Lesson 4: Overview

This lesson explores some of the ecological changes that have occurred as a result of global warming, and how changes in plant and animal behavior can be used as "bio-indicators" of global climate change.

Key Ideas

- **Activity 1: Trends Around New England**

  This activity focuses on the apparent range shift of two butterfly species in Massachusetts. It touches on the concept of local/regional extinction, and provides a concrete example of changes happening right now due to a warming climate. It also briefly covers the idea that changes to one species almost always cause changes to another species.

- **Activity 2: Modeling Ecosystems**

  By the end of this lesson, students should be able to think about how to build a representational model of a system given two interacting components.
  They should be able to take an average annual temperature and an average annual rainfall, and tell you what sort of ecosystem you're likely to find, using the Whittaker diagram to find it. Activity 3 of Lesson 5 gives students a chance to practice this

Materials

- Student sheets
- Blackboard/whiteboard
- Internet/Wikipedia access

Students should be prepared to take notes, either in a paper journal or on the computer.

Teaching suggestions

These activities include small group work and whole-class discussion. For convenience, you can divide your class into groups of 3-5 students at the start.
Distribute the student sheets at the beginning of the class.

Activity 1: Trends around New England [10 minutes]

Context for the teacher

This activity follows on from Lesson 2, looking at climate change in New England in greater depth. In addition to providing examples of documented species responses to climate change, it also covers the concepts of local vs. regional changes, and local extinction.
This is a small group activity. Questions are on student sheets. Provide answers if it's clear they're not coming up with them on their own.

Introduction

In 1992, the Atlantis Fritillary butterfly was a common sight in western Massachusetts. Between 1992 and 2010, its population declined by 90%, leaving it in very real danger of vanishing altogether.
At the same time, the Frosted Elfin butterfly, a rare sight in 1992, has seen a 1000% population increase in Massachusetts.

- Do you think the Atlantis Fritillary is going extinct? *[Correct answer: Not enough data to tell]*
- How do you think we could find out? *[Get data from outside Massachusetts]*
- Looking at the whole country, we know that Massachusetts is at the southern end of the fritillary's range. Does that change our idea about what's going on? *[Leading them towards the notion of range shift – the Atlantis Fritillary's southern range is contracting, moving its effective range north]*
- The Frosted Elfin is at the *northern* edge of its range in Massachusetts. What do you think is a likely cause of its dramatic population increase? *[Range shift again. We don't know what's happening at the southern end of its range, but it's expanding northward]*
- Might the same thing be happening to the Atlantis Fritillary farther north? *[Maybe]*
- Final question: What effect do you think these changes in butterfly populations might have on other species? *[For a few minutes of discussion – if they don't get there on their own, direct them to predator species, and plants that the butterflies might pollinate]*

Activity 2: Modeling Ecosystems (20+ minutes)

Context for the teacher

This is a guided discussion that will take students through the relationships between temperature and water availability that they've been exposed to during previous lessons.

Pre-class prep

Draw an empty graph with the X axis labeled as temperature ranging from 40˚C to -20˚C, and the Y axis labeled as annual precipitation ranging from 0cm to 500cm. Refer to the Whittaker diagram when laying this out. If you can easily lay out the grid shown in the Whittaker diagram, do that too, but it's not essential to the activity.

Flow of the activity

Starting with a town near the school, figure out where it would be on the graph. To do this, have its average annual temperature and precipitation to hand. Put a marker where the students tell you, and then ask what kind of ecosystem it is.
Next, have the students help you plot out Cairo and the pyramids at Giza.
From there, have the students pick out a different place from somewhere that's not near Egypt or your town, and quickly look up the info on it (most Wikipedia pages for towns or for countries will have this sort of information).
From there, go through the rest of the ecosystems by name. Have them tell you where they think the different kinds of ecosystems fall on the graph.
Once you've filled it out, put up a slide of the Whittaker diagram, and explain that it's a tool that already exists, and was put together by plant ecologist Robert Whittaker in the 1960s and 70s.
Take a few minutes to compare the model your students created with the "official" one. If you have time, pick out another location and have students find it on the diagram.

Figure 1 — Atlantis Fritillary

Figure 2 — Frosted Elfin

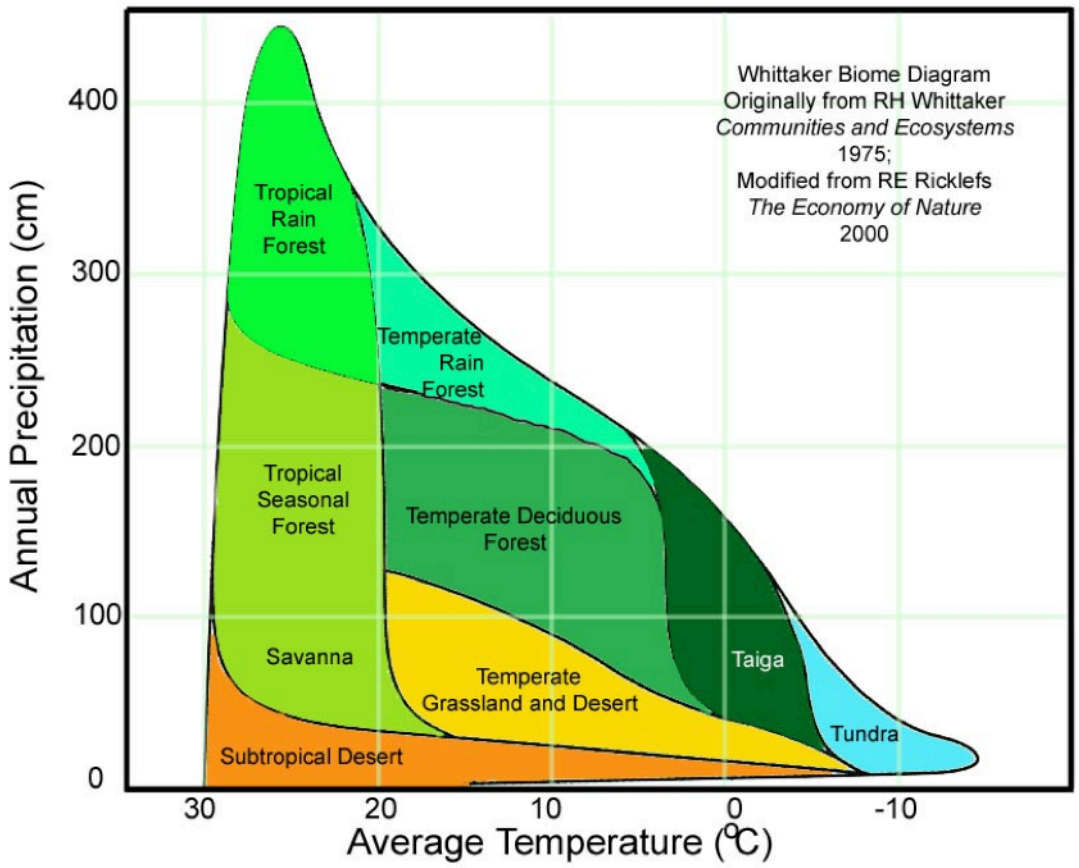
Whittaker Biome Diagram
Originally from RH Whittaker
Communities and Ecosystems
1975;
Modified from RE Ricklefs
The Economy of Nature
2000
Tropical Rain Forest
Temperate Rain Forest
Tropical Seasonal Forest
Temperate Deciduous Forest
Savanna
Temperate Grassland and Desert
Taiga
Tundra
Subtropical Desert
Annual Precipitation (cm)
400
300
200
100
0
30
20
10
0
-10
Average Temperature (°C)

Figure 3

Lesson 4 Review and Vocabulary

Context for the teacher

These are questions and terms you may find useful either for homework, for reviewing the lesson, or as part of a review of the whole unit for the students. Use them or not as you see fit.

Review Questions

- Aside from temperature, what is another part of the climate that can change and cause species to change behavior or location as a result?
- How could you investigate whether a species is going extinct, or simply moving to a new territory?
- How can ecological mismatch lead to an evolutionary response to climate change?

Vocabulary

Model: A scientific model is a representation of some phenomenon in reality. These can range from graphs and charts, to equations, to literal three-dimensional models of something. Models are often used as tools to further understanding. If, for example, a computer model of the climate can accurately show weather and climate events from the past when data about the past are fed into it, then it is reasonable to assume that it will be fairly accurate at predicting the future under specified conditions. In the case of the Whittaker Diagram, you can take data – annual precipitation and average temperature – and use it to predict what ecosystem you find in that location with reasonable accuracy.