UNIVERSITY OF IDAHO

Plant community composition along an environmental gradient in a central Idaho wilderness

University of Idaho Taylor Research Ranch

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Introduction

Background

Plant species assemblages are integrated by both independent and interdependent relationships which collectively compose plant communities (Lortie et al. 2004). These interactions between species vary as local environmental conditions change across the landscape. If conditions change in a relatively predictable manner, then environmental gradients arise (Lortie et al. 2004, Lookingbill 2005). One such situation exists along an elevational gradient, where abiotic factors such as temperature and precipitation may increase or decrease, depending on other abiotic variables such as slope, aspect and topography (Lookingbill 2005). This relationship makes elevation capable of being used as an indirect variable to infer differences in other abiotic variables, such temperature and precipitation (Lookingbill 2005).

Because these changes exist along an elevational gradient, plant community composition varies in response to the increased stress experienced by species within the community (Lortie et al. 2004, Maestre et al. 2009, Callaway 1998). Stress, defined by Grime (1977), is an environment where a producers ability to photosynthesize is limited (Maestre 2009). Dominant plant interactions change with increased degrees of stress (Callaway 1998). In more benign environments, negative competitive interactions are dominant between plants. However, as stress increases along an elevational gradient, positive facilitative effects become the more frequent plant interaction (Maestre 2009, Callaway 1998), highlighting that plant community structure is dependent on species present and abiotic conditions.

Plant communities respond to other situations which alter the degree in which plants within a community interact; these include exotic invasions and disturbance. Plant invasions can disrupt community integration and threaten biological diversity by reducing gene pools, forcing extinction of native species, and altering community ecosystem processes (Lortie 2004, Vilà 2010). Disturbances can increase resource availability, which consequently can alter plant community composition by altering competition between plants (Adair and Burke 2008, Newingham 2006). Disturbance can include drought, herbivory, flooding, fire, as well as invasive species.

Cheatgrass (*Bromus tectorum*), an invasive annual grass native to Eurasia, has displaced over 40 million hectares of sagebrush/bunchgrass communities in the intermountain American west in approximately 200 years since its introduction (Adair and Burke 2008). Cheatgrass possesses many attributes that contribute to its invasive success, including high phenotypic plasticity, rapid uptake of available nitrogen as well as altering nitrogen cycling and increases in nitrogen pulses into an ecosystem by increasing fire frequency (Gundale et al. 2008). Cheatgrass invasions can result in habitat loss in addition to declines in biodiversity (Vilà 2010). Consequently, communities become less resilient.

Fire is an important disturbance for vegetative composition. Fire can increase the rate of successional processes. However, these processes differ depending on the post fire environment (Thonicke et al. 2001). Timing and frequency of burns affect how communities respond successionally. When fire regimes change, as occurs with invasions of annual grasses, native plant community composition can change rapidly and be completely displaced (Adair and Burke 2007, Gundale et al 2008, Peek et al. 2005, Thonicke et al. 2001).

Assessing community composition across environmental gradients, while considering abiotic variables such as soil moisture, texture and temperature, is important for predicting future vegetative patterns and how vegetation responds changes in these variables, as is expected from global climate predictions (Thonicke et al 2001). Exotic invasions, particularly those of annual grasses, can promote invasions from other exotic species and facilitate conditions detrimental to native species by increasing fire frequency and severity (Gundale et al. 2008).

Research Questions

1. How does *soil moisture and texture* vary along an environmental gradient?
2. How does *plant community composition* vary along an environmental gradient?
3. How does *fire* affect plant communities along an environmental gradient?

Research Objectives

1. Evaluate soil moisture and texture along an elevational gradient.
2. Quantify plant species composition along an elevational gradient. Particular species of concern, but are not limited to:
   a. Cheatgrass (*Bromus tectorum*)
   b. Tree regeneration
3. Compare community composition in unburned and burned areas.

Predictions

With increased elevation, soil moisture is expected to decrease. With decreased soil moisture in addition to decreased temperatures, soil texture is expected to change with increased elevation as well, possibly with an increase in sand due to slower soil formation. With changes in these abiotic conditions, plant community composition is expected to change as well. Tree regeneration is expected to increase with elevation and the composition of grasses and forbs are expected to change. Specific predictions on specific species along elevational gradients are difficult to predict since study sites have not been observed, however cheatgrass' occurrence is expected to decline past a certain elevation.

Methods

Site Description

The Frank Church "River of No Return" Wilderness is located in the Payette National Forest of central Idaho. The University of Idaho's Taylor Research Ranch, found in the Frank Church Wilderness, is eight miles west of the Middle Fork Salmon River on Big Creek. Taylor Ranch found at 1178 m above sea level, though the terrain varies drastically, ranging from 600 m on the main Salmon River to 3000 m at the Big Horn Crags.

Taylor Ranch receives an average annual rainfall of 40 cm, about 50% of which falls in December and January (Peek et al. 2005, Jackson and Sullivan 2009). Minimum average temperature is 14^{o}F and maximum average temperature is 88^{o}F (Peek et al. 2005), though temperature has shown a steady increasing trend in the last 30 years (Clippinger 2009).

Soils are derived from the Idaho batholiths, which erupted about 55 million years ago (Peek et al. 2005). This granitic parent material formed soils characterized as shallow and course with many rocky outcroppings (Peek et al. 2005).

Vegetation is dominated by Douglas fir (*Pseudotsuga menziesii*) stands interspersed with mountain mahogany (*Cercocarpus* montanus) and snowberry (*Symphoricarpos ablus*) dominated shrub-steppe areas. Other conifers include ponderosa pine (*Pinus ponderosa)* and lodgepole pine (*Pinus contorta)* (Jackson and Sullivan 2009, Peek et al 2005). Idaho fescue (*Festuca idahoensis*) and bluebunch wheatgrass (*Pseudoroegneria spicata*) are the dominant grasses in both the shrub-steppe communities and as an understory species in forested areas (Peek et al 2005).

Fire regimes in the region are highly variable. An alluvial sediment analysis for the past 8000 years puts the historic fire regime somewhere between 33 to 80 years (Jackson and Sullivan 2009). Another study puts ponderosa pine forests at a return interval of 13 years, substantially lower than the regional estimates. Douglas fir fire regimes have been found to be highly variable (Jackson and Sullivan 2009).

Several Fires have burned Big Creek since the Diamond Point Fire in 2000 (Jackson and Sullivan 2009). The Diamond Point fire burned over 270,000 acres in and around Taylor Research Ranch located eight miles upstream of the Middle Fork along Big Creek. Three fires have burned around Taylor Ranch since 2000 in the summers of 2006 and 2008. The Dunce Creek Fire burned 6800 acres in 2006, Cabin Fire burned 4600 acres, Westy Fire burned 2800 acres and Rush Creek burned 1300 acres, all in 2008.

Sampling

Sampling will be based out of Taylor Research Ranch. Tributaries of Big Creek from the Middle Fork to Cave Creek (including smaller forks of each) will be considered potential study sites and approximately five tributaries will be selected. Most Big Creek tributaries run north to south, thus most study sites will have an east or west aspect. One hundred meter transects will be placed on each E-W aspect parallel to the channel starting in the riparian zone and again 150 m up in elevation until available elevation is exhausted. This pattern will be repeated four times for each tributary on the E-W aspects while also accounting for spatial variability in N-S aspects.

Transects will be established using an altimeter to ensure constant elevation across transects. Metal nails will be placed in the ground to mark transects along with GPS coordinates every ten meters for each 100 m transect (refer to *figure 1*). Metal nails will be used as a way to discreetly mark transects and to locate transects using a metal detector. Aspect for each transect will be noted, as ensuring each transect maintains the same aspect would be difficult, however aspects will be maintained as best as possible. Transects will be laid to best fit topographical variation to include ridges and depressions of small drainages located on each tributary.

Nested tree and herbaceous plots will be established on alternate sides every 10 m along each transect. Daubenmire plots will be used for herbaceous species (0.25 m x 0.50 m), while tree plots will be 1 m by 1 m nested around the Daubenmire plots.

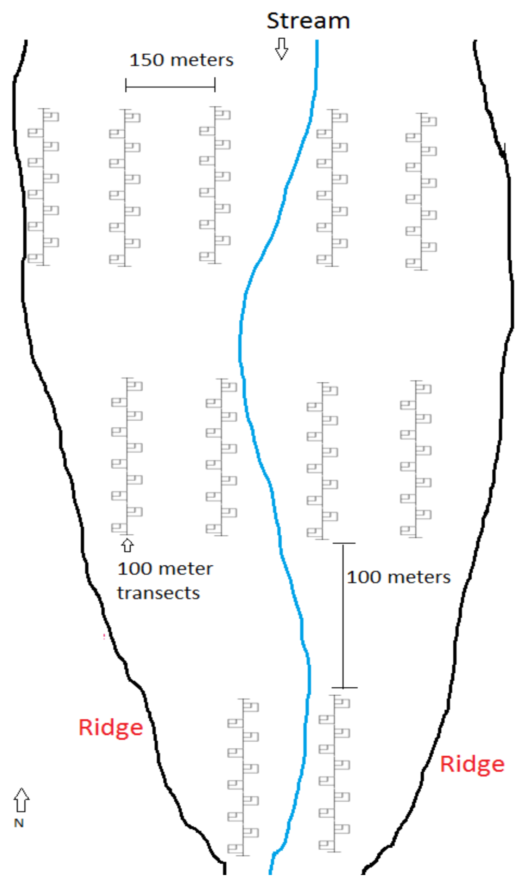

Figure 1–General layout of transects and plots.

Herbaceous species canopy cover will be estimated using one of seven cover classes. Cover classes will be 1) 0-1%, 2) 2-5%, 3) 5-15%, 4) 15-35%, 5) 35-50%, 6) 50-70%, 7) 70-100%. Tree regeneration will follow methods used by Clipinger (2009) and trees will be classified by three categories: 1) emergent, 2) seedling and 3) sapling. Emergents are less than one year old, seedlings are between one and five years old and shorter than 6 cm tall and saplings are five to eight years old. The DBH any live or dead standing tree within each plot will also be measured.

Four soil samples will be taken directly downslope from each 1st, 5th and 10th plot for each transect. The 12 samples will be composited as one sample per transect and analyzed for texture. Soil volumetric water content will be assessed along the elevational gradient at 150 m intervals several times over the growing season using a Hydrosense (Cambell Scientific).

Data Analysis

Regressions will be run on soil moisture and elevation, soil texture and elevation, and species cover and elevation. Species cover will be compared with t-tests between unburned and burned areas.

Scientific Relevance

Community composition is not well quantified around Taylor Research Ranch. Thus, this study will establish long-term vegetation plots that can be used for future vegetation monitoring. These plots, along with data produced from this study can be used in conjunction with the wireless sensor network being installed at Taylor in the coming years. This network will measure soil moisture, soil temperature, air temperature, humidity, precipitation and atmospheric carbon dioxide concentrations. Therefore, data can be used for future inferences on vegetative responses to fire and climate changes at Taylor Ranch and increase our understanding of these ecosystems in response to fire and invasions.

Timetable

Assessing the study area will begin May 31st, 2011. During the next 10 weeks, data will be collected and entered. During the Fall semester, soil samples will be processed and data will be analyzed.. Final results will be presented in Spring 2012.

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