Development of resilience-based state-and-transition models

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Introduction The objective of this paper is to recommend the incorporation of additional resilience concepts into the state-and-transition model (STM) framework. Ecological resilience describes the amount of change or disruption that is required to transform a system from being maintained by one set of mutually reinforcing processes and structures to a different set of processes and structures (e.g., an alternative stable state). In the light of this concept, effective ecosystem management must focus on the adoption of management practices and policies that maintain or enhance ecological resilience to prevent stable states from exceeding thresholds. Therefore, resilience-based management does not exclusively focus on identifying thresholds *per se*, but rather on within-state dynamics that influence state vulnerability or proximity to thresholds.

Methods and materials The concepts reported in this paper were partially developed at a State-and-Transition Ecological Theory workshop sponsored by USDA-NRCS on the campus of Oregon State University, August 2006. Academics and managers convened to identify and summarize the most important advances and necessary requirements for STM to more effectively describe ecosystem dynamics.

Results and discussion The assessment of state resilience requires the development of recognizable indicators to identify when states are approaching thresholds as well as how far states have moved beyond thresholds when they have been crossed (Stringham et al. 2003). In an effort to incorporate resilience-based concepts in the STM framework, we recommend that triggers, at-risk community phases, feedback mechanisms, and restoration pathways be incorporated for each threshold separating individual states, including process-specific indicators to identify at-risk plant communities and potential restoration pathways. Triggers describe biotic or abiotic variables or events that initiate threshold-related processes by contributing to the immediate loss of ecosystem resilience. Selection of at-risk communities requires identification of community phases known or assumed to have the least ecological resilience within a state and that immediately precede shifts to alternative states. Indicators of positive and negative feedbacks, contributing to either decreasing or increasing state resilience, respectively, can be inferred from altered patterns and processes within individual states. Patterns and processes associated with negative feedbacks in alternative states can be used to develop indicators of the resilience attained by these states after thresholds have been surpassed. Restoration pathways can be assessed with indicators that identify the residual properties of former states that continue to exist within alternative states after thresholds have been crossed. Community phases within alternative states that have developed the least resilience (e.g., fewest negative feedbacks) and possess the greatest proportion of residual properties of the former state are the most likely candidates from which to initiate restoration pathways (Bestelmeyer 2006; Briske et al. 2006).

Conclusions The incorporation of resilience-based concepts into the STM framework will promote adaptive management by emphasizing indicators of state resilience in addition to indicators of pending thresholds and it will identify additional variables to better inform ecosystem managers of risk and restoration options.

References

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