Phenology: Climate Change in Your Schoolyard

Activity Overview
Students will learn about climate change and phenology.

Objectives
Students will:

- Define and give examples of phenology (the timing of life cycles)
- Understand how changes in climate affect plant phenology
- Formulate ideas and questions about how changes in phenology may affect relationships among species.

Subjects Covered
Science and Language Arts

Grades
Targeted for grades 5 through 8
Modifiable for grades 3 through 12

Activity Time
50 minutes

Materials
A Sand County Almanac, journals for recording phenological observations, internet access to phenology-related Web sites

State Standards
Science:
Decide which collected data is pertinent to new problems (A.4.2)
Decide on changes that have occurred (A.4.5)
Collect scientific evidence (A.8.4)
Use models to predict actions and events (A.8.6)
Apply themes to develop future visions (A.12.1)
Ask questions, plan investigations, make observations, predictions (C.4.2)
Use data to answer questions (C.4.5)

Language Arts:
Create or produce writing (B.4.1, 8.1, 12.1)

Background

You may have heard of Aldo Leopold, a Wisconsin hero in restoration who is celebrated around the world for his work as an ecologist and his beautiful book, A Sand County Almanac. Aldo was an enthusiastic phenologist (someone who studies the timing of life cycles), always carrying a journal for recording events like the first bloom of flowers and return of migrating birds. If you read A Sand County Almanac with phenology in mind, it's almost like a beautifully written phenology notebook! The book contains observations Aldo made from 1935-1945 near the "Shack" in the Baraboo Hills. The whole Leopold family practiced phenology for fun during their trips to the Shack. In fact, when Aldo's daughter, Nina Leopold Bradley, moved back to Baraboo in 1976, she started right where Aldo left off, recording over 300 phenological events! Today, she still has a clipboard hanging in her kitchen for making observations.

While the Leopolds had a lot of fun doing phenology on the land they loved, it also turned out to be very useful for a reason no one would have imagined back in the 1930s: documenting climate change. That's because many plants and animals pay attention to temperature to decide their life schedules. Let's focus on plants, and think back to "Studying Plant Adaptations" (Section 1-8; Prairie Scavenger Hunt). When it comes to phenology, there are a few main reasons why plants do things when they do. One is having enough light, so that plants grow and bloom only when the days are long enough. We would expect these plants to pretty much keep the same schedule from one year to the next. But plants also need water and nutrients...and how much of those things are available depends a lot on temperature (you can probably think of examples...for spring plants, that could mean having warm enough days to melt snow, and for prairie plants in summer, that could mean being in a hurry to get things done before it's too dry). Most plants take their cues for when to do things like grow, bloom, and set seed based on the temperature. So even though the fancy climate models used to show climate change are sometimes hard to understand, we can just look in our own backyards to see how the seasons are changing! Comparing plant phenology in Aldo's time with the past ten years of Nina's data (from 1997-2007) shows us how things are changing.

Activity Description

Here is the phenology of most of the plants you looked at in "A Prairie Year" (Section 5-1). Data were incomplete for little bluestem and purple coneflower, but the rest are shown below. For each species, this table includes the average date when Aldo saw it bloom between 1935 and 1945 (with the exception of big bluestem, which is a grass-its 'bloom' is really first pollen). Then it has the Julian date, or the day of

Understand forms, structures, & punctuation marks (B.4.3, 8.3, 12.3)

Source

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the year, of that date (e.g. Jan 1 would be 1, Jan 2 would be 2, etc). Then the same information is listed from Nina's observations. The day of year makes it easier to compare Aldo's and Nina's observations with each other.

Plant Species	Aldo 1st bloom	Aldo day of year	Nina 1st bloom	Nina day of year
Pasque flower	April 19	110	April 7	98
Lupine	May 20	141	May 13	134
Shooting star	May 22	143	May 10	131
Spiderwort	June 2	153	May 25	146
Black-eyed Susan	June 22	174	June 13	165
Butterfly weed	July 5	187	June 21	173
Bergamot	July 12	194	July 3	185
Yellow coneflower	July 14	196	June 30	182
Compass plant	July 15	197	June 25	177
Prairie dock	July 19	201	July 15	197
Big bluestem	July 30	212	July 24	206
New England Aster	August 21	234	August 27	240
Stiff goldenrod	August 27	240	August 9	222

Discussion

How many species bloom earlier now than when Aldo saw them? How many are later? Which ones have changed their schedules the most? Can you think of reasons for these differences? What would this mean for planning your prairie?

You may notice that nearly all the plants bloom earlier now than they did when Aldo observed them. This is probably largely due to the warmer average temperature that plants experience. Even though the blooming date changes a lot from one year to the next, and is different for different species, the overall change we see across years and across species gives us a pretty strong picture that summer is coming earlier and staying later. You may also notice that New England Aster actually blooms later now than it did in Aldo's time... this could be because this is an 'early fall' species, and since fall arrives later, so does the onset of flowering for this species. Some of these species are on such a different schedule that Aldo would need to write a new Sand County Almanac! For example, the compass plant appears in the 'July' chapter, but would now need to be in the 'June' chapter!

Extensions

- There is still an awful lot we don't know about how climate change is affecting plant phenology! These data focus on the first bloom of plants. You may wish to also pay attention to things like how long blooming lasts for these species in your prairie (i.e., the time between the first individual

blooming to the last setting seed) or the peak bloom (i.e. when about half of the plants of that species are in bloom).

- What about phenology of the organisms with whom these plants have relationships, like pollinators (bees, butterflies), or even diseases (like fungus or galls)? You may wish to observe these events, too.
- Older students may make graphs of data, or visit the Paradise Lost? Web site (listed below) to work with the entire Leopold phenology data set.
- Locate as many species as you can in A Sand County Almanac, and on Web sites like the Wisconsin State Herbarium to learn more about their biology.
- Write a phenological 'personal ad' for species whose relationships may be disrupted! Here's an example:

  NO LONGER WAITING 4 U. All summer long I anticipated your vibrations. I bloomed showier than ever, with the most alluring UV stripes and sweetest nectar, just for you. So many lonely days in waiting...afraid I'd go unpollinated & finally gave my reward to another. Where were you?

Additional Resources

Books

- Bates, J. (1997). A northwoods companion: Spring and summer. Mercer, WI: Manitowish River Press.
- Bauer, C. & M. Smith Fry. (2000). My nature journal: Explorations of the natural world using phenology.
- Cochrane, T.S., K. Elliot, & C.S. Lipke. (2006). Prairie Plants of the University of Wisconsin-Madison Arboretum. Madison, WI: University of Wisconsin Press.
- Leopold, A. (1949). A Sand County Almanac. New York: Oxford University Press.
- Weber, L. (1996). Backyard Almanac. Duluth, MN: Pfeifer-Hamilton Publishers.
- Wright, S.D. & N.L. Bradley. (2008). Thinking like a flower: phenology and climate change at the Leopold Shack. In The Vanishing Present: Wisconsin's Changing Lands, Waters, and Wildlife. Chicago: University of Chicago Press.

Web sites

- Wisconsin State Herbarium: www.botany.wisc.edu/wisflora
- Paradise Lost? art exhibit on climate change & Web library for high school science teachers: http://cbe.wisc.edu/paradiselost/
- Project BudBurst, National Phenology Network citizen science campaign to track the seasons: www.budburst.org
- Journey North, educational site on phenology for schools: www.journeynorth.org
- Earth Alive!, Madison Metropolitan School District & Aldo Leopold Nature Center site on phenology: www.naturenet.com/EarthAlive

Assessments

- Students create graphs, charts, or pictures which convey how phenology has changed between Aldo's and Nina's period of observation
- Students look at Wisconsin weather records to discern relationships between weather and phenology from one year to the next (i.e. interannual variability)
- Students create a set of research questions they would like to explore about changes in phenology (e.g. will monarch butterflies and milkweeds, which need each other, still be on the same schedule?), and create a plan for answering their questions
- Students keep a phenology journal about a question that interests them
- Students do library or Web research to get more information about a phenological event not included in the Leopold set, such as ski resort seasons, ice fishing, insects, etc.
- Students interview an older family member, tribal elder, community member, farmer, or scientist about how phenology has changed over time and present their findings
- Students present research on their phenological event of interest (based on data they collect in the schoolyard) at the EPS symposium or other student event
- Students create writing or art based on their findings and hold a 'phenological art opening'