

Unit of Study
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Unit Title: The Delicate Balance within a Forest Ecosystem

Overview: As we study the dynamics of a forest ecosystem, we will focus on the causes and effects of alterations. Regardless of how resilient nature appears to be, past events are a testimony to the vulnerability of all species. We will come to realize that many of our actions may appear to have only minor consequences, but they are likely to lead to extinctions of large numbers of populations.

Length of Unit: 2 weeks

Organizer: Man the Terminator – to be or not to be?

Grade Level: 9-10

Essential Questions: (3-5)

1. What factors alter the environment and how?
 2. How does an ecosystem recover from disruptions?
 3. Why should humans be aware of how their actions alter ecological systems?
- As the forest continues to evolve, its evolution actually changes its environment. Factors, such as overcrowding of species, alter the environment to where new species of plants may take root & others may die off. This is known as succession
 - Factors, such as fire, reverse the process of succession. The result could lead to different species entering into the altered environment. These new species are better adapted to the altered environment. The change of the environment affects most plant and animal life.
 - All humans must be aware that their actions, ranging from the introduction of species to past failed attempts to “fix” existing problems, may radically alter ecological systems and realize that they have the potential to destroy species.

Standards:

Academic Expectations

- 2.2** Students identify, analyze, and use patterns such as cycles and trends to understand past and present events and predict possible future events.
- 2.3** Students identify and analyze systems and the ways their components work together or affect each other.
- 2.4** Students use the concept of scale and scientific models to explain the organization and functioning of living and nonliving things and predict other characteristics that might be observed.
- 2.5** Students understand that under certain conditions nature tends to remain the same or move toward a balance.
- 2.6** Students understand how living and nonliving things change over time and the factors that influence the changes.

Program of Studies

- S-HS-LS-5** Students will examine how species change over time.
- S-HS-LS-7** Students will investigate the cycle of atoms (e.g., carbon) and molecules (e.g., nitrogen, carbon dioxide, oxygen) within the biosphere.
- S-HS-LS-13** Students will analyze the flow of matter and energy through and between living systems and environments.
- S-HS-LS-14** Students will investigate behavioral responses to internal changes and external stimuli.

Core Content for Assessment

SC-H-3.4.1 Species change over time. Biological change over time is the consequence of the interactions of (1) the potential for a species to increase its numbers, (2) the genetic variability of offspring due to mutation and recombination of genes, (3) a finite supply of the resources required for life, and (4) natural selection. The consequences of change over time provide a scientific explanation for the fossil record of ancient life forms and for the striking molecular similarities observed among the diverse species of living organisms.

SC-H-3.5.1 Atoms (e.g., carbon, nitrogen) and molecules (e.g., water) cycle among the living and nonliving components of the biosphere.

SC-H-3.6.3 As matter and energy flow through different organizational levels (e.g., cells, organs, organisms, communities) and between living systems and the physical environment, chemical elements are recombined in different ways. Each recombination results in storage and dissipation of energy into the environment as heat. Matter and energy are conserved in each change.

National Standards

NSS12_3.16	Energy flows through ecosystems in one direction, from photosynthetic organisms to herbivores to carnivores and decomposers.
NSS12_3.17	Organisms both cooperate and compete in ecosystems. The interrelationships and interdependencies of these organisms may generate ecosystems that are stable for hundreds or thousands of years.
NSS12_3.18	Living organisms have the capacity to produce populations of infinite size, but environments and resources are finite. This fundamental tension has profound effects on the interactions between organisms.
NSS12_3.19	Human beings live within the world's ecosystems. Increasingly, humans modify ecosystems as a result of population growth, technology, and consumption. Human destruction of habitats through direct harvesting, pollution, atmospheric changes, and other factors is threatening current global stability, and if not addressed, ecosystems will be irreversibly affected.

Culminating Performance:

With you lab partner, you will produce an educational video within the forest discussing the major concepts addressed within this unit. You may choose to focus on individual topics or a combination of topics. Videos may be informative or persuasive in nature. The following must be submitted by each group:

- Script of video narration
- 5-10 minute video
- 3 references using proper citation format

Possible objectives:

1. Describe the contributions of various living & nonliving materials in a forest ecosystem.
2. Explain that forests are complex systems constantly changing, recycling, adapting, and evolving.
3. Explain how and why human intervention in a forest ecosystem can be very destructive.

Culminating Performance Rubric:

Daily Instructional Plans: (3-5 Lesson Plans)

Lesson Title: Lesson of the Kaibab

Purpose:

- to graph data on the Kaibab deer populatio of Arizona from 1905~1939
- to analyze the methods responsible for the changes in the deer population
- to propose a management plan for the Kaibab deer population



Background:

The environment may be altered by forces within the biotic community as well as by relationships between organisms and the physical (abiotic) environment. The carrying capacity of an ecosystem is the maximum number of organisms that an area can support on a sustained or continuing basis. The population density (number of individuals per unit area) may produce such profound changes in the environment that the environment becomes unsuitable for the continued survival of that species. Humans can also interfere with natural interactions of species with their environments with either positive, negative, or neutral effects. This activity will show how these interactions affect a population of deer in Arizona.

In 1905, the deer population on the Kaibab Plateau in Arizona was estimated to be about 4,000 on 300,000 hectares of range. The average [carrying capacity of the range was estimated to be about 30,000 deer.](#) On November 28, 1906, President Theodor Roosevelt created the Grand Canyon National Game Preserve to protect what he called the "finest deer herd in America."

Unfortunately, but this time, the Kaibab forest area was severely overgrazed by sheep, cattle, and horses. Most of the tall, perennial grasses had been eliminated in the area. The first step in protecting the deer was to ban all hunting in the area. Then, in 1907, the Forest Service tried to exterminate the natural predators of the deer, killing approximately 800 mountain lions, 20 wolves, 7400 coyotes, and 500 bobcats between 1907 and 1939.

Signs that the deer population was out of control began to appear as early as 1920. The most important sign was severe and rapid deterioration of range grass and abundance and quality. The forest service then reduced the number of livestock grazing permits to allow more grass for the deer. By 1923, however, the deer were reported to be near starvation and the range conditions were described as "deplorable."

A Kaibab Deer Investigation Committee recommended that all livestock not owned by local residents be immediately removed from the range and that the number of deer in the herd be reduced by 50 percent (culling) as quickly as possible. Deer hunting was reopened and during the fall of 1924, about 675 deer were killed. These deer represented only 10 percent of the number that had been born that spring!

Today, the Arizona Game Commission carefully manages the Kaibab area with regulations geared to specific local needs. Hunting permits are issued and predators are protected to keep the deer in balance with their range so that the herd size does not exceed the carrying capacity.

Materials:

- graph paper
- colored pencils
- population data

Procedure:

- Prepare a graph of deer population size (y-axis) vs. year (x-axis) using the [data chart \(below\)](#)
- Draw a horizontal line representing the [carrying capacity](#)
- Answer the analysis questions

Data:

Deer Population of the Kaibab			
Year	# Deer	Year	# Deer
1905	4,000	1927	37,000

1910	9,000	1928	35,000
1915	25,000	1929	30,000
1920	65,000	1930	25,000
1924	100,000	1931	20,000
1925	60,000	1935	18,000
1926	40,000	1939	10,000

Results: This will be your graph!

Analysis & Discussion: Answer the following questions

- During 1906 and 1907, which 2 methods did the Forest Service use to protect the Kaibab Deer
- Were these methods successful? Explain using data from the graph
- How many total predators were eliminated from the preserve between 1907 and 1939?
- What was the relationship of the deer herd population size and the carrying capacity of the range in
 - 1915
 - 1920
 - 1924
- Explain using NUMBERS from the data chart or graph
- Did the Forest Service program appear to be successful between 1905 and 1924. Explain using data from the graph
- Why do you suppose the population of deer declined in 1925 despite the elimination of predators?
- Do you think any changes occurred in the carrying capacity of the range between 1900 and 1940. Describe what you think occurred.
- Why do you think the deer population size was 4000 in 1900 when the carrying capacity was actually 30,000 deer?
- If the Forest Service had not interfered (in its well-meaning way) with the deer population, what do you think would have happened to the deer population?
- List major lessons learned from the Kaibab deer experience
- Based on these lessons, suggest what YOU would have done in the following years to manage the deer herds:
 - 1915
 - 1923
 - 1939
- What future management plans would you suggest for the Kaibab deer herd?

Conclusion: A one sentence testable statement that follows from your results or analysis