The Shifting Signs of the Seasons

Monitoring Phenology in the Northeast Temperate Network

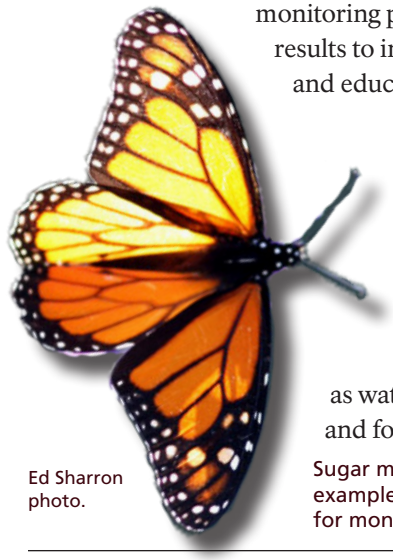
Background

Phenology refers to the timing of seasonal or periodic biological events, and is a key indicator of the pace of climate change. Phenological events are critical to both people and the functioning of ecosystems, and provide one of the most fundamental ways people relate to nature. In the Northeast, phenological events mark the coming of spring with the emergence of the first leaves and butterflies, the sounds and activities of birds and frogs, and the flowing of maple sap. Likewise, leaf color change, southerly bird migration, and crop harvest mark the onset of autumn. Almost every ecological relationship and process—including predator-prey and plant-pollinator interactions, the spread of disease, pest outbreaks, and water and carbon cycling—depends on the timing of phenological events. Scientists are finding that many of these ecological relationships and processes have already been affected by climate change, and more change is inevitable.

National parks are deeply concerned about climate-driven phenological changes because they so closely coupled with harmful events such as outbreaks of forest pests and increases in fire severity in many western parks, wildflower population drop-offs in northeastern parks, and the spread of invasive species throughout the national park system. By monitoring phenology in their parks, NPS staff and volunteers can play a key role in helping to understand the causes and consequences of these changes.

Purpose and Scope

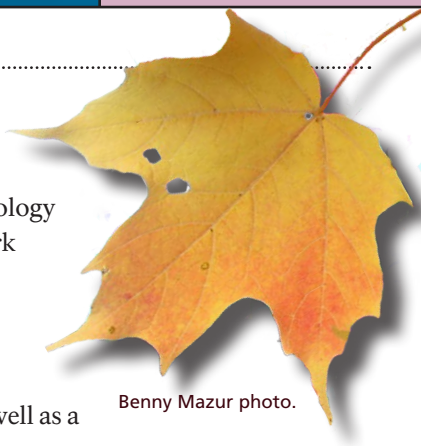
Studying phenology provides information for national park managers and local examples of the effects of climate change that are relevant to visitors and the communities surrounding parks. The Northeast Temperate Network (NETN) is one of several national park programs and partners that are utilizing techniques such as citizen-science data collection and remote sensing for monitoring phenology, and then using the results to inform science, management, and education. These activities will make significant contributions to the NPS's understanding of the effects of climate change and how best to communicate climate change science to the public. Tracking phenology will also enhance information gathered from other monitoring efforts such as water quality, animal population sizes, and forest health.



Ed Sharron photo.

Sugar maples and monarch butterflies are examples of core and optional species selected for monitoring in NETN's phenology program.

The overall goal of NETN's phenology monitoring program is to determine trends in the phenology of key species in order to assist park managers with the detection and mitigation of the effects of climate change on park resources. The network also aims to interest and educate park visitors and staff, as well as a cadre of volunteers.



Benny Mazur photo.

Monitoring Methods

NETN's phenology monitoring program provides standardized methods for monitoring phenology within NETN parks, which include the Appalachian National Scenic Trail, Acadia National Park, the Boston Harbor Islands National Recreation Area, and 10 National Historical Parks and National Historic Sites in the Northeast.

Monitoring methods were developed together with the USA National Phenology Network (USA-NPN), and utilize Nature's Notebook, USA-NPN's online plant and animal phenology observation program. Organized in 2007, USA-NPN is a nation-wide partnership among federal agencies, schools and universities, citizen volunteers, and others to monitor and understand the influence of seasonal cycles on the nation's biological resources.

Depending on the monitoring goals and capacity of their volunteer community and park staff, parks rely on combinations of trained volunteers, staff, and automated cameras and audio recorders to observe the phenological status of a particular target species. "Status monitoring", as defined by USA-NPN, is the evaluation of the phenological status of a species over the course of a year using carefully defined "phenophases". A phenophase is a specific seasonal life history stage or behavior with a measurable duration, such as the length of time a white wood aster has open flowers, or the period during which male Ovenbirds can be heard singing their territorial song.

Volunteers interested in helping to make repeat observations attend a training session held annually at each participating park and within each Appalachian Trail region. Training focuses on understanding material in the NETN Phenology Observer Training Manual, and includes a brief introduction to phenology, locations of designated monitoring sites, description of monitored species and phenophases, and directions for submitting data online.

Automated monitoring using relatively inexpensive time-lapse cameras helps to provide a more complete observational record of individual plants and also allows for automated detection of certain phenophases at the individual and stand scales. Automated audio monitoring is very effective at capturing the breeding vocalizations

Vernal pools are a core habitat for NETN parks that contain them. Here, a spotted salamander (an optional species for monitoring) emerges during spring migration. Dave Huth photo.

of frogs, toads, songbirds, and some insects, as well as trends in the general soundscape. After the recordings are made, NETN uses specialized software to identify indicator species whose vocalizations are well-suited to automatic detection.

Phenology monitoring is one of NETN's newest programs, and it will take place in network parks where resource management staff are able to coordinate monitoring activities for their park. Some phenology monitoring has already occured in many network parks including Acadia NP, the Appalachian NST, Boston Harbor Islands NRA, Marsh-Billings-Rockefeller NHP, Morristown NHP, the Roosevelt-Vanderbilt NHS's, Saugus Iron Works NHS, Saratoga NHP, and Weir Farm NHS. Two core habitats (vernal pools and northern hardwood forest) have been identified by NETN and can be monitored at all parks except the Boston Harbor Islands and Saugus Iron Works - the two network parks that do not contain those habitats. Park staff can also choose to monitor optional habitats that occur in their park. At each participating park, at least three sites are selected for phenology monitoring within each monitored habitat. Fifteen plant and 12 animal species that inhabit the two core or optional park habitats have been selected as possible subjects for monitoring.

Annual reporting will include descriptive statistics for select phenophases of monitored species, and once 10 years of data have been collected, network staff can begin to analyze and report on trends in phenology and explore correlations between phenological data and climate variables. This will allow for the development of hypotheses about impacts of climate change on phenology.

More Information

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Full Protocol online at: https://irma.nps.gov/App/Reference/Profile/2197242

NETN Phenology Monitoring webpage:
http://science.nature.nps.gov/im/units/netn/monitor/programs/phenology/phenology.cfm

USA - National Phenology Network: https://www.usanpn.org/

In Depth : Automated Monitoring with Cameras and Microphones

Volunteers are an integral and essential part of monitoring phenology in NETN parks, but they can't be in the field 24-7. Enter automatic recording and photography. Using off-the-shelf technology, or even do-it-yourself-know-how, parks have the option of using automated recorders to capture animal sounds and digital time-lapse photography of plants, both important data sources for long-term phenological research. The choice of whether to implement automated audio monitoring and which recording option to use is left up to the individual parks. Commercial devices are more convenient, more powerful, and come with a certain amount of technical support, but as one may expect they also have a higher price tag than the do-it-yourself units. Besides being about a quarter the price of the commercial device, the DIY units offer the added benefit of a potential learning experience for a park intern, high school science class, or other group.

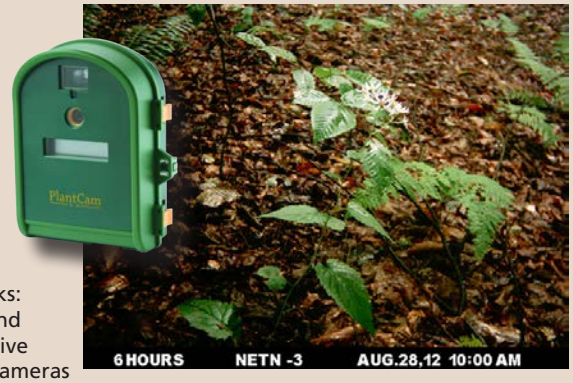
The do-it-yourself recorder (background) and microphone makes a great project for a park intern or local science class.

The Song Meter has more flexibility, and some units can even capture the echolocation calls of bats.

Either audio unit provides a consistent and objective stream of data, and can be placed in remote and hard to access locations. Once deployed, they will capture the vocalizations of many kinds of animals including birds, amphibians, insects, and with some units - even bats. The sounds animals make are important because they are an auditory clue as to what migratory or reproductive phenophase the vocalizer is in.

The two recording unit options available for participating parks are the off-the-shelf Song Meter recording units produced by Wildlife Acoustics, Inc., and the inexpensive homemade unit designed by University of Vermont grad students Jon Katz and Corinne Brauer, whose main piece of hardware is an Olympus digital recorder. Song Meter units are programmed to record the first 10 minutes of every hour or continuously, depending upon the species and phenophases of interest. Olympus units have limited programming options, and are set to record continuously. Units are visited regularly for maintenance and to collect and replace the datacards.

Digital time-lapse photography can be used to track the seasonal changes of individual plants and tree canopies. There are two options for automated cameras as well for participating parks: outdoor webcams, and Plant-cams (inexpensive outdoor time-lapse cameras targeted at hobbyists). Cameras are programmed to capture images multiple times a day.



Inexpensive PlantCams can be used to capture phenophases of park target species. The image above is of a flowering white wood aster in Marsh-Billings-Rockefeller NHP.

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