Investigating the Effects of Land Management Practices on Abiotic and Biotic Factors in a Prairie Ecosystem

Lee Ann Stover

Westview HS

Omaha Public Schools

NEBRASKA

THE PRAIRIE PROJECT

- A collaboration between research, teaching, and extension faculty from Texas A&M, Oklahoma State University, and University of Nebraska.
- Learn and share knowledge from the most current research and management experience to tackle the problems of woody plant encroachment, more extreme climate, and increasing wildfire.
- The goal is to not only maintain livestock production but increase it while simultaneously providing the vital ecosystem services the Southern Great Plains provide.

NE College and Career Ready Science Standards Addressed

SC.HSP.7 Interdependent Relationships in Ecosystems

- SC.HSP.7.2 Gather, analyze, and communicate evidence of interdependent relationships in ecosystems.
  - SC.HSP.7.2.B Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
  - SC.HSP.10.5.E Evaluate evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.
  - SC.HSP.7.2.D Design, evaluate, and refine a solution for increasing the positive impacts of human activities on the environment and biodiversity.

SC.HSP.10.5 Gather, analyze, and communicate evidence of biological evolution.

  - SC.HSP.10.5.E Evaluate evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

Guiding Questions

How do humans impact our environment?

How do different types of grassland management practices impact biotic and abiotic factors in a prairie ecosystem?

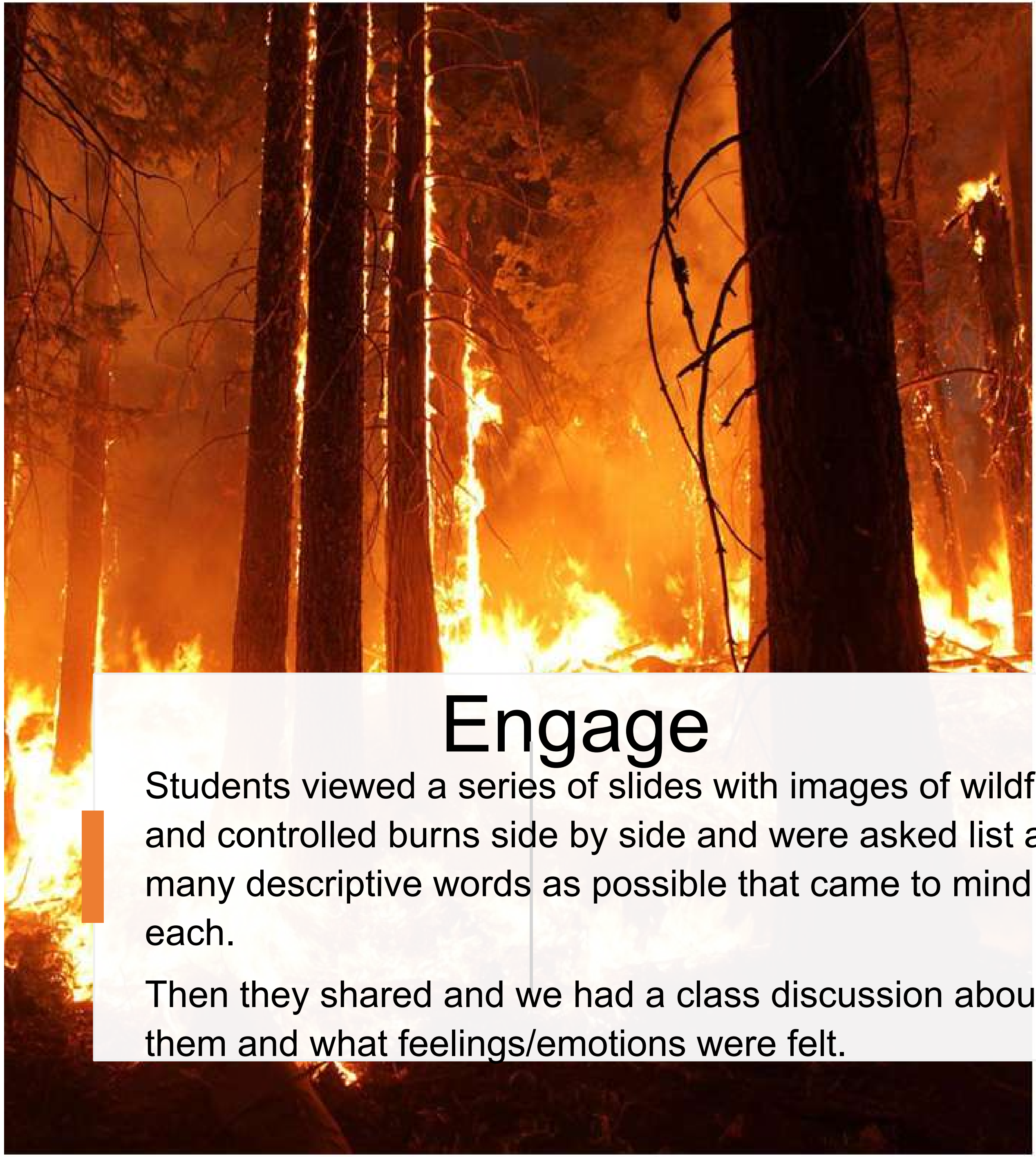
Lesson Overview

This inquiry-focused experience includes:

- Historical information about the United States grassland regions and how they have been/are used and maintained
- Native Indigenous knowledge and perspectives on prairie use and management
- Field experience to our local managed prairie that has been historically used for many years to investigate impact of various types of grassland management methods on prairie ecosystems.
- Make observations, ask questions, develop a testable hypothesis, design an investigation, gather and analyze data

Time Required -

- ❖ 1 block period for the compare contrast wildfires versus controlled burns and read the **History of Grassland Management** to build background information
- ❖ 1-2 block period for lecture portion and preparation for the inquiry experience
- ❖ 3-4 hours on site at Glacier Creek Prairie
- ❖ 2-3 block periods to conduct in-lab experiments
- ❖ 1-2 block periods for final assessment



Engage

Students viewed a series of slides with images of wildfires and controlled burns side by side and were asked list as many descriptive words as possible that came to mind about each.

Then they shared and we had a class discussion about them and what feelings/emotions were felt.

Wildfire versus Controlled Burn

What’s the difference?




Five facts on the 2020
California wildfires

Explore

Article formatted with embedded reading comprehension questions included in the folder for this lesson.

Lesson 3: History of U.S. Rangelands

How Were U.S Rangelands Managed in the Past?

History and Management of the U.S. Rangelands

How Were U.S Rangelands Managed in the Past?

When the first people came to what would become the United States, large grazers or megafauna existed on the western rangelands. These grazers included woolly mammoths and giant bison, and other herbivores. Native Americans hunted the large ungulates and used fire to drive animals as one of their hunting techniques. After megafauna became extinct, other grazing animals – bison, elk and pronghorn - filled the herbivore niche.

In 1540, Francisco Vasquez de Coronado brought the first domestic livestock to what is now the southwestern United States. This included 5,000 sheep, 500 cattle and 1,000 horses. When missions and outposts were established in the 1700's across the areas that are now Texas, New Mexico, Arizona and California, 50,000 sheep and 20,000 cattle were brought north from Mexico.

The 1862 Homestead Act, which opened the western U.S. to settlement, offered settlers up to 160 acres of public land after they lived on and cultivated it for five years. In 1909, the enlarged Homestead Act increased the maximum size of a homestead to 320 acres. The Stockraiser's Act of 1916 allowed 640 acres to anyone with at least 50 head of cattle. By 1934, ownership of more than 270 million acres of public land was transferred to over 1.6 million homesteaders.

Another important act that further divided public lands was the Morrill Act of 1962. This Act granted land in every state to fund colleges that would promote agricultural and mechanical arts. The purpose of the Morrill Act was to make higher education available to more people. Colleges established under this process are known as land grant universities. The University of Nebraska-Lincoln is one of these land grant universities.

Through the years, animals had escaped from the missions, ranches and outposts and multiplied rapidly due to the mild climatic conditions and abundant forage in the Southwest. By 1860, the number of cattle in California reached an estimated 3.5 million head and 4 million head in Texas.

1. What types of animal species were abundant on the western US rangelands when only Native Americans lived here?
2. What species later evolved and replaced them?
3. What were the first types of domesticated animals brought to these regions?
4. What was the name of the earliest government program that encouraged people to settle in this region?
5. By 1934 how much public land became privately owned by homesteaders?
6. What was the purpose of the Morrill Acto of 1962?
7. How and why did domesticated animals become "wild" and abundant?

Sources:
https://www.thefencepost.com/news/rangelands-in-western-nebraska-are-an-often-overlooked-valuable-resource
https://www.nrdnet.org/nebraska-envirothon#:~:text=The%20Nebraska%20Envirothon%20is%20a,environmental%20policy%20and%20current%20issue.

Prescribed Burn at Shaw Nature Reserve

Missouri Botanical Garden

6.59K subscribers

https://www.youtube.com/watch?v=9d4j8wYUaQ4&t=73s

Once-ignored Indigenous Knowledge of Nature Now Shaping Science

https://www.mprnews.org/story/2022/07/27/onceignored-indigenous-knowledge-of-nature-now-shaping-science

MPRnews NORTH STAR JOURNEY

Explain

- Fire as a Force in Rangeland Development
- Fire Frequency in North American Ecosystems
- Benefits of Periodic Fire
- Reasons for Removal of Fire from Landscapes
- Unintended Consequences of Fire Removal
- Plant Response to Fire
- Animal Response to Fire

Explain: The Prairie Burns With Desire (Data Nugget)

DATA Nugget

The prairie burns with desire
Featured scientist: Stuart Wagenius from the Chicago Botanic Gardens
Written by: Harrison Aakre

Research Background:

Fire plays a crucial role for prairie habitats across North America. Native Americans have long observed that lush and green pastures grow after a wildfire. In many areas, it is part of current and historical native culture to imitate this natural process by deliberately burning the prairie in a controlled way. This land management practice has many benefits, such as helping native grasses form seeds, thinning out plants, and enhancing habitat for prairie animals. By using controlled fires to cultivate these areas, Native Americans increase the availability of food and connect to the environment and their cultural traditions.

Stuart showing an *Echinacea* flower setting seed.

Some land management agencies plan prescribed burns to increase the health of prairie ecosystems. However, fire is still suppressed in many North American prairies due to the possible damage to human development. In these areas, scientists have observed that fire suppression contributes to local plant species extinctions, but we do not know why.

had almost no flowers! He kept retu
the site was again filled with flowers
seeing the impacts of fire on the lan

Stuart became interested in learnin
native prairie plants. He knew that
a hard time making seeds. This ger

fertilized with pollen from a genetically different plant. *Echinacea* plants are also dependent on insects, such as bees, to pollinate them.

Researchers in the field collecting data on *Echinacea*.

In 1996, a research team started collecting data on *Echinacea* plants in a large research site in Minnesota. This prairie site had a schedule for **prescribed burns**, or controlled fires that are started by experts to manage the land. These burns would happen every 4-6 years during the spring.

The team established a set of plot locations that they visited each summer. They searched for and mapped the location of all flowering *Echinacea* plants within these plots. They took measurements on each *Echinacea* plant – whether it was flowering, and the distance to its second closest *Echinacea* neighbor.

Echinacea flower

Stuart decided to take a new look at this long-term dataset. He had two ideas for how fire might be helping *Echinacea* plants. First, fire might help all the plants get on the same schedule and make flowers at the same time. This **synchrony**, or flowering at the same time, could help pollen get from one flower to another. Second, fire might remove competing plants from the area, opening up bare ground for new seeds to establish. This would allow *Echinacea* plants to be closer to one another, again making it easier for pollen to move between flowers.

With these data, Stuart could compare years with and without prescribed burns to see whether fire helped *Echinacea* flowering. To look at whether fire decreased the space between blooming *Echinacea* plants, he looked at the distance between a focal plant and its second-closest neighbor. To see whether fire increased the synchrony of flowering, Stuart used the data to calculate the proportion of *Echinacea* plants that were in bloom during the summer sampling period.

Scientific Question: How does fire affect the flowering synchrony and distance between *Echinacea* plants?

What is the hypothesis? Find the two hypotheses in the Research Background and underline them. A hypothesis is a proposed explanation for an observation, which can then be tested with experimentation or other types of studies.

Scientific Data:

Use the data below to answer the scientific question:

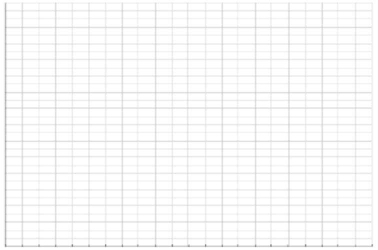
Location	Year	Burned or Unburned	Average distance to second nearest flowering *Echinacea* (m)	Proportion of plants in flower
west	1996	burned	1.9	0.69
west	1997	unburned	2.8	0.12
west	1998	unburned	14.5	0.05
west	1999	unburned	3.6	0.18
west	2000	unburned	4.1	0.11
west	2001	burned	2.4	0.61
west	2002	unburned	6.7	0.10
west	2003	unburned	2.9	0.09
west	2004	unburned	4.1	0.14
west	2005	unburned	2.3	0.16
west	2006	unburned	4.2	0.13
west	2007	burned	1.6	0.59
west	2008	unburned	3.1	0.16
west	2009	unburned	3.0	0.20
west	2010	unburned	2.0	0.31
west	2011	unburned	3.7	0.21
west	2012	burned	1.7	0.41
west	2013	unburned	2.8	0.18
west	2014	unburned	4.0	0.16
west	2015	unburned	3.3	0.30
west	2016	burned	1.8	0.64

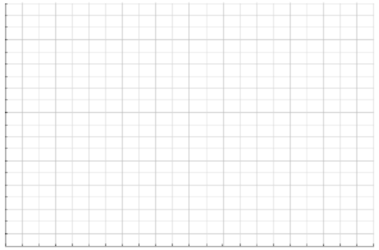
What data will you graph to answer the question?

Independent variable(s): ____________________

Dependent variable(s): ____________________

Draw your graph(s) below: Identify any changes, trends, or differences you see in your graphs. Draw arrows pointing out what you see and write one sentence describing what you see next to each arrow.





Interpret the data:

Make a claim that answers the scientific question - How does fire affect the flowering synchrony and distance between *Echinacea* plants?

What evidence was used to write your claim? Reference specific parts of the table or graph(s).

Explain your reasoning and why the evidence supports your claim. Connect the data back to what you learned about the reproductive needs of Echinacea.

Did the data support Stuart's hypotheses? Use evidence to explain why or why not. If you feel the data are inconclusive, explain why.

Your next steps as a scientist: Science is an ongoing process. What new question(s) should be investigated to build on Stuart's research? How do your questions build on the research that has already been done?

Extend

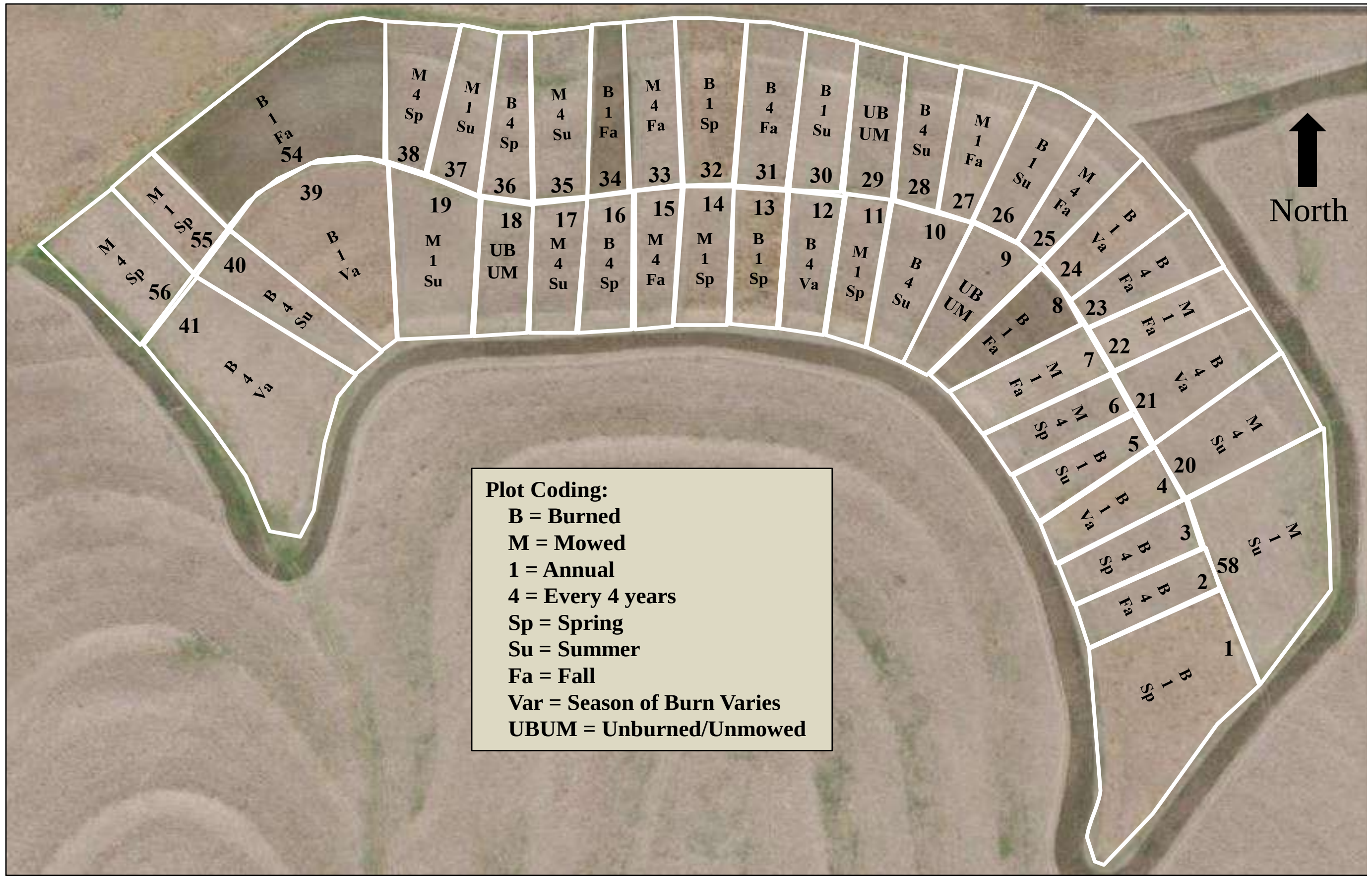
Students visit Glacier Creek Prairie to conduct their investigations and gather data to answer their testable questions.

- Glacier Creek Preserve is a 212 ha (525 acre) preserve NW of Omaha in the rolling hills.
- Within the Preserve is the 57 ha (140 acres) Allwine Prairie Tract, a restored tallgrass prairie created in 1970 which incorporates and entire sub-watershed.

Researchers, educators and the public have studied and enjoyed the biodiversity, ecosystem services and human impact on the important prairie biome here for nearly 50 years!

Glacier Creek Preserve LTER Research Plot Schematic for All Treatments

11 August 2015



The experimental research plots at Glacier Creek Preserve are part of a long-term study that has been carried out over 30+ years to study the effects of burning and mowing on the prairie community.

The main differences among the experimental research plots at Glacier Creek Preserve are the ***type***, ***frequency,*** and ***season*** of management interventions.

****IMPORTANT**: Do NOT walk through the research plots! Research in these plots is ongoing and we do not want to trample plants that are being monitored. ALL OBSERVATIONS AND MEASUREMENTS SHOULD BE MADE FROM THE MOWED PATHS!!!**

Learning Objectives of this Inquiry Experience:

- Observing and making **qualitative** and **quantitative** assessments of plant community responses to various treatments.
- Collecting data on variables related to plant community structure and habitat availability.
- Analyzing the effect of the various treatments on both biotic and abiotic conditions and factors in the tall grass prairie.

PROCEDURES

1. Experimental inquiry begins by making observations, from which you can develop questions. Take a few minutes to walk around the research plots and record any notable observations and/or questions below. Consider both **biotic** and **abiotic** factors in your analysis.

AVAILABLE TOOLS AND EQUIPMENT:

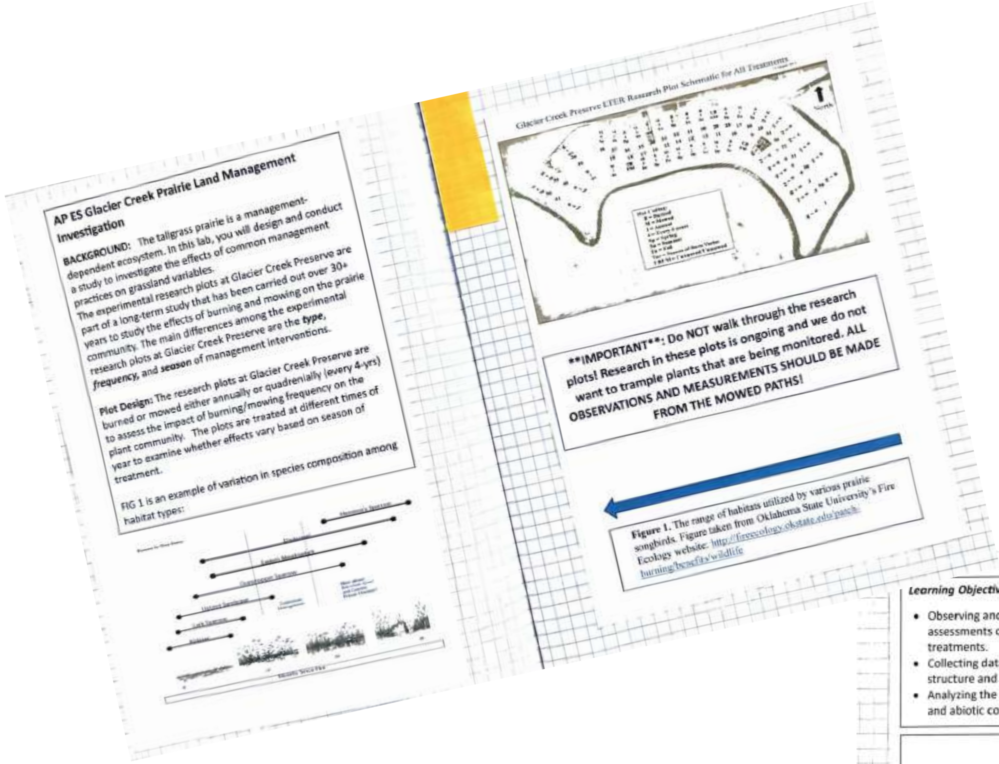
- Kestrel (atmospheric conditions (temperature, humidity, windspeed)
- .5 m2 quadrant (biodiversity)
- Sweep net (biodiversity)
- Soil penetrometer
- Soil temperature probe
- Meter stick
- Infrared thermometer
- Soil auger for collecting soil samples to take back to the lab with us.

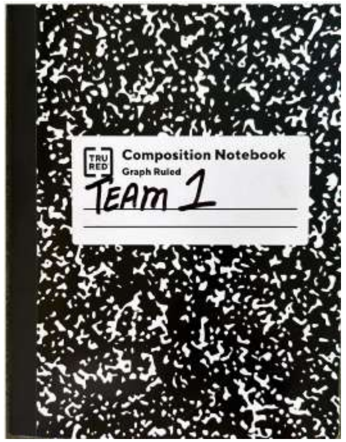
EXPERIMENTAL DESIGN

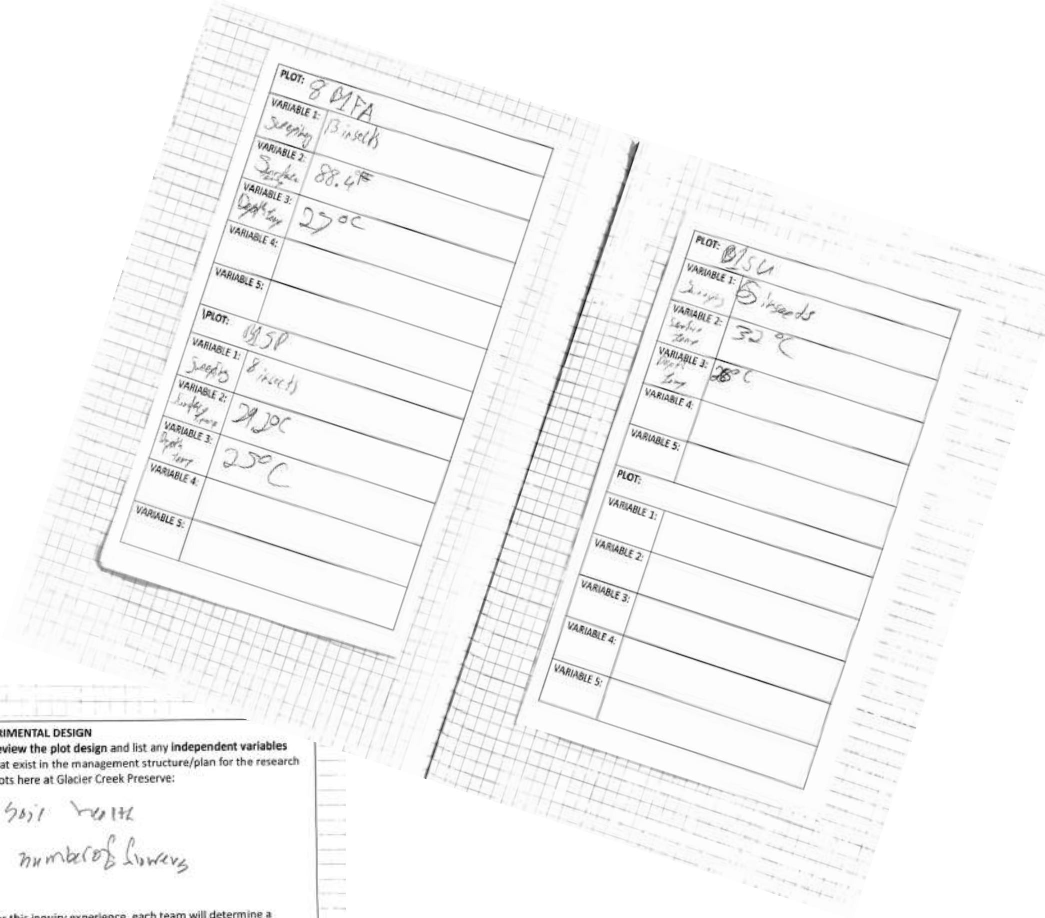
A. Review the plot design and list any **independent variables** that exist in the management structure/plan for the research plots here at Glacier Creek Preserve.

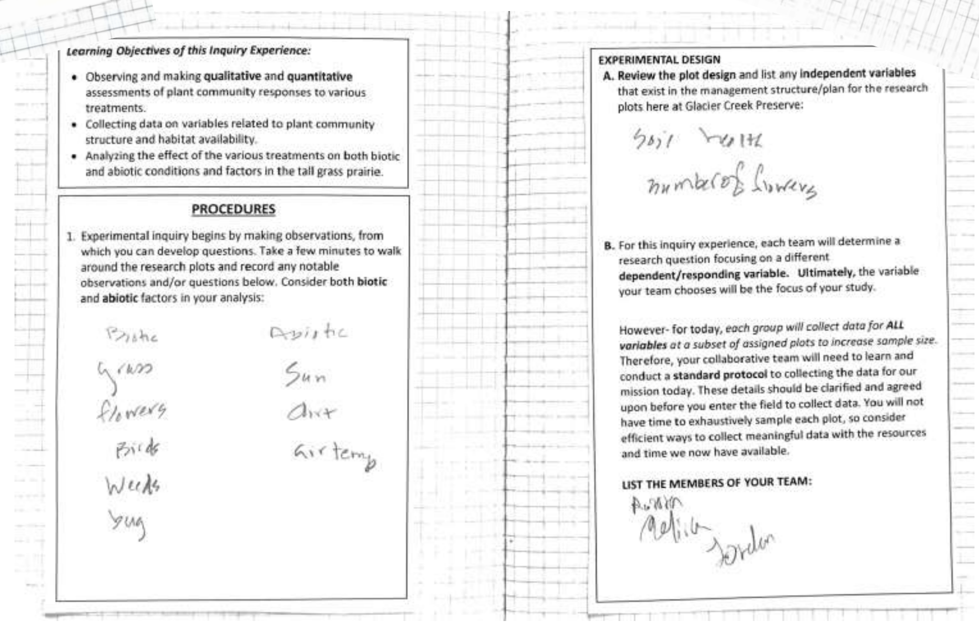
B. For this inquiry experience, each team will determine a research question focusing on a different **dependent/responding variable.** **Ultimately,** the variable your team chooses will be the focus of your study.

Field Notebook









Soil Lab Testing in the Classroom

Chemical Properties

- Soil Fertility – pH – N – P – K test kits (from Menards or Amazon)

Physical Properties

- Color, Feel/Texture, Soil Moisture (SM), Soil Organic Matter (SOM)

Additional Soil Testing Ideas –

- Porosity and Permeability
- Biological Activity with CO_2 monitor for respiration or Burlese Funnel for isolation of living organisms

THE PRAIRIE PROJECT

Fire, Grazing, and Grasslands

THE PRAIRIE PROJECT

Link to Educator Resources

https://www.theprairieproject.org/resources/education/teaching-resources/general-teaching-resources