Green	406–411
Bone Mineral Density in Male Baltic Grey Seal (<i>Halichoerus grypus</i>) P. Monica Lind, Anders Bergman, Mats Olsson and Jan Örberg	385–388	Riverine Inputs of Organic Carbon and Nitrogen to Norwegian Coastal Areas Aud Helland, Gjertrud Holtan and Per Jørgensen	412–417
Reserves, Resilience and Dynamic Landscapes Janne Bengtsson, Per Angelstam, Thomas Elmqvist, Urban Emanuelsson, Carl Folke, Margareta Ihse, Fredrik Moberg and Magnus Nyström	389–396	Ecological Aspects of Transformation in Poland's Agriculture Based on the Wielkopolska Region Janusz Jankowiak, Barbara Szpakowska and Jerzy Bienkowski	418–423
Reindeer in the Swedish Mountains: An Assessment of Grazing Impacts Jon Moen and Oje Danell	397–402	The Fate of Chloroacetanilide Herbicides and Their Degradation Products in the Nzoia Basin, Kenya Odipo Osano, Daniel Nzyuko, Mwakio Tole and Wim Admiraal	424–427
Decadal Changes in a Polluted Bay As Seen from Its Seaweed Flora: The Case of Santos Bay in Brazil Eurico C. Oliveira and Yaobin Qi	403–405	Disturbance, Life History, and Optimal Management for Biodiversity Qinfeng Guo	428–430