Resilience of Ecosystem Structure and Function during Succession Following Prescribed Burning in a Shrub-Steppe Ecosystem in Wyoming, USA

E. Pendall
University of Wyoming

M. B. Cleary
University of Wyoming

B. E. Ewers
University of Wyoming

K. Naithani
University of Wyoming

H. Kwon
University of Wyoming

The 21st International Grassland Congress / 8th International Rangeland Congress took place in Hohhot, China from June 29 through July 5, 2008.

Proceedings edited by Organizing Committee of 2008 IGC/IRC Conference

Published by Guangdong People's Publishing House

Resilience of ecosystem structure and function during succession following prescribed burning in a shrub-steppe ecosystem in Wyoming, USA

E. Pendall, M.B. Cleary, B.E. Ewers, K. Naithani, and H. Kwon
Department of Botany and Program in Ecology, University of Wyoming, Laramie, WY 82071 USA, E-mail: Pendall@uwyo.edu

Key words: aboveground biomass, roots, soil organic matter, N availability, sagebrush steppe

Introduction Prescribed burning is applied in mountain big sagebrush (*Artemisia tritentata* var. *vaseyana*) communities across the Intermountain West, USA, to reduce shrub cover, increase herbaceous biomass, and enhance wildlife habitat and rangeland health. When properly managed, succession following burning in these upper elevation rangelands follows a predictable pathway. Initially, perennial bunchgrasses (including *Festuca* spp., *Stipa* spp. and *Poa* spp.) dominate, and sagebrush cover increases to pre-burn levels within about 40 years as grasses decline (Ewers and Pendall 2008). We hypothesized that N availability would be stimulated following burning, and that aboveground and belowground biomass and soil organic matter storage would increase as shrub cover increased during succession.

Methods We studied the effects of burning on ecosystem structure and function at three chronosequence sites in Wyoming, ranging in age from 0 to ~40 years since disturbance. We measured vegetation cover and leaf area index (LAI), and developed new allometric relationships for estimating aboveground and coarse root biomass for sagebrush (Cleary et al. 2007). Fine root biomass, soil organic matter (SOM) and KCl-extractable NH_4^+ and NO_3^- content were also measured at one chronosequence to 2-m soil depth. SOM was further fractionated into active, slow, and non-hydrolyzable C (NHC) pools using long-term incubations and 6-*N* HCl digestion. We applied a vector approach, by repeated sampling of several parameters at multiple time points, and replicated the chronosequences, to test chronosequence assumptions.

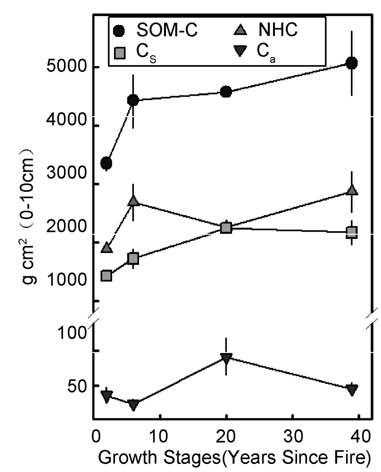

Figure 1 *Soil C pools in top 10-cm over succession. SOM-C, total; NHC, non-hydrolyzable C; Cs, slow pool C; Ca, active pool C.*

Results and discussion We found that increases in aboveground biomass, cover and LAI were driven by sagebrush establishment and growth over 40 years of succession following burning. Aboveground biomass accumulated at a net rate of approximately 15 g C m^{-2} y^{-1}, to a maximum of about 600 g C m^{-2}. Coarse root biomass in the top 25-cm soil accumulated at approximately 8 g C m^{-2} y^{-1} to a maximum of 350 g C m^{-2}. Fine root biomass was maintained near steady state, at approximately 450 g C m^{-2}, throughout succession, for a total biomass C inventory of about 1400 g m^{-2} in the climax shrub-dominated community. Total SOM in the top 10-cm depth increased from about 3200 g m^{-2} to 5000 g m^{-2} over 40 years, with the largest increases observed in the slow and NHC pools (Figure 1), which have mean residence times of decades to centuries. The regrowth of aboveground biomass and maintenance of belowground biomass and SOM indicate that this ecosystem is resilient to *fire*.

A pulse of available N was observed in the first 3-4 years after a burn, mainly in the form of NH_4^+ (Figure 2). This available N was likely responsible for vigorous growth of herbaceous biomass following burning. Repeated measurements confirmed the validity of our chronosequence approach. Changes in net N mineralization during succession were not observed due to high variability.

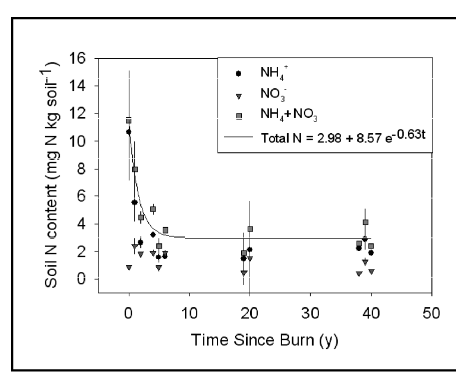

Figure 2 *Annually repeated measurements of soil NH_4^+ and NO_3^- pools during succession in a burn chronosequence.*

Conclusions Aboveground biomass and C stocks in SOM increased during succession, corresponding to changes in shrub cover, while N availability peaked in the first few years following burning. Maintenance of fine root biomass, provided by perennial grasses, appears to be critical to resilience of ecosystem structure and function in sagebrush steppe.

References

Cleary, M.B., Pendall, E., and Ewers, B.E. (2007). *Journal of Arid Environments*. DOI:10.1016/j.jaridenv.2007.07.013.

Ewers, B.E., and Pendall, E. (2008). *Plant Ecology* 194, 67-83, DOI 10.1007/s11258-007-9275-z.