



Taking Phenology Education to the Next Level!

Leveraging Phenocam Resources for Schools

Featuring the work of Schoolyard Teacher, Katherine Bennett, in collaboration with PhenoCam, NEON, and Project Budburst

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Harvard Forest Schoolyard Ecology

Project BudBurstSM

Timing is Everything!

Engaging students,
Encouraging inquiry,
With Project BudBurst

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Welcome to Phenology 101 for Educators

The Phenology 101 for Educators educational materials are divided into three units, each with a background guide, hands-on activities, and videos.

The materials are all in draft form. Please share any feedback, including suggestions, with us at budburstinfo@neoninc.org that can be used to improve the final version.

Unit 1: What is Phenology?

[Introduction to Phenology PDF](#)

[Intro Trailer Movie](#) - Activity

[PBB Single Report](#) - Activity

[PBB The Stories Plants Tell](#) - YouTube Movie

[PBB Changing Climates](#) - YouTube Movie

Unit 2: How can we (scientists and citizens) monitor phenology remotely?

[Monitoring Phenology PDF](#)

[PhenoCam Location](#) - Activity

[Annotate SeasonSpotter Images](#) - Activity

[Measuring Plant Phenology from Ground to Space](#) - YouTube Movie

[Mapping the Invisible: Introduction to Spectral Remote Sensing](#) - YouTube Movie

[Season Spotter Tutorial: Marking Polygon Features](#) - YouTube Movie

[Season Spotter Tutorial: Editing Polygon Features](#) - YouTube Movie



Long time Harvard Forest Schoolyard Ecology teacher, Kate Bennett, contributed to some of the Project BudBurst's web resources available at:

<http://budburst.org/pheno-logy-101>

Introduction to Phenology Activity

Create a Phenology Movie Trailer

Introduction

Phenology "Trailers" are an exciting way to introduce the science of phenology and the Phenocam network. Students can use the fun and super easy iMovie app on an iPad to create professional looking movie trailers to present an introduction to phenology or to explain a particular phenophase. Videos can be saved and projected on an interactive white board or uploaded to Vimeo or other video sharing websites.

Estimated Time:
1 - 2 hours

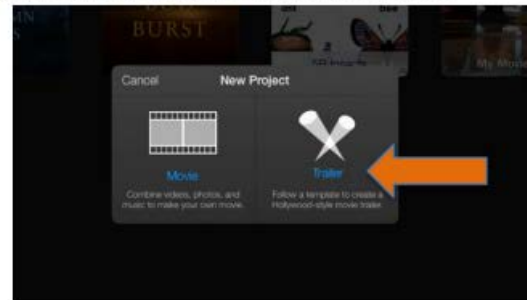
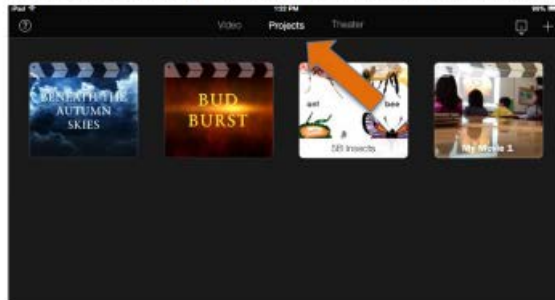
Materials: Internet connectivity, an Internet browser (e.g., Google Chrome, Mozilla Firefox, etc.), ability to print from the Internet, writing utensils

Activity Instructions

Task 1: Setup your movie trailer

Get started! Remember, a trailer is like an advertisement for a movie. It is short- but powerful.

1. Open iMovie and go to Projects. Touch the plus sign. You will have a choice of a movie or trailer. Choose Trailer.



Kate has developed lesson plans and educational activities to engage K-12 students in the science of phenology as part of Harvard Researcher, Andrew Richardson's, Phenology research and outreach over the past several years.

This educational resource work has been funded by grants from agencies including National Oceanic and Atmospheric Administration (NOAA) and the National Ecological Observatory Network (NEON).

Phenocam Connections



Monitoring Phenology Activity

Exploring the PhenoCam Locations

Introduction

In this activity students become familiar with the PhenoCam website and the network by comparing the images from diverse PhenoCam locations. They will locate and explore the PhenoCam gallery, map, and site table.

Estimated Time:

One 60-90 minute class period

Suggested Grade Level:

Grades 5-9

Materials: Access to computers and the internet for research, PhenoCam Student Recording Sheet (one per student)

Preparation: Make photocopies of the PhenoCam Site Table Recording Sheet (on page 4), prep for PhenoCam online access - copy link onto school website

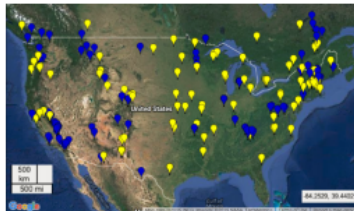
Learning Outcomes

Students will be able to:

- Navigate the PhenoCam website and complete a chart recording latitude, longitude, elevation, terrain, urban-rural suburban classification, water features, and vegetation of eight diverse PhenoCam sites.
- Answer open-ended questions concerning the effects of climate change on plant phenology and ecosystem functions.

Background Information

PhenoCam (phenocam.unh.edu) is a network of digital cameras that are used to record vegetation phenology, in terms of seasonal changes in the greenness of the canopy. Cameras record digital images hourly over the course of a year at all the PhenoCam locations. The images are computer analyzed for color and generate a numerical value of canopy greenness which is then a part of a timeseries graph. Scientists can then identify major phenophases such as budburst from these graphs. The core sites include images of forest canopy, shrubs, grasslands, and cropland. There are urban, suburban, and rural sites.



Left: Map of PhenoCam locations around North America. Yellow pins represent core sites. Blue pins show affiliated sites.

Looking for more information on PhenoCam?

Check out the website: phenocam.unh.edu



Introduction to Phenology Data

Downloading PhenoCam Images

Introduction

In this tutorial, you will learn how to download images from any site in the PhenoCam Network and get activity ideas for using the images with your students. Students can use the images to make time lapse series and analyze changes in phenology over time or use them to make Phenomovies. With more than 80 cameras at different sites uploading half-hourly imagery to the PhenoCam server, there are many photos to choose from!

Estimated Time:

15-30 minutes

Materials:

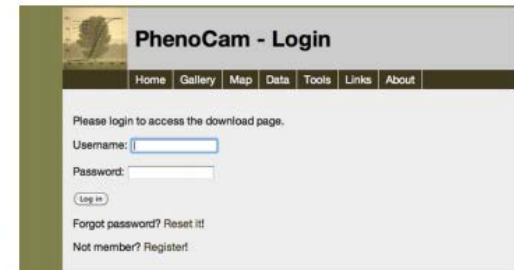
Internet connectivity, an Internet browser (e.g., Google Chrome, Mozilla Firefox, etc.)



Activity Instructions

Create an Account

1. **Go to the PhenoCam website.** Click on the data tab. It will bring you to this page (see image below). Before you can download data you have to set up an account. It's easy and free - then you can log in.



What to learn more about PhenoCam Photos and Data?

Check out the other Unit 3: Introduction to Phenology Data materials

Harvard Forest and JR Briggs Featured Here

Downloading PhenoCam Photos



Activity Ideas

PhenoCam Image Activities

1. Make PhenoMovie Trailers (*Phenology 101 Unit 1 Activity* - <http://budburst.org/phenology-101>)



2. Use PhenoCam images to compare the timing of major phenological events in different latitudes, elevations, or climates.

| Site Name | Latitude |
|------------------|----------|
| shenandoah | 38.5926 |
| national capital | 38.8882 |
| usgsreston | 38.9471 |
| woodshole | 41.5495 |
| caryinstitute | 41.7839 |
| northattleboroma | 41.9837 |
| springfieldma | 42.1352 |
| harvard | 42.5378 |
| ashburnham | 42.6029 |
| hubbardbrook | 43.9439 |
| arbutuslake | 43.9821 |
| bartlett | 44.0646 |
| queens | 44.565 |



Downloading PhenoCam Photos



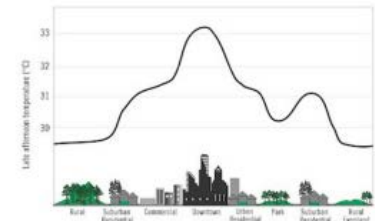
PhenoCam Image Activity Ideas (cont.)

3. Compare rural and urban sites to look at the urban heat island effect. For example, you could have students compare the images from Ashburnham, MA to those from Boston Common.



Background Information: Urban Heat Island

As developed areas expand, the amount of heat retained also grows. In turn the amount of air that is warmed, expands. This process is sometimes referred to as the "Urban Heat Island Effect". This compounding warming effect in turn triggers variability in phenophase timing. A red maple (*Acer rubrum*) in a developed area, may experience initial stages of the leaves unfolding sooner than a red maple in an undeveloped area. On a smaller spatial scale, a red maple next to an asphalt road, may also flush sooner than a red maple that is close to the interior of a forest, or to a stream filled with cool running water.





PhenoCam Image Activity Ideas (cont.)

4. For younger learners: Look at the seasons or even the weather on particular dates, such as holidays or on their birthdays, at various locations. For example, you might compare how a PhenoCam near you looks versus a PhenoCam near a relative's home.

Ashburnham, Massachusetts throughout the year

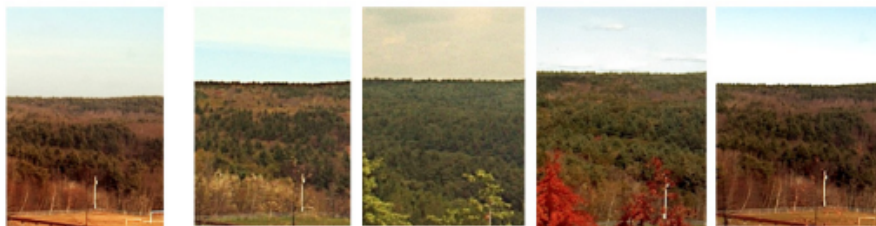
January 5

April 24

July 16

October 17

November 28



Wrap-up

Summary and Next Steps

By downloading images from the PhenoCam website, your learners will have access to phenology data from across the United States. The activities described above are intended to spark ideas for using PhenoCam images with your learners and by no means are an exhaustive list!

What's next?

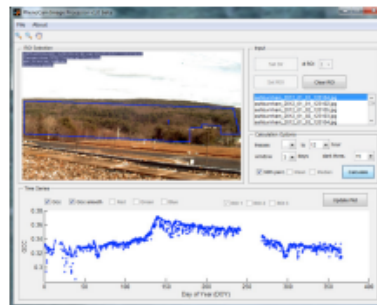
If your learners are comfortable working with PhenoCam images, you might consider introducing them to Green Chromatic Coordinate or GCC data (see image to the right). GCC values are the levels of red, blue, and green in an image added together then divided by the green level. This number can tell you when bud burst happened and when the leaves turn color in the fall. The following resources will help you get started with GCC data:

Phenology 101 - Unit 3

Introduction to Phenology Data - Background Guide

PhenoCam Data Matching - Activity

Graphing PhenoCam Data - Activity



More Phenology Resources:

Only a small sample of these educational resources are featured here.

For more Project Budburst resources, go to:

<http://budburst.org/phenology-101>

For the PhenoCam website, go to:

<http://phenocam.sr.unh.edu/webcam/>

For phenology lesson plans from Kate Bennett, go to :

- Bennett. 2011. Phenology and student scientists: [part I](#) and [part II](#).

- Bennett. 2012. [Phenology and student scientists \(5th grade\)](#).

For more on Harvard Forest's Phenology project, go to:

harvard.edu/buds-leaves-global-warming