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Harvard LTER Schoolyard Program

Teacher Developed Lessons and Documents that integrate Harvard Forest Schoolyard Ecology Themes into curriculum.

- Lesson Title:

Phenocam Lesson 2: Comparing Local Green Up and Brown Down to Boston Common- Is There Really an "Urban Heat Island" Effect?

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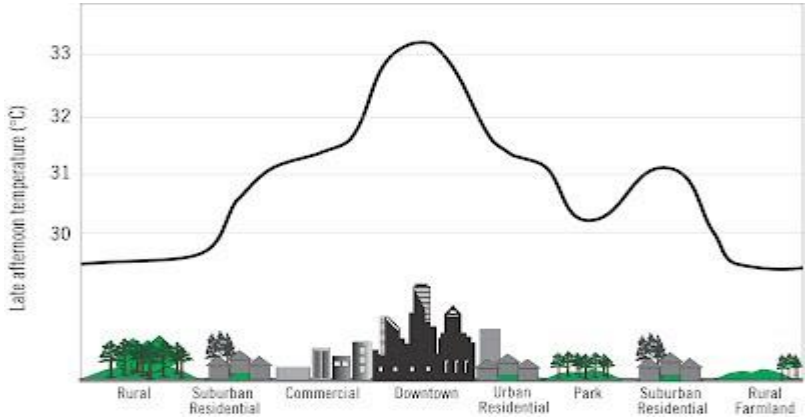
- School: J.R. Briggs Elementary School, Ashburnham
- Level: Grade 5
- Date: August, 2012

Using the Phenocam images with the Harvard Forest Schoolyard Ecology Program protocol- *Buds, Leaves, and Global Warming*

Students will compare images from the Ashburnham Phenocam to the same dates from the Boston Common Phenocam to determine if the dates of the color change and leaf drop and budburst in the Spring are the same or different from Boston Common and discuss if any differences might be the result of the urban heat island effect.

What is the "Urban Heat Island" and how might it affect phenology?



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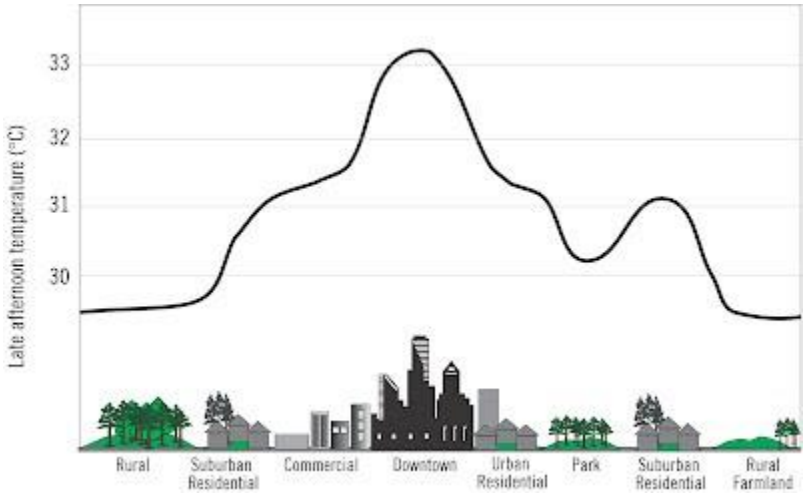
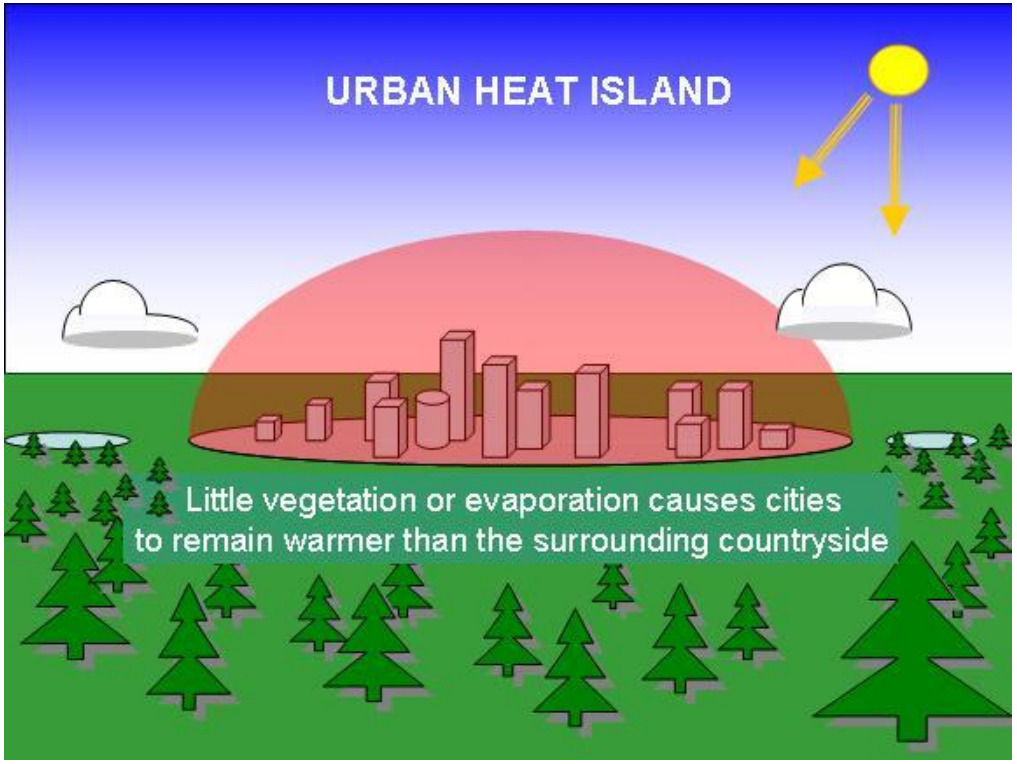


What Is an Urban Heat Island?

As urban areas develop, changes occur in their landscape. Buildings, roads, and other infrastructure replace open land and vegetation. Surfaces that were once permeable and moist become impermeable and dry.[1] These changes cause urban regions to become warmer than their rural surroundings, forming an "island" of higher temperatures in the landscape.

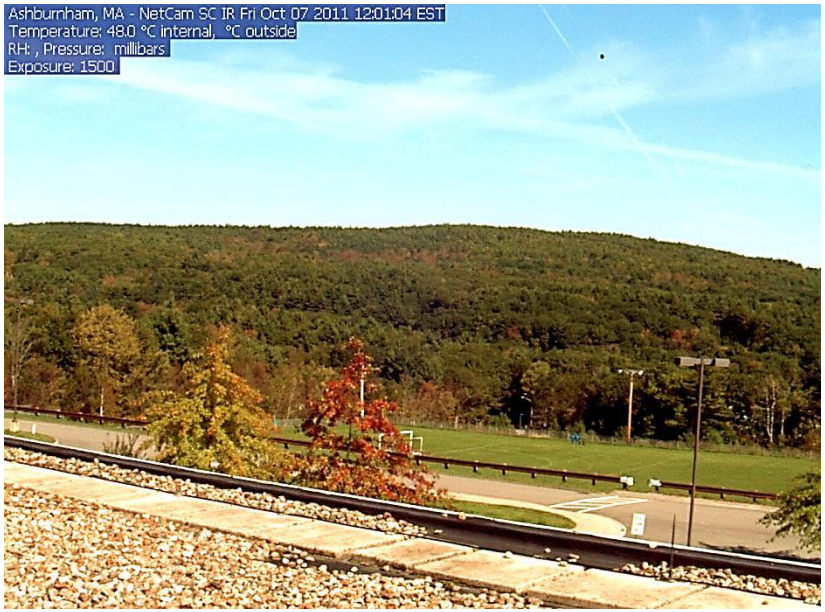
Heat islands occur on the surface and in the atmosphere. On a hot, sunny summer day, the sun can heat dry, exposed urban surfaces, such as roofs and pavement, to temperatures 50–90°F (27–50°C) hotter than the air,[2] while shaded or moist surfaces—often in more rural surroundings—remain close to air temperatures. The annual mean air temperature of a city with 1 million people or more can be 1.8–5.4°F (1–3°C) warmer than its surroundings.[3] On a clear, calm night, however, the temperature difference can be as much as 22°F (12°C).[3]

Heat islands can affect communities by increasing summertime peak energy demand, air conditioning costs, air pollution and greenhouse gas emissions, heat-related illness and mortality, and water quality.
Can they also affect color change and leaf drop in the fall and budburst in the spring?



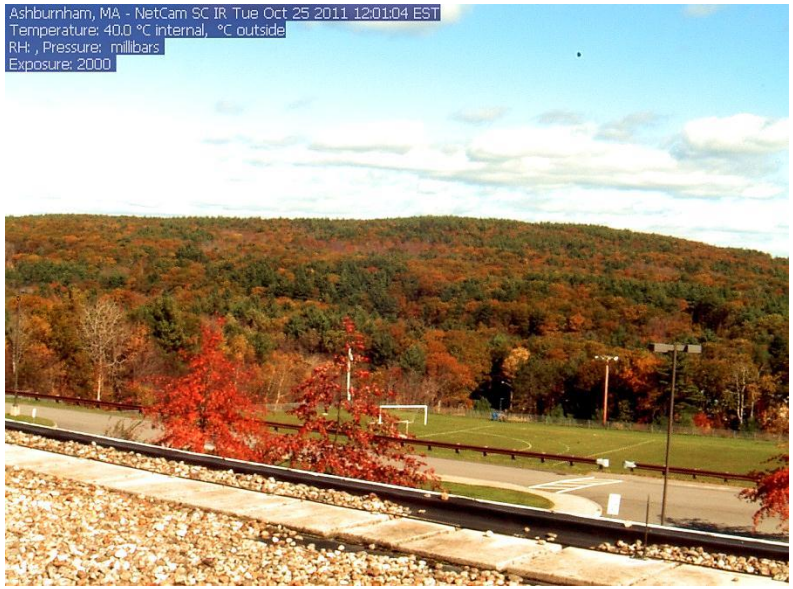
urbanheatislands.com

Ashburnham vs. Boston Common- are there similar pheno dates?
Compare the pictures taken by phenocams on the same dates.
Let's start with the fall. These images were taken on the same day- October 7, 2011



Overlook Middle School Ashburnham **Boston Common**

Estimate- What percent of the leaves have changed in Ashburnham?
Boston Common?



October 25, 2011

Estimate- What percent of the leaves have changed in Ashburnham?
Boston Common?
How long do you think it will take for Boston Common to "catch up" with Ashburnham?





October 7 **October17** **October25** **November 7** **November 19**





October 9 **October25** **November 8** **November 16** **November 24**

Look at the two sets of images carefully. Which is the *first* date that it appears that *most* of the leaves have either changed color or fallen off? What is the difference between the dates?

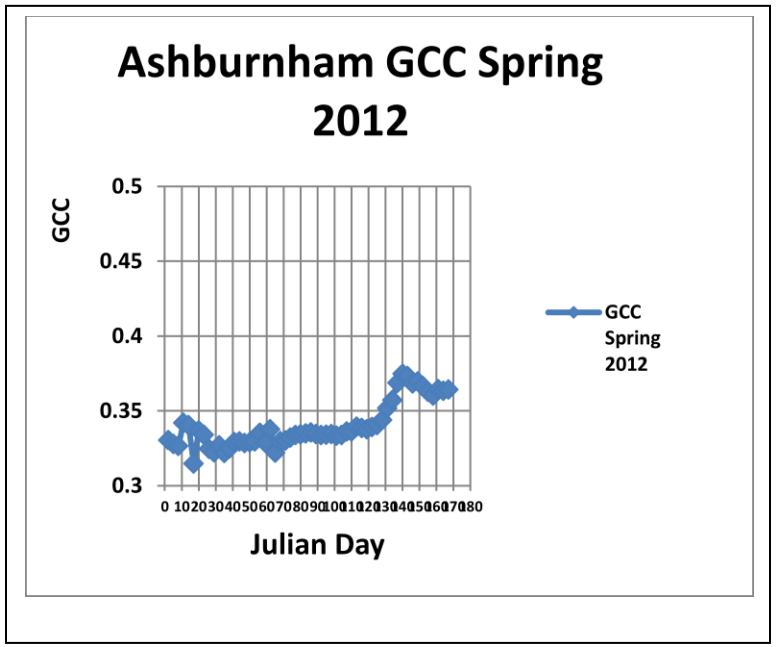
Hint- Our schoolyard tree data showed that *most* of our leaves had reached 100% color change by November 1st!

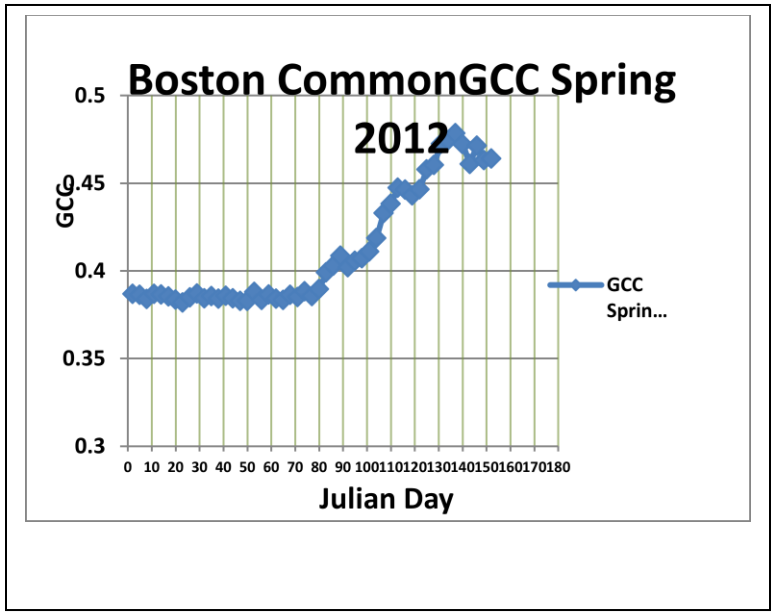
What about budburst in the spring?

Now look at the two sets of images carefully. Which is the *first* date that it appears that *most* of the leaves have come out? What is the difference between the dates?

Hint- Our schoolyard tree data showed that *most* of our leaves were out by May 7st!

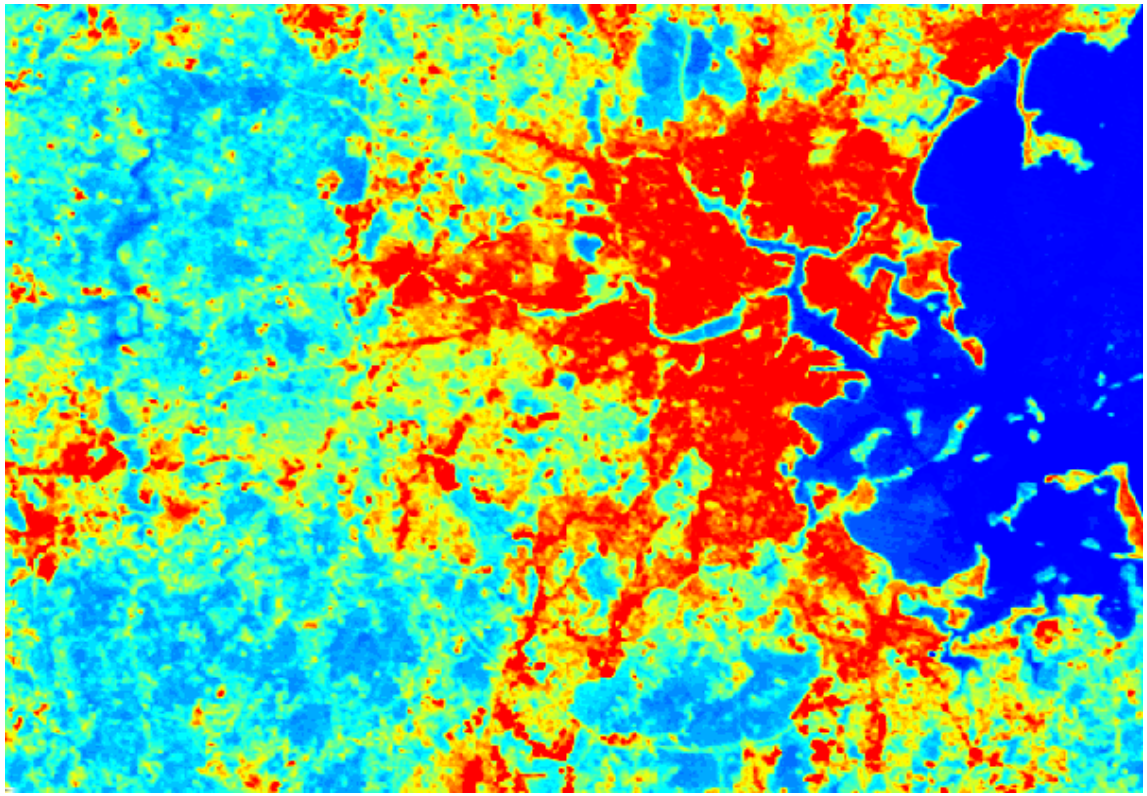
Computer programs can analyze the green color in the actual pixels in each image. The program determines the green chromatic coordinate or **GCC**. This will give you the date there is the most green in the image.





Compare the two graphs. What day does “green up” seem to begin?
What day does the green reach its peak?
At which site does budburst happen earlier?
What other differences can you see between these two graphs?

Boston- a day in 2oo9
Thermal infrared image
urbanheatislands.com



Data has shown that warmer temperatures caused by the urban heat island effect can cause earlier budburst in the spring and later color change and drop off in the fall.
Can you think of any other factors which might have an effect on the dates of phenological events in these two areas?

Hint:

Site Name: ashburnham

Location: Ashburnham State Forest

Lat: 42.6029

Lon: -71.9260

Elev(m): 292

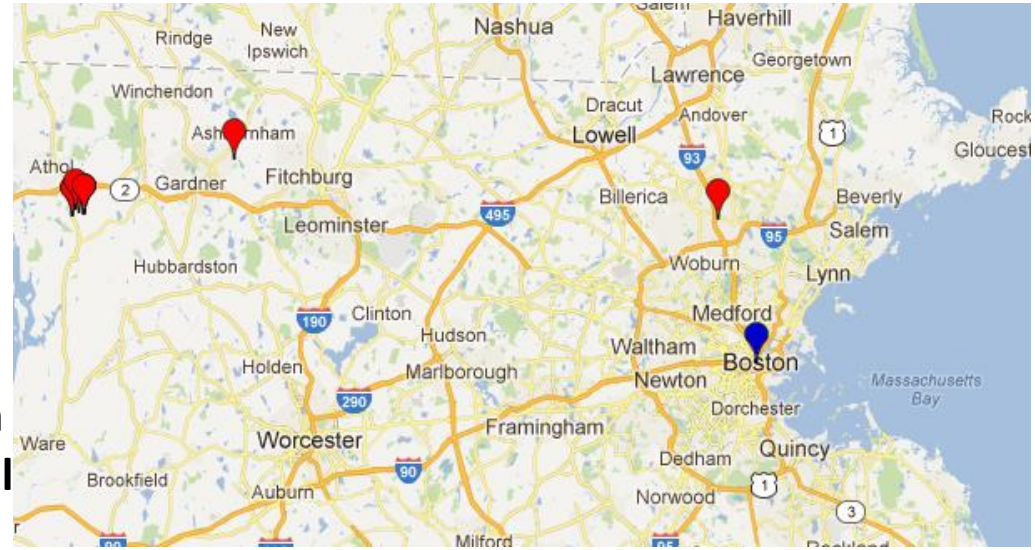
Site Name: bostoncommon

Location: Boston Common

Lat: 42.3559

Lon: -71.0641

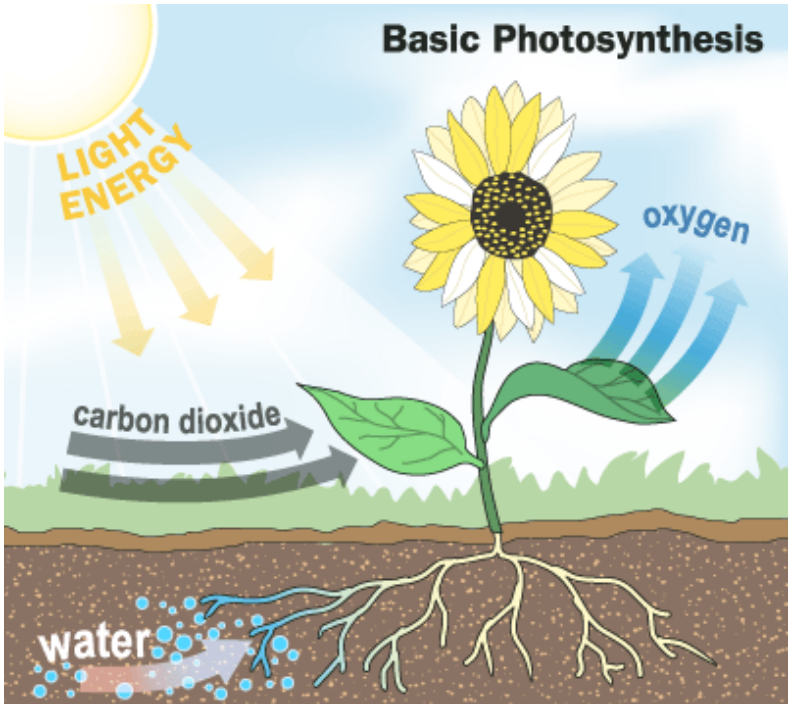
Elev(m): 10



Even if these differences have an phenodates, could they be compl the differences in the dates?

Could the differences result from of a *combination* of factors?

We know that the increased temperatures from the urban heat island effect can cause pollution and heat related illnesses, but can the change in phenological event dates cause other types of changes to the environment?



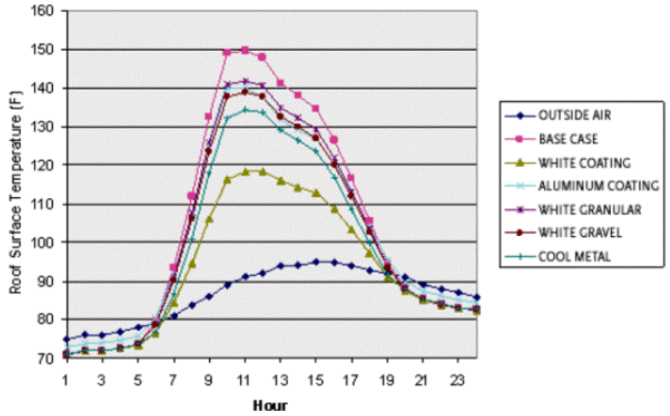
Hint: Think *photosynthesis*!

What can we do about it??

What cities are doing to address the problem -

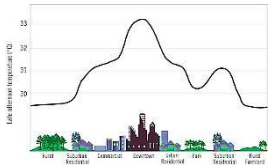
Perennial Raingarden

Roof gardens and increased green space make a big difference.



Using a white coating on rooftops reflects solar energy which helps keep the whole building cooler.

Name_____ Date_____



What is the Urban Heat Island Effect and what problems can it cause?

_____

_____

How many days earlier/later did the leaves reach their peak color at Boston Common? _____

How many days earlier/later did the leaves come out at Boston Common?_____

Do you think the urban heat island effect is responsible for the differences in phenodates between Ashburnham and Boston Common? Explain_____

_____

What other factors could affect these differences? _____

_____

What possible changes to the environment could these phenological shifts cause?

_____

_____

On the back list some ideas **you** have that would help with the problem of urban heat islands.