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# K-12 Partnership Lesson Plan

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# *How Do Scientists Study Succession*

# *Explore plant community dynamics through time*

## Overview

KBS scientists maintain 4 different types of successional plots: two get tilled every year and two have been undisturbed since 1988. One of the tilled and one of the untilled plot get fertilized with nitrogen, an important nutrient limiting plant growth, every year; the other two plots do not. Each year, scientists collect data on which plant species are there, how much they grow, and other characteristics of the plants. In this lesson, students will explore this data to learn about succession, human disturbance (tillage), plant traits, plant life history, and population growth. They will also gain scientific skills in graphing and math.

**Objectives**

At the conclusion of the lesson, students will be able to:

* Work with a real data set from the KBS LTER
* Understand how management regimes can influence communities
* Have a good understanding of using Microsoft Excel to analyze data

**Length of Lesson**

Three to four 55-minute class periods (2-3 for intro and making graphs, 1 to use the graphs to answer worksheet questions)

**Grade Levels**

8-12th grades

**Standards covered (NGSS)**

Disciplinary Core Ideas:

 *Middle School*

* **MS-LS2-4**: construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations
* **MS-LS1-5**: construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms

*High School*

* **HS-LS2-2:** use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales
* **HS-LS2-6**: evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem

Cross Cutting Concepts:

* Patterns
* Cause and effect
* Scale, proportion, and quantity
* Systems and system models

Science and Engineering Practices

* Analyzing and interpreting data
* Using mathematics and computational thinking
* Engaging in argument from evidence

***Previous Michigan Standards Met:***

* **B3.4A**: describe ecosystem stability. Understand that if a disaster such as flood or fire occurs, the damaged ecosystem is likely to recover in stages of succession that eventually result in a system similar to the original one
* **B3.4B**: recognize and describe that a great diversity of species increases the chance that at least some living organisms will survive in the face of cataclysmic changes in the environment
* **B3.4C**: examine the negative impact of human activities
* **B3.5A**: graph changes in population growth, given a data table
* **B3.5B**: explain the influences that affect population growth
* **B3.5e**: recognize that and describe how the physical or chemical environment may influence the rate, extent, and nature of population dynamics within ecosystems

**Materials**

* Introductory powerpoint
* Student worksheets
* Excel file with KBS succession data (available on “How do scientists study succession” lesson page on the KBS GK-12 site.

**Background**

Background material is included in the LTER Powerpoint, which is attached. This covers information on succession, the LTER experiments, the treatments applied (tillage and fertilizer), links to good resources on using Microsoft Excel, the LTER dataset available online, and recommended questions that can be explored. Information on the treatments in the KBS LTER (Kellogg Biological Station Long Term Ecological Research) successional plots is in the first tab of the Excel file containing the dataset. Maps of the site are in the introductory powerpoint.

### Activities of the session

1. Go through introductory Powerpoint with basic information on KBS LTER succession plots, experimental design, etc.
2. Hand out student worksheets
3. Step the students through the dataset. How were the data collected? What kind of data do we have?
4. Ask the students to brainstorm how they could use the dataset to answer the questions on the worksheet.
5. Discuss data analysis issues:
	1. Why did they collect replicate datapoints? What are we going to do with the replicates? (Average them? Look at each replicate plot separately through time?)
	2. What are we going to do with outliers (data points that seem really extreme or bizarre in some way)? (Scientists have to include these points unless they have some reason to be suspicious of data being collected improperly, contamination, or whatever. We have no information on how any of these data could be wrong, so we have to include them—even if they are very messy and it’s difficult to draw conclusions from them.)
6. Plot the data
	1. If you wish, you can take the students to a computer lab and have them calculate means.
	2. Or, calculate averages by hand (average all six replicates of each treatment within each year—so you will have 64 averages (4 treatments x 16 years) for each variable (total biomass, number of species, number of annual species, number of perennial species).
	3. Plot over time each variable you are interested in, using different colors or different dashed lines for the different treatments.
	4. Optional: Also calculate an estimate of variability (standard deviation, range) using the six replicates. Discuss why replication is so important and what we learn from comparing different replicates of the same treatment.
7. Use the plots to answer the questions on the sheet.
8. Emphasize making the connections to data when discussing the answers to the worksheet questions. Ask students to refer to specific parts of the data. For example, “the red line on the graph goes up, so this tells us that there are more perennials in the untilled plots over time.”
9. When the students are designing experiments, allow them to be creative, but follow basic rules of experimental design (controls, replicates, etc).

**Resources**

* Powerpoint, LTER student worksheet, and LTER data set available on the “How do scientists study succession” lesson page on the KBS GK-12 website.

**Extensions and Modifications**

For students with a good understanding of datasets and statistics, more challenging questions can be approached, such as whether the treatments create statistically significant differences in responses. It would also be beneficial for the students to understand the concepts behind the analyses they are using, rather than just performing the techniques.

Additionally, these students can also explore the dataset and ask their own questions (which are not provided) with the data and subsequently explore it. This would demonstrate the power of complex datasets and long term ecological experiments.