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## Meeting Reviews

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### Coordinating a Northeast Regional Phenology Network

The inaugural workshop of the Northeast Regional Phenology Network was organized by Ellen Denny and Brenden McNeil, and held in Durham, New Hampshire, 8–9 November 2007. The workshop was made possible with primary funding support from the Northeastern States Research Cooperative and additional support from an NSF-RCN grant to the Northeastern Ecosystem Research Cooperative.

Phenology, defined as the study of the timing of seasonally recurring biological events, is increasingly recognized as a vital aspect of understanding how organisms and their associated ecosystems respond to climatic variability. Similar to studies conducted elsewhere, recent studies in forests of the northeastern United States and adjacent Canada (i.e., “the Northeast region”) indicate that recent warming trends have resulted in an extension of the growing season (earlier springs and later autumns), a phenological impact with important ecological, hydrological, and biophysical ramifications. However, related studies from the Northeast region highlight that there is considerable, and still poorly understood, spatial variability in the phenology indicated by ground observations and remote sensing, and further questions remain about the correspondence between the spring phenology observed on the ground and the green-up signal seen from space. Thus, identifying the patterns and drivers of spatial and temporal variability in phenology is a prerequisite to understanding the consequences of climatic change in the Northeast region. Following the models of cooperative phenology observation networks formed elsewhere (e.g., in Europe, as well as the newly established USA National Phenology Network, USA-NPN), the Northeast Regional Phenology Network (NE-RPN) was recently formed to develop a cooperative effort that would (1) coordinate phenological monitoring by researchers and citizen scientists across the Northeast, (2) develop and evaluate common protocols specific to the flora (and eventually the fauna) of the region, (3) facilitate data sharing and regional phenological syntheses, and (4) contribute to the efforts of USA-NPN.

In addition to attendance by key representatives of the USA-NPN, the workshop had a capacity attendance (34 participants) from a very diverse cross-section of citizen science and research groups drawn from across the Northeast. The enthusiastic participation of all the attendees provided a valuable contribution toward the broader goal, shared by the USA-NPN, of working together to develop a spatially extensive, multitaxa, and multiscale phenological observation data resource that will support research, management, and policy objectives.

A series of introductory presentations at the workshop highlighted the observation that phenology is more than an indicator of climatic variation; it affects biophysical phenomena, such as ecosystem–atmosphere exchanges (e.g., surface energy balance, transpiration and photosynthesis, all of which have feedbacks to the climate system), as well as ecological phenomena (e.g., nutrient cycling,

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species distributions, and trophic interactions such as herbivore–host synchrony). The remainder of the presentations provided details of some existing phenology monitoring protocols used in the region, with an emphasis on the phenology of herbaceous and woody species characteristic of the region’s deciduous forests. Four distinct approaches were described: (1) long-term field observations at well-studied research sites (e.g., Hubbard Brook and Harvard Forest LTERs), (2) citizen-science-based protocols (e.g., volunteer programs coordinated by the Appalachian Mountain Club and Cornell’s Project BudBreak), (3) “near” remote sensing, including upward-looking digital photography, tower-mounted webcams, and radiometric instruments, and (4) various algorithms for extracting phenology signals from satellite remote sensing platforms (e.g., MODIS, Landsat).

The presentations of existing protocols in the region laid an excellent foundation for two breakout group discussions that concluded the first day of the workshop. One breakout group identified and discussed four postulates for successful integration of citizen science efforts in a regional phenological monitoring program: (1) ensuring scientific utility of the collected data through quality control and self-evaluation of the accuracy of species identification, (2) focusing on engaging amateur botanists (e.g., master gardeners) but also encouraging participation from the broadest possible audience (e.g., K–12 students, humorously referred to as “kinder-gardeners”), (3) providing guidance and support (e.g., defining protocols and species lists, supporting web site and database development, and offering training materials such as an online library of photographs illustrating different phenophases), and (4) providing resources that keep citizen-scientists involved year after year (e.g., newsletters or annual reports with observation summaries, online discussion groups, e-mail lists, and annual meetings). The group also outlined recommendations for the specific responsibilities of local citizen science groups, and of the regional and national networks, in meeting these objectives. These discussions, which effectively defined the scope of citizen science efforts for this cooperative network, were viewed by many as a highlight of the workshop because of the excellent opportunities to educate the public about phenology, climate change, and ecology, and the huge amount of data and support a citizen science effort can offer.

The second breakout group focused on approaches for integrating ground observations with remote sensing. The group concluded that the development of empirical “transfer-functions” between ground-based and satellite-based phenology measurements could be facilitated if ground-based protocols met several criteria: (1) they provide a temporally continuous (rather than event-based) measure of leaf expansion and senescence, (2) they are representative of the species composition (which needs to be reported) of the canopy at the pixel scale, and (3) they report ancillary data, particularly regarding snow cover, which will be valuable for improving algorithms.

The workshop continued on day two with a second set of breakout groups. The first of these compiled a list of target plant species for the region, and discussed a tiered (by observer skill level) protocol system for ground observations that would capture the overall state of the development of the deciduous forest canopy (to be linked to remote sensing data), and would be compatible with existing long-term phenological data sets in the region and other national and international protocols. The regional protocols are currently being developed in conjunction with those of the USA-NPN with the goal of having a prototype version to be tested across the region in the spring of 2008. The second breakout group discussed a range of topics, including: (1) a data-sharing and “fair use” policy (to be modeled after

AmeriFlux), (2) an outline of content for the NE-RPN web page <www.nerpn.org>, and (3) plans for a regional synthesis (coordinated by Brenden McNeil) that could draw on existing long-term data sets to explore cross-taxa synchronies and patterns of spatial variability.

Several challenges and opportunities lie ahead for the NE-RPN. These include: (1) reconciling existing ground protocols, (2) ensuring and testing interoperability among ground, citizen-science, “near” remote sensing, and satellite remote sensing observations, (3) meeting the four postulates for successful citizen science participation, (4) attracting new participants and ensuring continued participation of all existing participants, (5) working with USA-NPN to design a cyberinfrastructure that meets the specific needs for data submission by both researchers and citizen scientists, and also supports data distribution and flow to analysis and synthesis efforts at regional and national scales, and (6) obtaining additional funding to support a network coordinator as well as future meetings and synthesis activities. As the NE-RPN moves forward toward its objectives, anyone who is interested in participating is urged to contact the group organizers, Ellen Denny and Brenden McNeil. (Brenden E. McNeil is the corresponding author.)

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