

Recognizing Patterns in Biology

Phenology is the study of the timing of the biological events in plants and animals, such as flowering, leafing, hibernation, reproduction and migration. There are patterns to the timings of these events.

To observe these behaviors and patterns, scientists use large datasets over long periods of time and look for trends. Some of these data come from websites which work with “citizen science.” Many people, for example, go bird-watching and keep track of the birds they see. Cornell University maintains a website, ebird.org, where people can upload the data they collect on bird sightings and then others can see the data and use them in different studies.

You will create your own dataset and follow the life of a deciduous tree over the school year, starting with summer. Think of it as a phenology journal. Choose a deciduous tree in the area that you can observe over the course of the year; a tree in your yard or nearby, even a tree on school property. The tree should be mature, not a sapling.

You need to record the dimensions of your tree. Measure the circumference and determine the diameter of the trunk. Using your geometry skills, calculate the height of the tree and estimate the volume of the tree where there are leaves. Over the year, there will be changes to the tree and you need to record those in your data set, making at least 1 observation every two weeks.

Make a data table to record the date of your observation, the leaf color, and the percentage of leaves that change, the percentage of leaves that dropped, the percentage of fruit that dropped and anything else you want to note. You need to make these observations of your tree on **6 different dates**, preferably spread out over the course of the summer, or at least over the course of a few weeks. You may not do 6 observations over 6 days in a row.

The phenology journal should have a **first page that includes** a picture or drawing of your tree, the address where your tree is located, the diameter of the trunk, a description of the distribution of the leaves and the volume of the leaves on the branches. Project Budburst, <http://budburst.org/> may be a helpful resource in directing what you need to consider when studying a tree. In addition on a **second page**, make other detailed observations about your tree: the characteristics of the leaf, including a picture or drawing of a leaf, a description of the bark, its flowers and its fruit. The fruit is the structure that contains the seeds and is not edible, necessarily. On **the third page**, write a few paragraphs describing the habitat and the niche for your tree. In other words, describe the kind of environment where your tree is found, what animals use the tree for shelter or food and what diseases would harm or kill the tree and the causes of those diseases.

There are many studies that show the Earth's climate is changing. The increasing global temperature is only one part of the observed global climate change. Precipitation patterns are also changing; storms and other extremes are changing as well, along with glacier melting and the changes in the levels of the oceans. (<https://www.ncdc.noaa.gov/indicators/>) Evidence that indicates a changing climate comes from different sources. We are focusing on organism behavior and those factors that affect organisms.

On the first day, you should hand in a hard copy of the first 3 pages of your journal as describe above and your data table.

Read this short summary of phenology. Be ready to discuss the effect of climate change on phenology.

Documented results of climate change: past and present

Scientists have geological evidence of the consequences of long-ago climate change. Modern-day phenomena, such as retreating glaciers and melting polar ice, cause a continual rise in sea level. Changes in climate can negatively affect organisms.

Geological climate change effects

Global warming has been associated with at least one planet-wide extinction event during the geological past. The Permian extinction event occurred about 251 million years ago toward the end of the roughly 50-million-year-long

geological time span known as the Permian period. This geologic time period was one of the three warmest periods in earth's geologic history. Scientists estimate that approximately 70 percent of the terrestrial plant and animal species and 84 percent of marine species became extinct, vanishing forever near the end of the Permian period. Organisms that had adapted to wet and warm climatic conditions, such as annual rainfall of 300–400 cm (118–157 in) and 20 °C–30 °C (68 °F–86 °F) in the tropical wet forest, may not have been able to survive the Permian climate change.

Present climate change effects

A number of global events have occurred that may be attributed to recent climate change during our lifetimes. Glacier National Park in Montana, among others, is undergoing the retreat of many of its glaciers, a phenomenon known as glacier recession. In 1850, the area contained approximately 150 glaciers. By 2010, however, the park contained only about 24 glaciers greater than 25 acres in size. One of these glaciers is the Grinnell Glacier at Mount Gould . Between 1966 and 2005, the size of Grinnell Glacier shrank by 40 percent.

Similarly, the mass of the ice sheets in Greenland and the Antarctic is decreasing: Greenland lost 150–250 km³ of ice per year between 2002 and 2006. In addition, the size and thickness of the Arctic sea ice is decreasing.



Glacial recession

The effect of global warming can be seen in the continuing retreat of Grinnel Glacier. The loss of a glacier results in the loss of summer meltwaters, sharply reducing seasonal water supplies and severely affecting local ecosystems.

This loss of ice is leading to rises in the global sea level. On average, the sea is rising at a rate of 1.8 mm per year. However, between 1993 and 2010, the rate of sea-level increase ranged between 2.9 and 3.4 mm per year. A variety of factors affect the volume of water in the ocean, including the temperature of

the water (the density of water is related to its temperature) and the amount of water found in rivers, lakes, glaciers, polar ice caps, and sea ice. As glaciers and polar ice caps melt, there is a significant contribution of liquid water that was previously frozen.

In addition to some abiotic conditions changing in response to climate change, many organisms are also being affected by the changes in temperature.

Temperature and precipitation play key roles in determining the geographic distribution and phenology of plants and animals. Phenology is the study of the effects of climatic conditions on the timing of periodic life cycle events, such as flowering in plants or migration in birds. Researchers have shown that 385 plant species in Great Britain are flowering 4.5 days sooner than was recorded during the previous 40 years. In addition, insect-pollinated species were more likely to flower earlier than wind-pollinated species. The impact of changes in flowering date would be mitigated if the insect pollinators emerged earlier. This mismatched timing of plants and pollinators could result in injurious ecosystem effects because, for continued survival, insect-pollinated plants must flower when their pollinators are present.