Recovery Following Fire and Long Term Persistence of Mountain Sagebrush Communities

Zach Nelson[1], Peter Weisberg[1], Stanley Kitchen[2], Dongwook Ko[1]

[1]University of Nevada, Reno, [2]Shrub Sciences Laboratory-Rocky Mountain Research Station

BACKGROUND

Mountain Big Sagebrush landscapes include patches of (1) grassland, (2) mountain shrubland, and (3) pinyon and juniper woodland. The relative proportions of these vegetation states in the mosaic are influenced by factors such as (1) fire frequency, (2) fire size, and (3) succession rate.

Fire histories of sagebrush communities are difficult to reconstruct and justification for restoration based on implicit assumptions of fire regime change are often controversial. This poster outlines some initial questions that are part of a larger study to better understand feedbacks between landscape structure, heterogeneous productivity gradients and fire probability in mountain sagebrush systems.

QUESTIONS

1.What is an appropriate measure of vegetation recovery following fire? Should recovery be evaluated at (A) the single species level, or (B) the community level?

2.What RANGE of fire regime parameters (e.g. fire size and frequency) is compatible with the persistence of mountain sagebrush patches in the landscape?

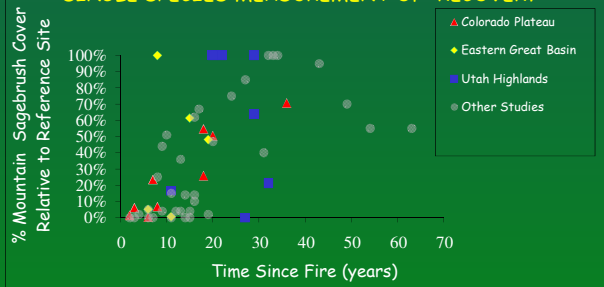
FIELD METHODS

Vegetation was measured at 25 burned sites with paired, unburned reference sites in the (1) Colorado Plateau, (2) Utah Highlands, and (3) Eastern Great Basin

Burned Site

Reference Site

SINGLE SPECIES MEASUREMENT OF "RECOVERY"



• % mountain sagebrush recovery over time in each of the 3 ecoregions is similar to other studies conducted over the last century.

•However the variation in successional trajectories in relation to environmental and productivity gradients needs to be evaluated to better understand the spatial heterogeneity in feedbacks between landscape structure, succession, and fire (planned for 2008).

•A community level approach to assessing "recovery" after fire may be more appropriate. Landscape restoration of vegetation mosaics and disturbance processes requires consideration of multiple species and their ecological interactions.

COMMUNITY-LEVEL ASSESSMENT OF "RECOVERY"

•To evaluate "recovery" of sagebrush systems after fire, both paired reference and burned sites were plotted in ordination space, based on similarity in species composition, using non-metric multidimensional scaling (NMDS).

•Using NMDS axis scores, 50%, 90%, and 95% kernel density estimators were calculated for reference sites and interpreted as 3 dimensions of a "recovery space". Burned sites that occur in the 50% kernel density estimator are most similar to the centroid of the recovered sites and may be interpreted as "recovered" in terms of community composition.

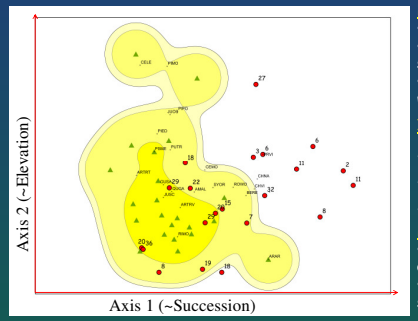


Figure description
•Reference sites (green)
•Burned sites (red) labeled with time since fire.
•Centroids of woody species are labeled with species code.

Interpretation of NMDS Axes

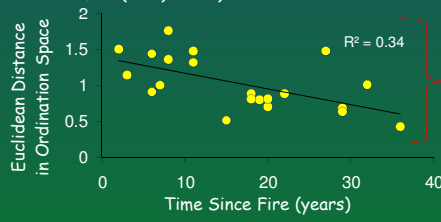
Axis 1: succession gradient

Axis 2: elevation gradient

Axis 3 (not shown): productivity gradient

Future Directions
•Partition sites based on environmental and regional gradients.
•Double the number of sites (2008 field season)

"Recovery" relative to a reference site : Represented below as the Euclidean Distances (in 3-D ordination space) between burned sites and paired reference sites (plotted against time since fire (TSF) below).

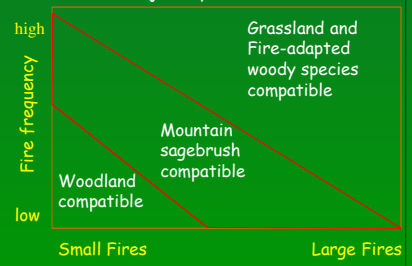


•After 35 years, communities are not fully recovered.
•We need more data to better describe this trend (2008 field season).
•Lack of fit indicates other variables are probably important in successional trajectories including:
1.climate before/after fire
2.burn severity mosaic
3.propagule availability
4.productivity gradients

CONCLUSIONS

Community level approaches to measuring "recovery" of sagebrush systems after fire are probably more appropriate than single species measures, given spatial heterogeneity in species pool across regional scales. With more sites (added in summer 2008) we intend to evaluate the influence of the burn severity configuration, and environmental gradients on rates and trajectories of succession. The complex interactions between landscape structure and disturbance processes are not easily elucidated through field sampling and fire history studies. Dynamic simulation models will help us to understand sagebrush persistence in the context of spatially heterogeneous landscapes. We intend to use data from fire history and vegetation recovery studies as model input. The model will test assumptions about the long term persistence of mountain sagebrush communities in the landscape under alternative fire regime and succession trajectory scenarios.

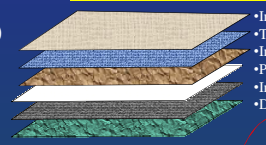
"Bracketing" the range of fire regime parameters (e.g. fire size, and frequency) that are compatible with mountain sagebrush persistence in the landscape will require simulation modeling to incorporate (1) stochasticity, (2) feedbacks between shifting vegetation states and disturbance over time and (3) testing the sensitivity of mosaic configuration and landscape structure to a range of fire regime parameter values.



FUTURE DIRECTIONS -- LANDSCAPE SIMULATIONS

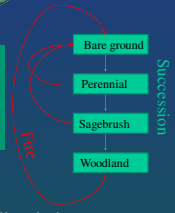
Model components
•Vegetation succession (parameterized from field data) State-and-transition Markov based approach
•Seed dispersal
•Climatic influences on (a) seed production before fire, (b) establishment conditions after fire and (c) stochasticity in fire regime.
•Fire regime (range of values bracketed around those from the LANDFIRE project VDDT succession model)

Raster based cellular automata model



•Initial vegetation layer
•Time since fire layer
•Initial age layer
•Productivity
•Initial seed bank layer
•Distance to seed source

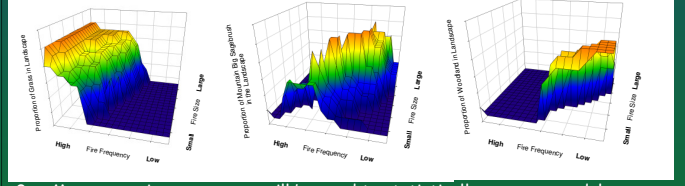
Model platform: SELES (spatially explicit landscape event simulator)



Model Output

1. Model outputs for multiple, stochastic simulation runs will include maps describing the long-term probability of each vegetation type (e.g. mountain sagebrush) on a pixel level.
2. Outputs will allow assessment of the likelihood of mountain big sagebrush persistence given alternative scenarios of fire frequency, fire extent, spatial structure of the burn severity mosaic, and rate of sagebrush recovery based on a community level framework.

Simulation output will consist of the proportion of each "seral stage" : (1) grassland, (2) mountain sagebrush, (3) and woodland as represented in the hypothesized model output below.



3. Map comparison measures will be used to statistically compare model predictions for sagebrush persistence with actual sagebrush distribution, over each of the model scenarios for fire frequency, extent and spatial pattern.
4. Based on this analysis, we will quantify those combinations of fire regime parameters (frequency, extent, patchiness) which are compatible with long-term mountain big sagebrush persistence in a probabilistic sense.
5. This will be done graphically, and by constructing multivariate confidence ellipses for pairwise combinations of fire regime predictors for the subset of model scenarios where sagebrush persistence was observed.
6. We can then evaluate whether current LANDFIRE model parameters lie within the range of variability that is feasible for the mountain sagebrush potential natural vegetation group (PNVG), and develop any necessary recommendations for modification.

ACKNOWLEDGEMENTS: Funding is provided by the Joint Fire Science Program. Assistance with field data collection provided by the Shrub Science Lab, Rocky Mountain Research Station. Travel funding provided by the University of Nevada EECB small grants award and the University of Nevada Graduate Student Association.

Common names for species codes in ordination plot.

AMAL	Saskatoon Serviceberry	ERFA	Mojave Buckwheat	ABCO	White fir
ARAR	Low Sagebrush	GUSA	Broom Snakeweed	ACGR	Big leaf maple
ARNO	Black Sagebrush	PRVI	Common Chokecherry	CELE	Curl leaf mountain-mahogany
ARTRT	Basin Big Sagebrush	PUTR	Antelope Bitterbrush	JUOS	Utah Juniper
ARTRV	Mountain Big Sagebrush	QUGA	Gambels Oak	JUSC	Rocky mountain Juniper
BERE	Creeping Barberry	ROWO	Woods Rose	PIED	Pinyon Pine
CEMO	True-Leaf Mountain Mahogany	SYOR	Mountain snowberry	PIMO	Single Leaf Pinyon
CHNA	Rubber Rabbitbrush	TECA	Gray Horsebrush	PIPO	Ponderosa pine
CHVI	Green Rabbitbrush	RIMO	Mountain Gooseberry	POTR	Quaking Aspen
				PSME	Douglas Fir

Joint Fire Science Program