Fire and Biodiversity

Lesson 9

Lesson Overview After an instructor-led discussion that reviews ecological concepts associated with **biodiversity**, students will investigate the relationships that populations and communities have with fire by reading technical "research briefs" developed from **primary literature** sources.

Lesson Goal Students will understand that fire is a disturbance that has a positive impact on biodiversity. Students will summarize and communicate scientific information in the form of a slideshow presentation.

Subjects: Science, Reading and Writing

Duration: 60 minutes (one class period). More time will be needed if students present their slideshows.

Group Size: Individuals or Groups of 2

Setting: Classroom

Vocabulary: Biodiversity, Community, Community Ecology, Fire Ecology, Fire Intolerant Species, Fire Tolerant Species, Forest, Habitat, Niche, Population, Population Ecology, Primary Literature, Savanna, Species, Woodland

Objectives

- ➔ Students can explain the differences between the terms "niche" and "habitat."
- ➔ Students can determine whether a species is **fire tolerant** or **fire intolerant**.
- ➔ Students can define population ecology and community ecology.
- ➔ When given a summary of an ecological study, students can state the study's hypothesis/primary question and describe its experimental design.
- ➔ Students can explain the beneficial role fire plays in ecosystems.

Academic Standards

Table 1: Next Generation Science Standards - Science & Engineering Practices (SEP)

Asking Questions and Defining Problems	Analyze complex real-world problems by specifying criteria and constraints for successful solutions.
Constructing Explanations and Designing Solutions	Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Engaging in Argument from Evidence	Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments.
Obtaining, Evaluating, and Communicating Information	Communicate scientific information (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).

Table 2a: Next Generation Science Standards - Performance Expectations

HS-LS2 Ecosystems: Interactions, Energy, and Dynamics	HS-LS2-6: Evaluate 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 system. HS-LS2-7: Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
HS-LS-4 Biological Evolution: Unity and Diversity	HS-LS4-5: Evaluate the 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.

Table 2b: Next Generation Science Standards - Disciplinary Core Ideas (DCI)

HS-LS2 Ecosystems: Interactions, Energy, and Dynamics	HS-LS2.A: Interdependent Relationships in Ecosystems ● Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and non-living resources and from such challenges as predation, competition, and disease. HS-LS2.C: Ecosystem Dynamics, Functioning, and Resilience ● A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of

	ecosystems in terms of resources and habitat availability. ● Moreover, anthropogenic changes (induced by human activity) in the environment - including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change - can disrupt an ecosystem and threaten the survival of some species.
HS-LS4 Biological Evolution: Unity and Diversity	HS-LS4.D: Biodiversity and Humans ● Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus, sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.
HS-ETS1 Engineering Design	HS-ETS.B: Developing Possible Solutions ● When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts.

Table 3: Next Generation Science Standards - Crosscutting Concepts (CC)

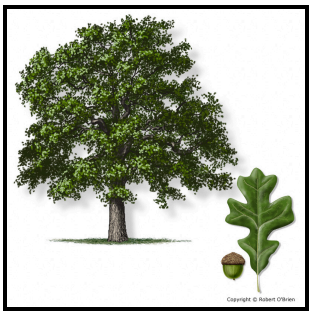
Cause and Effect	Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
Stability and Change	Much of science deals with constructing explanations of how things change and how they remain stable.
***Connection to Nature of Science**	**Science Addresses Questions About the Natural and Material World** - Scientific knowledge indicates what can happen - not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge.

Teacher Background In this lesson we will learn about how fire can affect biodiversity. Basic ecological concepts will be reviewed in this lesson's slideshow and are presented in this section.

- A species' **niche** in an ecosystem includes such factors as a **habitat**, trophic category, and how it fits into a food web. The terms "habitat" and "niche" are often confused. Habitat only describes "where" a species is found

while niche includes habitat and a species role in its ecosystem.

- A **population** is a group of individuals of a single species. **Population ecology** investigates factors that cause a population's numbers to increase or decrease. There could be changes in abiotic factors, such as nutrients, sunlight, precipitation, temperature, or changes in biotic factors, such as predators, herbivores, and diseases.



- A **community** is all the populations of organisms living together in the same area, usually interacting or depending on each other for existence. **Community ecology** is the study of interactions among species and the stability of a community's species composition.
- No species is isolated. All species interact with and depend upon other species. Thus, all populations interact with and depend upon populations of different species.

- Due to morphological characteristics **fire tolerant species** have a lower probability of being injured or being killed by fire. Such organisms are also referred to as **fire resistant species**.
- **Fire intolerant species** have a relatively high probability of being injured or killed by fire because they are very sensitive to fire or the heat produced by a fire. In the Cross Timbers, Eastern Redcedar trees are an excellent example of a fire intolerant species because they are easily damaged or killed due to thin bark, shallow roots, inability to resprout, and highly combustible evergreen foliage. Eastern Redcedar can survive in fire prone areas if they grow in areas protected from fires.

The primary question addressed in this lesson is "Why is fire important for species and communities?" Students will read "research briefs" or summaries of **primary literature** dealing with **fire ecology** in order to address that question.

Table 4: Population Ecology (links to primary literature included in research briefs)

Oak Woodlands & Forests Fire Consortium [OWFFC] Research Brief Title	OWFFC Research Brief #
Forage Availability for White-Tailed Deer Following Silvicultural Treatments in Hardwood Forests	RB-06
Relationships Between Bat Occupancy and Habitat and Landscape Structure Along a Savanna, Woodland, Forest Gradient in the Missouri Ozarks	RB-12

Brood Cover and Food Resources for Wild Turkeys Following Silvicultural Treatments in Mature Upland Hardwoods	RB-16
Genetic restoration in the eastern collared lizard under prescribed woodland burning	RB-22
Pyric-Carnivory: Raptor Use of Prescribed Fires	RB-23
Reptile and Amphibian Response to Season of Burn in an Upland Hardwood Forest	RB-28
The Phenology of Ticks and the Effects of Long-Term Prescribed Burning on Tick Population Dynamics in Southwestern Georgia and Northwestern Florida	RB-30
The Influence of Prescribed Fire on Wild Turkeys in the Southeastern United States: A Review and Synthesis	RB-32
Direct and Indirect Effects of Fire on Eastern Box Turtles	RB-36

Table 5: Community Ecology (links to primary literature included in research briefs)

Oak Woodlands & Forests Fire Consortium [OWFFC] Research Brief Title	OWFFC Research Brief #
Prescribing Fire in Eastern Oak Forests: Is Time Running Out?	RB-01
Refining the Oak-Fire Hypothesis for Management of Oak-Dominated Forests of the Eastern United States	RB-02
The Importance of Shortleaf Pine for Wildlife and Diversity in Mixed Oak-Pine Forests and in Pine-Grassland Woodlands	RB-04
Effects of Late Growing-Season and Late Dormant-Season Prescribed Fire on Herbaceous Vegetation in Restored Pine-Grassland Communities	RB-05
Effect of Fire Intensity on Litter Arthropod Communities in Ozark Oak Forests, Arkansas, U.S.A.	RB-10
Structure and Composition of an Oak-Hickory Forest After Over 60 Years of Repeated Prescribed Burning in Missouri, U.S.A.	RB-14
Fire Frequency and Tree Canopy Structure Influence Plant Species Diversity in a Forest-Grassland Ecotone	RB-20

Landscape and Site Level Responses of Woody Structure and Ground flora to repeated prescribed fire in the Missouri Ozarks	RB-29
Vegetation Response to Canopy Disturbance and Season of Burn During Oak Woodland and Savanna Restoration in Tennessee	RB-33

Table 6: Key Terms

Biodiversity	The variety of organisms considered at all levels, from genetic variants belonging to the same species through arrays of species to arrays of genera, families, and still higher taxonomic levels; includes the variety of ecosystems, which comprise both the communities of organisms within particular habitats and the physical conditions under which they live (Wilson, 1992).
Community	All the populations of organisms living together in the same area, usually interacting or depending on each other for existence.
Community Ecology	The study of interactions among species and the stability of a community's species composition.
Fire Ecology	A scientific discipline concerned with natural processes involving fire in an ecosystem and the ecological effects, the interactions between fire and the abiotic and biotic components of an ecosystem, and the role of fire as an ecosystem process.
Fire Intolerant Species	Organisms with a relatively high probability of being injured or killed by fire.
Fire Tolerant Species	Organisms that have a lower probability of being injured or killed by fire due to morphological or physiological characteristics. Such species are also referred to as "**fire-resistant**."
Forest	A formation dominated by trees, in which the canopy is more closed than open.
Habitat	The place where an animal or plant normally lives or grows, usually characterized either by physical features or by dominant plants. Deserts, lakes, and forests are all habitats (Art, 1993). This kind of environment a species occurs in, as this environment may be described in physical and chemical terms and often by factors, such as elevation and topographic position (Whittaker, 1970)

	An environment of a particular kind, such as lake shores or tall-grass prairie; also a particular environment in one place, such as the mountain forest of Tahiti (Wilson, 1992).
Niche	Role or "profession" of an organism in the environment; its activities and relationships in the community (Krebs, 1994). The place occupied by a species in its ecosystem - where it lives, what it eats, its foraging route, the season of its activity, and so on. In a more abstract sense, a niche is a potential place or role within a given ecosystem into which species may or may not have evolved (Wilson, 1992).
Population	Group of individuals of a single species.
Population Ecology	The study of factors that cause populations to increase or decrease.
Primary Literature	In the sciences, primary literature disseminates recent results of original research or new scientific findings. Examples of primary literature include articles in peer-reviewed journals, conference proceedings, technical reports, and dissertations all of which can often be found on the internet.
Savanna	A formation in which the overstory is dominated by woody vegetation growing as scattered individuals or in clusters.
Species	A naturally occurring population or a group of interbreeding populations that is reproductively isolated (cannot exchange genetic material) from other such populations or groups.
Woodland	A formation in which tree cover is greater than shrub cover, but the canopy is not closed.

Materials and Preparation

- This activity requires that students have access to computers/Chromebooks connected to the internet.
- There are no "physical" materials to prepare unless paper copies of the student worksheet will be used. A link to the "Student Worksheet" is provided in **Table 7** (below).
- Students will need computers/Chromebooks to access and read research briefs found in **Table 4** and **Table 5** (above). These tables are also included on the student worksheet.
- Students will also use computers/Chromebooks to produce presentation slideshows using the guidelines set forth in **Part B** of the student worksheet. A "Presentation Scoring Checklist" is provided to assist with presentation evaluations. This scoring checklist can be found in **Table 7**.

- On the worksheet, students will also respond to various prompts over the background information covered in this lesson slideshow. A "Student Worksheet Key" is available in **Table 7**.
- The student worksheet is a great reference for becoming familiar with the presentation's expectations.
- It would be helpful to read through the lesson plan's background information and the slideshow script to become familiar with related concepts and terminology.

Table 7: "Fire and Biodiversity" Resources

"Cross Timbers Tree Model" Resources
Student Worksheet
Student Worksheet Key with Presentation Scoring Checklist
Presentation Scoring Checklist
Tree Model Webpage (JenksFERST)

Procedure

1. If paper copies of the student worksheet will be used, distribute them to students. If an "electronic" copy of the student worksheet will be used, be sure that students have used the link to prepare their own document file.
2. Present this lesson's slideshow while reading the slideshow script. Students should complete **Part A** of their worksheets during the presentation.
3. After the slideshow, students should work on their presentations on their own or in groups of 2 by following the guidelines in **Part B** of the student worksheet.
4. After students have completed their slideshows, they can present them to the class and/or submit them for evaluation. Be sure to provide instructions for the presentation submission process.
5. Once all worksheet prompts have been completed, the worksheet can be submitted/turned in. If students are using electronic copies of the worksheet, be sure to give instructions on the submission process you would like for them to follow.
6. Evaluate the presentations using the scoring checklist provided in **Table 7** (above).
7. **Time permitting, class discussions could be conducted comparing the studies found in the research briefs.**

Assessment

- Sample quiz/review questions for "Fire and Biodiversity"

  1) Which of the following are "part" of a niche?

a) Habitat
b) Trophic category
c) Impact on ecosystem
d) All of the above

Answer: d

2) "A naturally occurring population or a group of interbreeding populations that is reproductively isolated (cannot exchange genetic material) from other such populations or groups" is the definition for which of the following?
a) Community
b) Population
c) Species
d) Biodiversity

Answer: c

3) "All the populations of organisms living together in the same area, usually interacting or depending on each other for existence" is the definition for which of the following?
a) Community
b) Population
c) Species
d) Biodiversity

Answer: a

4) "The number and relative abundance of all the species within a given area" is the definition for which of the following?
a) Community
b) Population
c) Species
d) Biodiversity

Answer: d

5) Fire intolerant plant species may be able to survive in a fire prone area if they grow in a
a) Niche

b) Habitat
c) Fire shadow
d) All of the above

Answer: c

Evaluation

- **Presentation Scoring Checklist** provided in **Table 7** (above).
- **Student Worksheet**
  - A key for the student worksheet can be found in **Table 7**.
- **Sample quiz/review questions for "Fire and Biodiversity"**
  - Answers provided with the questions in the **Assessment** section.

Extension

- There are no extensions for this activity.

References/Resources

Images and diagrams by Bryan Yockers unless cited/listed below or in the lesson materials.

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