Vegetation dynamics following low-intensity ground fire on a rare ecosystem subtype - Grass Bald

Masters student thesis proposal for Western Carolina University

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# INTRODUCTION

## Round Bald

Round bald is located along the borders of North Carolina and Tennessee of the Appalachian Trail. The site is about 20 miles North of Bakersville, North Carolina and about 13 miles South of Roan Mountain, Tennessee. Round bald has been experiencing woody encroachment from invasive species like *Rubus allegheniensis*, *Rubus canadensis*, *Vaccinium spp.*, *Rhododendrom spp.* and saplings from the surrounding spruce-fir forest. These species are causing the bald to shift from a grass bald suptype into a heath bald subtype. Grass balds are defined when the majority of vegetation is grass or sedge, while Heath balds are dominated by ericaceous shrubs. Following woody encroachment, shrubs intermingle with grasses and sedge to transform the bald into the heath bald subtype. This conversion has the potential to extirpate a rare ecosystem that hosts a number of rare endemic species such as Roan Lily (*Lilium grayi*), Spreading Avens (*Geum radiatum*), and Roan sedge (*Carex roanensis*). In the nearly 40 years since the initial reports from Murdock (1986) and Hamel and Somers (1990), and the recent study by Stokes and Horton (2022), Round bald has been facing stand type alteration from a grass bald to a heath bald. In February of 2022, a ground fire broke out burning almost 10 hectares, or the first four transects re-established by Stokes and Horton (2022) who had surveyed the bald in 2020 examining vegetation dynamics following 30 years of management.

## History

Upper montane treeless meadows - balds - host high floral diversity, panoramic views of the landscape, and origins hotly debated to this day (Gersmehl 1970, Murdock 1986, Hamel and Somers 1990). Many speculate that balds were cleared by early settlers for pasturing livestock in the spring and summer seasons (Lindsay and Bratton 1979b) - anthropogenic origin. Others believe that they are of a climate-herbivore driven change in the landscape, making it a natural ecosystem (Weigl and Knowles 1995, 2014). True balds are above 1,400 meters in elevation, while any bald can exist on a rock outcrop above 1,200 meters in elevation (Gersmehl 1970). Furthermore, true balds occur only in the Southern Blue Ridge Physiographic Province, other balds - apparent balds - are distributed globally with sites in Siberia and Australia, among others. There has been much in the way of bald history in the literature, but data regarding vegetation dynamics following disturbance is scant or focused on other balds. Management of these balds varies by managing agency, type of bald - heath or grass, and proposed origin - whether it was cleared, grazed, burned, or some combination of these (Lindsay and Bratton 1979b, Weigl and Knowles 1995, 2014). Separating bald origins and subtype vegetation dynamics is key to preserving these dwindling ecosystems and conserving them for future generations (Moravek et al. 2013). Within the mindset of a landscape ecologist, the point-of-view is all about differences in scale and size. Here, I examined changes to Round bald at the plot level scale to determine change in the vegetation community following a low-intensity ground fire disturbance in February 2022 which burned approximately 9.7 hectares. This study builds on the recent survey from Stokes and Horton (2022), who examined the vegetation composition following 30 years of mowing management. In this study I intend to quantify the change in the vegetation structure following fire disturbance.

### Seed Bank

The soil seed bank is an ecologists term for the “potential community” layer. It is the prequel layer to the advanced regeneration layer that is currently growing on the forest floor. In this sense, ecologists look at the soil seed bank to predict what can grow in the next few growing seasons. Estimates of the soil seed bank are more accurate when using two methods - seedling emergence and seed extraction (Price et al. 2010, Abella et al. 2013, and Chiquoine and Abella 2018). The first seed bank sample was collected following the 2022 vegetation survey, while the second sample was collected in January of 2023 and set in the fridge until late March 2023.

### Woody Encroachment

The United States Forest Service (USFS) acquired some of the Southern Appalachian bald lands in the late 1920s after which, active management and general recreation ceased (Lindsay and Bratton 1979b). This led to shrub succession in the late 1930s and a management problem in the 1950s (Lindsay and Bratton 1979a, Lindsay and Bratton 1980). Despite the shrub succession on these balds, there is debate about whether to protect these areas or not. This is because the literature is unclear about bald origins - whether they are natural formations or human-engineered ecosystems. Following management cessation, the range of grass balds along the Southern Appalachian Mountains (SAMs) has shifted since the study by Murdock (1986), who had surveyed round balds in the 1980s. A repeated survey of the balds of Carver’s Gap in 2020 by Stokes and Horton (2022), examined the first 3.36 km of the balds. Based on primary analysis of 2022 sampling data in excel, the cover of *Rubus allegheniensis* and *Rubus canadensis* (Rubus or blackbery) has increased slightly between 2020 and 2022. These *Rubus* spp. are two primary native invasive species transforming this area from a grass bald into the heath bald subtype. On ideal balds, grass balds are dominated by grasses and sedge, while health balds are dominated by ericaceous shrubs. Without active management, natural succession alters these balds from the grass to heath subtype.

### Managment

Bald management within the Southern Appalachian Mountains varies by managing agency and bald history, with most practices promoting mowing or grazing, with few instances of fire or clearing. When used, fire must be high intensity or high duration to provide a significant effect against woody encroachment (Lindsay and Bratton 1980). Germination requirements of the invasive genus Rubus include scarification - some damage to the seed has to occur for the seed to germinate (Davies 1998). Fire can provide that damage and could possibly increase growth the following season. Sufficiently hot or lengthy burns have the potential to prevent the growth of blackberry, however post-burn analyses of the vegetation community indicates that the resulting community is not characteristic of grass balds (Lindsay and Bratton 1980). Likewise, prescribed burns are difficult to manage at such high elevations, soil moisture levels, and effects on rare and endemic species of historic balds.

### Objectives

The objectives of this study are; 1. Quantify vegetation composition and the soil seed bank over the first and second growing seasons following the low intensity ground fire on Round Bald, and 2. Propose methods to improve management for conservation of these rare ecosystem subtypes. The general question is, how has the low-intensity ground fire affected vegetation dynamics and are there management practices that could be gleaned from this disturbance? I expect that there is little to no decrease in the cover of *Rubus* spp., likely there will be a slight increase in blackberry cover following slight scarification from the February 2022 ground fire.

# METHODS

## 2022

### Study Site

Round bald is located in the Roan Mountain Massif of the Unaka Mountain range of the Southern Appalachian Mountains, between Carver’s gap and Engine gap. The Appalachian Trail (AT) bisects the study site into North of the trail and South of the trail. The site itself is spread across Pisgah National Forest in North Carolina and Cherokee National Forest in Tennessee, at approximately 36° 06’N and 82° 60’W. In 2020, Stokes and Horton (2022) surveyed the balds of Carver’s Gap following a 30-year mowing management protocol from Hamel and Somers (1990) and Murdock (1986). They detailed the vegetation composition of the balds according to vegetation genera. Their data was entered into PCORD and produced a schematic of the vegetation communities across the balds of Carver’s Gap (McCune and Medfford 2016). In February 2022, a low-intensity ground fire burned roughly 9.7 hectares of aboveground vegetation and was quickly expunged before it could spread further. This provided an opportunity to examine the changes in vegetation composition following low-intensity ground fire over two sampling seasons in June of 2022 and 2023.

### Field Methods

In this study I sampled the first four transects reestablished by Stokes and Horton (2022), quantifying vegetation to genera and combining genera into functional types; *Rubus*, *Vaccinium*, *Rhododendron* (Rhodo), *Angelica*, Forb, Fern, Grass, Sedge, Moss, Rock, or Bare ground. I measured the percent coverage of vegetation using a 1-m^2 PVC quadrat divided into 100 equal sized squares, following Stokes and Horton (2022). Each square was visually assigned by dominant vegetation genera to equal 100% coverage per plot of aboveground vegetation up to 1-meter in height. Using the data collection sheet from Stokes and Horton (2022) and USFS botanist Gary Kauffman - which quantifies vegetation based on focal genera - a total of 226 plots along 12 transects were sampled in 2020, of these, 52 plots - along the first four transects were in the February 2022 fire - and another 47 plots - along the same transects - were untouched by the fire.

### Soil Seed bank

To examine the effects of the fire on the seed bank, seed bank samples were collected in July 2022 and January 2023. At those times, approximately 200 grams of soil was obtained from the top 5 cm of soil at six random sites in 2022 in one of four treatments; over 50% Rubus/burned, over 50% Rubus/unburned, under 25% Rubus/burned, under 25% Rubus/unburned. The first - over 50% Rubus/burned - describes plots with greater than 50% cover of blackberry and burned from the February 2020 fire, followed by greater than 50% blackberry and unburned, less than 25% blackberry and burned, lastly, less than 25% blackberry and unburned. Two measurements of the seed bank were collected in July of 2022 and January of 2023. In July 2022, I took 24 samples of the seed bank following the February 2022 ground fire that occurred on Round Bald. In January 2023, the second soil seed bank sample was collected at three spots, on three separate sites, along all four transects, in both burned and unburned areas of Round Bald. A total of 72 seed bank samples were collected and set in the fridge until March 2023. At that point, I plan to fractionate the samples into four categories; burned, unburned, control, and greenhouse control. I will then examine which vegetation genera germinate among each category. Initially these samples will be propagated with seltzer water to increase germination by providing extra CO2 to the seeds, followed by tap water to continue growth. This is because of a STEM student science project which showed carbonated water helping to jump start germination and tap water to supply micronutrients to the growing plants.

### Greenhouse

A total of 24 soil seed banks samples were taken, placed in tins, transferred to the greenhouse, then sown in 28x22 cm seedling trays filled with potting mix to 5 cm depth. An additional six trays were filled with unaltered potting mix which acted as greenhouse controls to rule out contamination. Trays were then randomly set in the greenhouse at ambient temperature and humidity and measured continuously with a Govee probe - which continuously measures temperature, percent relative humidity (%RH), dew point (DP), and vapor-pressure-deficit (VPD). As seedlings emerged they were identified, recorded, and removed. The seedlings that could not be identified were re-potted until identifiable following Price et al. (2010). Each month the trays were rotated in random order to rule out growth condition bias. In December of 2022, the soil sample trays were placed outside to simulate winter conditions and potentially germinate seeds in the seed bank over the next spring. A second soil seed bank germination trial following the same protocol will be conducted in mid-to-late March of 2023 onward. These samples will examine what is readily germinable following natural winter weathering and will be compared to the first seed bank set to examine post burn germinable seeds versus post winter germinable seeds.

## 2023

### Field Methods

In the summer of 2023 I plan to repeat surveys of the first four transects. In 2022, soil emergence was utilized for the sake of time and I plan to add a modified soil extraction method from Price et al. (2010); Abella et al. (2013); and Chiquoine and Abella (2018) for the second sample set. These authors identify that both methods can provide insight into the potential vegetation community, but a combination of the two provides a more robust estimate of the state of the seed bank. In the second method to the soil seed bank analysis I fractionate the samples into field control, greenhouse control (unaltered potting mix), burned, and unburned. These samples will be exposed to two levels of light, humidity, soil moisture, and temperature to examine the germination requirements of seeds in the seed bank. This should make it more comparable to the current vegetation structure and speculate on the future composition of Round Bald as a result of continued mowing management.

### Analysis

For the time being, the data were recorded manually, then entered into excel to get a glimpse at the dynamics behind the low-intensity ground fire disturbance from January 2022. Based on cursory examination, blackberry is slightly increased in burned vs unburned. However, more analysis is needed. To do that I plan to follow the statistic tests that Stokes and Horton (2022) had conducted in 2020. Once I fully understand their analysis, then I will be able to connect the data in 2020 to the data in 2022 and 2023. Otherwise, I will also be using analysis conducted by Price et al. (2010), Monar and University (2018)), and Murdock (1986).

### Expected Outcomes

I expect that Blackberry (Rubus) has slightly increased coverage following the February 2022 ground fire. I also expect that grasses and sedges are little to not-at-all different after the disturbance. If these statements are true, then implications for management are unchanged - fight fire as it arises and to not let the fire spread across the balds of Carver’s Gap. More data will be gathered over March through August to better compare the dataset from Stokes and Horton (2022), with the data that has been gathered for this study.

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