**Homeostasis of Ecosystems & Climate Change Unit**

**Lesson 1. Introduction to Climate Change**

90-180 minutes
(Can modify lengths of group & class discussions as well as if reading and/or writing is done inside or out of class.)

**Goals for the Lesson**

1. Introduce students to 1) the science of climate change, 2) the need for media literacy, and 3) varying perspectives on climate change.
2. Draw connections between climate change as a global issue and a local environment, Tucker Prairie.

Unit Guiding Question
How might climate change affect the complex interactions in local ecosystems?

Lesson Guiding Questions
What is global climate change?
What evidence do scientists have for global climate change and its causes?
What are the varying perspectives in regard to global climate change?

**Lesson Assessment**
Written Response to Following Prompt:

- Describe three different perspectives on climate change.
- Why do you think people have such varied responses to climate change?

**Climate Change Learning Resources Website**
http://restem4.wix.com/learning-resources

| **Instructional Sequence** | **Materials/Supplies** |
|---|---|
| Prior to 1st class –<br>Students read excerpt from *Climate Change: Evidence & Causes*<br><br>Students take notes on their reading, using the following prompts:<br>• Green house gases affect temperatures on earth by…<br>• Evidence linking human activity with increased greenhouse gases includes…<br>• General notes related to temperature changes, impacts of climate change, and evidence: | Copies of reading (also available on Climate Change Learning Resources Website)<br><br>Climate Change Note-taking Prompts |
| Teacher helps class review basic understanding of *Climate Change: Evidence & Causes*. Possible discussion questions include:<br>• According to the reading, what is your understanding of the greenhouse effect? What are greenhouse gases?<br>• How do greenhouse gases relate to climate change?<br>• What evidence is given for climate change and how humans activity is linked to climate change? | Lesson 1 PPT |

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| Students explore sources of the *Climate Change: Evidence & Causes*.<br>• Students are divided into 7 small groups.<br>• Each group reviews the unit website for one of the source organizations using taking brief notes on the following questions:<br>o Who is (or what organization or company) presenting the information?<br>o What is the purpose of the publication?<br>o What expertise and/or relevant experience does the author (or organization or company) have?<br>o What biases does the author (or organization or company) have and how might those biases affect the presentation of information?<br>o Does the information presented seem to be accurately reported? Are the claims made in the presentation supported? Do any facts or analyses seem to be distorted?<br>o Does the presentation leave important information out? Does the presentation offer information that is unnecessary (particularly if the extra information distorts the message)?<br>• Each group shares with the rest of the class what they learned about their assigned source. | *Know Your Sources* handout<br><br>2-4 Laptops per group<br><br>Climate Change Learning Resources Website |
| Teacher guides students through explanation of the greenhouse effect. Students take brief notes in student notebooks. | Lesson 1 PPT<br><br>Student Notebooks |
| In small groups (they could be the same or different groups), students examine the graphs presented in the report and analyze what each graph represents. Guiding questions for their analysis include:<br>1. What variables are represented in the graphs?<br>2. What do the axes represent? What units of measure are being used?<br>3. What is the scale of each axis?<br>4. Are the graphs based on data that have been collected or predictions from models?<br>5. What conclusions can be drawn from the graph?<br><br>Small group analysis is followed by a full class discussion. What conclusions can be drawn from each graph? | Lesson 1 PPT<br><br>2-4 Laptops per group<br><br>Unit Website |
| Teacher introduces the controversy of climate change by asking, "Why is climate change controversial?" Teacher allows students to briefly comment on the question as a whole class.<br><br>Teacher then suggests that we get a feel for our own "beliefs" before moving forward. Teacher reminds students that there is no right or wrong answer; that we are just getting a feel for our personal thoughts.<br><br>Students then arrange themselves along an agreement continuum (strongly disagree on one side of the room/strongly agree on the other side) in response to several questions regarding climate change<br><br>Teacher presents summary statistics of CC views | Unit 1 PPT<br><br>Posted signs:<br>"Strongly Agree"<br>"Strongly Disagree" |

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| Teacher reviews scientific consensus on CC<br>Teacher explains a range of views on CC<br><br>(Optional) Students may share the reason for their location on the continuum.<br><br>Teacher then leads students through a variety of social and scientific perspectives on climate change. | |
| Students review "Media resources that provide examples on controversy associated with climate change" (4 of the 8) and respond to writing prompt.<br>• Describe three different perspectives on climate change.<br>• Why do you think people have such varied responses to climate change?<br>Note: This may be completed as a homework assignment. | Climate Change Learning Resources Website |

**Homeostasis of Ecosystems & Climate Change Unit**

**Lesson 2. Carbon Cycling and Photosynthesis**

330 Minutes

**Note:**
There are various ways to split this large lesson up into multiple days. Some individual activities can be given as homework. Students should be encouraged to study notes in preparation for assessments.

**Goal for the Lesson**

1. Students create and revise a model to explain how Carbon cycles through biotic and abiotic factors.
2. Students explain the process of photosynthesis and its connections to cellular respiration and the Carbon cycle.
3. Students relate changes in the Carbon cycle to climate change and its impacts.

Unit Guiding Question
How might climate change affect the complex interactions in local ecosystems?

Lesson Guiding Question
How do photosynthesis and cellular respiration transfer energy in organisms and ecosystems?
How do photosynthesis and cellular respiration cycle matter in organisms and ecosystems?
How do changes to the Carbon cycle relate to global climate change and corresponding impacts?

**Lesson Assessments**

1. Carbon Cycle Model—Draft 1 & Draft 2
2. Fish / Elodea Lab Model—Draft 1 & Draft 2.
3. Fish / Elodea Lab Written Conclusion—Claim, Evidence, Reasoning
4. Photosynthesis Pre-test
5. Photosynthesis Quiz (Can be used as an informal formative assessment or as a mid-unit formative assessment for a grade.)

**Climate Change Learning Resources Website**
http://restem4.wix.com/learning-resources

| **Instructional Sequence** | **Materials/Supplies** |
|---|---|
| Class De-brief on the variety of social perspectives:<br>1. What were some of the perspectives about climate change?<br>2. What are the arguments/reasons for these different perspectives?<br>Quick review of scientific evidence for climate change.<br>1. What evidence do scientists have for climate change?<br>2. What is the cause of climate change? | |
| Remind students that a major factor in climate change is the amount of carbon dioxide and other greenhouse gases in the air. We are going to take time building an understanding of how carbon dioxide gets into and is taken out of the atmosphere. In order to track our understanding, we are going to complete a series of models that explain the movement of carbon through ecosystems and the biosphere. Before doing so, we need to build some common terminology. | Student notebooks for notes<br><br>Ecology Terms PPT<br><br>Carbon Model Handout |

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| Notes on levels of organization as it pertains to ecology:<br>• Ecology<br>• Individual<br>• Population<br>• Community<br>• Ecosystem<br>• Biosphere<br>• Biotic<br>• Abiotic<br><br>Now that we've established some important terms for this entire unit, please take a moment to draw a model that explains the movement of carbon through the biosphere.<br><br>As a class…share initial ideas of how carbon moves through an ecosystem. May share is small groups or generate an initial class model on the front whiteboard / SmartBoard. | |
| Point out to students that there are certain biological processes involved with the movement of carbon dioxide into and out of the atmosphere. One of those is cellular respiration, which we learned about in an earlier unit. The other is photosynthesis. We are going to spend a couple days building an understanding of photosynthesis.<br><br>First, see what students already know with a small pre-test. Then have students use resources (textbooks and/or online resources) to fix / add to pre-test. | Photosynthesis Pre-test<br><br>Class computers and/or textbooks. |
| Introduce Fish / Elodea Lab—students work in small groups to complete the following tasks:<br>• Collect data<br>• Create a model on a whiteboard that explains the results—<br>  o What is the relative concentration of carbon dioxide in each jar?<br>  o What cell processes (photosynthesis or cellular respiration) are occurring in each jar?<br><br>Full class discussion about the lab. Have students explain their thinking at this point. Save initial lab models. | Fish / Elodea Lab<br><br>Whiteboards & dry erase markers OR Butcher paper & markers<br><br>Post-its |
| Notes—Photosynthesis, Cellular Respiration Review, and Relationship between Photosynthesis and Cellular Respiration. Emphasize the relationship between nutrient cycling and the energy flow. | Photosynthesis PPT |
| Return to Fish / Elodea Lab Models<br>• Students do a round robin to give feedback on post-its for:<br>  o Clarity of the model. Can they understand what the model is showing without verbal explanation?<br>  o Accuracy of the model. Do they agree with what the model is explaining?<br><br>• Fix models based upon feedback and new understanding from the notes. Models can then be posted around the room. | |

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| • Summarize new learning in notes (or to turn in), answering the following prompt.<br>  o Make a claim that explains why there were differing amounts of carbon dioxide in each jar.<br>  o Describe and analyze the data to justify your claim.<br>  o Things you need to include to fully justify your claim are:<br>  ▪ Photosynthesis / Cellular Respiration<br>  ▪ Color of solution / pH / relative amounts of carbon dioxide<br>  ▪ Presence of organisms and light. | |
| Return to Carbon Cycle Model<br>• As a class, review and analyze evidence for climate change. New evidence includes, ocean acidification, polar ice caps, sea levels, etc.<br>• Individually, revise carbon cycle model based upon what we've learned about photosynthesis and cellular respiration. Think about how these processes are affected by human activity and how the effects connect to the graphs we have reviewed. | Photosynthesis PPT<br><br>Carbon Cycle Model |
| Photosynthesis Quiz—this quiz can be given at anytime based upon schedule to formally assess the process of photosynthesis, it's relationship to cellular respiration, and it's connection to the carbon cyle. | Photosynthesis Quiz |

**Homeostasis of Ecosystems & Climate Change Unit**

**Lesson 3. Climate Change and Local Ecosystems**

30 – 45 minutes prep for field trip
Half-day school for field trip
20-30 minutes debrief before moving into lesson 4

**Note**
This lesson will describe how we connected ecological impacts to a local prairie system. It could be modified to other local ecosystems. Some individual activities could be assigned as homework to save classtime.

**Goals for the Lesson**
1. Students develop an understanding of the importance of biodiversity in a local ecosystem.
2. Students explore how climate change might affect a local ecosystem.

Guiding Question
How might climate change affect the complex interactions in local ecosystems?

**Lesson Assessments**
1. Class list of main ideas of learning
2. Tucker Prairie Summary

**Climate Change Learning Resources Website**
http://restem4.wix.com/learning-resources

Tucker Prairie Website
http://hcmfh3.wix.com/tuckerprairie

| Instructional Sequence | Materials/Supplies |
|---|---|
| Teacher segues students from climate change as a GLOBAL issue to the idea that it is also a local issue. Teacher introduces the field trip and purpose for the field trip. The purpose of the field trip is to teach students about the importance of biodiversity in ecosystems and other related concepts of how organisms interact with the biotic and abiotic factors in their ecosystem as well as to study the impacts of climate change on a local ecosystem.<br><br>In preparation for the field trip, students read the Tucker Prairie Website and answer questions at the bottom. Purpose of the website is to introduce prairie ecosystems and to introduce the idea climate change impacts on a native species in the prairie. | Tucker Prairie PPT<br><br>Tucker Prairie Website |
| **Tucker Prairie Field Trip.** Students spend half a day at Tucker Prairie, one of the last remaining natural prairies in Missouri. Students rotate among 5 stations that are run by University of Missouri professors and graduate students to learn about the abiotic and biotic factors necessary to maintain a stable prairie ecosystem. Students take data at several stations, so that they can make some general qualitative conclusions. Driving questions for the stations are:<br>• Station 1—Burn Plots:<br>  ○ How does controlled burning affect Tucker Prairie? | For each student:<br>Tucker Prairie Handout<br>Clipboard<br>Pen / pencil<br>Sack lunch<br>Water bottle<br>Sunscreen / Bug spray<br>Backpack |

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| <ul><li>How is climate change affecting Tucker Prairie and what is the role of modeling in understanding these changes?</li></ul><ul><li>Station 2—Tucker Prairie Insects:<ul><li>What organisms live in grassy areas?</li><li>How are these organisms suited to live in grassy areas?</li><li>How can changes in the environment (grassland to woody) impact the species populations within this area?</li><li>Why are insects important to the environment and how can humans have an impact both positive and negative on insects' roles within the environment?</li></ul></li><li>Station 3—Prairie Plant Diversity:<ul><li>What is biodiversity? Why is biodiversity important?</li><li>How does the biodiversity of the prairie compare to the neighboring agricultural field? Which community is more adaptable to change? Why?</li></ul></li><li>Station 4—Soil and Earthworms:<ul><li>How does the soil affect what lives at Tucker Prairie?</li><li>How do living things affect the soil at Tucker Prairie?</li></ul></li><li>Station 5—Woody Thicket versus Grass Competition & Historical Photos of Tucker Prairie:<ul><li>How does the environment differ around and within the woody thicket?</li><li>Based on historical photos, how has Tucker Prairie changed?</li></ul></li></ul> | For stations:<br>Quadrats / hula hoops<br>Sweep nets<br>Insect dichotomous keys<br>Light Sensors<br>Soil Moisture Sensors<br>Flags for important landmarks<br>Soil samples<br><br>General supplies:<br>Busses<br>Garbage<br>Water coolers<br>Back-up lunch supplies<br>Back-up sunscreen & bug spray<br>Hand sanitizer<br>Paper towels<br>(Port-a-potties) |
| Class De-brief the day after the field trip. Generate a quick class list of what students saw and learned on the field trip. Tie that learning to terms we have already discussed, i.e., levels of organization.<br><br>Individually, students write a response to the following prompt (can be done as homework):<ul><li>Describe what you learned about competition and biodiversity at Tucker Prairie.</li><li>How might climate change be affecting the biotic and abiotic factors of this local ecosystem?</li></ul> | Whiteboard / Smartboard<br><br>Tucker Prairie Summary Handout |

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## Homeostasis of Ecosystems & Climate Change Unit

## Lesson 4. Competition Among Plants on the Prairie

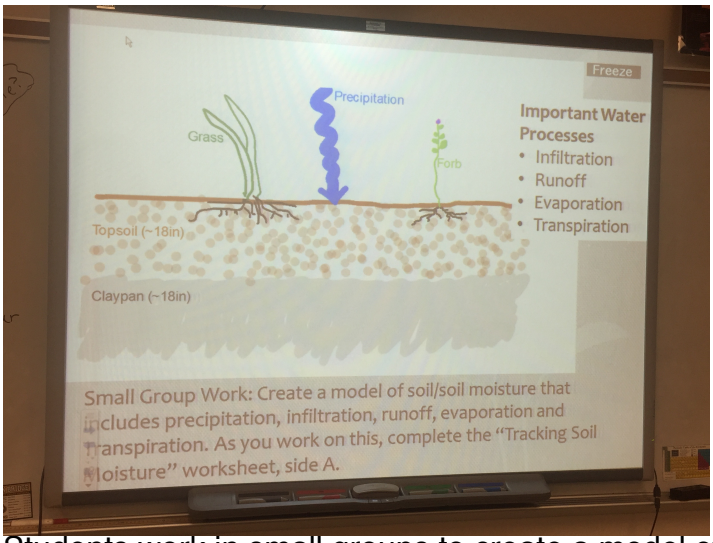
45-90 minutes

### Goals for the Lesson
1. Students explain the factors of competition between woody and herbaceous plants.
2. Students predict impacts of changing climate on competition between woody and herbaceous plants.

### Unit Guiding Question
How might climate change affect the complex interactions in local ecosystems?

### Lesson Guiding Question
How might a changing climate affect competition in Tucker Prairie?

### Lesson Assessment
1. Group Whiteboards
2. Classroom discussion

| Instructional Sequence | Materials/Supplies |
|---|---|
| Instructor presents guiding question: How might a changing climate affect competition in Tucker Prairie? | |
| Using the Woody v. Herbaceous PPT, instructor leads students through notes and discussion of competition, succession, communities, and disturbances in Tucker Prairie. | Woody v. Herbaceous PPT<br>Whiteboard<br>Computer<br>Projector<br>Student notebooks for notes |
| Instructor presents on SmartBoard diagram of soil moisture conditions.<br>  <br><br>Students work in small groups to create a model of soil/soil moisture that includes precipitation, infiltration, runoff, evaporation, and transpiration. Models are drawn on whiteboards or butcher paper.<br><br>While working on soil moisture model, students complete Side A of Tracking Soil Moisture Worksheet<br><br>Approximately 10 minutes working on models | Woody v. Herbaceous PPT<br>Small Student Whiteboards<br>Computer<br>Projector<br><br>Tracking Soil Moisture Worksheet |

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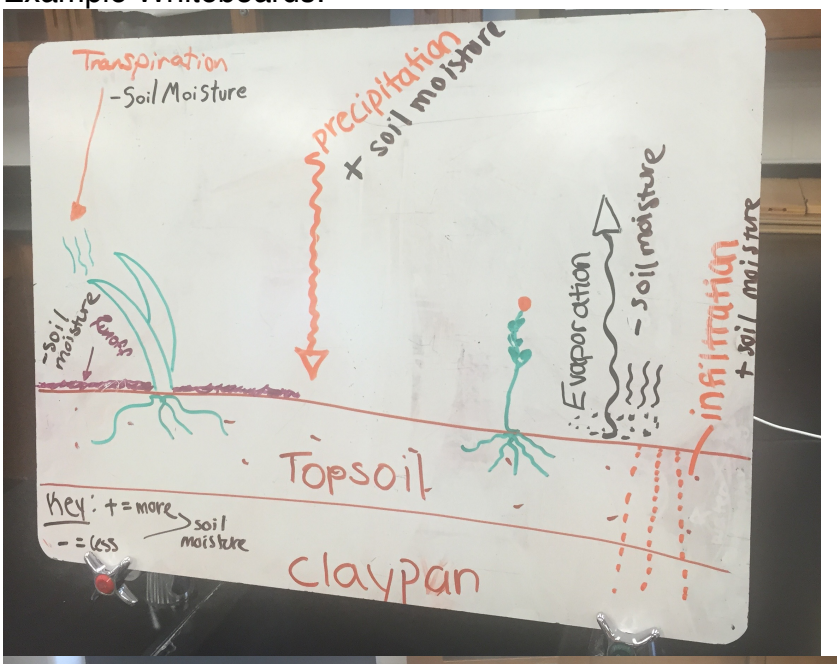
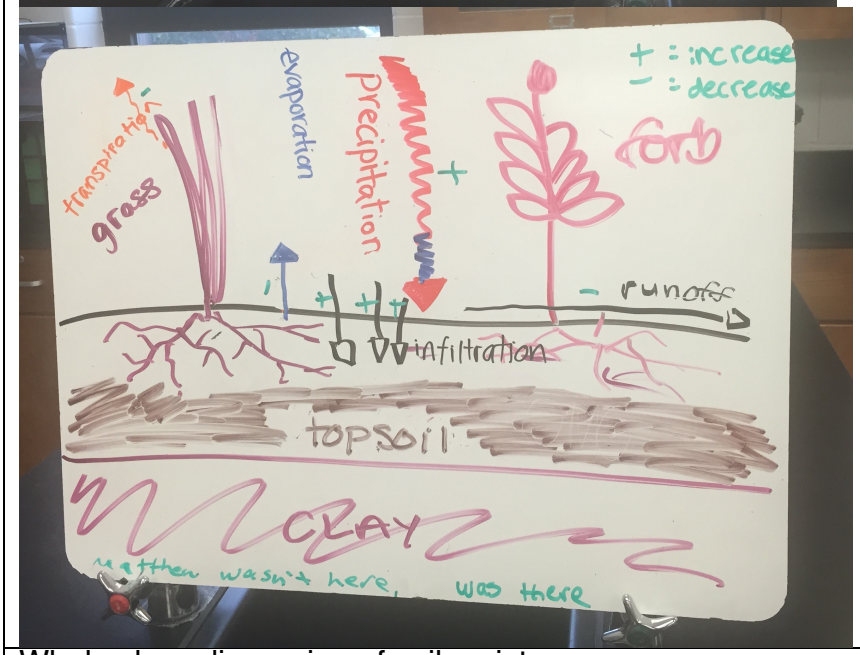
| Students participate in gallery walk to compare and contrast the different models. What were the similarities and differences in both explanation as well as design of the model to explain the processes? | Small student whiteboards<br>Tracking Soil Moisture Worksheet |
| Example Whiteboards:<br>  <br><br>  <br> | |
| Whole class discussion of soil moisture processes. Instructor leads students through a Q/A incorporating whiteboarding activity while covering processes on worksheet. Sample questions include:<br>• What effects do the different processes have on soil moisture?<br>• How do the relationships among these different processes ultimately affect soil moisture? | Student Notebooks<br>Tracking Soil Moisture Worksheet |
| Discussion shifts to woody vs. herbaceous competition. Instructor engages students in a discussion of the | Woody v. Herbaceous PPT |

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| differences between woody and herbaceous plants. Sample questions include:<br>• What did you learn at Tucker Prairie about the structure of woody plants vs. the structure of herbaceous plants?<br>• What conditions favor woody plants?<br>• What conditions favor herbaceous plants?<br><br>Instructor then shows drawing of tap roots versus fibrous roots. Instructor asks students about the advantages and disadvantages of these different structures? | Student Notebooks<br>Tracking Soil Moisture Worksheet |
| Instructor tells students that we are going to investigate a little further about the structure of roots and how that affects competition for water.<br><br>Students read an excerpt of a scientific paper (Kulmatiski & Beard, 2013) on precipitation at Tucker Prairie. Students work together to answer questions about how the frequency of rain events may affect competition. | Competition-Precipitation Worksheet |
| Class discusses findings of the Kulmatiski & Beard (2013) paper and how this relates to Tucker Prairie.<br><br>Class adds woody plants to the soil moisture consensus model.<br><br>Each student should recreate the class consensus model for him/herself in notes and write a summary about the differences tap roots of woody plants versus herbaceous fibrous roots. | Woody v Herbaceous PPT<br>Student Notebooks |

## Homeostasis of Ecosystems & Climate Change Unit

## Lesson 5. Vanishing Prairie, Indicator Species

90-120 minutes (+ Independent work)

### Goals for the Lesson

1. Students develop understanding of niche, habitat, competition, food webs & food pyramids
2. Students develop understanding of energy flow through trophic levels in an ecosystem
3. Research Tucker Prairie Indicator species to conceptualize goals 1 & 2

### Guiding Question

How might climate change affect the complex interactions in local ecosystems?

### Lesson Assessments

1. Informal assessment from listening to small group and whole-class discussion.
2. Final Carbon Cycle Model
3. Ecological Relationships Quiz (This can be used as an informal formative assessment or as a more formal quiz for a grade.)

### Climate Change Learning Resources Website

http://restem4.wix.com/learning-resources

### Indicator Species Website

http://restem4.wix.com/ssi-eco

| Instructional Sequence | Materials/Supplies |
|---|---|
| Discussion and review of previous class period material about woody and herbaceous plants and precipitation patterns; Students discuss briefly with shoulder partners<br><br>Take-home message:<br>Woody organisms do better than herbaceous plants because they get water from deep down because their roots are deeper; wood on woody plants are dead cells and don't need water, but herb plants are all living cells and all of them need water, and they can't store it as long as woody plants; the rain patterns are moving towards more rain at once with more time in between, so herbaceous plants don't get the water that they need. | |
| Intro Indicator Species—Instructor than leads students into thinking about the other organisms that live in the prairie. If plants change because of changing abiotic factors, what does that do to the organisms that rely on those plants?<br><br>Each student is assigned 2 species to research and become experts on. (There are 6 species. 1/3 of the class should do 2 species, 1/3 of the class should do another 2 species, and 1/3 of the class should do an additional 2 species.)<br><br>Teacher leads students through a discussion of various links on web page and credibility of sources, and instructs student to use the guiding questions to inform their research. Students should answer each question for their assigned organisms, provide specific evidence that supports that answer, record where they found their | Climate Change Learning Resources Website http://restem4.wix.com/learning-resources<br><br>Indicator Species Website http://restem4.wix.com/ssi-eco<br><br>Teacher computer and projector<br><br>Student computers, iPads or other electronic devices to use for research<br><br>Indicator Species Follow-up Worksheet |

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| information, and be ready to share with others at the end of today or next class period. | |
| Indicator Species Follow-up:<br><br>Students are organized into groups of 3 students so they can share information about the 6 indicator species as experts.<br><br>Students are instructed to share what they learned about their organisms based on what is on follow up worksheet. Students should record overall findings on the Indicator Species Follow-up Worksheet.<br><br>Whole class discussion of indicator species work. Summarize habitat, niche, potential climate change affects. Students should take notes on habitat and niche in notebooks. | http://restem4.wix.com/learning-resources<br>http://restem4.wix.com/ssi-eco<br><br>Indicator Species Follow-up Worksheet<br><br>Student Notebooks |
| Food Web & Ecological Pyramid Analysis<br><br>Students work in small groups to make a food web using indicator species as their starting point and then they add organisms including Tucker Prairie as a whole.<br><br>After students complete their food web and introduction to ecological pyramids, there is a whole class discussion and follow-up notes on:<br>• Food webs / food chains<br>• Trophic levels—producers, primary consumers, secondary consumers, etc.<br>• Herbivores, omnivores, carnivores<br>• Predators, scavengers<br>• Decomposers<br>• 10% Rule<br>• How this all fits back together with photosynthesis, cellular respiration, and the Carbon Cycle. | Food Web & Ecological Pyramid Worksheet |
| Have students return to Carbon Cycle one last time. They should make a final cycle that puts together everything they have learned to this point. There is a final prompt for them to answer afterward. | Carbon Cycle Worksheet |
| Ecological Interactions Quiz—This quiz can be given on a subsequent day as appropriate in the schedule. | Ecological Interactions Quiz |

## Homeostasis of Ecosystems & Climate Change Unit

## Lesson 5. Vanishing Prairie, Indicator Species

90-120 minutes (+ Independent work)

### Goals for the Lesson

1. Students develop understanding of niche, habitat, competition, food webs & food pyramids
2. Students develop understanding of energy flow through trophic levels in an ecosystem
3. Research Tucker Prairie Indicator species to conceptualize goals 1 & 2

### Guiding Question

How might climate change affect the complex interactions in local ecosystems?

### Lesson Assessments

1. Informal assessment from listening to small group and whole-class discussion.
2. Final Carbon Cycle Model
3. Ecological Relationships Quiz (This can be used as an informal formative assessment or as a more formal quiz for a grade.)

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### Indicator Species Website

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| Instructional Sequence | Materials/Supplies |
|---|---|
| Discussion and review of previous class period material about woody and herbaceous plants and precipitation patterns; Students discuss briefly with shoulder partners<br><br>Take-home message:<br>Woody organisms do better than herbaceous plants because they get water from deep down because their roots are deeper; wood on woody plants are dead cells and don't need water, but herb plants are all living cells and all of them need water, and they can't store it as long as woody plants; the rain patterns are moving towards more rain at once with more time in between, so herbaceous plants don't get the water that they need. | |
| Intro Indicator Species—Instructor than leads students into thinking about the other organisms that live in the prairie. If plants change because of changing abiotic factors, what does that do to the organisms that rely on those plants?<br><br>Each student is assigned 2 species to research and become experts on. (There are 6 species. 1/3 of the class should do 2 species, 1/3 of the class should do another 2 species, and 1/3 of the class should do an additional 2 species.)<br><br>Teacher leads students through a discussion of various links on web page and credibility of sources, and instructs student to use the guiding questions to inform their research. Students should answer each question for their assigned organisms, provide specific evidence that supports that answer, record where they found their | Climate Change Learning Resources Website http://restem4.wix.com/learning-resources<br><br>Indicator Species Website http://restem4.wix.com/ssi-eco<br><br>Teacher computer and projector<br><br>Student computers, iPads or other electronic devices to use for research<br><br>Indicator Species Follow-up Worksheet |

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| information, and be ready to share with others at the end of today or next class period. | |
| Indicator Species Follow-up:<br><br>Students are organized into groups of 3 students so they can share information about the 6 indicator species as experts.<br><br>Students are instructed to share what they learned about their organisms based on what is on follow up worksheet. Students should record overall findings on the Indicator Species Follow-up Worksheet.<br><br>Whole class discussion of indicator species work. Summarize habitat, niche, potential climate change affects. Students should take notes on habitat and niche in notebooks. | http://restem4.wix.com/learning-resources<br>http://restem4.wix.com/ssi-eco<br><br>Indicator Species Follow-up Worksheet<br><br>Student Notebooks |
| Food Web & Ecological Pyramid Analysis<br><br>Students work in small groups to make a food web using indicator species as their starting point and then they add organisms including Tucker Prairie as a whole.<br><br>After students complete their food web and introduction to ecological pyramids, there is a whole class discussion and follow-up notes on:<br>• Food webs / food chains<br>• Trophic levels—producers, primary consumers, secondary consumers, etc.<br>• Herbivores, omnivores, carnivores<br>• Predators, scavengers<br>• Decomposers<br>• 10% Rule<br>• How this all fits back together with photosynthesis, cellular respiration, and the Carbon Cycle. | Food Web & Ecological Pyramid Worksheet |
| Have students return to Carbon Cycle one last time. They should make a final cycle that puts together everything they have learned to this point. There is a final prompt for them to answer afterward. | Carbon Cycle Worksheet |
| Ecological Interactions Quiz—This quiz can be given on a subsequent day as appropriate in the schedule. | Ecological Interactions Quiz |

## Homeostasis of Ecosystems & Climate Change Unit

## Lesson 6. Culminating Climate Change Model

180 minutes (Portions of two class periods)

### Goals for the Lesson

1. Assimilate information gained over the course of the unit into a culminating project illustrating climate change impacts on a single organism
2. Use the scientific process of modeling as a predictive feature for the previous stated goal.

### Unit Guiding Question

How might climate change affect the complex interactions in local ecosystems?

### Culminating Project Guiding Question

How will climate change impact a species over time?

### Assessment

1. Culminating Project—Organism Model and Paper
2. Ecology Content Test (Optional)

### Climate Change Learning Resources Website

http://restem4.wix.com/learning-resources

### Climate Change Learning Resources-Ecology Unit Final Project

http://restem4.wix.com/learning-resources#!ecology-unit-final-project/c1wfv

### Ecology Unit Final Project – Sample Model

http://media.wix.com/ugd/e3ba52_838752e92ced4939ad851f18c19f63eb.pdf

### Ecology Unit Final Project – Sample Paper

http://media.wix.com/ugd/e3ba52_7c6e854056204f62af431a8944854248.pdf

| Instructional Sequence | Materials/Supplies |
|---|---|
| Instructor presents guiding question and culminating project:<br>*How might climate change impact a species over time?*<br><br>Students will create a predictive model consisting of a visual model and an explanatory manuscript illustrating the climate change impacts for an example species | Whiteboard<br>Computer<br>Projector<br><br>Unit 2 Assessment |
| Before students begin working on their culminating project, they should take time to review and evaluate sample models from the unit.<br><br>Students have created and revised a series of explanatory models. They should use chosen samples of these models for this activity.<br>1. Fish/Elodea (Cellular Respiration/Photosynthesis)<br>2. Carbon Cycle (3 iterations)<br>This activity is designed to help them create a list of criteria needed for an effective culminating predictive model. | Sample models for review and evaluation.<br><br>Model evaluation worksheet |

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| Students work in small groups to evaluate and critique sample models.<br><br>Explain to students that these models are all explanatory models. Their culminating model should be explanatory and predictive. | |
| <u>Culminating Project</u><br><br>Students will create a predictive model consisting of a visual model and an explanatory manuscript illustrating the climate change impacts for an example species<br><br>First step: Evaluation of sample model:<br>Students work in groups to evaluate a sample model provided by instructors illustrating one of the previous species from the indicator species activities in class around Tucker Prairie climate change impacts.<br><br>2nd Step: Students are provided with a list of 10 suggested species that they may research to develop a predictive visual model with accompanying written paper. Students may choose a species not included on the list if approved by instructor.<br><br>3rd Step: Students individually work on their model and paper. They will should be given class time but will need to work on the assessment outside of class as well. | Sample model: Henslow's Sparrow.<br><br>Model Evaluation Worksheet<br><br>Summative Project Species Examples with active hyperlinks.<br><br>Unit 2 Assessment.docx<br><br>Unit 2 Assessment Teacher Guide.docx |
| <u>Ecology Content Test</u><br>Although the culminating project will assess most of the learning goals of this unit, the instructor may want to give a more explicit content test. | Ecology Content Test |