Climate Change & Ecosystems *Lesson Plan*

Students research interrelationships in ecosystems and predict the effects of climate change.

Topic: Students research the connections among plants, animals and environmental factors in an ecosystem, and explore how climate change might affect those connections and the ecosystem as a whole. Based on ***Union of Concerned Scientists Global Warming: Early Warning Signs Lesson 4***.

Grade Level: High School (9^{th}–12^{th})

Time Allotted: at least 2 hours, more if the extensions are done

Performance Objectives

References are to the Next Generation Sunshine State Standards (2007).

Science

SC.912.L.17.4	Student will be able to describe changes in ecosystems resulting from seasonal variations, climate change and succession.
SC.912.L.17.8	Student will be able to recognize the consequences of the losses of biodiversity due to catastrophic events, climate changes, human activity, and the introduction of invasive, non-native species.
SC.912.L.17.9	Student will be able to use a food web to identify and distinguish producers, consumers, and decomposers. Explain the pathway of energy transfer through trophic levels and the reduction of available energy at successive trophic levels.
SS.912.G.5.4	Student will be able to analyze case studies of how humans impact the diversity and productivity of ecosystems.
SC.912.L.17.16	Student will be able to discuss the large-scale environmental impacts resulting from human activity, including waste spills, oil spills, runoff, greenhouse gases, ozone depletion, and surface and groundwater pollution.
SC.912.N.1	Identify the basic process used in scientific investigations, including questioning, observing, recording, determining, and sharing results.

Prior Knowledge

Students should understand the concept of an ecosystem, including the relationship between abiotic and biotic factors and how a food chain works. They should also know the physical/atmospheric measurements that are used to characterize a region's climate.

Overview

Students will first consider ways that climate may affect local plants and animals. They will then choose a local ecosystem, research it, and create a relevant food web, using a variety of sources. Students will each choose a specific species and prepare a report describing how climate change may affect it. After

listening to each other's reports, they will redo their ecosystem webs for possible change in the year 2100. Extensions include adding an exotic ecosystem to study, as well as a field excursion to the ecosystem of choice.

Key Vocabulary

Abiotic
Referring to non-living chemical and physical factors in the environment.

Biotic
Relating to life and living organisms.

Climate
The long-term average of conditions in the atmosphere, ocean, and ice sheets and sea ice described by statistics, such as means and extremes.

Climate change
A change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forces, or to persistent anthropogenic (human-caused) changes in the composition of the atmosphere or in land use.

Ecosystem
The interaction of a biological community and its environment, considered collectively. Each ecosystem is made up of biotic and abiotic (living and nonliving) components.

Food chain/web
A diagram of energy and/or nutrient transfer between organisms in an ecosystem.

Pathogen
A micro-organism that causes disease, such as a virus, bacteria or fungus.

Materials

- Regional nature guides (online or text)
- Biology or environmental science textbooks for reference (online or text)
- Computers with internet access
- Global Warming: Early Warning Signs map (see Resources)
- Science Notebook

Resources

These documents may be found in the Digital Library of the Orange County Water Atlas:

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Source: U.S. Environmental Protection Agency. 2010.

Climate Change and Wildlife Health: Direct and Indirect Effects
Source: U.S. Geological Survey. 2010.

Florida's Wildlife: On the Front Line of Climate Change Climate (2008 Summit Report)
Source: Florida Fish & Wildlife Conservation Commission. 2008.

Robertson, Kevin. Wildfire, Prescribed Fire and Climate Change in Florida. 2007. Tallahassee, FL: Tall Timbers Research Station.

Wekiva River Case Study: Part of Adaptation Options for Climate-Sensitive Ecosystems and Resources Chapter 6 -- Wild and Scenic Rivers
Source: U.S. Environmental Protection Agency. 2008.

Other Orange County Water Atlas Resources:

Orange County Water Atlas Advanced Mapping Tool:
FNAI Managed Lands map layer
Land Use map layer

Other Resources:

Cook, John. Skeptical Science: Getting Skeptical About Global Warming Skepticism. Website. Accessed June 2011.

FNAI Species and Communities Tracking List
http://www.fnai.org/trackinglist.cfm

Global Warming: Early Warning Signs
http://www.climatehotmap.org/

Intergovernmental Panel on Climate Change. Website. Accessed June 2011.

National Assessment of the Potential Consequences of Climate Variability and Change
http://www.usgcrp.gov/usgcrp/nacc/default.htm

Power Up Florida (Orlando/Orange County web portal to sites for electrical efficiency, solar usage, electric vehicles, clean technology, Climate Change Education Center and more). Accessed July 2011.

Stanton, Elizabeth K., and Frank Ackerman. Florida and Climate Change: The Cost of Inaction. 2007. Tufts University Global Development and Environment Institute and Stockholm Environment Institute—US Center.

Union of Concerned Scientists Global Warming: Early Warning Signs Lesson 4
http://www.climatehotmap.org/curriculum/climate_change_guide.pdf

USA Phenology Network
http://www.usanpn.org/

World Wildlife Fund Impacts of Climate Change
http://wwf.panda.org/about_our_earth/aboutcc/problems/impacts/

Procedure

Engage/Elicit

Ask the class to think of different ways that climate affects plants and animals, and generate a list (on whiteboard or projected computer). Depending on their ecological prior knowledge, guide their responses by having them consider these and other topics:

- latitude
- altitude
- life cycles (e.g., mating, hibernating, migrating)
- distribution & ranges
- predators, pathogens & parasites

Distribute this list once it is generated so students may use it for the following activities.

Explore

Have your students make a list of local ecosystems – the Land Use Cover layer on the ***Orange County Water Atlas Advanced Mapping Tool*** will likely be helpful here. Let students choose an ecosystem to focus on, or if field trips are a possibility, choose one or more that you will be able to visit (see Extension 2).

Ask students to research as a class the basic components of the ecosystem they have chosen. Students should look for organisms in each category of Producers, Herbivores, Omnivores, Carnivores, and Decomposers. Nature guides, library books, and the Internet could all be sources of information for this exercise. The web sites of State Departments of Conservation or the local Audubon Society would be good resources. If possible, consider Extension 2 and visit the ecosystem.

Explain

After the class has finished their research, have each student create a web (using drawings or pictures, for example) of the basic components of the ecosystem showing interrelationships. The web should include abiotic factors such as the Sun, atmosphere, water, soil, and nutrients.

Next, have students develop hypotheses concerning how climate change might affect the ecosystem. Points to consider include: species that are considered endangered or threatened, habitat availability, seasonal shifts, drought, inundation, fires, hurricanes, and invasive species.

Then, ask each student to read the text on Plant and Animal Range Shifts from the ***Global Warming: Early Warning Signs*** map to learn some examples of how climate change affects organisms. Then have each student prepare a report to be presented orally to the class on how climate change could affect one of the plants or animals in the regional ecosystem. You may use the Student Activity Sheet (see below) to guide them. Students can also use the information generated by the class in the Engage

activity above. Teachers should use the Regional reports of the ***National Assessment of the Potential Consequences of Climate Variability and Change*** to find the projected climate changes for Florida.

Extension 1: Exotic Ecosystems

Have students research the possible effects of climate change on an ecosystem significantly different from the one they have just studied. This might be a temperate coastal system, coral reef, desert, or mountainous area. If possible pick an area in a country other than the United States (i.e. Great Barrier Reef, Canadian Arctic). The World Wildlife Fund Impacts of Climate Change web site is a good source for information on climate change impacts. Ask students to compare and contrast the impacts in each of the two systems they have studied.

Extension 2: Visit Your Local Ecosystem

If at all possible, take students on a field trip to collect data on the types of plants and animals found in the ecosystem. You may also assign to a local park on their own as a bonus activity. Either students or the teacher can design a species observation sheet, and guidebooks can be used to assist with identifications in the field.

Supplement the field observations with Internet or library research, especially for the larger mammals or nocturnal animals. Be sure to consider natural communities, interesting species, invasive species, etc. Take photographs and make notes during your visit, then write a story and post it on the Orange County Water Atlas Watershed Excursion.

Exchange/Evaluate

Each student should present their research findings in the form of hypotheses concerning how the projected climate changes might affect their organism, and the reasoning behind the hypotheses.

After the students have heard the hypotheses related to other species, have each student prepare a description of the ecosystem as it is today, using their web for illustration, and a description of what they think the ecosystem might look like in 2100 if the projected climate changes occur, using a new web for illustration.

Consider the Student Activity Sheets. for the individual species projects, using the initial list of factors generated in Engage as a benchmark to see how much the students covered.

Consider their individual ecosystem food web drawings.

Consider their research and papers/presentation from Extension 2 if they did them.

Consider field notes and research from Extension 2: Visit Your Local Ecosystem – these can be evaluated and shared, including as a post on the Orange County Water Atlas.

Orange County Water Atlas Learning Kit

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Water Atlas Curriculum Lesson 32

Curriculum developed for Orange County Environmental Protection Division by USF's Florida Center for Community Design & Research. This material is based upon work supported by the Department of Energy under Award Number DE-EE0000791.

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