Harvard Forest Schoolyard
Water in the Landscape: Vernal Pools

Project Overview

Pamela Snow and Dr. Betsy Colburn

2005 Revision Committee: Susan Wright, Ivan Ussach, Barbara Walker
2009 Revised by Betsy Colburn and Pamela Snow
2015 Revised by P. Snow

I. Schoolyard Study Questions:

A. Big Ideas- Questions for Long Term Study: *"How do water levels in vernal pools vary over time, and how do those water level variations change between years and with differences in weather? How might such variations affect plants and animals that live in vernal pools?"*

B. Concrete Concepts: "*How do water levels of our vernal pool change seasonally this year?*"

II. Study Summary: Vernal pools are very common in New England woodlands, and they are critical freshwater habitats for many kinds of animals that don't live in permanent ponds and lakes, or in streams. We know that the timing of when pools fill with water and dry up affects the kinds of animals found in the pools and whether the animals can complete their life cycles successfully in a given year. Surprisingly, though, we do not know very much about how water levels in individual vernal pools vary over time, either within a given year or between years. Schoolyard studies of vernal pools from fall to spring, and from one year to the next, can help students learn about how water levels vary with natural cycles of weather and the seasons, and how animals' life cycles are tied to water levels in the pools.

III. Field Time:

A. **Minimum** number of data collection field visits: 4 field sessions total.

1. **September** prior to leaf drop.
2. Late **November** after leaf drop.
3. Late **March or early April**, after snowmelt
4. Once in **June** before the end of the school-year.

B. **Recommended** frequency of data collection: Ideally students will be able to go out more frequently than the minimum number of times listed above. The more data students collect, the more complete the picture of seasonal changes will be. Going out once a week would be very effective in tracking short term changes in water levels after weather events such as rain storms, as well as tracking the longer term seasonal changes.

IV. Related Research at Harvard Forest:

Aquatic ecologist, Dr. Betsy Colburn, has researched and written about vernal pool biodiversity in relation to hydrology and other environmental variables. Dr. Colburn's past work has looked at the animals and plants in a series of pools with a range of water depths and flooding durations. Dr. Colburn has also studied vernal pools in a wide variety of woodlands across Massachusetts. This research has looked at how factors such as geology, forest ecology, and land-use history influence the animals that occur in pools in different areas.

V. Project Objectives:

A. Students will learn how to do **field research** by participating in a program associated with the **Harvard Forest Long Term Ecological Research Site**.

B. Teacher and students will **collect vernal pool field data** yearly.

C. Students will **monitor seasonal water level changes** in the Vernal Pool.

D. Sharing of information among schools looking at pools with different flood timing and duration will help students learn about how much variation there is in vernal pool hydrology, and (if animals are studied) **how environmental differences may be related to differences in the animals in pools.**

E. Data will be given to HF to share on our Schoolyard Ecology Online Database. These data are of particular interest to other schools participating in this study or citizen scientists who seek to understand the hydrology of vernal pools across the landscape. To see where our participating schools are studying vernal pools across Massachusetts and connect to their data, go to: Vernal Pool Field Site Map

VI. Connections to Science Frameworks: See a specific list of which frameworks are addressed in Our Schoolyard projects at:

2009 Mass. State Frameworks Connections to HF-sLTER

2013 Mass. Science Framework Connection to HF-sLTER

Next Generation Science Standards (NGSS) Connections

VII. Materials

A. Materials for all vernal pool field work:

- Data sheets, clipboards/pencils
- Thermometers (2 for calibration)
- A Field Guide to the Animals of Vernal Pools
- First Aid Kit
- Pre-marked metric meter stick or gauge
- Metric measuring Tape
- Flagging and permanent marker

B. Other optional materials:

- Binoculars
- Few pairs rubber boots for student use
- 1 pair wading boots for adult leader
- Microscopes (in the classroom only)
- Pondwatcher's Guide to Ponds and Vernal Pools fo Eastern North America-laminated field guide
- See a list and links to reading materials related to Vernal Pools on our webpages at: http://harvardforest.fas.harvard.edu/museum/data/k12/suggested-reading.html#vernal

VIII. Guidelines for Choosing Vernal Pool Study Site

Teachers choose and flag an appropriate vernal pool. An appropriate study site offers:

A. Edge Access: Easy access to a vernal pool edge, in walking distance to school, and without poison ivy or thorny plants along the shoreline.

B. Study Area: An open area some distance from the pool's edge should be located for large group work.

Note: Limit disturbance of the pool and bank. Teachers need to be sensitive to the need to minimize trampling of the shoreline, as salamanders and other animals often hide under leaves and other debris and can be readily injured if stepped on. If the bank is damaged, hiding places for animals may be lost, and sediment pollution from runoff can affect the pool water. Sampling areas in the pool itself should be located away from places where there are large numbers of amphibian egg masses in the spring. In-pool sampling should minimize disturbance of the bottom and should be carried out away from egg masses.

IX. Site preparation:

A. Depth Gauge: Teachers place a pre-marked metric measuring stick or depth gauge in the deepest part of the pool for measurement of water depths over time.*

1. Commercial Gauge: Metric gages from Forestry Suppliers, $38 for 1-meter gauge with numbers.

2. Homemade Gauge: Mark a 2 meter length of white PVC pipe with black lines every 5 or 10 cm (permanent marker) and with smaller lines in between. These are relatively easy to read from shore with binoculars.

3. *Gauge Placement: Absolute deepest spot is not critical, as long as gauge is placed in a relatively deep area so that you won't have your measuring stick suspended over dry bottom when there is still a large pool of water in part of the vernal pool.

B. Maximum Pool Diameter Transects: Measure the distance between two trees or other markers on opposite sides of the pool along its longest length, at the highest water mark. The transect should cut across the center of the pool. This will be used to determine the flooded diameter at any time during the year by subtraction of distances between the pool edge and the ends of the transect.

NOTE: Because this method produces an estimate of maximum diameter, it is possible that at some later time when the pool is flooded you will measure an actual diameter that is greater. In that case the "Maximum diameter" value will need to be adjusted. See Section XIII, below, for details.

1. Transect markers: 2 flags, rebar posts, pvc pipe, or tree trunks can serve as endpoints for the diameter measurement.

2. Determining the High Water level: Actual measurements of a flooded pool during periods of high water provide the best documentation of maximum diameter. In such a case, place the transect markers at the water's edge on each side of the pool, along the pool's long axis.

When beginning a schoolyard vernal pool study , however, it is often necessary to estimate the maximum diameter in advance of spring flooding. Also, even if initial measurements are made in spring, in most years the pool may not contain the maximum possible amount of water.

If the pool is not obviously flooded to its maximum, you can estimate the maximum diameter by noting the elevation of dark stains on tree trunks, and the extent of water-stained leaves on the pool bottom. You can also look on the pool bottom for empty caddisfly cases, or the shells of aquatic snails or fingernail clams. The presence of wetland plants around the edge of the pool can also be indicators of the normal high water line. Place your transect markers where you estimate the high water level to be.

Stained leaves, tree trunks, and vegetation may or may not show the maximum extent of high water that may occur in very wet years. If the transect you establish ends up being shorter than high water level during a very high water year, classes taking measurements at that time will just measure distance beyond the high water line that was established. For future sampling and ongoing data analysis, the transect markers will need

to be moved to reflect the new, measured maximum diameter (see Section XIII, below, for more information).

C. Optional site preparation activities: We recommend that you take the time to map and describe your field site either with or without students.

X. Data Management:

A. Data Collection: Students record data on field data sheets during each field site visit. See project protocol for detailed instructions on data collection.

B. Data Submission to Harvard Forest Online Database: In order to best manage your data and to make it accessible to others, we strongly encourage you to submit your data using our simple Online Database on the HF website. Information from data sheets is to be transferred to this online database on the computer by either students or teachers.

Submit fall data to the Harvard Forest Schoolyard data system by January 1st, and spring data by June 1st.

D. Data storage: We recommend teachers save the original student data sheets.

XI. Data Analysis: Teachers may choose to analyze data in a number of ways.

A. HF Graphing Manual- Highly recommended that you refer to Betsy Colburn's data manual for schoolyard studies on HF website at: http://harvardforest.fas.harvard.edu/sites/harvardforest.fas.harvard.edu/files/data/k12/Colburn%202009%20Graphing%20Manual.pdf in order to find suggestions for graphing and analyzing project data. There are other data analysis resources available on that same page of our website.

B. Other suggestions for graphing VP data:

1. Water levels this year: Water levels and pool sizes can be graphed against time to show how the levels change seasonally.

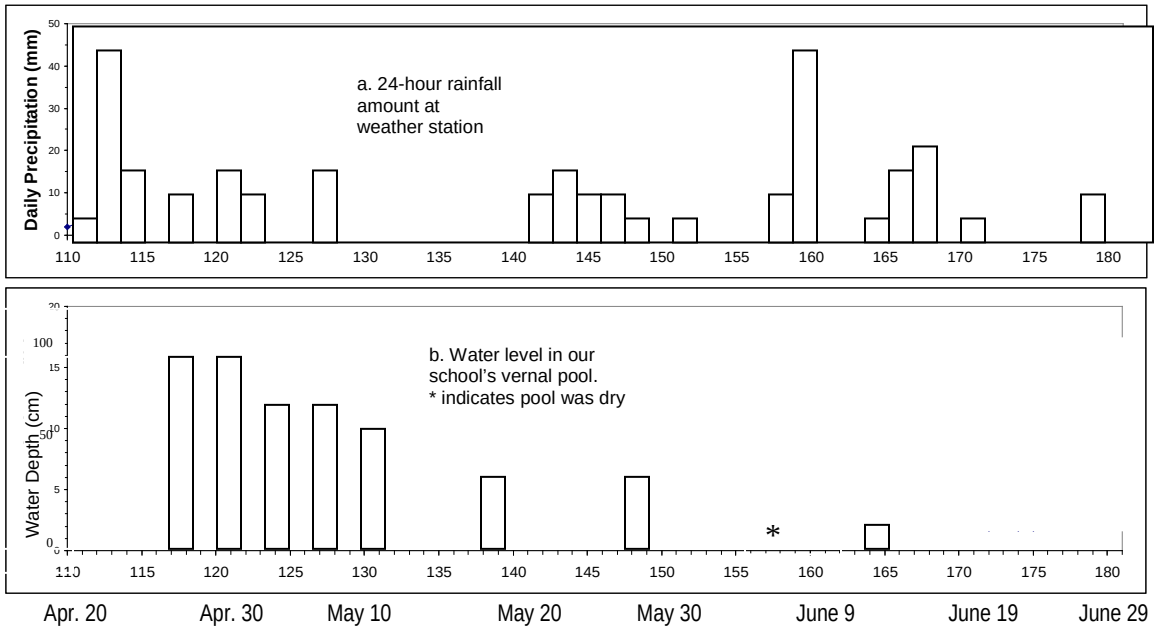
2. Water levels over the long term: Students can compare their results with those from previous years of measurement, if available.

3. Water levels in different pools: Students can compare their results with those from other vernal pools being studied by other classes

C. Weather Data: Using information from sources such as the HF weather station at: http://harvardforest.fas.harvard.edu/harvard-forest-weather-station or the US weather service records for a location near their school, students could analyze the connection between water level changes and weather. Each year, as well as over the course of several years, teachers and students will start to see patterns in water-level changes in relation to weather patterns.

1. Precipitation: Students can note on their own graphs when rainfall occurs. They can do this in several ways. One involves adding another graph showing amount of rainfall over time (see figure 1). Another involves marking an arrow on the x axis whenever there is a rainstorm
1.

Figure I. Change in pool water levels and precipitation over a two-month period



2. Temperature. Students can also look at how water levels change with average temperature. Again, this is most easily done by adding a graph showing mean daily temperature to the water-level graph.

D. Other Field Observations: How do changes in pool water levels correspond to changes you observed in the presence of leaves on trees, plants growing in the water or next to the pool, or animals observed during water-level measurements?

E. sLTER data graphing tool online : Classes can review Schoolyard ecology data online at : http://harvardforest2.fas.harvard.edu/asp/hf/php/k12/k12_graph.php to compare their results to past data at their site as well as other schoolyard sites.

XII. Optional Supplemental Activities:

Teachers may choose to supplement this field research study with a number of related activities depending on their time available and curriculum needs. Below are some suggestions:

B. Vernal pool habitats:

1. Plant ID practice: Using keys and guidebooks at your field site, students could practice learning to identify common aquatic plants found in and around vernal pools. Teachers could either bring samples into the classroom, or bring students out to the field.

2. Habitat discussion: General questions could help students think about what makes vernal pools a unique habitat. Questions that you may choose to ask students include:

- Do other wetlands/waterways look like vernal pools?
- How do they resemble them?
- How are they different?

This could lead to a follow-up conversation about where plants and animals might survive if the vernal pools were filled/houses built here.

C. Vernal Pool Certification: Students could learn how to officially certify a vernal pool in order to help protect this habitat from development. See Division of Fisheries and Wildlife "Certification Criteria," enclosed in your notebook, and Certified; A Citizen's Step by Step Guide to Protecting Vernal Pools (Mass Audubon), edited by Dr. Colburn as well as Leo Kenney's Wicked Big Puddles.

D. Invertebrate Sampling. Students can use nets and/or kitchen strainers to search for invertebrates and may refer to field guides to try to identify and record findings informally. Note that accurate invertebrate sampling can be challenging. We recommend not making I.D. the focus of your work at the K-12 level.

D. Amphibian Studies/activities: Because vernal pools host a number of amphibians, some of which are threatened, salamanders and frogs in vernal pools can be a worthwhile focus for your students.

1. Audio learning: Consider asking your project coach for access to a frog sounds audio tape to bring in multi-sensory learning.

2. Amphibian activities: Vernal Pool Lessons and Activities is a good resource for a number of amphibian activities by Nancy Childs and Betsy Colburn (MA Audubon).

3. Legal and Ethical Issues: Note that collecting and keeping salamanders and other amphibians requires a permit. Raising eggs in the classroom and then releasing the animals back into nature can introduce fungi and viral diseases into natural populations and cause extinction of the population in a pond. Permits are issued by the Massachusetts Division of Fisheries and Wildlife (MassWildlife), Department of Fish and Game, in Boston. They can be reached at:

251 Causeway Street, Suite 400
Boston, MA 02114-2152
Tel: (617) 626-1590
Fax: (617) 626-1517
www.mass.gov/dfwele/dfw/ or E-mail: Mass.Wildlife@state.ma.us

G. One Page Summary: We encourage coaches, teachers, and/or students to complete a one-page summary of the study after each year to reflect on what parts of study were implemented, and what was learned.

H. Project WET Curriculum and Activity Guide and Project Aquatic Wild: Many choices of water related activities are provided in these great resources. Online at: http://www.projectwet.org/ and http://www.projectwild.org/.

I. Inquiry-based research project: Students may be given an opportunity to create their own ecological study. They can develop their individual research question that can be studied at the schoolyard. LTER teacher's manual lessons 4 and 6 are helpful resources for this. A copy of the manual is available online at: http://www.dnr.cornell.edu/ext/LTER/lter.asp

XIII. Adjusting Field Diameter Transect and Data If Measured Diameter is Greater than Original Estimate

Occasionally, in a wet year (it may be either normally wet or unusually wet, depending on the site), the actual pool diameter may be greater than the estimated Maximum Diameter. In the rare event that the measured diameter is greater than the original estimate of Maximum Diameter, you will need to adjust your field transect and your data, as follows. (First, while doing the field measurements, be sure that the flooded area does actually extend past the ends of the transect, meaning that the actual maximum really is greater than the original estimate or prior measurement.)

A. Add the measured difference between the edge of the water and the transect markers at each end of the transect to the original measurement of maximum diameter, to get the new maximum. (This will generally be done in the field, at the time of measuring the new maximum diameter.)

B. Move the transect markers to the water's edge to mark the new maximum diameter, for future field measurements. (Ideally, this should be done while you are in the field taking the measurement, so that the transect markers will be placed at the correct location to record the maximum extent of water.)

C. Change the "Maximum Diameter" value you use for estimating the current diameter on your field sheets.

D. Notify the Schoolyard Coordinator and the Data Manager of the change in the Maximum Diameter. This will allow the value to be changed in the data base for data already submitted. (This is valuable both for other schools that may be making comparisons with your data, and for members of the broader scientific community who may be looking at information on pool sizes.)

E. If you make comparisons between current diameter and maximum diameter as part of your analysis (for example, looking at changes over time in current diameter as a percentage of maximum diameter), you will need to re-do your calculations for previously collected data based on the new maximum.

Contact Pamela Snow, Schoolyard Coordinator, at psnow@fas.harvard.edu or (978) 724-3302 x246 to begin your schoolyard research project.