Joining the Climate Lab project
Five lessons = Five pieces of a puzzle

Lesson 1: Climate

Later this spring, you will be going out to a field site to take data on plant growth, as part of the Climate Lab project with the Manomet Center for Conservation Sciences and TERC (a research institution in Cambridge).

The Climate Lab is part of a world-wide effort to understand and combat human-caused global climate change, but it might not be obvious how your activities fit in. These lessons are intended to help you make the connection.

The lessons include some specific information about climate science, especially about how it can be seen in the part of the world where you live. It's just as important, though, for you understand what the big questions are, what still needs to be figured out, and how and why, citizens — like yourself — are an important part of this picture.

Activity 1: Signal vs Noise

To begin with, look at an image from "Where's Waldo?". As the class looks for Waldo for a bit, consider the following questions:

1. What is the purpose of the game?

2. What is the purpose of everything in the puzzle that is *not* Waldo?

3. What help do we have in finding Waldo?

4. Based on this picture, would you be able to predict Waldo's location in other pictures?

Activity 2: Weather vs. Climate.

When you're trying to understand something like climate change by looking at temperature and precipitation measurements over time, it's important to have as big a period of time as possible, or you'll miss things. Look at this graph.

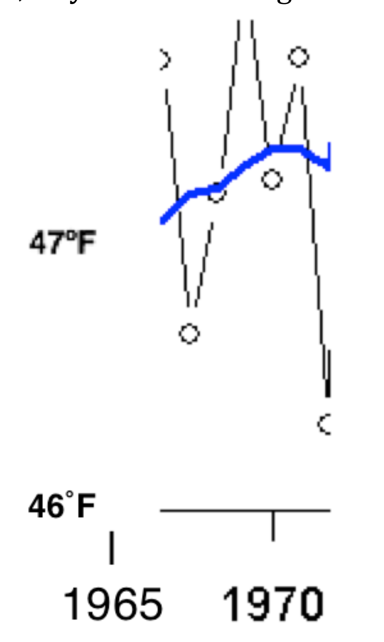


Figure 1 – Massachusetts average temperature from about 1965-1973

1. Approximately what was the average temperature in Plymouth during the time period shown?

2. If that's the average, what does it say about temperatures in different seasons?

3. Based on this graph alone, what would we expect the average temperature to be in the year 2020?

Now look at this second graph, Figure 2, which takes in many more years:

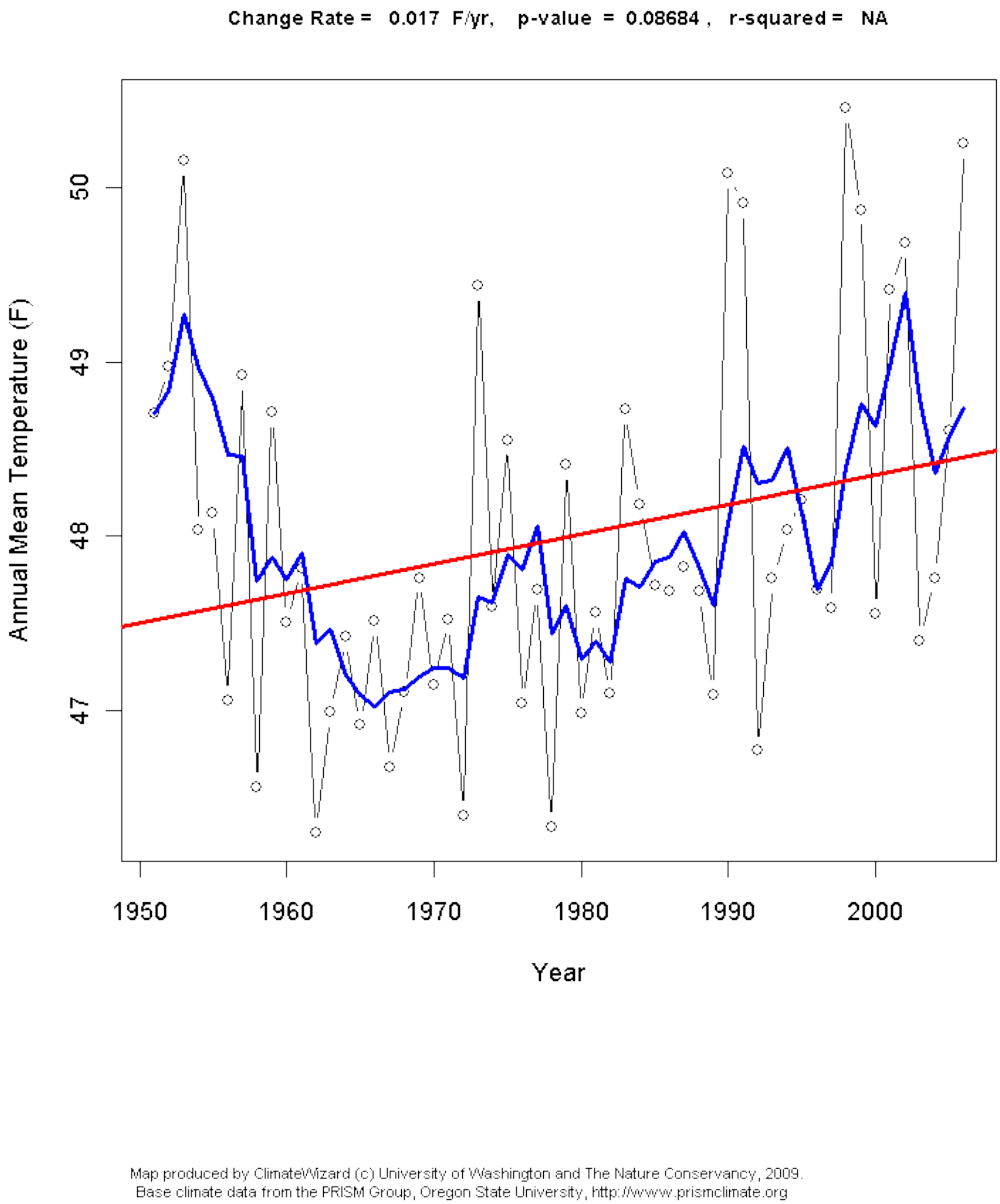


Figure 2 – Massachusetts average temperature between 1950 and 2010

4. Where does Figure 1 fit into Figure 2?

5. Now that you've seen this graph, do you have a different prediction for the average temperature for the year 2050?

6. What made you change your prediction?

7. Is this graph showing us weather data or climate data?

8. Why?

Homework: Climate and Birds [20-30 minutes]

For homework, read the following four science briefs, and as you read them, consider the following questions:

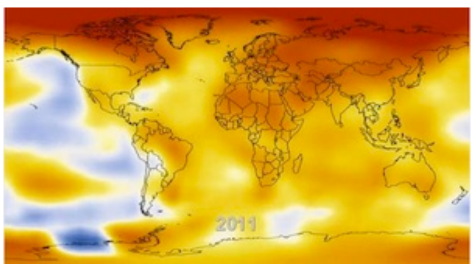
- The science brief talks about ecological mismatch, when there are changes in seasonal patterns with the result that seasonal behaviors that would normally happen at the same time, to happen at different times. One common example of this is the European Pied Flycatcher, whose migration timing has not changed as much as the climate in its summer breeding grounds. As a result, the birds are missing the springtime insect boom they rely on for feeding their young, and the young starve. Which of the two species is most vulnerable to ecological mismatch, and why?
- Which species is *least* vulnerable, and why?
- The information in these examples is presented as evidence of the effect that global warming is having on migratory birds. How could changes in seasonal behavior be used to tell us about changes in climate, even without a temperature record? How could we use bird data like this as "bio-indicators" of what is happening in Earth's climate?

Climate and the New England Biosphere: How can plants and animals respond to climate change?

Earth's climate system is changing, and New England's climate is showing the effects. The organisms of our backyards, forests, and coastlines are starting to make this very clear. What are the options for plants and animals in a fast-changing climate? How will their responses shape New England's landscape in the future?

What climate scientists are telling us

The number of Americans who accept the reality of climate change is increasing. However, many think the change will come in a few years, and will affect other parts of the world. But changes in the climate here in New England have already been seen.



For example: Since 1970, the yearly average temperature has risen about 0.54°F each decade— more than 2° so far. During the same time, the growing season has expanded by 2.5 days per decade. Ice-out, the dates when the ice cover on ponds and lakes breaks up, now comes 8-10 days earlier in New Hampshire. There have also been significant changes in precipitation.

How organisms respond to climate changes

Climate change is a constant feature of Earth's history. It is an important part of the history of life as well. Present climate change, driven by humans, is unusual because it is happening so fast. Changes of a few degrees in average temperature have happened many times. However, until now, they have happened over thousands or tens of thousands of years. The climate change we are now experiencing has happened over a few decades.

Organisms have the same 4 options they have had throughout the history of life on earth. Many of the options described below have not been recorded in New England yet. However, they have been seen elsewhere, and are likely to be happening here as well.

a. Change behavior. Plants are flowering earlier, and many bird species are arriving at their northern nesting ranges earlier. However, ecological mis-matches are happening for some species. For example plants may now be flowering before their insect pollinators start to fly, or bird nestlings hatch before the caterpillars they feed on have hatched.

b. Change range. Many bird species have expanded their breeding ranges. The breeding ranges of others have moved northward. Mountain species, such as the pika, are moving higher up their mountains to avoid the stress of rising temperatures.

c. Evolve. Some insect and bird species have evolved in response to climate change.

d. Go extinct. Climate change can lead to local extinctions. For example, if the range of a species has moved northward, populations of the species in the southern edge of the range can go extinct.

Open questions

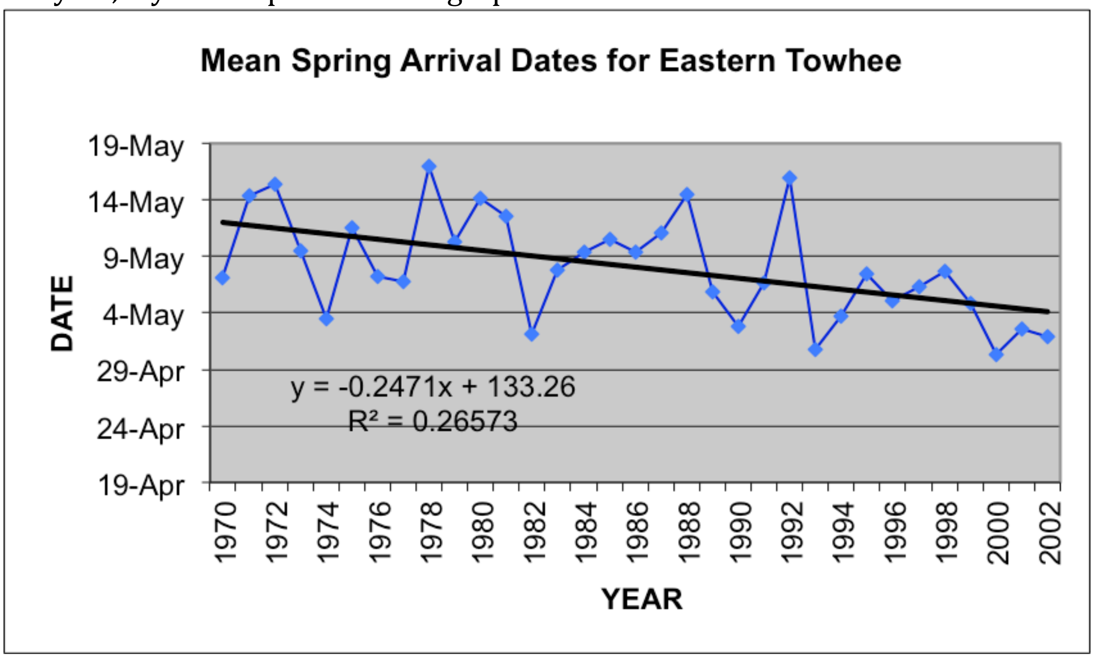
The climate of New England is changing. Climate scientists can predict what our temperatures and precipitation may be like in 10, 20, 75 years. It is harder to predict how the plants and animals will respond. What the changes will mean for the quality of life for New England's people is not at all clear, either. However, we can all contribute to a better understanding by paying attention to the landscape we live on, and the organisms that share it with us. In other readings, we'll provide up-to-date science behind the changes that you are tracking in your own area.

Eastern Towhee (Pipilo erythropthalmus)

The Eastern Towhee lives in the United States. In some areas in the Southeast, the towhee lives in the same place all year. Others live in the Northeast during summer, migrate to the southern states for the winter, and come back north in the spring.

Towhees eat a variety of things like seeds or insects. They will even eat small salamanders or snakes, if given the chance.

Their lives and migration patterns are strongly affected by seasonal changes in daylight and temperature. Because of this, we expect them to show the biggest changes of the two bird species you are reading about. They do, if you compare the two graphs:



Compared to the species described next, they migrate a relatively small distance. This could be a good thing for this species. It would enable them to change the timing of their migration from year-to-year. This would allow them to benefit from the "boom" in food that happens every spring when spring arrives earlier. In fact, the change in migration time suggests that the Eastern Towhee is already adapting to climate change by adjusting its migration time.

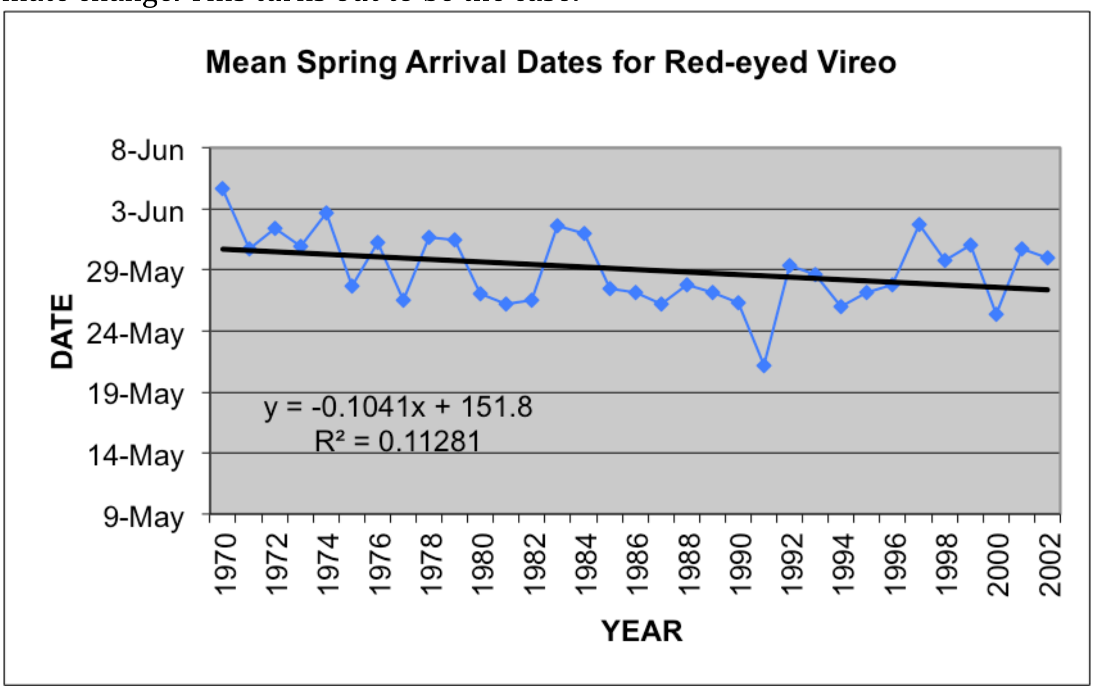
Red-Eyed Vireo (*Vireo olivaceus*)

Photograph by William H. Majoros

The Red-eyed Vireo spends its winter in South America's tropical forests. Like the Towhee, they migrate north into the United States and Canada to feed on the explosion of life that occurs in spring.

The abundance of caterpillars and other insects provides them with enough food for breeding and for raising their young.

Because tropical day length and temperatures are always more or less the same, they rely on an internal clock to tell when it is time to migrate. Birds that winter in the tropics try to fly towards the north in the spring even when in closed rooms where they cannot tell what's happening outside! Since they rely on an internal, we would expect them to show the least response of our two species to climate change. This turns out to be the case:



You can see that they *are* arriving earlier in the year as time goes by. However, the change is not as large as it is in the species that winter in North America. One possible explanation for this is that any individuals in the population that happen to arrive earlier might be more successful at reproduction. As a result, their young are beginning to make up a larger portion of the population.