University of Victoria | Graduate Studies

Notice of the Final Oral Examination
for the Degree of Doctor of Philosophy

of

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## "Understanding Ecological Response to Disturbance: Mechanisms and Management Strategies in a Changing World"

School of Environmental Studies

Monday, January 22, 2018
2:30 P.M.
Clearihue Building
Room B017

Supervisory Committee:
Dr. Brian Starzomski, School of Environmental Studies, University of Victoria (Co-Supervisor)
Dr. Rachel Standish, School of Environmental Studies, UVic (Co-Supervisor)
Dr. John Paul Volpe, School of Environmental Studies, UVic (Member)
Dr. A. Cole Burton, Faculty of Forestry, University of British Columbia (Outside Member)

External Examiner:
Dr. Ross Thompson, Institute for Applied Ecology, University of Canberra

Chair of Oral Examination:
Dr. Reuven Gordon, Department of Electrical and Computer Engineering, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

## Abstract

Ecosystems in the modern world face a vast array of disturbances, from globally shifting abiotic conditions, to increasingly variable extreme natural events, to high intensity discrete human-caused disturbances. Well-developed, applicable theoretical frameworks on how ecosystems can respond to and withstand these disturbances are needed for adequate management of valued ecological systems. To date, the most promising theoretical development for understanding ecological response to complex sets of disturbances is resilience. Ecological resilience acknowledges non-linear ecosystem behavior, incorporates the role of slowly changing environmental parameters in ecological dynamics, and offers one of the few potential methods to predict, and avoid, impending ecological collapse. However, as ecological resilience has evolved conceptually to include social, political, and economic fields, it has become increasingly difficult to clearly define in, and apply to, managed ecosystems. This dissertation pairs ecological resilience with other, well-established attributes of ecological response to disturbance, namely resistance, persistence, and recovery. By doing so, we can clearly define and quantify each attribute in a range of ecosystem types and over a variety of ecological scales. In Chapter 1, we use microcosm communities to test the relationship between one potential mechanism, landscape connectivity, and multiple attributes of ecological response to disturbance including resistance, resilience, and recovery. We find that each attribute responds uniquely to connectivity, and that generalizing the role of connectivity over all three may give an inaccurate prediction of how ecosystems may respond to individual disturbances. In Chapter 2, we experimentally investigate the presence of early warning indicators of approaching critical thresholds. Using water table drawdown treatments in bog, we test for critical slowing and increased autocorrelation as the bog approaches a transition to forest. We find that critical slowing is clear in composition and moss cover, but that autocorrelation is not apparent. The decoupling of critical slowing and increased autocorrelation could be due to a number of complex ecosystem dynamics, all of which are common in ecosystem management globally. Thus, early warning indicators likely need further development if they are to become applicable. In Chapter 3, we observationally study how conservation management actions may increase or decrease ecological resilience. In particular, we explore how invasive species management intensity correlates with changes in functional redundancy, response diversity, and spatial occurrence of regime shifts in Garry oak meadows. We find that more intense management correlates with less area lost to woody encroachment and increases in functional redundancy through time. However, the relationship was strongly mediated by individual landscape settings. Finally, in Chapter 4, we scale up to a provincial study, investigating persistence of ecosystems and large mammal species in the face of the continuous pressures of land use change. In the results from all four chapters, it is clear that individual attributes of ecological response to disturbance, i.e. resistance, persistence, resilience, or recovery, all play unique roles in ecosystem dynamics. Additionally, the metric chosen to quantify each attribute can play a pivotal role in how we interpret observed dynamics. The work in this dissertation highlights that we cannot understand or predict ecological response to disturbance without clear, measurable concepts. Around a single state of interest, resilience is only one among a suite of attributes that are important to understand. Its additional strength, of potentially predicting the occurrence of ecological thresholds, is still being developed as we explore methods of quantification and application in individual ecosystems.