



Taking the Pulse of Our Planet
USA National Phenology Network
Strategic Plan: 2011 to 2015

April 2011

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EXECUTIVE SUMMARY

The USA National Phenology Network (USA-NPN) is a new partnership among federal agencies, the academic community, and the general public to establish a national science and monitoring initiative focused on phenology. Phenology refers to recurring plant and animal life cycle stages, such as leafing and flowering, maturation of agricultural plants, emergence of insects, and migration of birds. It is also the study of these recurring plant and animal life cycle stages, especially their timing and relationships with weather and climate.

USA-NPN is a consortium of individuals and organizations that collect, share, and use phenology data, models, and related information. The Network serves science and society by promoting broad understanding of plant and animal phenology and its relationship with environmental change. Operationally, the Network encourages people of all ages and backgrounds to observe and record the activity of organisms through space and time as a means to discover and explore the nature and pace of our dynamic world. In turn, the Network makes phenology data, models, and related information freely available to empower scientists, resource managers and the public in decision-making and adaptation in response to variable and changing climates and environments.

The USA-NPN consists of a National Coordinating Office (NCO), a Board of Directors, and many partners, including citizen scientists, resource managers, educators and scientists. Partners represent a range of organizations including public agencies, tribes, non-governmental organizations, specialized networks, and academic institutions.

The NCO is a coordination and resource center working to advance the mission of the USA-NPN. The NCO maintains a national phenology information management system, develops and promotes the use of standardized approaches to monitoring phenologies, encourages widespread collection of phenology data, and facilitates communication within and external to the USA-NPN. The NCO also facilitates basic and applied research related to phenology, the development and dissemination of decision-support tools, and the development and dissemination of education materials and activities.

To maximize the long-term (i.e., 30+ years) potential of USA-NPN to serve scientists, resource managers, policy makers and the public, the NCO developed this strategic plan to guide its operations and programmatic development between 2011 and 2015, though longer-term strategic planning is required. This 5-year plan builds from vision and mission statements approved by the Board of Directors in 2009, and will be reviewed by stakeholders in 2010. The document is organized to reflect the seven key operational functions of the NCO, with appendices as appropriate: National Phenology Information Management System (NPIMS); National Phenology Monitoring System (NPMS); Partnerships; Education, Outreach and Training; Research; Decision Support; and Operations and Governance.

Over the course of the next 5 years, activities of the NCO will focus on programmatic development of the NPIMS, the NPMS and the building of partnerships, and will facilitate outreach and education activities, research, and development of decision-support tools through collaborative partnerships.

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INTRODUCTION

Why a USA National Phenology Network?

Phenology refers to recurring plant and animal life cycle stages, such as leafing and flowering, maturation of agricultural plants, emergence of insects, and migration of birds. It is also the study of these recurring plant and animal life cycle stages, especially their timing and relationships with weather and climate. Phenology is a critical component of many aspects of human life, including agriculture, gardening, health, cultural events, and recreation, and nearly all ecological relationships and processes, including plant-pollinator and predator-prey relationships, competition, and carbon and water cycling. In addition, phenology is sensitive to environmental variation, particularly variation in climate. Recent climate change has led to widespread changes in phenology. Such changes have been linked to changes in the timing of allergy seasons and cultural festivals, increases in wildfire activity and pest outbreaks, shifts in species distributions, declines in native species, the spread of invasive species, and changes in carbon cycling in forests. However, the role of phenology as a driver and regulator of ecosystem structure and functioning in many systems is poorly understood. To increase understanding of phenological drivers and to maximize the predictive potential of phenology necessitates a large-scale, focused data collection and sharing effort.

A USA National Phenology Network (USA-NPN) is essential to detect and evaluate ongoing environmental changes. It will capitalize on integration with other physical and atmospheric observation networks and remote sensing products, emerging technologies and data management capabilities, formal and informal education opportunities, and a new readiness of the public to participate in investigations of natural systems on a national scale. In addition, many phenological stages are relatively simple to observe and record, making it an ideal way to engage non-scientists and enhance climate change education efforts. Many Americans believe that the impacts of climate change are distant in both time and space. Phenology can provide concrete, local examples of climate change impacts that are happening at the neighborhood level and affect essentially all people and natural systems.

What is the USA National Phenology Network?

The USA-NPN is a consortium of individuals and organizations that collect, share, and use phenology-related data and information. The Network serves science and society by promoting a broad understanding of plant and animal phenology and the relationship of phenology to environmental and climatic change.

The USA-NPN consists of a National Coordinating Office, a Board of Directors, and many partners, including citizen scientists, resource managers, educators and scientists. Partners

represent a range of organizations including public agencies, tribes, non-governmental organizations, specialized networks, and academic institutions.

The USA-NPN National Coordinating Office (NCO) is a coordination and resource center working to advance the mission of the USA-NPN. The NCO maintains a national phenology information management system, promotes the use of standardized approaches to monitoring phenologies, encourages widespread collection of phenology data, and facilitates communication within and external to the USA-NPN. The NCO also facilitates basic and applied research related to phenology, the development and dissemination of decision-support tools, and the development and dissemination of education materials and activities.

The USA-NPN Board of Directors provides leadership and guidance regarding the activities of the USA-NPN, and the NCO in particular, by holding regular board meetings, convening topic-related committees and working groups, and communicating with the NCO and partners. The BOD consists of twelve members (Chair, Vice-Chair and ten additional members), all of whom serve specified terms.

Partners of the USA-NPN collect and share data and information, pursue basic and applied research projects, develop decision-support tools, and conduct education and outreach activities related to phenology. The continuing operations of the USA-NPN depend on financial and in-kind support from sponsoring partners.

Research Priorities

- Determine spatial and temporal trends in phenology across the nation.
- Use phenology as an indicator of species and habitat vulnerability to environmental variability and climate change.
- Determine the relationship between phenology and ecosystem processes and services.
- Optimize and standardize methodologies and data for local to international projects.
- Integrate with existing research, decision-support, and education/youth programs.

Monitoring Priorities

- Organize and enhance historic and contemporary data on phenology for plants, animals, and landscapes for research and decision-support.
- Promote internationally consistent terminology and definitions for monitoring phenology.
- Develop and promulgate methods, standards, and protocols for phenology monitoring across scales from organisms to landscapes, by existing or new monitoring programs.

A continental, collaborative approach to research and monitoring across scales

USA-NPN includes four observation scales, or tiers (Figure 1). Each tier represents a different level of spatial coverage and related environmental information. First, the USA-NPN will interface with existing networks of local intensive sites focused on detailed environmental measurements and process studies, such as the AmeriFlux network of ~100 research sites, the National Ecological Observatory Network (NEON) and the Long-Term Ecological Research (LTER) network. The next conceptual tier includes spatially extensive environmental networks focused on standardized observations distributed across the country (similar to the U.S. Cooperative Observer weather station network), including National Park Service Inventory and Monitoring sites, National Wildlife Refuge System sites, Organization of Biological Field Stations sites, botanical gardens and arboreta. Observers in this tier include professional scientists and citizen scientists cooperating through these partner organizations.

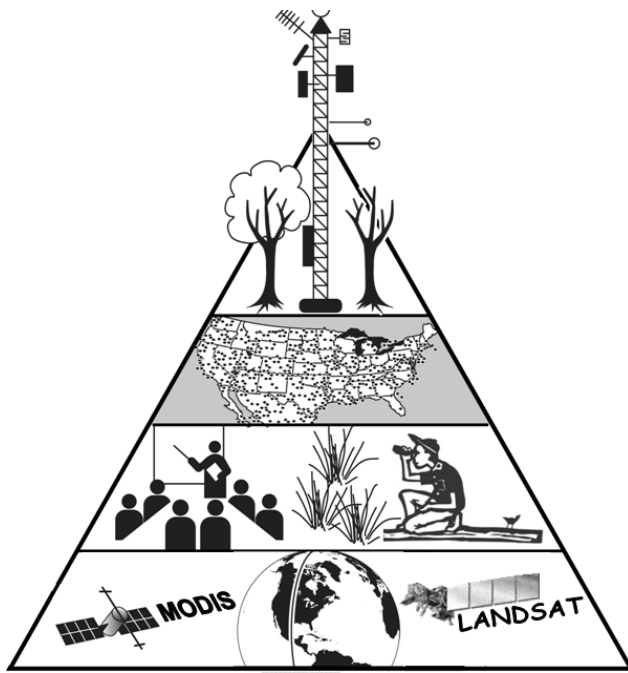


Figure 1. The Committee on Natural Resources and the Environment (CENR; 1997) multi-tiered monitoring framework modified to reflect the structure of USA-NPN. From top to bottom, the tiers reflect local intensive research sites, spatially extensive in-situ monitoring, volunteer (citizen science) opportunities, and remote sensing programs.

The USA-NPN citizen science volunteer programs will leverage existing volunteer and education networks; this tier will allow all interested members of the public to participate in phenology observation while enabling the use of phenology as an integral part of environmental education. USA-NPN will develop and distribute standardized educational/outreach materials, training modules and other volunteer training materials that can be coupled with education and outreach programs being conducted by collaborating networks and organizations.

Finally, the USA-NPN will support the development and application of remote sensing products for land surface phenology to extend surface observations across landscapes, regions or the nation as a whole. In addition, ground observations will be collected in such a manner that they can be used to validate

or interpret remotely sensed images. Scaling algorithms will serve as a tool to interpret satellite observations collected over recent decades, thus providing a longer time-series of phenology measures from which to establish short- and medium-term trends.

This multi-tiered approach is designed to create a national-scale observatory, where observations of phenology and phenological processes are collected using standardized protocols at a projected 100,000 locations across the nation. The intensive and extensive observation tiers provide a strong scientific basis for the monitoring network and facilitate integration of localized process studies with spatially extensive observations. However, they represent a limited number (i.e., several thousand) of observation locations. Volunteers collecting high-quality phenology observations can fill key gaps, contributing to the high-density observatory network required to understand climate change impacts across the diversity of ecosystem types represented in the nation. Lastly, land surface phenology yields a continuous distribution of phenology observations that can be coupled with ground observations to understand phenology at landscape to national scales.

History of the USA National Phenology Network

The USA-NPN has its roots in the lilac phenology networks developed by Joseph Caprio (Montana State University) in the west and W.L. Colville (University of Nebraska) in the east and continued by Mark Schwartz (University of Wisconsin-Milwaukee). Cloned lilacs (and models developed from them) serve as “anchor points” binding together phenology observations from native species in diverse ecoregions, climate data, and remote sensing observations across the continent.

More recently, Schwartz foresaw the need for a national network that would revitalize and broaden the lilac network, while extending phenology observations to other native and non-native species. Julio Betancourt of the U.S. Geological Survey independently arrived at the same conclusion after co-chairing an American Institute of Biological Science Grand Challenge Workshop that explored the role of the National Ecological Observatory Network (NEON) in studying ecological responses to climate. When it appeared that NEON might be designed around intensively sampled regional nodes, Betancourt teamed with Schwartz to begin organizing a spatially distributed network that would achieve continuous continental coverage for phenology observations and operate independently but ultimately in coordination with NEON.

A series of workshops was held to bring this idea to fruition. The first planning meeting was held in August of 2005. An implementation team was formed and met in March 2006, and again in October 2006, to focus on securing stable funding from federal agencies for a national coordinating office, renewal and expansion of the lilac network, and adoption of phenology monitoring across existing environmental networks. These efforts led to the creation of the National Coordinating Office (NCO) of the USA-NPN through a cooperative agreement between the University of Arizona and the U.S. Geologic Survey. Jake Weltzin was hired through the U.S. Geological Survey as the first Executive Director and Mark Losleben was hired through the University of Arizona as the first Assistant Director.

The implementation team also developed a proposal for an USA-NPN Research Coordination Network (RCN), which was funded by the National Science Foundation (for the period 2007-2012). The RCN supports annual meetings to enhance communication, coordination and collaboration among key researchers and educators in the field of phenology and to foster the growth of the USA-NPN. The RCN also funds workshops to address specific topics.

A Strategic Plan for the USA National Phenology Network

To maximize the long-term (i.e., 30+ years) potential of USA-NPN service to scientists, resource managers, policy makers and the U.S. public, the NCO staff recognized the need for a long-term strategic plan to guide the operations and development of the USA-NPN. This strategic plan is focused on the activities of the NCO from 2011 until 2015, but it is a living document, and will be modified as the priorities of participants of the USA-NPN and U.S. society change over time. To this end, the Executive Director of USA-NPN will lead an annual review of the strategic plan and incorporate revisions as appropriate. The USA-NPN Board of Directors will review and approve each revision of the strategic plan. Appendix A articulates a plan for updating this Strategic Plan.

This plan builds from mission and vision statements developed by NCO staff and approved by the Board of Directors. Thereafter, the document is organized to reflect the seven key operational functions of the NCO, with appendices as appropriate: National Phenology Information Management System (NPIMS); National Phenology Monitoring System (NPMS); Partnerships; Education, Outreach and Education; Research; Decision Support; and Operations and Governance.

Over the course of the next 5 years, activities of the NCO will focus on programmatic development of the NPIMS, the NPMS and the building of partnerships. During this time, because of resource constraints vis-à-vis the need to focus on programmatic development, the NCO will facilitate (rather than create or conduct) outreach and education activities, research, and development of decision-support tools.

This particular stage of the USA-NPN strategic planning process was initiated in Spring 2009, and builds on the outline of a strategic plan developed by the USA-NPN steering committee in 2007. NCO staff who participated in development of the 2009 strategic plan included Jake Weltzin and Theresa Crimmins, Ellen Denny, Mark Losleben, Abraham Miller-Rushing, Alyssa Rosemartin and Kathryn Thomas.

VISION AND MISSION

Vision

The USA National Phenology Network (USA-NPN) encourages people of all ages and backgrounds to observe and record phenology as a tool to discover and explore the nature and pace of our dynamic world. The Network makes phenology data, models, and related information freely available to empower scientists, resource managers and the public in decision-making and adaptation in response to variable and changing climates and environments.

Mission

The USA National Phenology Network (USA-NPN) serves science and society by promoting broad understanding of plant and animal phenology and its relationship with environmental change. The Network is a consortium of individuals and organizations that collect, share, and use phenology data, models, and related information.

NATIONAL PHENOLOGY INFORMATION MANAGEMENT SYSTEM

Data management and information sharing are central to the USA-NPN mission. The NCO develops, implements, and maintains a comprehensive information management system to serve the data and information sharing needs of the USA-NPN, including the collection, storage, versioning and dissemination of phenology data, access to phenology-related information, tools for data interpretation, and general online communication among partners of the USA-NPN (Figure 2).

The USA-NPN's Information Management System (IMS) includes components for data storage, such as the National Phenology Database (NPDb), and a variety of online user interfaces to accommodate data entry, data download, data visualization and catalog searches for phenology-related information. The IMS is governed by a set of standards to ensure security, privacy, data access, and data quality.

A broad vision for the IMS and NPDb is in Appendix B.1. Appendix B.2 contains a detailed description of the existing and proposed elements of the IMS.

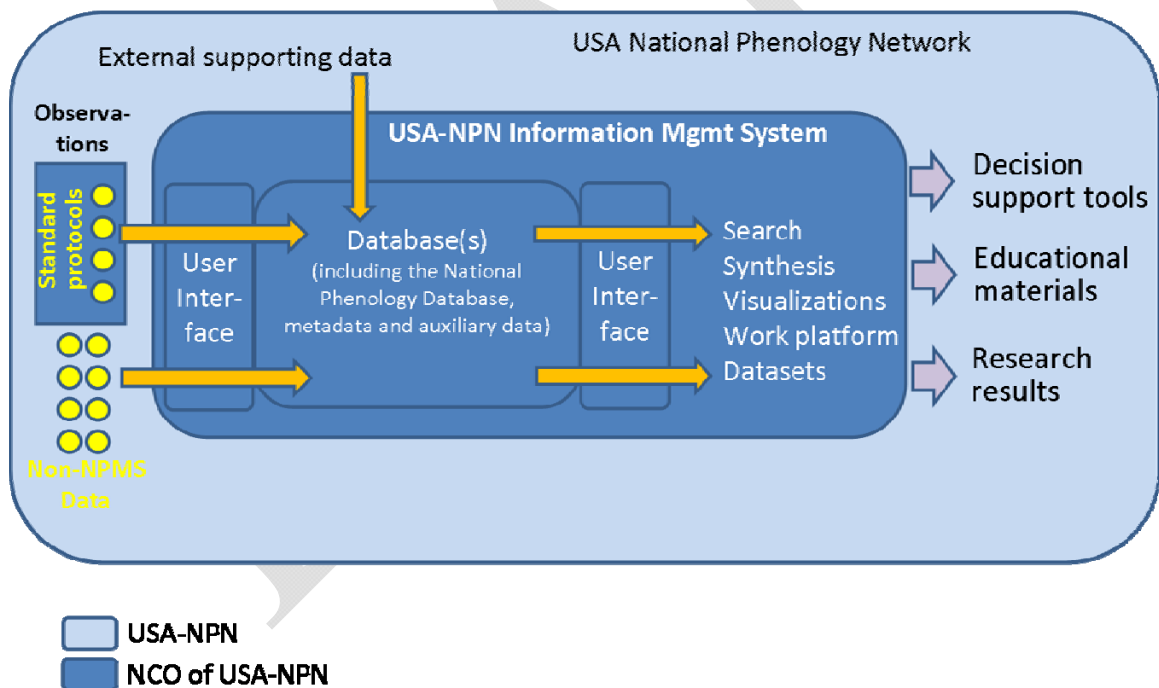


Figure 2. Components of the USA-NPN Information Management System.

Goals and objectives

1. Serve as a national repository for phenology data, models, and information
 - a. Create and maintain a database architecture that provides for the collection, storage, versioning and documentation of phenology data from multiple sources

- b. Develop and maintain user interfaces for the entry of plant and animal phenology data collected by approaches outlined in the National Phenology Monitoring System (NPMS)
 - c. Develop a strategy for collection and documentation of non-NPMS data and metadata, including “integrated” data that will be incorporated within the National Phenology Database (NPDb), “non-integrated” data that will be stored in alternative formats (e.g. Excel worksheets), and “distributed” data that is stored and maintained by other organizations or individuals
 - d. Create a metadata catalog and search tools that provide easy access to integrated, non-integrated and distributed datasets by a variety of users
 - e. Create searchable catalogs of phenology-related tools and information available from the USA-NPN or other organizations or individuals (e.g. online field guides, education materials, other phenology or resource monitoring programs, etc.)
2. Ensure that phenology data stored in the NPDb are usable, traceable, identifiable, reliable, and shareable
 - a. Develop and implement a data management plan, to include provisions for data management and distribution beyond the duration of the Network
 - b. Develop, document and implement quality control/quality assurance standards for the entire life cycle of managed phenology data
 - c. Develop a strategy for the “integration” of non-NPMS datasets into the NPDb to facilitate comparisons across datasets
 - d. Provide for regular system backup
 3. Provide synthesis and analysis products appropriate to broad audiences
 - a. Create interactive mapping and graphing tools for visualization of data in the NPDb
 - b. Create interactive decision support tools for targeted resource management applications
 - c. Compile and post basic summaries of phenology data
 4. Maximize interoperability with national eco-informatics initiatives
 - a. Maintain close consultation with the US Geological Survey (GIO, NBII) and other organizations to maximize interaction with developing national database initiatives (e.g., the Climate Effects Network, Ecosystem Science Umbrella Projects, and the National Climate Change and Wildlife Science Center, Council on Data Integration, DataONE)
 - b. Share best practices, technologies and solutions with partners
 5. Ensure the NPIMS remains useful, up-to-date, and secure
 - a. Incorporate current technologies available for social networking, on-line field guides, incorporation of visual records, and emerging methods of data reporting (e.g. cellular phone technology)
 - b. Regularly evaluate NCO staff skills and resources necessary to maintain oversight of the NPIMS development and operations, and ensure that these skills are represented in the NCO staff

- c. Provide for thorough system security
- d. Provide for regular external review of the information system to ensure adoption of best practices
- e. The Cyberinfrastructure Plan for the USA National Phenology Network (2007 revised) serves as the initial planning document for the NPIMS. Identify a person(s) and procedure to document the policies, procedures, and infrastructure for each implementation cycle.

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NATIONAL PHENOLOGY MONITORING SYSTEM

An essential activity of USA-NPN is the collection of contemporary and historic phenology data. The NCO provides and promotes a vetted, well-documented, flexible phenology monitoring system, the National Phenology Monitoring System (NPMS). Implementation of this system in monitoring programs across the nation will facilitate the widespread collection of integrated, high-quality ground observations of plants, animals, and (eventually) related biophysical factors. Data collected using this system (or “integrated” into this system after collection) will provide a valuable resource for research, decision support, and educational purposes.

The NPMS includes standard monitoring methods, recommended species, and internationally standardized phenophase and phenological event definitions for collection of contemporary phenology data and comparison of many historical phenology datasets. A general description of the NPMS is included in Appendix C.1. A description of our current implementation of the NPMS as Nature’s Notebook is included as Appendix C.2. The following outline describes the goals and objectives for this monitoring system over the next 5 years.

Goals and objectives

1. Refine the monitoring system to allow the broad participation of different observer groups in collecting high-quality data
 - a. Identify target uses for phenology ground monitoring data, e.g.:
 - i. Climate research related to start of spring
 - ii. Canopy green-up research related to carbon cycling
 - iii. Species interactions and land management implications
 - iv. Invasive species management
 - v. Allergy season prediction
 - vi. Validation of remote-sensing products
 1. Identify target observers and how to accommodate them within our monitoring system
 - Define observer groups according to combinations of skill level and time commitment
 - vii. Determine motivation of observer groups in order to retain participation, e.g.:
 1. Level of complexity in phenophase definitions
 2. Number of phenophases to follow
 3. Effort required in site set-up
 4. Effort required to record data
 5. Effort required to report data
 6. Visitor services
 7. User feedback

- viii. Partner with established organizations to more efficiently accommodate and expand some or all observer groups
 - b. Refine and justify the selection of calibration and other high priority species for plant and animal monitoring
 - c. Refine plant and animal phenophases and phenological events
 - d. Refine and justify recommended sampling approaches
 - e. Define biophysical events to track with phenology at an observation site
 - f. Consider a landscape phenology component to the ground observation monitoring system
- 2. Engage and encourage observers to collect high-quality data by maintaining data standards and cultivating a positive monitoring experience
 - a. Create portals and develop online training tools targeted to different observer groups to provide adequate and appropriate observer training and better ensure collection of high-quality data
 - b. Create clear direction for observers to begin participation in a monitoring program that is appropriate for their skill level and time commitment to ensure a fun, rewarding experience and maximize observer retention
 - c. Create a mechanism to encourage observers to provide even higher-quality data by participating at a more advanced level as their skill or time commitment increases
 - d. Develop mechanisms for providing rapid feedback to observers submitting data
 - e. Develop mechanisms to ensure data meet minimum quality standards (e.g., are within expected ranges)
 - f. Develop QA/QC mechanisms to ensure proper species ID and phenophases ID (see Appendix B.1)
- 3. Promote widespread acceptance and use of the monitoring system by researchers, resource managers, educators, and citizen scientists for coordinated, nationwide phenology monitoring
 - a. Provide user interfaces for entry and download of data collected via the monitoring system
 - b. Create partnerships with other organizations collecting phenology or phenology-related data
 - c. Encourage geographic affiliates to promote the monitoring system
 - d. Conduct campaigns to capture targeted observer audiences or encourage data collection efforts targeted for specific purposes or species Conduct public and professional outreach/communication
 - e. Engage partners as a “developer” community to help select priority species and refine the monitoring system
 - f. Facilitate research, education, and decision support tools using our data
 - g. Create visualizations and data products that can be tailored to partner needs
 - h. Provide users with updates

- i. Publish monitoring system components in peer-reviewed and non-peer-reviewed venues, including in a standard operating procedures (SOP) format
- 4. Vet the existing monitoring system and document a procedure for modification and update of its components
 - a. Conduct a formal review of the monitoring system
 - b. Consider creating an advisory group for the monitoring system and define its tasks, goals and interactions with the NCO
 - c. Gather feedback from observers, data end-users, and partner organizations regarding data collection procedures, data quality, and other aspects of the monitoring system
 - d. Work with the monitoring system committee to review and update the monitoring system

PARTNERSHIPS

The USA-NPN consists of individual and organizational partnerships within and between communities of researchers, land managers, policy-makers, citizen scientists, educators and others to achieve common phenology-related goals on a national scale (Figure 3). **Members** of the USA National Phenology Network include **Collaborating Individuals** and **Partners**. **Collaborating Individuals** are persons who are participating directly in Nature's Notebook and other USA-NPN programs. We recognize the following types of **Partners**:

- **Geographic Affiliates** - geographically-organized groups ranging in scope from a town or university to several states, and organized for the purpose of monitoring plant and/or animal phenology, and that have established a relationship with the USA-NPN. Representative Geographic Affiliates are listed in Appendix D.1.
- **Collaborating Organizations** – Organizations that exist independently and have established a relationship with the USA-NPN to accomplish a wide variety of goals, including but not limited to engaging members in phenology monitoring, using the USA-NPN as an archive for phenology data, and pursuing joint funding proposals. Representative Collaborating Organizations are listed in Appendix D.1.
- **Collaborating Projects** – USA-NPN Collaborating Projects are variable and can address topics ranging from specific data collection efforts to the development of visualization tools. These efforts are typically short duration (lasting a few years), have specific goals, and are grant-funded. Representative Collaborating Projects are listed in Appendix D.1.

Through our partnerships we seek to encourage and maintain the participatory spirit of the USA-NPN and the involvement of diverse user groups. The NCO coordinates the efforts of USA-NPN partners to productively and efficiently advance the vision and goals of the USA-NPN; effective partnerships are critical to the success of the network. The NCO aims to strike a balance between actively seeking key partners that help us most efficiently fulfill our Mission and Vision statements and working with partners that come to the USA-NPN seeking to work together.



Figure 3. The USA-NPN consists of many partners, including citizen scientists, resource managers, educators, and scientists from organizations including public agencies, Native American tribes, non-governmental organizations, specialized networks, and academic institutions. The USA-NPN National Coordinating Office (NCO) is a coordination and resource center working to advance the mission of the USA-NPN. The NCO, the Board of Directors, and partnering organizations and individuals together comprise the USA-NPN.

Goals and objectives

- Engage partners strategically to provide the greatest benefit to the Network
 - a. Develop and maintain a quantitative method for prioritizing potential partner organizations
 - b. Identify services and benefits to USA-NPN partner organizations (Appendix D.2 and available online at www.usanpn.org/participate/new-partners)
 - c. Identify services and benefits that partnerships might provide the USA-NPN, include those identified in other sections of this strategic plan (Appendix D.3)
 - d. Develop partnerships along with services and benefits to partners (in order of priority)
- Engage partners that broaden the diversity and scope of the network
 - a. Periodically evaluate demographics of partners and participants to identify missing user groups
 - b. Identify partners to engage in order to increase participation of the missing user groups
 - i. Consider the demographic, geographic, and taxonomic coverage of existing partner groups
- Develop strategic collaborations as proof-of-concept to facilitate broad adoption of phenology activities
- Support the establishment of USA-NPN Geographic Affiliates
 - a. Develop a tool on the USA-NPN website for Geographic Affiliates to self-register and share information about their organization
 - b. Provide materials and expertise to enhance their local engagement and phenology monitoring efforts

EDUCATION, OUTREACH, AND TRAINING

The NCO facilitates the development of outreach and education materials to communicate with diverse audiences in support of the USA-NPN phenology monitoring efforts and to support scientific discovery and inquiry. Education is defined as the intentional facilitation of learning, generally through institutions. It encompasses formal, informal, and non-formal education. The NCO also participates directly in outreach activities, defined as the dissemination of ideas and concepts that engage the parties in a two-way conversation.

Goals and objectives

1. Provide communication about phenology and environmental variation and change
 - a. Develop outreach materials for use by NCO staff and others participating in the USA-NPN (See Appendix E.2 for messages we wish to communicate to our audiences)
 - b. Provide demonstrations and examples of the utility of phenology data and information in decision making
2. Engage a broad variety of audiences to increase science and climate literacy
 - a. Engage the public in dialogue on the role of phenology in ecology, day-to-day life, and impacts of climate change, through meetings, forums, newsletters, and popular media.
 - b. Engage the public in asking and answering questions about phenology and changing climate, incorporating the learning of key concepts and cognitive skills and the development of skills to organize, collect, analyze, and interpret quantitative data.
 - c. Develop outreach materials for use by NCO staff and others participating in the USA-NPN (See Appendix E.2 for messages we wish to communicate to our audiences)
 - d. Facilitate the development of targeted campaigns around phenology-related topics (e.g., PhenoClim)
3. Increase and sustain participation in *Nature's Notebook* and other NCO and affiliated Network programs
 - a. Identify potential groups of observers to target, ensure appropriate level and content in communications
 - b. Identify potential formal and informal science education program partners in the form of schools, nature centers, etc.; work to establish phenology monitoring partnerships with these groups (Appendix E.1 includes strategies we might use with each group)
 - c. Forge partnerships with existing education-oriented phenology monitoring programs (e.g., Journey North)

- d. Undertake outreach through the media: advertize phenology monitoring programs
 - e. Identify and implement methods to sustain observer participation (e.g. provide engaging visualizations, social-networking opportunities, newsletter, etc.)
 - f. Develop targeted campaigns around selected species or themes (e.g., plant-pollinator interactions)
4. Maximize data quality by providing appropriate training and materials
- a. Identify and develop informational materials necessary for adequate understanding of monitoring implementation by our different observer groups (see Monitoring System plan)
 - b. Develop partnerships to provide other materials as feasible
 - c. Evaluate overall data quality of observer groups and reassess needs for more or improved training materials
 - d. Explore and implement ways to direct and encourage observers to start at an appropriate level of participation and to advance to more involved levels when appropriate
 - a. Provide a clearinghouse for education and outreach materials and coordinate the development of new materials as appropriate. Compile and maintain a list of existing phenology-related educational materials (i.e. the Educator's Clearinghouse)
 - b. Organize, facilitate, and/or participate in meetings to develop and share educational materials centered on phenology and climate change
5. Periodically evaluate the success of education and outreach programs for engaging the public
- a. Facilitate periodic evaluation of education/outreach materials and compilation of "lessons learned"; use findings to adapt materials/approach
 - b.

RESEARCH

An important aspect of the NCO is the facilitation of basic and applied research on all aspects of phenology and on the relationship of phenology to rapidly changing environmental conditions and climate. In addition, the NPIMS and NPDb, which serve as a centralized hub for phenology-related data and information, are key services provided by the NCO to scientists, resource managers and policy-makers. The NCO also facilitates communication among researchers, works to identify key gaps in our understanding of the role of phenology in natural and managed ecosystems, and supports coordination of research to fill those gaps.

Goals and objectives

1. Coordinate the development of a national research agenda for phenology. A working research agenda includes:
 - a. Determine spatial and temporal trends in phenology across the nation
 - b. Use phenology as an indicator of species and habitat vulnerability to environmental variability and climate change
 - c. Determine relationships between phenology and population-, community- and ecosystem-level processes, goods and services
 - d. Optimize and standardize methodologies and data for projects at local to international scales
 - e. Integrate with existing research, decision-support and education/outreach programs (e.g., Climate Science Centers, Landscape Conservation Cooperatives, DOI and WH initiatives, National Climate Assessment, EPA Climate Change Indicators report)
 - f. Develop the concept of climate-informed ('Climate Smart') monitoring for use in the implementation arm of most adaptive management strategies and for achieving management objectives related to climate change adaptation
2. Provide phenology and phenology-related data and information to researchers
 - a. Internationally standardized definitions, protocols and methodologies
 - b. On-line user interface for data entry, exploration and download
 - c. Documentation including metadata and vetted methodologies with version control
 - d. Dataset registry tools and access to historical datasets
 - e. Database for storage of contemporary and historical data
 - f. Integration of phenology-related information (e.g., climatology)
 - g. Facilitate communication and coordination among research groups
 - h. See also details in information management system
3. Facilitate a national assessment and gap analysis of phenology information
 - a. Coordinate efforts with the NSF-funded Research Coordination Network (RCN). For more information on the RCN see www.usanpn.org/history

- i. Ensure continuation of RCN research mission following the conclusion of the RCN funding in 2012
 - b. Lead or participate in the preparation of research strategy documents (e.g., national assessments of climate change impacts)
 - c. Write or encourage review papers on specific topics relevant to the USA-NPN, such as the quality of citizen science observations, national trends in phenological change, etc.
 - d. Coordinate the scoping of a national assessment of phenology
 - 4. Facilitate research collaborations between key partners and stakeholders
 - a. Facilitate research communication (e.g., conference calls, webinars, workshops, and conferences) on topics relevant to phenology
 - b. Develop partnerships with key research and data-using organizations—e.g., LTER, NEON, OBFS, ESA, TWS, BSA, MTNCLIM, USGS, US Forest Service, University of Arizona, USFWS
 - c. Write letters of support for research relevant to phenology
 - d. Participate in scoping or development of research proposals
 - 5. Link research to specific applications (resource management, health, agriculture)
 - a. Foster the development of forecasting tools and early warning systems (e.g., pollen release)
 - b. Identify key phenology-linked indicators of climate change impacts on people and ecosystems to use as communication tool to convey the importance of phenology to research, monitoring, and identification of climate change adaptation strategies.
 - 6. Facilitate or occasionally participate in new high-priority phenology research

DECISION SUPPORT

The NCO facilitates efforts within the USA-NPN to develop phenology-related decision support tools (such as models, visualizations, data summaries and syntheses) and provides a clearinghouse for these tools. These efforts serve to inform decisions made by resource managers, health officials, community and national planners, and other decision-makers. The particular role of the NCO in development, testing, and application of decision support tools is under consideration, and will likely change over time as datasets are developed and research or decision-support priorities change.

Goals and objectives

1. Facilitate the development and implementation of phenology-related decision support tools
 - a. Provide information or data for development or implementation of decision-support tools
 - i. Provide existing datasets, in raw or summarized form, for decision-support projects
 - ii. Develop new datasets for new or custom decision-support projects
 - iii. Collaborate to develop new data exploration, analysis and visualization tools for decision-support projects
 - b. Summarize and describe existing and potential phenology-related decision support tools
 - i. Participate in the preparation of decision support needs assessments and strategic planning for high priority applications (e.g., agriculture, human health, resource management)
 - ii. Prepare or facilitate review papers on specific topics relevant to the role of phenology in decision making
 - c. Identify and develop priority and/or proof-of-concept decision support tools in collaboration with partners
 - i. Collaborate with partners on the design, implementation and marketing of new or custom decision-support projects
 - ii. Provide other aspects of project support (e.g., user engagement, education/outreach, other communications)
 - d. Facilitate research and promote collaborations among researchers, planners, managers, policy-makers and other stakeholders for the creation of decisionsupport tools related to phenology
 - i. Prioritize research projects to fill gaps for ritical decision-making
 - ii. Develop partnerships with key research and management organizations focused on the development of decision support tools

- iii. Facilitate communication (telecons, workshops, conferences) on high-priority research for decision-support
 - iv. Provide letters of support for research relevant to phenology-related decision support tools
 - v. Participate in proposal development for funding needs assessments or tool development.
2. Conduct outreach to demonstrate the utility and importance of phenology-related decision support tools
 - a. Develop and distribute documentation, materials and marketing for projects developing or using phenology information for decision-support
 - b. Develop and distribute specific examples (vignettes) of how phenology information can inform decision-making and how managers and planners can integrate phenology-related information into decision-support projects
 3. Serve as a clearinghouse for decision support tools related to phenology
 - a. Host links to existing decision support tools housed elsewhere
 - b. Provide data output and syntheses via the USA-NPN website

OPERATIONS AND GOVERNANCE

The USA-NPN consists of the NCO, a Board of Directors, and many sponsoring and collaborating partners (Appendix D.1). The NCO develops, maintains, and promotes the use of standard monitoring methods and an information management system, and will be guided by the vision, mission, goals and objectives of the 5-year strategic plan. The BOD provides leadership and guidance regarding the activities of the USA-NPN, and the NCO in particular, by holding regular board meetings, convening topic-related committees and working groups, and communicating with the NCO and partners. The continuing operations of the NCO depend on financial and in-kind support from sponsoring partners.

An Executive Committee serves as the primary governing body of the USA-NPN. This committee consists of the twelve-member BOD and the NCO Executive Director and Assistant Director. The Executive Director is appointed by the appropriate official of an external supporting agency or organization after consultation with the BOD, and will be advised by the BOD. The Assistant Director is appointed by the Executive Director after consultation with the BOD. The USA-NPN Constitution and By-Laws describe the rules of governance for the USA-NPN, and are available on the web-site. The Executive Director and Assistant Director are primarily responsible for directing the operational activities of the USA-NPN through the NCO.

Over the first two years of operation, the NCO staff activities were loosely structured around four overlapping thematic areas: a plant phenology program, an animal phenology program, a biophysical program (linking biotic and abiotic observations), and a remote sensing phenology/land surface phenology program. This particular organization and staff allocation facilitated the development of these program components, and required a point person to seek, track and implement feedback. However, as the individual programs mature, we plan to move towards a more integrated single phenology monitoring program by the end of 5 years, and separate program coordinators will probably be replaced by a project management business model. In short, NCO staff would either serve as project managers and service coordinators. Services comprise the seven sections of this strategic plan (excluding Operations and Governance): Monitoring System; Information Management System; Partnerships; Education, Outreach, and Training; Research; and Decision Support.

Objectives

1. Develop and maintain the National Coordinating Office
2. Develop and maintain strategic and implementation plans and arrange for periodic reviews of plans and progress
3. Ensure regular and appropriate reporting and communications within the NCO and the Network to maintain institutional transparency

- a. Executive Director provides monthly and annual reports on NCO activities to sponsoring partners and the BOD; major accomplishments to date are in Appendix G.
- b. NCO staff provide basic data reports to observers via web interface
- 4. Acquire and maintain adequate human and financial resources and infrastructure to implement the strategic plan
 - a. Develop a human resources staffing plan (Appendix F.1)
 - b. Develop and maintain agreements and collaborations with the University of Arizona to ensure continuity of infrastructure (Appendix F.2)
 - c. Executive Director responsible for development and maintenance of financial resources to maintain activity of NCO (Appendix F.3)
 - d. Assistant Director oversees relationships with University of Arizona for space and services and budgets for office infrastructure and equipment
 - e. Develop yearly action plans for each operational area of this strategic plan



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APPENDICES

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APPENDIX A. PLAN FOR UPDATING THE USA NATIONAL PHENOLOGY NETWORK STRATEGIC PLAN

Routine updates

Because the USA-NPN is young and is developing quickly, we expect that we will want to modify our strategic plan will arise occasionally during the year. We suggest the following process to incorporate these modifications into the strategic plan in a timely manner.

- A “static” copy of the strategic plan will be posted on the USA-NPN website.
- A “living” copy of the strategic plan will be posted to the USA-NPN intranet.
- As National Coordinating Office (NCO) staff members, the board of directors, and others come across changes they would like to make to the strategic plan, they can add those changes to the “living” copy on the intranet, using the Track Changes feature in Word.
- A committee will review proposed updates and accept or reject them on a quarterly basis.
 - Committee members:
 - Executive Director
 - Chair of the Board of Directors
 - 2-3 other rotating members
 - If appropriate, the entire NCO could be included in the decision process.
- A new version of the strategic plan, incorporating the accepted changes, will replace the previous “static” version on the USA-NPN website. This new version will remain unchanged until the next quarterly review.

Annual review

Annual reviews will provide a forum to review the plans and progress of the USA-NPN during the previous year, and a mechanism to develop plans for the next year. Reviews should be held around June each year, so they are completed in time for the beginning of the next fiscal year (October 1).

- The NCO staff will review:
 - The strategic plan to ensure that it is still up to date and appropriate.
 - The previous year’s action plan to check whether we met our goals.
- The NCO staff will develop:
 - An action plan, including deliverables, for the next fiscal year.
 - A budget for the next fiscal year.

APPENDIX B.1 VISION FOR THE USA-NPN INFORMATION MANAGEMENT SYSTEM (IMS)

A core function of the USA-NPN is the provision of an information management system (IMS) and associated National Phenology Database (NPDb) to categorize, store, maintain and distribute the diversity of plant and animal phenology datasets available across the nation. The development, implementation and maintenance of the IMS, NPDb and associated cyberinfrastructure (CI) are critical to the long-term (i.e., 30+ years) function of the USA-NPN.

Although phenology data have been collected across the nation for over two centuries (e.g., by such culturally important figures as Thomas Jefferson, Henry David Thoreau, and Aldo Leopold), the utility of these data are constrained by a lack of nationally standardized definitions or methodologies. In short, national phenology data are characterized by a diversity of methodologies, formats and availabilities. To overcome these limitations, the USA-NPN is developing and encouraging the use of a set of standardized protocols based on published, international standards. Standardized protocols for contemporary monitoring of plant, animal and landscape phenology are under development, and are described elsewhere. In addition, USA-NPN is developing a central repository for phenology or phenology-relevant datasets, the NPDb, which will contain the diversity of contemporary and historic (legacy) data on plant and animal phenology collected by scientists, resource managers, educators, and the lay public (aka citizen scientists) across the nation.

To facilitate standardized monitoring and ingestion of contemporary data into the NPDb, the USA-NPN has developed an on-line user interface, Nature's Notebook. Nature's Notebook includes tools for user, site and plant registration, standardized monitoring protocols, and a data entry system that provides information on sampling intensity and absence data, as well as rudimentary tools for data editing and visualization. Because of the diversity of users, Nature's Notebook is designed to be flexible and appealing to all levels of expertise. Nature's Notebook went live on 2 March 2009; by July 2009, ~2400 observers had registered and were collecting and entering data on 220 representative plant species according to standardized monitoring protocols. An animal phenology program was added in 2010. Quality assurance/quality control, bulk data upload, data download, and visualization tools for Nature's Notebook are in planning or development stages.

In addition to the contemporary phenology data program described above, the USA-NPN will categorize, store, maintain and distribute legacy phenology data. Legacy data sets include a variety of quantitative and qualitative data types, including scanned sheets; spreadsheet, text or database files; images, etc. These data sets are typically of unknown quality and follow unknown or unique standards, though they are invaluable for interpreting contemporary conditions. Examples include diary notes or records from Henry David Thoreau, Aldo Leopold,

Thomas Jefferson, or Lewis and Clark; citizen scientist observations; or data collected by scientists, resource managers, or educators. Because of their unique, non-standardized character, these data sets will be held independent of contemporary data in the NPDb. A legacy data set module for the IMS is in planning stages.

A third type of data includes affiliated phenology or other relevant (e.g., climate, stream gauge) data sets collected, stored and maintained by other organizations or networks ranging from citizen science groups (e.g., Journey North, Frogwatch) to the National Science Foundation's Long-term Ecological Research (LTER) network and other federal networks. These data sets also include explicit (i.e., direct observation of phenological events) and implicit (i.e., indirect observation or proxy measures of phenological events or effects) phenology data of use to scientists, managers and the public interested in summarizing or interpreting contemporary or legacy datasets. We envision standardized metadata search tools via a clearinghouse, but will let the data owner maintain the records. A rudimentary metadata search tool is available on the USA-NPN website for a limited number of records.

Quality assurance/quality control (QA/QC) will be applied where possible to all data associated with the NPDb. An integrated plan for QA/QC is under development. In short, QA/QC tools will be tailored to the various components of the IMS that provide data ingestion tools. For example, contemporary data entered through Nature's Notebook should be subject to both *a priori* (i.e., before or during data entry) and *a posteriori* (i.e., after data entry) QA/QC. In all cases, because of limited resources vis-à-vis the scale of this project and the diversity of available datasets, QA/QC tools should be as automated as possible, and should place the burden of effort on the individual or organization initially providing the data. QA/QC tools are under development for the contemporary data entry system, and are being developed as part of the visioning stages for other components of the IMS.

USA-NPN will provide several critical functions to facilitate usability and to maintain user interest across all aspects of the IMS. One key function will be the development of engaging, high quality interactive real-time visualizations appropriate to general audiences. In addition, we envision interactive visualizations targeted for particular groups—gardeners, land managers, allergy sufferers, etc. that reflect underlying decision support tools developed by scientists, affiliated organization or industry partners. For example, contemporary data collected by the USA-NPN can be used in predictive models for pollen production and dispersion, control of invasive species, understanding flight trajectories of migratory birds, prediction of western wildfires, spread of pests or disease, or many other applications. Visualization and decision-support tools are in development or visioning stages. Web 2.0 services, including social networking, integration with on-line field guides, incorporation of visual records, etc. are in the visioning stage.

APPENDIX B.2 ELEMENTS OF THE USA-NPN INFORMATION MANAGEMENT SYSTEM (IMS)

IMS components (items in *italics* do not yet exist)

- **Information storage**
 - Database for website information (currently using Drupal)
 - Includes general info about the USA-NPN
 - Includes species profile information (some of which currently duplicates that in the NPDb)
 - Includes phenology “library” catalogs of the media center, education clearinghouse, publications, and outreach materials (the actual materials referred to in these catalogs may be stored as files in the IMS or as files or webpages on external servers)
 - National Phenology Database (NPDb) for phenology data
 - Includes species info, phenophase definitions, etc.
 - Includes NPMS data
 - *Includes integrated non-NPMS data (this is data that has been somehow cross-walked and ready for comparison with NPMS data)*
 - Files
 - Image files
 - PLANTS map files (these may eventually be pulled from an external server)
 - Datasheet pdfs
 - Phenology “library” materials (e.g. media, education, outreach, etc.)
 - *Non-integrated data pdfs, Word files, Excel files, etc. (these are the “legacy” or “contemporary” non-NPMS datasets that we want to make available without integrating in the database, either as a temporary or permanent way to make them available)*
 - Programming files
 - Scripts
 - Style sheets
 - Datasheet templates used for Nature’s Notebook
 - Etc.
 - *File cabinets for paper data not yet digitized*
 - *Other items for which exact storage location is unknown or TBD*
 - *Catalog of metadata for in-house and distributed datasets*
- **User interfaces**
 - General USA-NPN website (currently defined as Drupal portion)
 - General info about USA-NPN
 - Phenology “libraries”

- Education Clearinghouse
 - Media Center
 - Publications catalog
 - Outreach materials
- For data import into IMS
 - USA National Phenology Monitoring System (NPMS) data entry (Nature's Notebook)
 - *Bulk upload of NPMS data*
 - *Non-NPMS data entry (for integrated non-NPMS data; often referred to as the "Legacy data module")*
 - *Digital image upload*
 - *Partner data entry interfaces*
- For data export from IMS
 - NPMS data output
 - *Dataset search/metadata catalog (includes comprehensive catalog and search tool for ALL phenology datasets we know of, including datasets we do not hold, non-integrated datasets we do hold, and NPMS and integrated non-NPMS data in the NPDb; this UI provides access to metadata for the datasets and in some cases links to raw data)*
 - *Digital image search*
- For data products and applications
 - Journal publications search
 - *Visualizations (could be many different ones)*
 - *Decision support tools*
 - *Reports and data summaries*
 - *Education and outreach materials search*
- For IMS management
 - Of the Drupal website
 - Administrator access (e.g. Alyssa)
 - Content editing
 - Of the NPDb
 - Administrator access (e.g. Bruce, Ramon)
 - Species add or edit page
 - *Phenophase add or edit page*

- **Standards**

- Data quality control and assurance
- Data access rights
- Security
- Privacy (personal information)
- Standard Operating Procedures

APPENDIX C.1 THE USA NATIONAL PHENOLOGY MONITORING SYSTEM

The USA National Phenology Monitoring System (NPMS) was developed with the following objectives in mind:

1. Capture high-quality data that is broadly useful for a variety of purposes by
 - a. Providing a mechanism to report the status of a phenophase on any given observation date (e.g. open flowers)
 - b. Capturing uncertainty in the actual date of reported or inferred phenological events (e.g first flower)
 - c. Providing a mechanism to report abundance or intensity of each phenophase on each observation date (e.g how many flowers?)
 - d. Including mechanisms to evaluate observer skill and infer quality of their data
2. Conform to a universal code of phenological events to maximize the integration of the contemporary monitoring data with legacy data collected by common historical methods (e.g. the BBCH scale for plants)
3. Maintain uniformity and simplicity within phenophase definitions to facilitate comparisons across taxa
4. Incorporate flexibility to accommodate different levels of observer skill/commitment, different degrees of site accessibility, and different data collection technologies in order to maximize spatial and temporal coverage of observation data
5. Close the gap between traditional and citizen science by providing a single set of nested protocols for use by observers at all levels of expertise

Monitoring Methods and User Scenarios

Currently the NCO has developed a single general method for all-purpose monitoring of plants and animals, although the potential need for other specialized methods has been considered (e.g. for plant-pollinator monitoring). We have identified a number of “user scenarios” for the general method:

- **User Scenario 1:** for frequent repeated observation sampling by consistent observers (e.g. “The Backyard Observers”)
- **User Scenario 2:** for repeated observation sampling by many one-time observers (e.g. “The Self-Guided Trail Observers” observing marked plants/locations along a public trail)

- **User Scenario 3:** for one-time observation sampling (e.g. “The Backcountry Observers” observing unmarked plants/animals as they happen upon them opportunistically during a hike)

Monitoring Approaches

The NCO has identified two possible “approaches” to the monitoring of phenology, that might be appropriate for different observer skill and commitment levels within a user scenario:

- Phenophase Status Monitoring
 - Record every observation date
 - Evaluate and record status of each defined “phenophase”¹ at every observation

* Potential for high-quality data including sampling history, uncertainty in phenophase start and end dates, phenophase duration and repeating phenophases within a season, but considerable observer effort (requires or at least appears to require a certain level of organization that casual observers may shy away from)
- Phenological Event Monitoring
 - Watch for defined “phenological events”²
 - Report date of first observation of phenological event occurrence
 - Report last date of observation before event occurrence

* Potential for medium-quality data including uncertainty in event date, with minimal observer effort (no need to print out and maintain datasheets or to keep track of ALL observations; good for short attention spans and low time commitment)

Monitoring Protocols

For each method/user scenario/approach, the NCO will develop detailed recommended protocols to follow in order to carry out a monitoring program on the ground. Protocols include the following elements:

- Site/Subject selection protocol
 - Site selection
 - Subject selection
 - Marking of site and subjects
- Observation protocol
 - When to look (frequency of observations)

- What to look for (for each species this includes a specific set of phenophases/phenological events with specific definitions)
- Documentation protocol
 - Required elements
 - Recommended supporting data to describe an observer, site, subject, or observation

Standardized Phenophase and Phenological Event Definitions

At the center of the NPMS is scheme for standardization of phenophase and phenological event definitions not only within our monitoring system, but across many other contemporary and historical phenology datasets in the US and abroad. The scheme for standardization includes:

- A list of NCO-defined general “phenophase” definitions (e.g. breaking leaf buds, open flowers, nest building) for monitoring via the Phenophase Status Monitoring Approach
- A list of NCO-defined general “phenological event” definitions (e.g. first leaf, first flower, first nest building activity) for monitoring via the Phenological Event Monitoring Approach (these also define “phenophase” start and end points)
- A table matching each NCO-listed species with appropriate general phenophases and/or phenological events for monitoring, and including any supplemental species-specific definition
- Components that enable data transformation into a universal code, for integration with many historical and legacy datasets
 - Table matching start and end points of NCO-defined phenophases to corresponding NCO-defined phenological events
 - Table matching NCO-defined phenological events to a slightly modified version of the BBCH scale for plants (modifications mostly entail additions for phases missing in BBCH, e.g. leaf coloring), and an-as-yet-undetermined standard for animals

¹**Phenophase:** An observable stage or phase in the annual life cycle of a plant or animal that can be defined by a start and end point. Phenophases generally have a duration of a few days or weeks.

²**Phenological event:** A precisely defined point in the annual life cycle of a plant or animal, generally marking the start or end point of a phenophase. The occurrence of a phenological event can be pinpointed to a single date and time (in theory, if not in practice).

APPENDIX C.2 NATURE'S NOTEBOOK: THE USA-NPN ONLINE OBSERVING PROGRAM

The NCO has implemented a national campaign to engage volunteer observers in the collection of general phenological data for a broad range of species. As of Spring 2009 an online monitoring program, Nature's Notebook,—based on the National Phenology Monitoring System (NPMS)—has been developed and presented on the USA-NPN website to instruct and encourage observers to establish their own on-the-ground monitoring programs at home or in their local communities. A brief summary of the specific protocols for this general monitoring program is included here.

Specific Monitoring Protocols for the Online Monitoring Program

- Select site(s) to monitor.
 - A site may be a plot, yard, garden, trail, pond, park, or other area of any shape.
 - Select site(s) representative of the local area.
 - Select site(s) from a relatively uniform habitat.
 - Select site(s) no larger than 15 acres; smaller is fine.
 - Select replicate sites, if possible.
 - A one-time site along a trail may be fine.
- Select species to monitor at each site.
 - Select species that you know and can identify.
 - Select USA-NPN focal species.¹
- Select individual plant(s) to monitor.
 - Select healthy plants.
 - Avoid direct neighbors.
 - Select replicate plants, if possible.
- Observe and record phenophases.²
 - Observe phenophases defined by NCO.³
 - Make observations weekly or more frequently.
 - Record observations each time they are made.
- Record data.
 - Observer name
 - Location (latitude, longitude, elevation)
 - Species name
 - Phenophase observed
 - Phenophase status
 - Phenophase abundance or intensity
 - Supporting data to describe observer, site, plant, and monitoring technique
- Report data via the Nature's Notebook user interface


¹USA-NPN focal species currently include calibration and regional species, in addition to cloned plants. In the future, USA-NPN may also add focal species at smaller scales (e.g., subregional and local).

²NCO currently encourages participants to observe phenophases, not phenological events, because phenophases are more intuitive to monitor and facilitate reporting every time an observation is made, which is important for statistical analysis.

- **Phenophase:** An observable stage or phase in the annual life cycle of a plant or animal that can be defined by a start and end point. Phenophases generally have a duration of a few days or weeks.
- **Phenological event:** A precisely defined point in the annual life cycle of a plant or animal, generally marking the start or end point of a phenophase. The occurrence of a phenological event can be pinpointed to a single date and time (in theory, if not in practice).

³NCO has defined a set of specific phenophase definitions for each species that can be found on each species' profile page

APPENDIX D.1 REPRESENTATIVE PARTNERS AND COLLABORATORS

 **Sponsors** provide support for USA-NPN activities either through direct funding or substantial in-kind support or cooperation. Sponsors include funding agencies, foundations, corporations, and individuals.

 indicates a **Founding Sponsor**.

Geographic Affiliates

- California Phenology Project
- Mid-Atlantic Phenology Network
- Northeast Regional Phenology Network
- Wisconsin Phenological Society
- Florida Phenology Network
- Northern Indiana Phenology Project
- Old Dominion Phenology Project
- PennPhen
- Portland BudWatch
- Alaska Regional Phenology Network/Alaska Fireweed Network

Collaborating Organizations

- Ameriflux
- Appalachian Mountain Club
- Arbor Day Foundation
- Arizona-Sonora Desert Museum
- Bureau of Land Management
- Clean Air-Cool Planet
- CoCoRaHS (Community Cooperative Rain, Hail & Snow Network)
- Ecological Society of America
- Environment for the Americas
- Freshwater Society
- Great Sunflower Project
- HoneyBeeNet
- Hummingbird Monitoring Network
- Long Term Ecological Research Network
- Microsoft Research
- Monarch Watch
- National Aeronautics and Space Administration 
- National Ecological Observatory Network
- National Oceanic and Atmospheric Administration 
- National Park Service
- National Science Foundation  

- Northeastern States Research Cooperative
- NatureServe
- New York Botanical Garden
- North American Pollinator Protection Campaign
- Oak Ridge National Laboratory 🌍
- Picture Post
- Project BudBurst
- Science for Citizens
- University of Arizona 🌍 🗺️
- University of California-Santa Barbara Phenology Stewardship Program
- University of Wisconsin-Milwaukee 🌍 🗺️
- US Environmental Protection Agency 🌍 🗺️
- US Fish and Wildlife Service 🌍 🗺️
- US Forest Service
- US Geological Survey 🌍 🗺️
- The Wilderness Society
- The Wildlife Society 🌍
- YourGardenShow.com

Collaborating Projects

- USGS Status & Trends Project
- Juniper Pollen Project

To learn more about how we are working with these partners, please visit www.usanpn.org/about/partners.

APPENDIX D.2 SERVICES AND BENEFITS TO USA-NPN PARTNER ORGANIZATIONS

Benefits of becoming a USA-NPN Geographic Affiliate:

- Representation on the USA-NPN website (online tool)
- Training webinars for your organization
- Visualization, long-term management and archive of data submitted by members of your organization
- Guidelines for organizations workshops
- Guidelines and a tool for soliciting legacy datasets
- Guidelines and materials for hosting training sessions
- Request addition of species to USA-NPN recommended species list
- Use of USA-NPN logo on materials
- Feature content from organization on USA-NPN homepage and Twitter account
- Letters of support to granting agencies

Services and benefits available to USA-NPN Collaborating Organizations and Collaborating Projects:

- Legacy data registry
- Posting partner-related announcements via the USA-NPN Twitter account
- Featuring partner-related content on the USA-NPN home page
- Bulk data upload
- Training webinars and support materials
- Adding plant or animal species to the USA-NPN recommended species list
- Educator's Clearinghouse
- Data visualization
- Organizational "landing page"
- Communications materials
- Adding organization to the 'Register User' page
- Use of USA-NPN logo on partner organization's materials
- Posting link to partner site on USA-NPN website
- Periodic updates from USA-NPN National Coordinating Office
- Letters of support to granting agencies
- Year-end summary reports
- Data management and archiving

To learn more about each of these functions, please visit www.usanpn.org/participate/new-partners.

Services and benefits under development or under consideration for development for all USA-NPN partner groups:

- Developing “data entry skins” – allow members of partner organizations to enter phenology observations into NPN IMS from partner home website
- Flagging data points for location (i.e., within a National Park or other location) or program (observation specific to Monarch Watch or Great Sunflower Project)
- Allowing modifiable phenophases: make partner-specific phenophase lists available when observers indicate they are coming from a particular partner group; allow organizations to develop "templates" for members with particular phenophase recommendations
- Allowing modifiable species: make partner-specific species lists available when observers indicate they are coming from a particular partner group; allow organizations to develop "templates" for members with particular species recommendations
- Allowing ingestion data from groups/individuals that do not follow NPMS (contemporary or historical - this falls under Legacy data entry tool)
- Hosting a “work platform” on our site, allowing individuals to work with and modify data, and to create their own visualizations on the fly
- Allowing observations at the genus level
- Developing membership/USA-NPN seal of approval for phenology-related projects
- Hosting workshops targeted at research, management, education, citizen science
- Allowing observers to add their own species
- Allowing observers to add images of their sites/plants

APPENDIX D.3 SERVICES AND BENEFITS THAT PARTNERSHIPS PROVIDE TO USA-NPN

Services and benefits offered vary by partner. Possible services and benefits include:

- Tens of thousands of dedicated observers and/or a venue to reach many potential observers
- Heightened awareness of phenology and the USA-NPN
- Possible establishment of phenology gardens
- “Test bed” for protocols, especially for regional focal species
- Observations from highly instrumented sites
- Experience engaging citizen scientists
- Experience managing large datasets
- Funding support
- Educational materials
- Experience developing standardized observation protocols
- Information technology expertise and/or support
- Taxonomic expertise
- Venue to develop, test, and implement decision support tools
- Local connections

APPENDIX E.1 EDUCATIONAL STRATEGIES BY AUDIENCE

Audience	Goals/Outcomes	Strategy
Formal K-12 Teachers	Develop phenology lessons and collect data with students.	Educator's Clearinghouse, Training materials
Formal K-12 Students	Participation in the scientific method; increased awareness of nature and pace of our dynamic world.	Participation in monitoring program
Formal Post-Secondary	Participation in the scientific method; increased awareness of nature and pace of our dynamic world.	Participation in monitoring program, participation in programs offered through partners (i.e., SEEDS)
Informal Public (e.g., visitors of zoos, aquariums, nature centers)	Develop nature programs and exhibits, connect visitors with USA-NPN	Educator's Clearinghouse, Training materials
Non-formal (lifelong learning; outside of the classroom)	Encourage participation in USA-NPN, access to more in depth resources if desired.	Training material Supplementary materials for adults
Land Stewards	Increased understanding and application of phenology data/tools	Publications on website, webinars, decision support tools
Scientists	Understanding of role of phenology in ecology, evolution, and society	Scientific meetings, peer-reviewed papers, white papers
Phenology Programs (e.g. Journey North)	TBD	Partnerships
Non-Phenology Programs (e.g. nature clubs)	TBD	Partnerships

APPENDIX E.2 TARGETED MESSAGES FOR USA-NPN AUDIENCES

General Audience:

- By observing & reporting changes in plant and animal life cycles, you can help scientists and managers understand and adapt to our changing climate.

Policy-makers:

- Phenological information is key to understanding and managing natural resources under climate change.
- The USA-NPN engages the public in understanding and connecting to the impacts of climate change and increases scientific literacy.

Scientists:

- Advance your own research and contribute to the growing understanding of ecosystem response to climate change by housing your phenology observations in the USA-NPN Information Management System.
- The USA-NPN is developing a unique resource that integrates phenology and related environmental data for basic and applied science.

Managers:

- Current and historic phenology information is key for management of natural resources in the face of climate change.
- The USA-NPN will provide standard monitoring methods, an easy-to-use database system for storing and accessing data, data quality assurance, and decision support tools targeted at current management issues.

Educators:

- Studying phenology is a great way understand the effects of climate change and connect students to the natural world
- By participating as observers – your class can contribute to real science.

Potential Partners:

- By connecting with the USA-NPN your organization stands to gain:
 - national recognition
 - standard methods for phenology monitoring
 - a resource for data entry, storage and quality control
 - 'networking' - connections to other organizations/individuals
 - education and training resources
 - large dataset and data analysis resources (down the road)
 - tools for research & management (down the road)

APPENDIX F.1 RESOURCES: STAFF

DRAFT

APPENDIX F.2 RESOURCES: INFRASTRUCTURE

Office space (1400 sq ft) for staff and operations of the NCO are provided within the Office of Arid Lands Studies (OALS), part of the School of Natural Resources and Environment, College of Agriculture and Life Sciences, through a cooperative agreement with the University of Arizona (UA). The Executive Director and NCO staff who are UA employees are encouraged to communicate with UA Head of Department during University or Departmental reallocation or consolidation efforts to ensure continuity of space. Staffing plans should be coordinated with OALS to ensure sufficient space for 5 years. Computer infrastructure, telecommunications services, materials and supplies are generally the responsibility of the NCO; however, arrangements with UA that create efficiencies of scale should be pursued where possible. In addition to space for NCO staff, space should be maintained for occasional visiting scientists or post-doctoral researchers, 1-2 graduate and undergraduate students, and 1-2 volunteers.

APPENDIX F.3 RESOURCES: FINANCIAL

DRAFT

APPENDIX G. MAJOR ACCOMPLISHMENTS OF USA-NPN

Federal Fiscal Year (FY) 2007

- Search, hire and relocate Executive Director
- Developed 1-year sub-agreement to house USA-NPN office at the University of Arizona; office reconfiguration
- Held first national partners workshop to scope the structure and function of the USA-NPN
- Established web presence (www.usanpn.org)

FY 08

- Established governance plan and scientific Board of Directors
- Initiated partnerships with federal, state and local science and management agencies and universities for implementation including the U.S. Fish and Wildlife Service (FWS), the National Park Service (NPS), The Wildlife Society (TWS), Oak Ridge National Laboratory
- Created and maintained a national phenology information management system (including database and user-interface)
- Established and implemented external communications plan
- Held second national partners workshop to implement USA-NPN
- Scope decision support tools for applications and decision support

FY 09

- Developed two new co-op agreements with the University of Arizona to house the USA-NPN and for new phenoclimatologist faculty line
- Commenced national strategic planning activities with partners and local/regional pilot projects with FWS and NPS
- Completed major upgrades to data model, database, user interface and web-site
- Implemented plant phenology monitoring program using standardized methodologies
- Developed plan for a national animal phenology monitoring program
- 2500 registered observers, mostly citizens, participating in monitoring programs

FY 10

- Implemented animal phenology monitoring program using standardized methodologies
- Developed, implemented and marketed an identity for Nature's Notebook, the on-line interface for a national phenology monitoring program
- Developed and implemented on-line tools for registering and searching phenology datasets, publications and related information
- Established two major pilot projects with National Park Service to incorporate phenology into national park activities in California and in the northeastern United States

- First major stakeholders workshop to evaluate progress, determine future directions and establish new partnerships
- Participated in strategic planning and implementation of a regional human-health decision support tool for pollen early warning
- Complete draft 5-year strategic plan and review and vet among stakeholder community



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