

# The Effects of Ponderosa Pine Ecological Restoration on Forest Soils and Understory Vegetation in Northern Arizona

Elena Thomas, Kenneth Farrish, Scott Abella, and Brian Oswald

❖ Division of Environmental Science ❖ Stephen F. Austin State University, Texas 75962



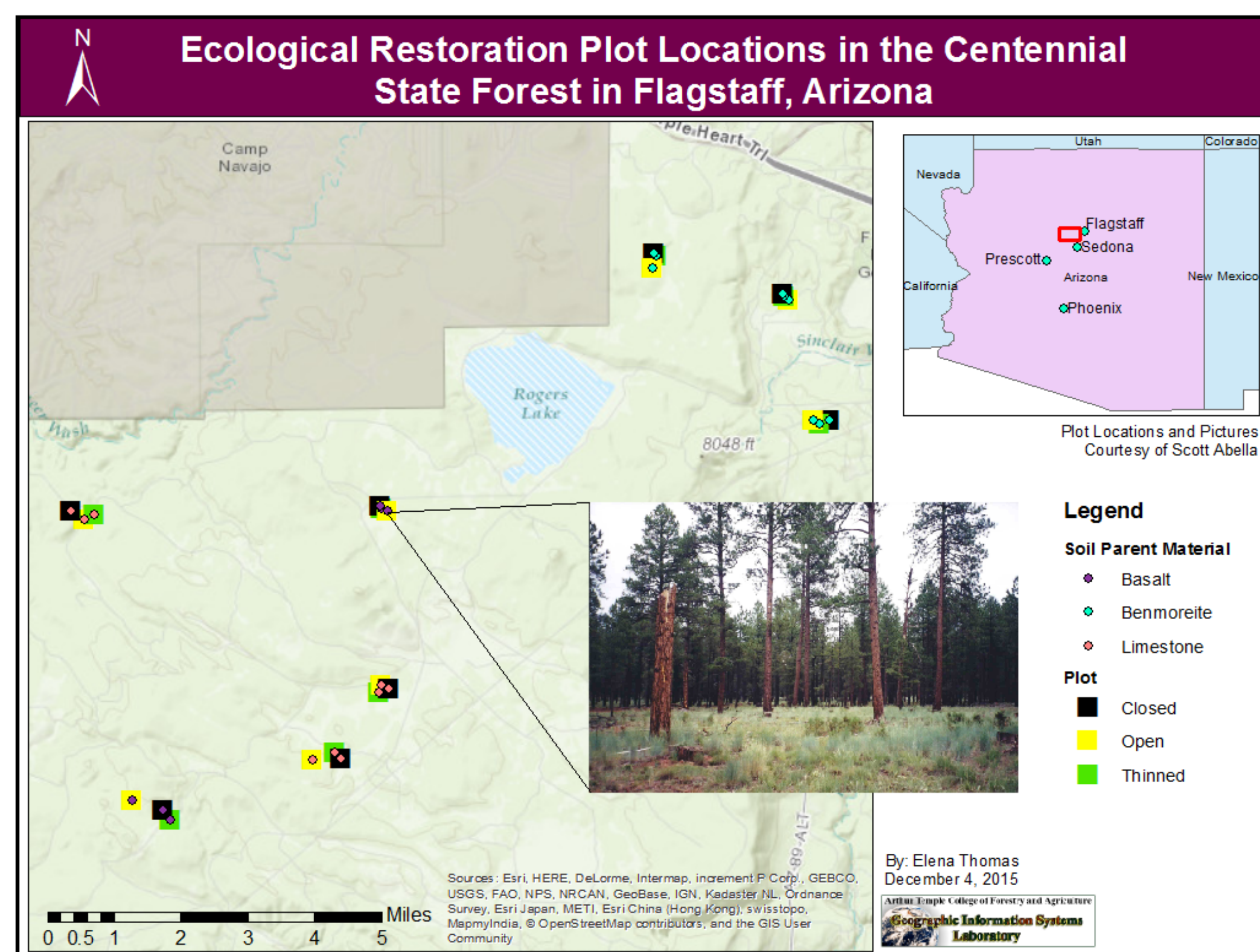
STEPHEN F. AUSTIN  
STATE UNIVERSITY  
NACOGDOCHES, TEXAS

## ABSTRACT

- Ecological restoration of ponderosa pine (*Pinus ponderosa* Dougl ex Laws) forest ecosystems to pre-settlement conditions in northern Arizona will have direct and indirect effects on soil chemical, physical, and biological properties. The pre-settlement ponderosa pine ecosystem had widely spaced, uneven-aged pine stands with diverse native plant understories. The human exclusion of wildfires and overgrazing by livestock since settlement has caused dramatic changes in this forest ecosystem, that includes significantly increased numbers of tree stems, reduced understory cover and diversity, and the unintentional introduction of invasive, non-native understory species. Ecological restoration treatments used in this ecosystem include tree stand thinning, prescribed burning, and changes in grazing practices. This study reports on changes in select soil properties, including organic matter and soil respiration, twelve years after tree thinning and grazing exclusion treatments were applied in ponderosa pine forests, on three different soil/geologic parent material types near Flagstaff, Arizona. Preliminary results are presented.

## INTRODUCTION

- Purpose of ecological restoration is to enhance human degraded ecosystems**
  - Fire exclusion led to dense, young ponderosa pine stands
  - Accumulation of litter and coarse woody debris can alter soil conditions
  - Lack of fire alters vegetation, soil microbial communities, and physiography
- Purpose of study is to examine effects restoration treatments have on forest soils in a ponderosa pine forest ecosystem**



## METHODS

- Restoration treatment plots (open, thinned, and closed) were set up on three different soil parent material types: basalt, benmoreite, and limestone, with grazing and grazing exclusion plots set up at each treatment plot location
- Soil respiration and soil samples were taken on five random, different 1m<sup>2</sup> subplots of the 9m<sup>2</sup> grazed and grazing exclusion plots
- The NRCS soil respiration field method was utilized for soil respiration sampling
- pH measured with portable probe in a 1:1 soil/water mixture
- Regression ran with coarse fragments and soil moisture and temperature as covariates for soil respiration
- Regression did not have significant model for soil respiration
- Mixed model ANOVA used to determine significance at 0.05 level

## RESULTS

- Soil temperature was significantly influenced by soil type, treatment, grazing, and the soil type and treatment interaction
- Soil moisture was influenced only by treatment
- Soil pH was influenced by soil type, a soil type and treatment interaction, and a soil type, treatment, and grazing interaction
- Treatment type did not influence soil pH

	Limestone	Benmoreite	Basalt
<b>Temperature (°C)</b>			
Closed	13.1	14.1	19.3
Thinned	15.1	18.2	17.0
Open	18.6	20.8	19.1
<b>Moisture (%GWC)</b>			
Closed	24.4	22.5	27.5
Thinned	22.2	22.8	36.3
Open	19.1	19.7	20.1
<b>Moisture (%VWC)</b>			
Closed	29.4	27.0	33.0
Thinned	26.6	27.4	43.5
Open	22.9	23.6	22.8
<b>pH</b>			
Closed	7.82	6.22	8.11
Thinned	7.43	6.87	8.02
Open	7.31	6.87	8.05
<b>Respiration (g C m<sup>-2</sup> day<sup>-1</sup>)</b>			
Closed	3.19	2.31	2.31
Thinned	3.44	2.65	2.90
Open	3.32	2.51	2.95

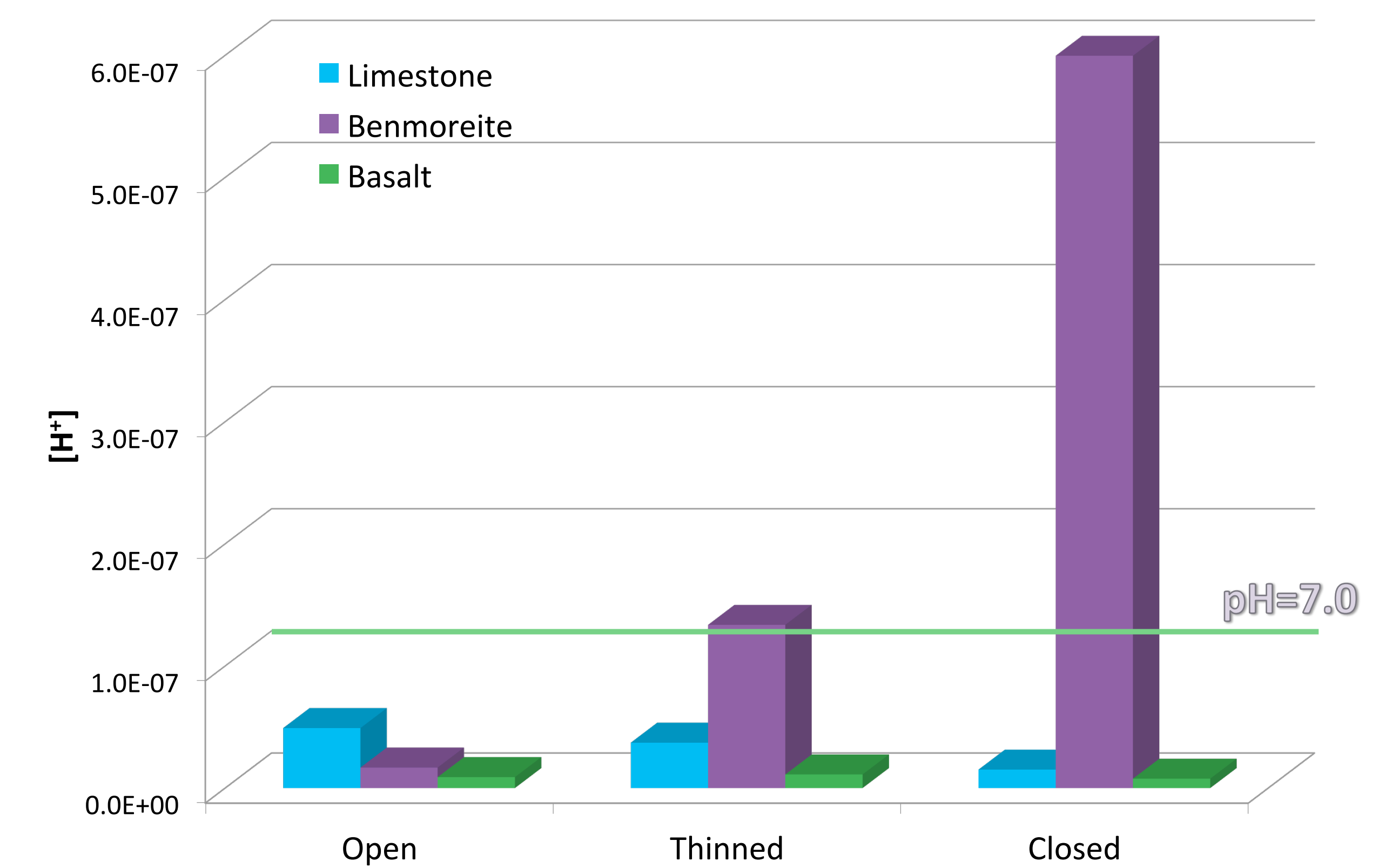


- Soil respiration was influenced by soil type, treatment, and a soil type, treatment, and grazing interaction
- Thinning treatments yielded highest soil moisture and respiration levels
- Limestone soils had highest soil respiration, but lowest soil temperature
- Benmoreite soils had lowest (most acidic) pH
- Temperature was the only parameter affected by grazing
- Open treatments yielded the highest soil temperature and lowest soil moisture

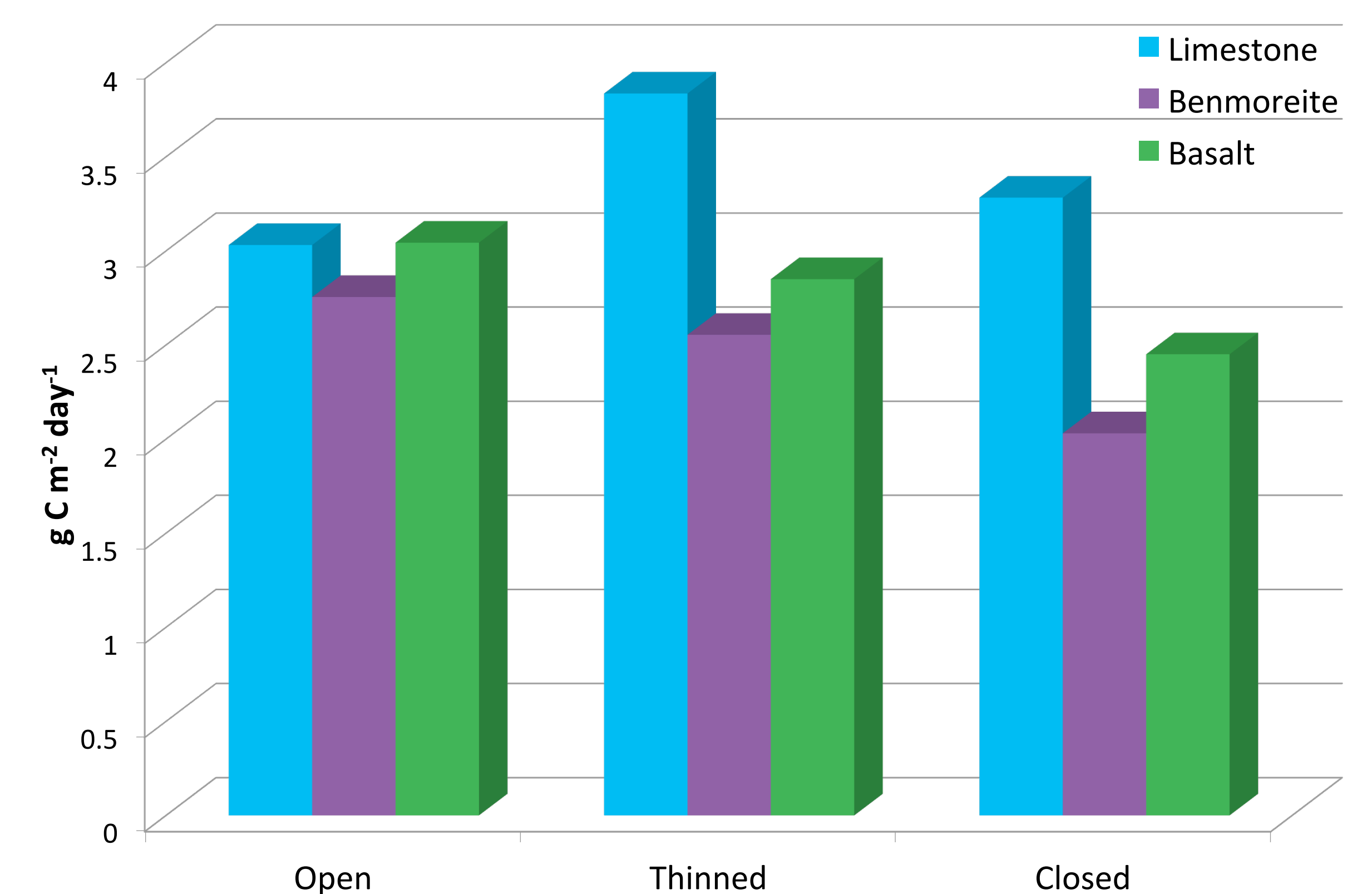


## RESULTS

Soil pH Among Soil Parent Material Types Under Grazing



Soil Respiration Rates Among Soil Parent Material Types Under Grazing



## ACKNOWLEDGEMENTS

- Scott Abella for allowing me to continue his project
- Kit MacDonald for help in the field and cool season vegetation data
- Sarah Zaraguski for help processing samples
- Kenneth Farrish and Arthur Temple College of Forestry for allowing me to conduct my research in Flagstaff