

Using multivariate control charts to communicate long-term changes in sagebrush-steppe vegetation communities

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1. Background

- Species richness and other univariate metrics provide limited information about how communities change over time
- Community composition is multivariate (multiple species present)
- Multivariate Control Charts (MCCs) provide a simple method for visualizing changes in composition
- We used MCCs to describe changes in the vegetation of the Arid Lands Ecology Reserve (ALE) between 1992 and 2010
- ALE was particularly affected by the 24 Command Fire in 2000 and the Milepost 17 and Wautoma Fires in 2007



The 24 Command Fire burning on ALE in 2000 (Heidi Newsome, US FWS)

2.1 Field Methods

- 56 permanent transects, each with twenty 20 x 50 cm vegetation quadrats
- Plant cover recorded by species
- Transects experienced 0-3 fires since they were established
- Transects also received different restoration treatments, including herbicide application and re-seeding with native species

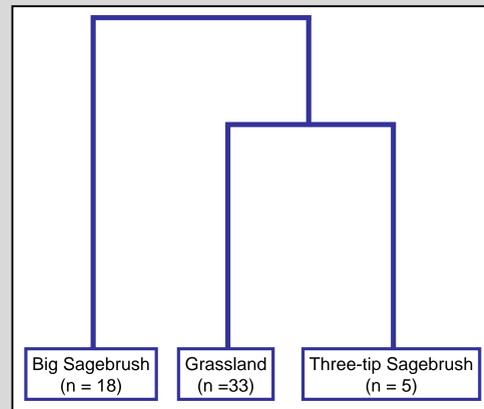
2.2 Cluster Analysis

- Identified groups of transects with similar initial composition

2.3 MCCs

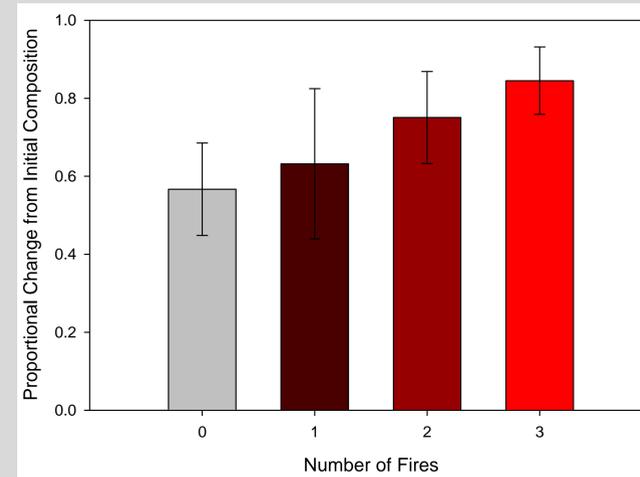
- Calculate proportional change in community composition from one year to another
- Two comparisons:
 - To initial composition
 - To composition during previous measurement
- Analytical details:
 - Rare species deleted** (those occurring in < 5% of transects)
 - Species abundance data **standardised** by column (species) maxima and row (transect) totals to provide **relative abundance**
 - Proportional change in community composition represented as **Bray-Curtis dissimilarity measure**

3.1 Results: Cluster Analysis

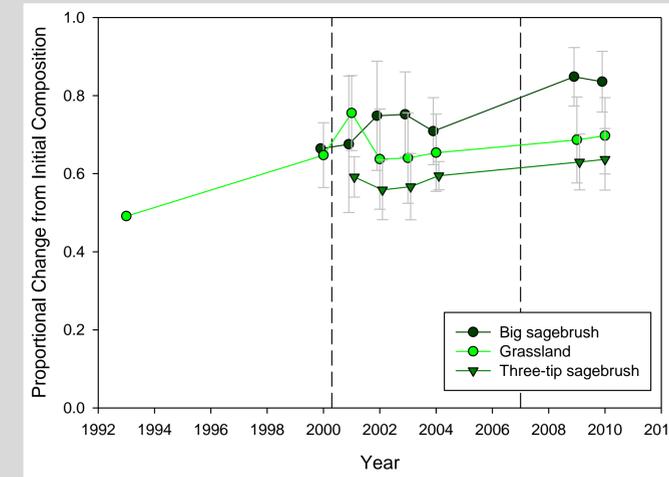


- Three distinct communities** at start of monitoring:
- Low elevation areas that contained big sagebrush
 - Low elevation grassland areas that had lost their shrub cover in earlier fires
 - High elevation areas that contained three-tip sagebrush

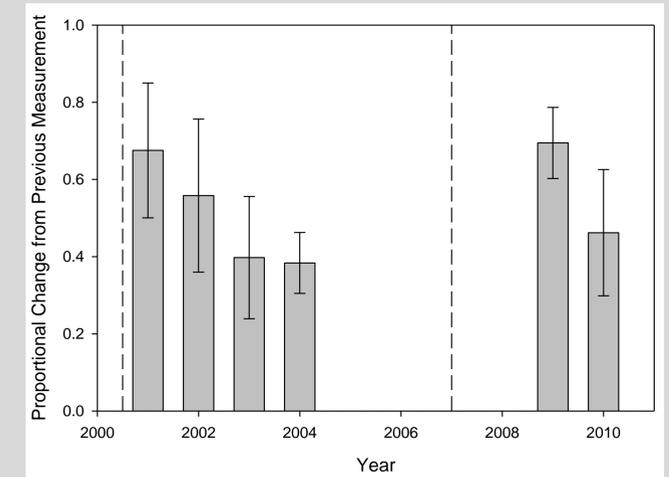
3.2 Results: MCCs



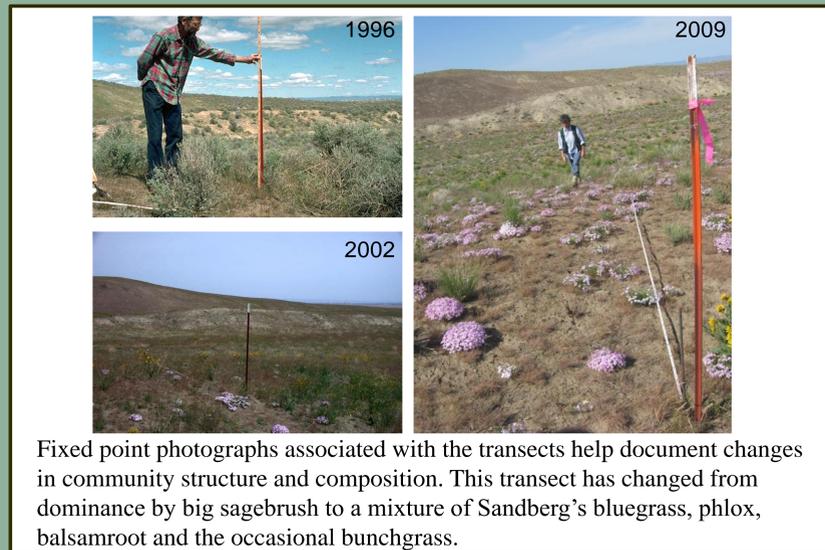
Composition changed more as the number of fires increased. Data from 2009-2010 for the low elevation big sagebrush and grassland transects.



Composition changed more in areas that contained big sagebrush and least in areas that contained resprouting species. Data from transects that experienced two fires (dashed lines) during the measurement period.



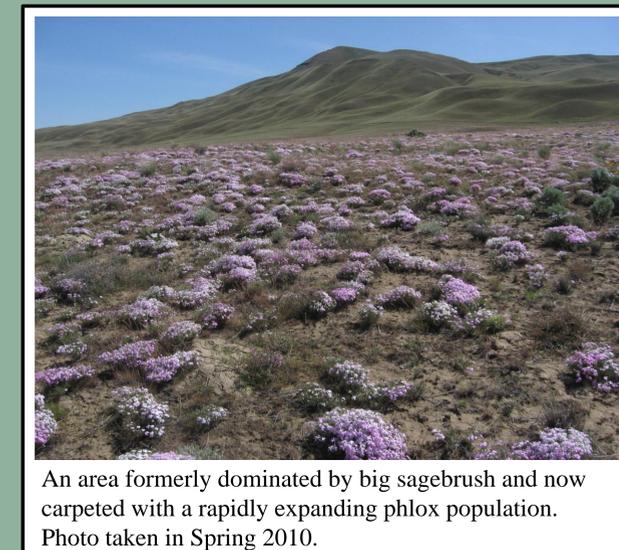
The largest changes occurred immediately following fires (dashed lines). Data from big sagebrush transects that experienced two fires (dashed lines) during the measurement period.



Fixed point photographs associated with the transects help document changes in community structure and composition. This transect has changed from dominance by big sagebrush to a mixture of Sandberg's bluegrass, phlox, balsamroot and the occasional bunchgrass.

4. Conclusions and Recommendations

- Multivariate control charts (MCCs) could be a valuable tool for managers
- Comparisons with different baselines can show how community responds to various disturbances:
 - Episodic ('pulse') – compare with static baseline
 - Chronic ('press') – compare with previous measurements
- MCCs do not show the direction in which communities have changed – should be integrated with other tools
- Large year-to-year variation in composition. Refine usage of MCCs by focusing on key life forms?
 - Native perennials = Recovery
 - Exotic annuals = Degradation



An area formerly dominated by big sagebrush and now carpeted with a rapidly expanding phlox population. Photo taken in Spring 2010.

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Reference

Anderson & Thompson. 2004. Multivariate control charts for ecological and environmental monitoring. *Ecological Applications* 14:1921-1935.

