TALL TIMBERS | Fire Frequency and Biodiversity | TEACHER GUIDE

OBJECTIVES| Students will be able to (SWBAT):

- Support claims based on evidence and reasoning.
- Engage in scientific argument based on evidence and reasoning.
- Discuss how changing environmental conditions result in changes to biodiversity.

MATERIALS & RESOURCES| Introductory "Roaming the Red Hills" video, copies of the student worksheet, student activity sheet, and a set of species cards for each group. Review the student worksheet and activity sheet first to help understand the lesson and the additional content included in this teacher guide.

IMPLEMENTATION| This lesson will take approximately 100 minutes for students with Claim, Evidence, and Reasoning (CER) experience to complete (2 class periods). If students are new to CER activities, you may need to budget an additional class period. Students can be divided into small groups of 3 or 4.

Day 1:

- Provide students with a copy of the student worksheet and have then watch the "Roaming the Red Hills" video as an introduction to this topic. If your classroom is not equipped to show a video, you may consider providing students with the link to watch it as homework prior to class or host this portion of the class in a computer lab.
- Take time to review the "activity" portion of the student worksheet as a class. Consider any reading strategies appropriate for the grade level.
- Review the table and photos on the second page of the student worksheet. Large color versions of the habitat photos are available on the lesson plan web site if you wish to display these on a screen in class.
- Provide students with copies of the student activity sheet and a set of species cards.
- Review the activity sheet parts and highlight the table they can use to record information from the species cards.
- Have students begin working together in their small groups to review and discuss evidence and develop their claim. <u>The goal for the first class period is to complete the property name, guiding question, our claim, and half or more of the evidence table on the activity sheet.</u>

Day 2:

- Have the students rejoin their small groups to complete their work developing evidence and their reasoning. Set a time to have them wrap up this portion of the activity and select a member to represent the group. If students struggle with ideas for the reasoning section, guide them back to the concepts mentioned in the background section or that you have already covered in class.
- The group representative stays at their table to present their claim, evidence, and reasoning, while the other students rotate and listen to the students representing other groups. Once each group has presented, students return to their groups and have an opportunity to revise their thoughts based on the feedback heard or provided from other groups.
- You may consider providing some guiding questions for the students who are rotating and listening to each presenter (Is the data organized as evidence to show trends, relationships, differences? Does the reasoning explain why the evidence supports the claim?).

<u>Homework:</u> Have each student write a thoughtful, well-written paragraph that includes the claim, evidence and reasoning based on the investigation done by their group. A rubric to evaluate student paragraphs and group paper is below.

EXTENSION & DISCUSSION IDEAS| These ideas are offered to further stimulate discussion or provide content for more complex projects or assignments.

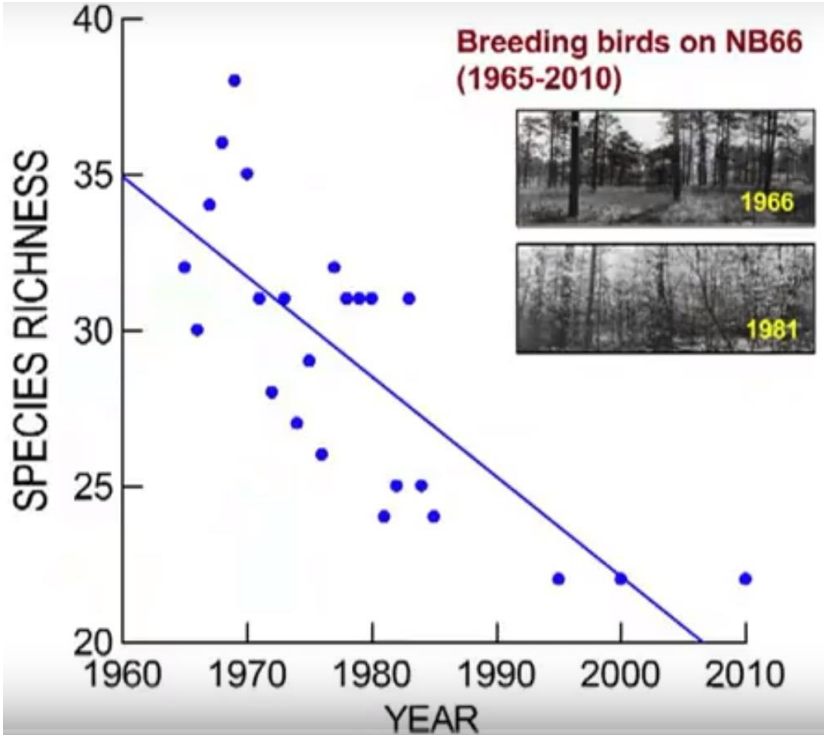
- **Is this Succession?** This is a good topic to have ready if students begin to use the concept of succession to describe plant community changes with or without fire. Succession as classically defined means the redevelopment of a community over time following a "disturbance" that removes vegetation or creates a new substrate for invasion of plants. In the case of longleaf pine communities with frequent fire, the term does not apply, since you are not creating a blank space for the invasion of new plants. Rather, for most all of the plant species in the longleaf pine system, fire is simply pruning the above-ground portion of the plants, which rapidly re-sprout. It is not a case of removing existing vegetation and initiating a process of redevelopment of the community. Fire is maintaining the well-developed community by preventing the invasion of non-fire-tolerant plants or the dominance of woody plants that would take over in the absence of fire. In other words, fire is not a "disturbance" in the sense of resetting the ecosystem to an early stage of succession. It is better described as an essential natural process that is needed to maintain the climax stage of succession.

  What happens in the absence of fire is also not really succession, but more accurately a change in the system that is the result of the absence of an essential natural process (fire) which would not have occurred with historic fire regimes (fire occurrence over a period of time). This change is more akin to desertification following clearing of tropical rainforests rather than a natural cycle. In this context, "fire" does not really behave like a disturbance in the classical succession sense, because it does not remove vegetation, rather it just keeps it in check. This is why native communities are rather resilient to invasive species and have few weedy species when the soil is not disturbed.

  An example of natural "disturbance" and "succession" in the longleaf pine ecosystem include smaller scale soil disturbance like a gopher tortoise burrowing and turning up an area of fresh soil, or a tree tipping over and exposing new bare ground. In both of these examples there will likely be a natural process of colonization by fast growing pioneer plant species, like annual plants, and then the gradual succession back to the stable condition of species that are long-lived and fire adapted. Unfortunately, larger scale soil disturbance by humans in the longleaf pine ecosystem can result in the loss of some native fire-adapted plants that depend on extensive root systems.

- **Species Richness**- The following graph can be used to assess student understanding of the consequences of excluding fire from ecosystems that evolved with it. You can use the graph for a class discussion or a more formal assessment tool.

  Assessment question: The following graph provides data from an on-going experiment at Tall Timbers Research Station. A 22-acre area was set aside and protected from fire since the beginning of the experiment in 1966. The site is known as No Burn 66 (NB66) and it has been utilized in a number of projects to help understand what happens when fire is excluded from fire adapted southern pine forests. The following graph provides data on the species richness, or number of species, for breeding birds in NB66. Identify the trend represented in the graph and provide a possible explanation.



- **Protect the house and barn** – Identify and explain how you would reduce the risk of fire to the home and barn site noted on the map of the new property in the Student Worksheet.
    - Possible Answers:
        - Use frequent prescribed fire or mowing to reduce and manage nearby natural fuels.
        - Remove leaf litter from siding, gutters, decks, and porches.
        - Move firewood, propane tanks, gas cans, and other flammables well away from structures.
        - Create defensible space around the buildings – things that aren't flammable
        - Keep lawns watered and green.
        - Maintain fire breaks around this area.

- **Single Species Management**- What if your group had compelling evidence that the area you are managing is in a critical location to aid in the recovery of Florida black bears – how would your strategies change?

- **Seasonality of fire** – How do you think changing the season (spring, summer, winter, fall) of when you burn would affect the plants and animals living there?

- **Write your fire prescription**- If students have lots of questions about the actual process of using prescribed fire, an activity centered around developing and writing the prescription or fire use on the example property in this lesson is a great way to apply their knowledge and critical thinking skills. If you are interested in a fire prescription activity, please contact Tall Timbers and we can work with you on content. If there is interest from teachers, we can work on developing this concept into a companion lesson plan.

STANDARDS ALIGNMENT

Georgia Standards of Excellence

- Addresses **SB5c, e.** Obtain, evaluate, and communicate information to assess the interdependence of all organisms on one another and their environment.
    c. Construct an argument to predict the impact of environmental change on the stability of an ecosystem.
    e. Construct explanations that predict an organism's ability to survive within changing environmental limits (e.g., temperature, pH, drought, fire).
- Addresses **SEV2c.** Obtain, evaluate, and communicate information to construct explanations of stability and change in Earth's ecosystems.
    c. Construct an argument to predict changes in biomass, biodiversity, and complexity within ecosystems, in terms of ecological succession.
- Supports **SEV1**. Obtain, evaluate, and communicate information to investigate the flow of energy and cycling of matter within an ecosystem.
    d. Evaluate claims, evidence, and reasoning of the relationship between the physical factors (e.g., insolation, proximity to coastline, topography) and organismal adaptations within terrestrial biomes.
    Note: Lesson provides support for standard through the discussion of adaptations to frequent fire.

Florida Next Generation Sunshine State Science Standards (NGSSS)

- Addresses **SC.912.L.17.4** - Describe changes in ecosystems resulting from seasonal variations, climate change, and succession.
- Addresses **SC.912.L.17.8** - Recognize the consequences of the losses of biodiversity due to catastrophic events, climate changes, human activity, and the introduction of invasive, non-native species.
- Supports **SC.912.L.17.12** - Discuss the political, social, and environmental consequences of sustainable use of land.

Next Generation Science Standards (NGSS)

- Disciplinary Core Ideas:
  - 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.
  - 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.
- Crosscutting Concepts:
  - Stability and Change – For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand.
  - Structure and Function- The way an object tis shaped or structured determines many of its properties and functions.
  - Scale, proportion, and quantity- In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change.
- Science and Engineering Practices:
  - Analyzing and interpreting data – Scientific investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious, scientists use a range of tools – including tabulation, graphical interpretation, visualization, and statistical analysis – to identify the significant features and patterns in the data. Scientists identify sources of error in the investigations and calculate the degree of certainty in the results.
  - Engaging in argument from evidence – Argumentation is the process by which evidence-based conclusions and solutions are reached. In science and engineering, reasoning and argument based on evidence are essential to identifying the best explanation for a natural phenomenon or the best solution to a design problem.

DIFFERENTIATION TIPS

- If students are struggling with developing a portion of their claim, evidence, or reasoning, direct students back to the Background section that was provided for them.
- For struggling readers, play the introductory video using the subtitles.
- If your class will struggle with the volume of information on the 10 species cards, you can assign each group 2 species cards. After the groups have learned about their species and estimated the fire frequency that will benefit their species, a representative from each group will report out to their findings to the rest of the class so that everyone can complete the table in the activity sheet and move forward with reviewing their claim and developing their evidence and reasoning.

Rubric

Students can be evaluated using the following 10 point rubric:

	Claim A statement or conclusion that answers the original question/problem.	Evidence Data that supports the claim. The data needs to be appropriate and sufficient to support the claim.	Reasoning: Completeness A justification that connects the evidence to the claim. It shows why the data counts as evidence by using appropriate and sufficient scientific principles.	Reasoning: Accuracy How accurate is the reasoning that backs up the claim and evidence?
0	Nothing turned in/blank			
1	Makes a claim selecting a single year or range for fire frequency (likely 2-years or 1-3 years)	Makes a general statement about the claim but does not include specific data.	Repeats evidence and links it to the claim, but does not include scientific principles.	The links between the evidence and the claim are based on incorrect ideas.
2	Makes a claim that includes varying the fire use on different parts of the property to support a diversity of habitat at any given point in time on the property. Can be as simple as burning three of the boxes created by the dirt roads one year, and the other three the next.	Supports claim with at least one piece of relevant evidence.	Used reasoning that is appropriate to evidence cited, and included at least one of the following concepts: • Biodiversity • Structure and function • Adaptation • Interdependence • Stability and Change • Transfer of energy • Human impacts	The evidence is tied to the claim by scientific concepts established in class and handouts provided.
3		Supports claim with 2 or more pieces of evidence.	Used reasoning that is appropriate to evidence cited, and included two or more of the concepts above.	

TALL TIMBERS | Fire Frequency and Biodiversity | TEACHER ACTIVITY SHEET

PROPERTY NAME | You pick This is an opportunity for creativity and investment in the idea of taking care of the property, no wrong answers.

CLASS PERIOD # :

NAME(S):

GUIDING QUESTION | What are we trying to find out?
How frequently should prescribed fire be applied to the site to promote biodiversity?

OUR CLAIM | After evaluating data from the species cards, lesson, and any background reading, answer your Guiding Question. Don't be afraid to revise your claim as you work on the evidence and reasoning sections. Remember, scientific knowledge is open to revision in light of new evidence.
The provided data will tend to yield student claims that applying fire every two years will support the highest biodiversity, and this is the currently accepted rule of thumb in the Red Hills region. However, claims with a wider range of fire frequency, such as 1 to 3 years, may demonstrate that students are thinking about the idea of varying fire frequency within a property to help create a diversity of habitat at any given time. Students may also develop a more complex claim based on the natural fire breaks included on the property map. The six separate areas created by the roads, lake, and wetland provide the opportunity to apply prescribed fire in several different ways.

OUR EVIDENCE | Use data from the species cards, lesson, and any background reading to develop evidence to support your claim. The table below can help you organize your data and present it as evidence. Shade the fire frequency that tends to support the habitat needs of each species. Bobwhite quail has been completed as an example.

Species	1	2	3	5	10	20
bobwhite quail	■	■	■			
Bachman's sparrow	■	■				
red-headed woodpecker				■	■	
red-cockaided woodpecker		■	■	■		
Sherman's fox squirrel		■	■	■		
Florida black bear					■	■
gopher tortiose	■	■	■			
Florida Pine Snake	■	■	■			
southern magnolia						■
lonfleaf pine tree	■	■	■	■		

Fire Frequency (Years)

Evidence: (some examples)

1. Our review of the data shows that 7 out of 10 of the species reviewed have habitat needs that are supported by a fire frequency of every 2 years.
2. The habitat photo we identified as having a 2 year fire frequency looks most like the longleaf pine photo in the species cards and we learned in the video that longleaf pine forests have high biodiversity.
3. The habitat photo we identified as having a 5 year fire frequency shows the woody plants beginning to outcompete the fire-adapted plants and we learned in the background information that this leads to a loss of biodiversity. This evidence supports our claim of 2 years (or 1-3) year fire frequency.
4. Sunlight is the source of energy for this ecosystem, and we learned that it needs to stay open enough for sunlight to reach the forest floor and support the plant diversity that helps support the overall biodiversity. Fire frequency of 1-3 supports this open structure.
5. In the video we learned that naturalists who visited the Red Hills region in the 1800s described the area as being very open with a grassy understory. In our data table we can see that higher fire frequency of 1-2 years supports more grasses in the groundcover, so this fire frequency supports the ecosystem that was observed before humans did more to prevent fires.

OUR REASONING | What scientific ideas, terms, theory, and/or laws help explain how your evidence supports your claim; tie the evidence to the claim? You can use your books & folder as resources.

1. Our first point of evidence supports our claim because it shows that we are promoting biodiversity because the highest number of species benefit from a fire frequency of every 2-years.
2. Our second point of evidence supports our claim because we know that structure and function are related and we observed that the structure of the 2-year fire plot and the longleaf pine species card look very similar, so we can infer their function may also be similar.
3. Our third point of evidence provides supports our claim by showing that fire frequency of 5-years and greater allows plants that don't have an adaptation to fire to colonize the site, and we learned that when plant species not adapted to the historic condition (fire) take over a site there is a loss of biodiversity.
4. Our fourth point of evidence supports our claim by recognizing the interdependent relationships in the ecosystem and the transfer of energy from the sun to the ground cover plants and into the reset of the system, helping to drive higher biodiversity.
5. Our fifth point of evidence supports our claim by recognizing the human impacts to the longleaf ecosystem through fire exclusion, and identifying evidence of the condition of the system prior to the human impact. This evidence helps us to target the fire frequency that would approximate this pre-impact condition, recognizing that our materials indicated that frequent fires support stability in this system and the change brought by human exclusion of fire results in less stability and loss of biodiversity.