MBACI Monitoring Set-Up for Tallgrass Prairie Restoration on Kansas State University Campus

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Introduction

Grasslands are one of the most diverse and most productive ecosystems in the world, covering 40% of the earth's terrestrial surface (Blackburn et al., 2021). The Tallgrass Prairie once spanned 170 million acres in the United States from Canada to Texas but has been depleted with only 4% remaining in its natural form (Haukos N.D.). The largest of these chunks is the Flint Hills (Fig. 2 top) which stretches from Manhattan, Kansas down to Oklahoma. Protecting the Flint Hills is part of the mission of Konza Prairie Biological Station which is situated outside Manhattan, Kansas(Fig 1.).

The Kansas State University Sustainability Coalition has set out to restore areas of campus to native tallgrass prairie. The first restoration location is The Meadow near the Beach Art Museum (Fig. 2, left), which was completed in 2013. The Sustainability Coalition is currently investigating converting Coles Hall lawn (Fig. 2, right) to tallgrass prairie. Coles Hall lawn is situated near the headwaters of Campus Creek, south of Coles Hall, and if restored, could help with improving water quality and reducing flooding.

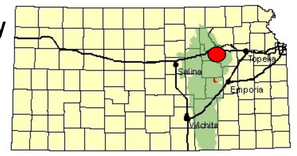

Figure 1. A map of the Flint Hills. The red dot represents Manhattan and Konza Prairie (NPS.gov).

Figure 2. On left restored tallgrass prairie on the KSU campus called The Meadow. On right, the proposed location of tallgrass prairies restoration south of Coles Hall on the KSU campus.

Project Objectives

To quantitatively assess the environmental changes that might occur due to urban tallgrass prairie restoration on the KSU campus, a Before-After Control-Impact Study (BACI) is established here.

The purpose of our project was to:

(1) Determine the best form of BACI to be used.

(2) Select at least 2 control sites, similar to the site characteristics of Coles Hall lawn.

(3) Begin to collect soil data of Coles Hall lawn to assist future research.

Objective 1: BACI Selection

A Before-After Control-Impact Study (BACI) is a method that aims to compare the before conditions to the after conditions at a control and impact site. BACI methods are an effective method to evaluate natural and human-induced stressors on ecological variables when treatment sites cannot be randomly chosen (Connor et al., 2016). A traditional BACI requires having a control site that can be compared to the impact site (Coles Hall Lawn). **This study instead will be using an MBACI or Multiple-BACI structure to collect data.** An MBACI differs slightly from a traditional BACI because it allows for multiple reference sites which is what is needed for this impact site because it allows for an urban restoration control site and a natural control site. There were other BACI alterations that were examined including Beyond-BACI which is like MBACI. The other method was BACI-Paired Series that requires data collection at same exact time at control and impact.

Objective 2: Control Site Selection

The Meadow (Fig. 2) was selected as the first control site and a total of 24 sites (Table 1) were analyzed as a second potential site. A rating system was used to aid in the selection of the second control site. Each parameter was rated from 1 to 5, with 5 being the highest and most similar to the impact site. The ratings were totaled up and the site with the highest final value was selected to act as the control.

Based on discussions the K-State Sustainability Coalition, **the enhancement of water quality and increase of flood reduction are two objectives that should be focused on during future NRES projects.** Important parameters to consider based on these objectives are as well as how the rating were determined are as follows:

- **Watershed area**: ratings decreased as the area became farther from the impact site (.25sq/mi),
- **Soil type**: similar soil types to Coles Hall (4050) were rated higher, such as other Ivan silt loams,
- **Land use/burn pattern**: areas burned less received higher ratings,
- **Disturbances**: cattle grazing was denoted as a similar disturbance to mowing and rated the highest, and
- **Hydrology**: based on closeness of the TR-55 results.

Location	Watershed Rating	Soil Rating	Burn Rating	Grazing Rating	Hydrology Rating	Final Rating #	Rank
Coles Hall, impact	5	5	5	5	5	25	
Beach Museum, control							
Konza	5	3	3	4	5	20	**1**
Konza	3	3	3	2	3	14	**2**
Konza	3	3	3	2	2	13	**3**
Konza	4	3	4	1		12	**4**
Konza	3	3	3	1		10	**5**

Table 1. Impact, Control 1, & top 5 potential sites, parameters, parameter weights, and ranks.

The comparison between Coles Hall impact site and the Konza prairie control site watershed area and soil types are depicted below in Figures 3 and 4, and Table 2.

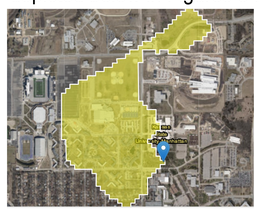

Figure 3. Coles Hall StreamStats watershed area (0.25sq/mi).

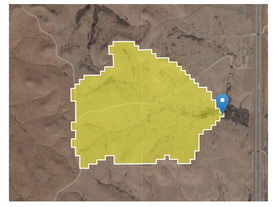

Figure 4. Konza Prairie StreamStats watershed area (0.25sq/mi).

Coles Hall impact site		Konza Prairie control site	
Soil Type	**% of watershed**	**Soil Type**	**% of watershed**
Smolan silt loam	40.3%	Benfield-Florence complex	90.8%
Wymore silty clay loam	33.8%	Dwight-Irwin complex	6.4%
Wymore silty clay loam	16.8%	Ivan silt loam	1.1%
Clime-Slogan complex	3.7%	Tully silty clay loam	1.1%
tully silty clay loam	1.9%	Clime-Slogan complex	0.7%
Ivan and Kennebec silt loams	1.7%		
Smolan silt loam	1.4%		
Smolan silty clay loam	0.4%		

Table 2: Comparison between soil types and percentages in the Coles Hall and Konza Prairie watersheds.

The Konza Prairie impact site is burned every four years and houses cattle from May to Oct. The TR-55 results differed <50 from the Coles Hall TR-55 values.

Objective 3: Coles Hall Lawn Soil Data

Soil samples were taken from eight different locations on the Coles Hall lawn (Fig 5.). The goal was to collect data on each side of the stream, as well as both near and far from areas with trees. To analyze the soil properties, a 1-cm diameter soil sampling probe was used to obtain samples to a depth of 15-cm. **Soil properties obtained from this sample included bulk density, soil moisture, and soil texture.**

- Bulk density ranged from 1.029g/cm^3 to 1.396g/cm^3 (avg. 1.23g/cm^3)
  - Soils with a higher bulk density have more tightly packed soils which causes there to be fewer large pores and an overall lower pore volume, which should impact infiltration rate.
- Gravimetric water content ranged from 17.37% to 32.51%
- The texture classification of the soil samples taken at Coles Hall were both silty clay loam using the hydrometer method, which differs slightly from Web Soil Survey.

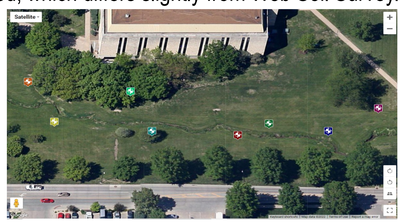

Figure 5. Locations of where the soil samples were taken from Coles Hall and tested for Bulk Density and Soil Texture.

Future Research

Our project determined control sites that future NRES groups could obtain data from to conduct an MBACI assessment. **There are many factors future teams could focus on to determine the differences and benefits between the ecosystems on Konza, The Meadow, and Coles Hall lawn, namely:**

- Infiltration rates (Selbig & Balster 2010) and soil bulk density,
- Invertebrate species composition (Galic 2013),
- Nutrient retention (Dodds & Oakes 2007), and
- Percent canopy cover (Dodds et al. 2004).

Other considerations of long-term assessment of tallgrass prairie restoration include:

- Restoration age and how it effects ecosystem services (McMillan 2014),
- Preventing the reinvasion of non-native species (Bickart 2013), and
- How a future tallgrass prairie on Coles Hall (upstream Campus Creek) can influence the ecosystem downstream (Dodds & Oakes 2007).

Conclusion

This team built a sturdy MBACI monitoring program for future NRES teams to build from. This was done by selecting the MBACI method to conduct research and by selecting control sites that will be used for data collection and comparison in the future. Collection of the "before" soil data at the proposed restoration site in the MBACI method provides a means for analyzing site conditions for future teams during and at the completion of their research. However, clear goals need to be made when enacting tallgrass prairie restoration on the K-State campus.

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