

Broader context

Phenology is a wonderful vehicle for instigating inquiry-based learning, boosting scientific literacy, and incorporating students into the citizen-scientist community. Practicing phenology offers students the opportunity to participate in broader networks of students and volunteer scientists whose observations help to address important and timely scientific questions. So far, long-term data sets such as those from Aldo Leopold and Henry David Thoreau have shown that life cycles of many species are on different schedules now than in the past, likely due to warmer temperatures and altered length of seasons. In general, spring arrives earlier and autumn lingers later than in the past. Data on phenology can help us to better understand what these changes mean for organisms and their relationships with one another (i.e. whether 'mismatches' may occur between the schedules of two species, like a pollinator and flower, whose survival depends on being in sync with each other).

Anticipated student outcomes from participating in Project BudBurst

Studies of phenology may be designed to meet a number of the American Association for the Advancement of Science's Benchmarks for Science Literacy, including (but not limited to) the following goals. By tracking the timing of leafing and floral bud emergence in their schoolyards and gardens, students will:

- Be able to identify several tree or flower species in their area, and observe the sequence of budding in those species relative to each other (e.g. spring ephemeral flowers on the forest floor bloom before the trees leaf out and block the sun) (**Benchmark: Systems**)
- Learn to observe budding phenology and understand how the budding stage fits into a plant's life cycle (**Benchmark: Constancy & Change**)
- Understand the relationship between weather and phenology (**Benchmark: The Interdependence of Life**)
- Learn to enter data into Web-based databases and compare their observations with those of students in other regions (**Benchmarks: The Nature of Science & The Diversity of Life**)
- Learn to interpret their data and convey results in graphics and/or in writing (**The Nature of Science**)

Furthermore, these studies help students to develop an affective appreciation of nature and awareness of their local ecosystems. Co-curricular activities which may be aligned with tracking budburst include writing and drawing exercises in conjunction with keeping a 'nature journal,' mapping and reading about historical uses of plants in social studies (e.g. *Little House on the Prairie* for Midwestern students), and making graphs or conducting statistics (for high school students).

Grade level: Studies of budburst can be adapted for any grade level; for example, older students may identify species on their own using field guides, while younger students may be guided to observe a particular species identified by an adult.

Timeline: Ideally, students would observe trees and flowers at least twice per week in the two weeks or so prior to buds bursting, and then make daily observations once leafing begins. The timing will vary, of course, by region; consult the Project BudBurst species descriptions or your own local gardening clubs and herbaria to get a better idea of when to expect budburst to occur in your area.

Tips for success:

- As teachers of younger students know, it may be difficult at first for students to focus on academics while outside. If time allows, plan a brief visit to your ‘outdoor classroom’ prior to data collection to allow time for students to learn to be still and quiet.
- You may find it useful to do some brief scouting of your outdoor classroom to see which species are present. You may wish to use the Project BudBurst species descriptions, and/or field guides specific to your area, to home in on species you’re likely to find there. For example, Stan Tekiela writes user-friendly field guides to trees of each U.S. state.

Steps to Monitoring BudBurst:

- You may wish to use the ‘Student Data Sheet’ on the Project BudBurst Website for your students to record their observations, especially for younger students; teachers and older students may use the more structured ‘BudBurst Data Sheet.’
- Any data will be useful, but having precise estimates of weather data along with your phenological observations will enhance the data and help students to make the connection between weather and timing of budburst. If you have instruments like thermometers and rain gauges, please do use them! Or, you may ask students to take turns recording weather data from newspapers or Web sites (the state climatology offices are good sources of information—you can probably find yours via a Web search).
- Proper species identification is important—please try to check your students’ data and/or assist them with identifying species. If you live near a university or botanical garden, it may be fun for everyone to invite a graduate student or gardener to train students and point out species.
- Students may enter their observations at the Project BudBurst website: www.budburst.org

Post-monitoring wrap-up:

After data are collected, you may wish to highlight the meaning of the students’ work by:

- Having students graph trends in temperature and in budburst by date, to make note of relationships between weather and phenology
- Compare budburst of species with each other, e.g. a tree versus a flower, to notice timing of events among species
- Compare budburst in your area with other areas to show differences among climate zones (e.g. budburst is later in more northerly latitudes and at higher elevations)