Lesson 2: Overview

This lesson explores how climate influences the lives and life cycles of flora and fauna in New England, and how data about local species' changes in behavior might provide an indication of what's going on in the climate.

Key ideas

- **Activity 1: Signal vs. Noise; What's really going on?**

  This activity is designed to reinforce the Signal vs. Noise theme. It provides an example of a case in which the intuitive explanation of something was wrong, because it left out an important factor. This activity should help students remember to question assumptions, and look for other factors at work.

- **Activity 2: How do plants and animals experience climate?**

  This activity is designed to get students thinking about the life histories and seasonal habits of local plants and animals, and how those are influenced or governed by the regional climate.

- **Activity 3: Manomet bird data**

  This activity should give students a basic familiarity with some of the ways wildlife responds to a changing climate. It also introduces the concept of "bioindicators" – using change in the behavior of various organisms to indicate what changes are happening in the regional climate.

Materials

- Student sheets
- Projector
- Blackboard/whiteboard

Students should be prepared to take notes, either in a paper journal or on the computer. Students should bring reading materials and notes taken from the previous night's homework.

Teaching suggestions

These activities include individual work, 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.

NOTE: All three activities in this lesson bear relevance for the last activity in Lesson 5. Be sure to mention this to students, and to encourage them to hold on to their notes and materials for later reference.

Activity 1: Signal vs. Noise; What's *really* going on? [10-15 minutes]

Context for the teacher

This activity is designed to reinforce the Signal vs. Noise theme, and help students remember to question assumptions, and look for other factors at work. It describes a study showing that, contrary to general predictions for ecological change, between 1930 and 2000 a number of plant species moved *downhill* despite climatic warming. It allows students to practice thinking about how to form proposed explanations, and then examine them critically. This activity also continues the examination of the connection between rising temperatures and water availability, which relates, in turn, to the plant data students are collecting in the field. Activity 3 of Lesson 5 relates to this one, so you may want give your students a heads-up, so they'll save any notes and keep a mental tag on it.

Flow of the activity

This is a small group activity. Questions, background, and student instructions are on the student sheets.

Background

Given that the range of many species is limited by temperature, one of the expected responses to global warming is a shift towards areas with lower temperatures. Plants and animals moving north on land, or towards deeper water in the ocean. These changes have been observed in ecosystems all over the world, more or less as expected.
In California, however, 64 plant species have moved *downhill* by an average of 260 feet between 1930 and 2000.

Student Questions

- In your small groups, discuss, and then agree on a possible explanation for why those species are moving downhill. You don't have much information, so just come up with the best idea you can, as a group, based on what you know.
- Once you have your hypothesis, think about how you might go about investigating further. What sort of information would give you a clearer signal about what's going on?
- What sort of information would disprove your hypothesis?

Now, look at this graph of temperature in California over the last 50 years, and think about it as you move into a full-class discussion.
Whole-class discussion (have each group give a brief summary for each question, questions not in student material):

- What was your reasoning in forming your explanation? What factors did you consider that might explain why plant species were moving downhill? (For

example, temperature as a factor – plants like warmer weather, in general, and it gets warmer as you move downhill)

- How were you planning to investigate to see whether your explanation is correct?
- How do the data presented in this graph affect your conclusions?
- Do you have a different idea of what might be happening, in light of these new data?

Note to teacher: Once students have gone through the discussion, you can give them the actual findings:
Researchers found that as temperatures rose, evaporation increased, and water availability decreased. The plants moved downhill after water.

Activity 2: How do plants and animals experience climate?
[15 minutes]

Context for the teacher

This activity is designed to get students thinking about the life histories and seasonal habits of local plants and animals, and how those are influenced or governed by the regional climate.
A good way to do this might be to select familiar plants and animals that interact in some way. For example Red-tailed Hawks sometimes migrate south in the winter, in part because of cold, and in part because the species they eat (e.g. chipmunks) have migrated, are hibernating, or are under the snow.
Chipmunks, sometimes food for hawks, hibernate because temperatures are low, and food is scarce in the winter, and foraging for food while maintaining body temperature would require a lot of energy.
Chipmunks in turn live off of a variety of foods, including fruits, nuts, bulbs, and mushrooms, all of which are dead, frozen in the soil, or too scarce to be a reliable food source during the winter. In summary, the fact that one species is effectively absent during the winter may result in the absence of another species that relies on the first.

Flow of the activity

This is a small-group activity moving into whole-class discussion. Questions for the small-group portion will be on student sheets.
Have your students divide into groups and assign each group a local plant or an animal. Preferably, the groups will cover a fairly diverse spectrum of local wildlife. If they don't, you can suggest common species to "fill in" so that major taxonomic groups are included. Using the charts in the student materials, each group should fill out a month-by-month calendar of events for their species. This should cover the following questions.

- Is your species active or visible in this month? If not, why not? *(Possible answers - hibernation, for some mammals, amphibians, and reptiles; migration for some birds; annual die-back for some perennial plants; dead/in seed form for some annual plants)*
- If active, what behavior is your species exhibiting? *(Example answers - seeking a mate, mating, flowering, fruiting, rearing young, migrating, growing, gathering resources for mating or for winter)*
- What would happen if less water was available than your species is used to at this time? *(Reproduction might be reduced or delayed due to scarce food or water)*
- What would happen if temperature increased and precipitation did not? *(The amount of available water would decrease)*

- What would happen if precipitation increased? *(There might be an increase in reproduction/growth, but some species might suffer, if it was too much water)*

After about 5-10 minutes (depending on how long it takes for them to fill out their charts), have each group give a brief summary of what their species is, and what it's doing throughout the year.
Then, ask them to consider as a whole class what similarities or patterns they notice. Questions for this discussion might include:

- What sorts of activity do we see in the winter? *(All warm-blooded animals, on land)*
- What sorts of things are missing in the winter? *(Cold blooded animals, most plants, some birds, some mammals)*
- Is there any connection between which species are present and which are missing?
- How is this similar to or different from the difference between wildlife around here and wildlife in the tropics?

Acivity 3: Manomet Bird Data [10 minutes]

Context for the teacher

This is a group discussion activity that reviews the readings the students were assigned overnight, and explores how the ways in which different species respond to climate change may be used to indicate changes independent of temperature records.

Flow of the activity

This is a whole-class discussion.
Have the students look at the reading materials from the night before, and briefly review the first two questions as a class:

- Which species is most vulnerable to ecological mismatch, and why? *(Red-eyed Vireo, because its migration timing is less tied to weather)*

- Which species is *least* vulnerable to ecological mismatch, and why? *(Eastern Towhee, because its migration timing is more tied to weather)*

Then discuss how changes in seasonal behavior could be used to tell us about changes in climate.

- How could we use bird data or other wildlife data as "bio-indicators" of what's happening to Earth's climate? *(Changes in their behavior and population size can indicate changes in climate conditions)*

Some points to revisit in this discussion:

- Signal vs Noise — what kind of data, and what amount of data might be enough to get a clear signal? *(population size, seasonal behavior changes, changes to food sources; multi-year to multi-decade datasets)*

  For this, look at the graphs — it's pretty clear from them that any one or two years would be insufficient to get the clear picture provided by the 30-year dataset collected by Manomet's Banding Lab.

- What other species might be good bio-indicators? *(Frogs, most plant species, other species with clearly defined weather-dependent seasonal behaviors)*

- What makes them good indicators? *(They will change their behavior patterns or population sizes/locations over time in responses to changes in climate conditions)*

- What sort of questions might you ask to discover what changes may be occurring and why? *(E.g., When do frogs start calling every year? When do they stop? When do leaves come out every year? How fast are leaves growing every year?)*

- What data would you need to gather to answer those questions? *(E.g., Frog call observations, leaf-out observations, leaf measurements)*
- For the changes we discussed, what other factors might cause them? *(For example later/less frog calling might be due to a drought, not cooler temperatures; changes in bird migration patterns could be due to increased use of bird feeders; or for changes in feeding habits, an increase in temperature could simply mean certain foods are more abundant than they used to be)*

Names of students in group: **Date:**_____

_____
_____
_____
_____
_____

Species name: _____

Using this chart, write down the main things your species will be doing, month by month. As you go, think back to the activity on weather and climate, and note any ways that temperature and precipitation may influence what your species is doing.

January - *Winter*	**February - *Winter***	**March - *Spring***
April - *Spring*	**May - *Spring***	**June - *Summer***
July - *Summer*	**August - *Summer***	**September - *Autumn***
October – *Autumn*	**November - *Autumn***	**December - *Winter***

Lesson 2 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 students. Use them or not as you see fit.

Review Questions

- How much of our local ecosystem, and the lives of the species living in it, is influenced by climate? (pretty much all of it)
- What is ecological mismatch, and what sort of species does it affect?
- What can "bio-indicator" species tell us about the changes in our climate?

Vocabulary

Bioindicator: A bioindicator is a species whose behavior can give us insight into changes occurring in an ecosystem, and into what effects those changes are having. Some examples would be – migratory species that change when they migrate in response to temperature change; plants that shift their ranges in response to change in water availability.
Phenology: Phenology refers to the recurring plant and animal life cycle stages, flowering, in plants, or hibernation, in some mammals, or migration, in birds.