

Agency Information and Listening Session Report

Washington, DC
3-5 May, 2011

July 2011

usanpn.org

USA-NPN Programmatic Series 2011-002

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USA National Phenology Network Agency Information and Listening Session Report

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EXECUTIVE SUMMARY

The Board of Directors of the USA National Phenology Network convened an Agency Information and Listening Session in Washington, DC in May 2011 that was attended by leaders from more than 10 federal agencies and organizations. The goals of the meeting were to (1) provide agency leaders with a brief summary of the scope, accomplishments and potential of the Network, (2) explore opportunities to leverage the capacity of the Network to meet agency needs for monitoring, management, decision-making and/or public engagement, and (3) solicit guidance on the strategic growth and long-term sustainability of the Network.

Participants identified the need for high-quality, historical and contemporary data and analytical products to describe the responses of natural and managed ecosystems to environmental variation and climate change. In addition, there was strong interest in collaboration on a variety of activities, including development of frameworks for monitoring, planning, decision-making, and education and outreach through public engagement. The Board and Staff of the Network will develop collaborative relationships to help agencies meet their particular needs over the next several years, while also refining a strategic plan to provide expanded Network services to agencies and other partners over the next several decades.

INTRODUCTION

Established in 2007, the **USA National Phenology Network (USA-NPN)**; hereafter “Network”; www.usanpn.org) is a national biological science and monitoring initiative that supports the collection and integration of phenological observations and information across space and time. The Network functions as a partnership of federal agencies, the academic community, and the general public, and brings together citizen scientists, government agencies, non-profit groups, educators, and students of all ages to monitor and record phenological observations of plants and animals in the United States. Through the accumulation and analysis of frequent, standardized observations of the natural world, the Network’s primary goals are (1) to facilitate an understanding of how species and landscapes respond to environmental variation and climate change and (2) to engage the public through hands-on scientific discovery.

On May 4, 2011, the Board of Directors (hereafter “Board”) and senior members of the National Coordinating Office (hereafter “Staff”) of the Network convened an **Agency Information and Listening Session (AILS)** at the Headquarters of the National Geographic Society (NGS) in Washington, D.C. Representatives from more than 10 federal agencies and organizations participated in the morning session based on shared interests and experiences in climate science, natural resource management, education and public outreach (participant list in Appendix A). The Webpage for the meeting includes links to this report and other logistical and supplemental materials (www.usanpn.org/ails).

PURPOSE

Federal agencies are a primary stakeholder group for the Network and its products and services. To understand and serve better the needs of these important partners, the main objectives of the information and listening meeting were to:

- 1. Provide participants with a brief summary of the scope, accomplishments and potential of the Network;*
- 2. Explore ways that federal agencies can leverage the capacity of the Network to meet agency needs for monitoring, management, decision-making and/or public engagement; and*
- 3. Solicit guidance on the strategic growth and long-term sustainability of the Network.*

MEETING OVERVIEW

The meeting agenda is in Appendix B. The meeting was facilitated by Leni Wilsmann, of Conservation Impact (www.conservationimpact.com/).

John Francis, Vice President for Research, Conservation, and Exploration at the National Geographic Society, opened the meeting by welcoming the group to NGS headquarters. Anne Kinsinger, Director of the Ecosystems Mission Area at the U.S. Geological Survey (USGS), provided formal opening remarks, including a brief description of the role of USGS in the support and development of the Network. She also highlighted opportunities for the generation of broader agency partnerships. Following a round of participant introductions, the Chair of the Board, Mark Schwartz of the University of Wisconsin, Milwaukee provided a brief overview of the Network's historical development (Appendix C).

To provide the group with further background and context, Jake Weltzin, an Ecologist with USGS and the Executive Director of the Network, gave a 30-minute presentation on several aspects of the Network (Appendix D). Jake first emphasized the importance of phenology in understanding the response of species and ecosystems to environmental variation and climate change. He also provided an overview of the management-, education-, and communications-related applications of phenological information. He highlighted major accomplishments of the Network to date, including the development of multi-taxa, national-scale monitoring protocols; the implementation of an on-line national phenology monitoring program, called *Nature's Notebook*, with a nationally-distributed set of observation sites; the availability of real-time, freely available data, metadata and documentation; the cataloging and maintenance of critical historical datasets; and the development of critical collaborations for implementation. Finally, he presented a vision for the future of the network, presented as a suite of hypothetical multi-agency reports that could be produced relatively quickly as conceptual frameworks later supplemented with detailed implementation plans.

A brief question and answer session immediately followed the presentation (Appendix E). Questions centered on understanding the scope and scale of the Network's monitoring activities. For example, participants asked whether the Network considers marine environments and land-use change; the Staff confirmed that the Network could be expanded to include these systems in the future, pending interest and funding. On the issue of scale, it was noted that a primary research focus of the Network is, and will continue to be, the development of methods to link ground-level organismal observations with remotely-sensed data sets for improved model validation. As such, the Network promotes the use of its data by researchers to develop robust spatio-temporal models for prediction of phenological phenomena at local, regional and national scales.

FACILITATED DISCUSSION

Following a short break, meeting organizers posed two questions to the group to facilitate discussion as to how the Network could be more useful to partners:

1. *What are your agency's current and future needs that could be met by the Network?*
2. *What opportunities and resources do you have that could be leveraged to increase the capacity of the Network?*

The ensuing discussion (summarized in Appendix F) centered on five key themes: (1) Data quality and integration, (2) Strategic design and growth of the monitoring network, (3) Climate change research and applications, (4) Educational opportunities, and (5) Public engagement. This input will be used to refine strategic and implementation planning as the Network grows. For example, now that the Network has the basic infrastructure for data generation and information management (e.g., standardized monitoring protocols, integrated database, online data-entry interface, training materials), it can now focus on improving data quality, quantity integration and dissemination through the development of strategic partnerships, and the production of enhanced, dynamic data products (e.g., visualization tools, decision support tools, national data products).

KEY OUTCOMES

Key outcomes from the meeting included:

- Agency leaders were informed about the scope, accomplishments and potential of the Network
- Agency leaders provided comments on the strategic and tactical direction of the Network
- Agency leaders described how the Network can meet their data and information needs
 - There is a need for high quality, contemporary data and analytical products to describe the response of natural and managed ecosystems to environmental variation and climate change

- Agency leaders learned how their organization could participate in a variety of activities including monitoring, planning and decision-making, and education and outreach
 - The Network’s phenology monitoring program, *Nature’s Notebook*, which utilizes standardized methodologies and protocols, can be readily adopted to facilitate interoperability across agencies
 - The capacity for public engagement (e.g., “citizen science”) provided by the Network is of interest to several agencies as a vehicle for education and public engagement
- Federal agency leaders learned that the Network is a broad partnership that includes many types of stakeholders
 - Potential audiences and stakeholders include a wide variety of organizations, from governmental agencies, non-governmental organizations, tribal organizations, academia, educators, planners, policy-makers and the public;
- Agency leaders were informed that although USGS provides base-stable support for operations of the Network, resources from a variety of sources are required for sustained growth of the network
 - There was strong interest in exploring collaborative or funded projects with the Network

NEXT STEPS

After the meeting, the Network Board and Staff developed a simple action plan and communication strategy (available upon request) to follow up with attendees on specific issues and to cultivate working relationships in support of the mission of the Network. In addition, building on the practices that have led to early accomplishments and partnerships, the Network Board and Staff are assessing the most effective manner to expand our services to federal agencies and other partners. Potential strategies include increasing the capacity of the Network to provide data products, monitoring protocols and platforms, decision-support tools, and scientific information for the many organizations tasked with understanding and managing ecological systems under changing environments. Specific opportunities discussed included using phenological data to produce and deliver near real-time or synoptic data products for national assessments, enhancing K-12 education to develop the next generation of conservation stewards, demonstrating changes in biological systems resulting from climate change in a non-politicized manner, and promoting public engagement in science and natural resource management.

CONTRIBUTIONS AND ACKNOWLEDGEMENTS

The development of this report could not have been possible without the valuable contributions from the workshop participants. Carolyn Enquist synthesized the content and drafted the report. Jake Weltzin, Alyssa Rosemartin, Ellen Denny, and Theresa Crimmins shaped subsequent versions of the document.

The NCO extends a very special thanks to all the meeting attendees. We also thank Leni Wilsmann and Conservation Impact for facilitating the meeting.

APPENDICES

APPENDIX A. PARTICIPANT LIST

Participant List
USA-NPN Agency Information and Listening Session
Headquarters of the National Geographic Society, 1145 17th Street NW, Washington, DC
May 4, 2011

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- * USA-NPN Board of Directors or Federal Liaisons to the Board of Directors
- ** USA-NPN National Coordinating Office Staff
- *** Meeting Facilitator

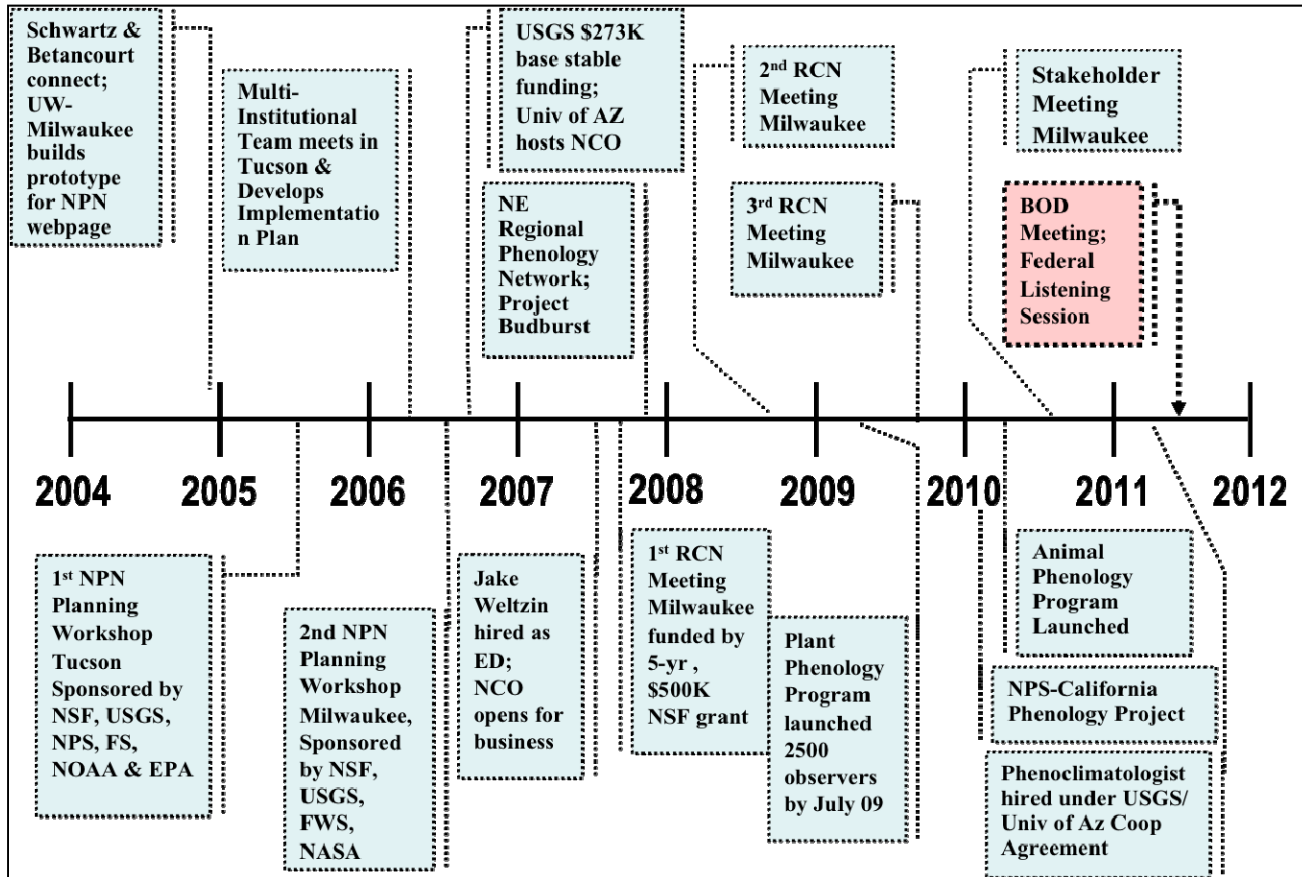
Updated June 1, 2011

APPENDIX B. AGENDA

Agenda
USA-NPN Agency Information and Listening Session
Headquarters of the National Geographic Society, 1145 17th Street NW, Washington, DC
May 4, 2011

9:30 - 10:00 am	Welcome & Introductions
10:00 - 10:45 am	Presentation Status of the Network with Q & A
10:45 - 11:00 am	Break
11:00 - 12:00 pm	Facilitated discussion
12:00 - 1:00 pm	Lunch for informal interactions
1:00 pm	Wrap up
1:00 - 2:00 pm	Informal discussions with Board and Staff

APPENDIX C. HIGHLIGHTS IN THE HISTORY OF THE DEVELOPMENT OF THE NETWORK



APPENDIX D. PRESENTATION SLIDES

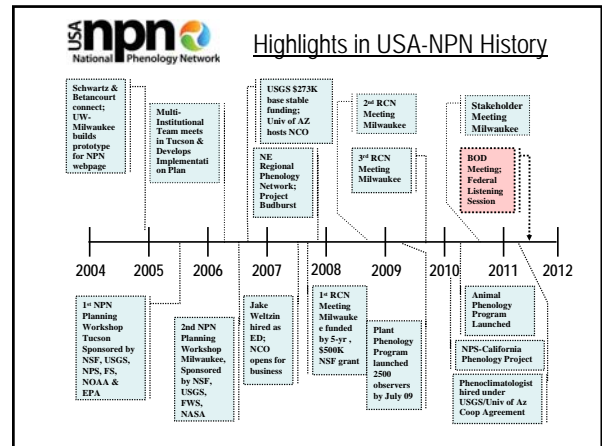
Presentation at the May 4, 2011 Federal Agency Information and Listening Session, National Geographic Society HQ, Washington, DC. Meeting website is www.usanpn.org/ails. Presented by Mark D. Schwartz (History of USA-NPN) and Jake F. Weltzin (rest of presentation). The “Vision for the Future” section consists of 6 example products, envisioned as reports that outline conceptual products and that can be produced relatively quickly and supplemented with implementation plans. These reports would represent collaborations among a variety of organizations/agencies interested in these topics, and could be organized by the USA-NPN National Coordinating Office (NCO). Key stakeholders for each topic would make the major contributions for each report.

The USA National Phenology Network

Phenology for science, management and public engagement in a changing world





www.usanpn.org



Outline

- Importance of phenology
- The National Phenology Network
- Applications, science, engagement
- Major accomplishments
- Vision for the future

Importance of phenology





Timing of life-cycle events of plants and animals:
Causes and consequences

Importance of phenology



Phenology is...

- Easy to observe
- Sensitive to environmental variation
- Scales from 'leaf to globe'
- Linked to ecosystem processes

Importance of phenology

"Phenology...is perhaps the simplest process in which to track changes in the ecology of species in response to climate change." (IPCC 2007)


USA npn National Phenology Network Taking the Pulse of Our Planet

Outline

- Importance of phenology
- The National Phenology Network
- Applications, science, engagement
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USA npn National Phenology Network Taking the Pulse of Our Planet

The Network



A new data resource—a national network of integrated phenological observations across space and time

USA npn National Phenology Network Taking the Pulse of Our Planet

The Network

Key Goal

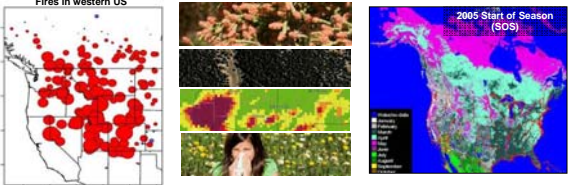
Understand how plants, animals and landscapes respond to environmental variation and climate change



USA npn National Phenology Network Taking the Pulse of Our Planet

Mission

Make phenology data, models, and related information available to scientists, resource managers, and the public



USA npn National Phenology Network Taking the Pulse of Our Planet

Mission

Encourage people of all ages and backgrounds to observe and record phenology



USA npn National Phenology Network Taking the Pulse of Our Planet

Strategic functions

- Develop a national phenology information management system
- Develop partnerships for implementation
- Facilitate phenology science and research
- Facilitate development of decision support tools
- Conduct and facilitate education and outreach
- Develop a national phenology monitoring system



USA npn National Phenology Network Taking the Pulse of Our Planet

Outline

- Importance of phenology
- The National Phenology Network
- **Applications, science, engagement**
- Major accomplishments
- Vision for the future

USA npn National Phenology Network Taking the Pulse of Our Planet

Applications

- Health
- Resource management
- Conservation
- Agriculture
- Understanding hazards
- Recreation

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Science and conservation

Predicting species populations: Vulnerability -vs- invasiveness

Willis et al. 2008 PNAS
Moller et al. 2008 PNAS
Willis et al. 2010 PLOS Biology
Ozgul et al. 2010 Nature
Hulme 2011 New Phyt.

USA npn National Phenology Network Taking the Pulse of Our Planet

Public engagement

- Connect people to nature
- *Nature Deficit Disorder*
- Agency engagement programs
- Formal/informal education
- Climate and science literacy
- Move beyond 'gloom and doom' of climate change

USA npn National Phenology Network Taking the Pulse of Our Planet

Outline

- Importance of phenology
- The National Phenology Network
- Applications, science, engagement
- **Major accomplishments**
- Vision for the future

USA npn National Phenology Network Taking the Pulse of Our Planet

Major accomplishments

Multi-taxa, national-scale monitoring protocols

USA npn National Phenology Network Taking the Pulse of Our Planet

Major accomplishments

Nationally distributed observation sites

3,160 observers at 4,412 sites observing 5,459 organisms
418,731 records from 76,304 observations Feb '11

USA npn National Phenology Network Taking the Pulse of Our Planet

Major accomplishments

Real-time data, metadata and documentation freely available

USA npn National Phenology Network Taking the Pulse of Our Planet

Major accomplishments

Organization of critical historical datasets

USA npn National Phenology Network Taking the Pulse of Our Planet

Major accomplishments

Critical collaborations for implementation

Northeast Temperate Network Inventory & Monitoring Program

Northeast Region National Park Service U.S. Department of the Interior

PROGRAM BRIEF

Acadia NP • Appalachian NST • Boston Harbor Islands NRA • Martha's Vineyard-Rockefeller NHP • Minute Man NHP • Montserrat NHP • Roosevelt-Vanderbilt NPS • Saint-Gaudens NHS • Sagadahoc NHP • Seaside Point NHS • Shenandoah NHP • West Lake NHS

Observing the Rhythms of Nature

Monitoring Phenology in the Northeast Temperate Network


- NPS needs
 - Status and trends
 - Decision-making
 - Public engagement
 - Standard protocols
 - Program integration
- NPN provides
 - Protocols
 - User interface
 - Training materials
 - Data management

USA npn National Phenology Network Taking the Pulse of Our Planet

Outline

- Importance of phenology
- The National Phenology Network
- Applications, science, engagement
- Major accomplishments
- Vision for the future


Phenology as a leading indicator of climate change impacts:
A contribution to the National Climate Assessment



A multi-agency collaboration
USA npn
National Phenology Network

2012

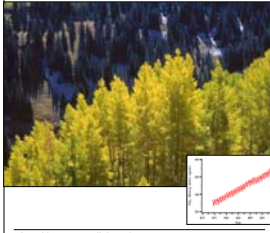
Understanding and managing pests and disease:
Phenology as a conceptual framework for decision-making



A multi-agency collaboration
USA npn
National Phenology Network

2012


Predicting carbon storage in our forests:
Phenology controls timing of the carbon uptake period



A multi-agency collaboration
USA npn
National Phenology Network

2012


Climate-smart monitoring for strategic habitat conservation and vulnerability assessments:
The role of phenology



A multi-agency collaboration
USA npn
National Phenology Network

2012

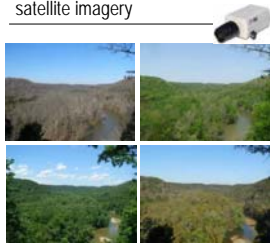
America's Great Outdoors:
Reinvigorating connections in changing environments



A multi-agency collaboration
USA npn
National Phenology Network

2012

A ground- and camera-based observation network for calibration and validation of satellite imagery



A multi-agency collaboration
USA npn
National Phenology Network

2012



The screenshot shows the website's navigation menu (ABOUT, PARTICIPATE, RESOURCES, EDUCATION, RESULTS, ARCHIVE), a search bar, and various content sections including 'Join Us!', 'USA-NPN News', 'Phenology Feed', and 'Join the Conversation'. A 'Visualization Tools' section is also visible. The URL www.usanpn.org is highlighted with a red circle at the bottom of the page.

APPENDIX E. QUESTION & ANSWER SESSION FOLLOWING THE PRESENTATION

Responses from Network Board and Staff are in *italics* and are assumed to be from Jake unless otherwise identified.

Woody Turner: Are you looking system-wide data, or just plants and animals at the organismal level? This is most limiting scale at this point, often the rate-limiting step.

For now, yes, but we are in the process for broadening this scope as we develop ground level information for developing process & models for scaling up, i.e., linking scales.

Chad McNutt: What about marine environments?

Mostly terrestrial for now; we do have some coastal and freshwater fishes currently. But we do want to move toward organizing marine and coastal information.

Tracy Connell Hancock: Is the NPN considering land use change?

Not now; hope to build on what's going on in this area; using maps that exist (land cover and trends) to overlay our data on; and more integration in the future using web services.

Gerald ("Stinger") Guala: How far down the road are you on spatio-temporal modeling?

Don't have the resources right now; but would like to go there; our data is complex; how to do this is something we want to work with partners with. Cornell Lab, NOAA-NCDC data.

David Inouye: *If we have phenological data and can understand how they are changing, and can make predictions, we can then link this to land use change prediction (gave farmer-farm land example).*

Diana Jerkins: Is there a mechanism to transfer data from different, existing systems (LTERs, NEON, and other scientific outlets)?

We want to help organize this coordination of existing data sets & link to phenology data; want to facilitate making those connections; data registry tool; going to meetings. We are curating some historical data sets; helping standardize protocols, bring data sets formerly collected to the light of day. Traditional Ecological Knowledge (TEK) is also something we want to incorporate that will also facilitate working with Tribes.

Mark Schwartz: *We also partner with those who collected historical data sets to continue building on those.*

APPENDIX F. FACILITATED DISCUSSION SESSION NOTES

Guiding questions for discussion

Q1: What are your agency's current and future needs that could be met by USA-NPN?

Q2: What opportunities & resources do you have that could be leveraged to increase the capacity of the Network?

Responses from Network Board and Staff are in *italics*.

Woody Turner: NASA produces coarse resolution data products; these are sometimes limited by good organismal data, place, time & number of organisms; puts our climate data into more of a biological context to better work with managers and others; challenge is to integrate at different spatial scales. NPN needs to think about how this is done with other data products.

Tim Watkins: USA-NPN core functions seem to include facilitating research, education & outreach, partnerships; these are the definitions of the Research Learning Centers. I'm very interested in working with NPN in bringing phenology into parks. One way to do that is to have monitoring system on home computers; but at a park, monitoring could do this side-by-side with experts; this connects people and parks physically in this really exciting citizen science endeavor.

John Gross: *Adding to that, we have a lot of buildings; we have some cameras with an internet connection (each costing ~\$1500); we need more of these; they could pipe data down into visitor center; we can have gold standard species, such as the cloned lilac, outside the door for monitoring; people also can go on a walk to monitor other species as well. This is a great way to leverage technology that's already out there. Where we have those buildings this could be a great way to build the network using both cameras and people.*

Rob Mangold: Comment on earlier presentation. In the future, you're going to have to better design for the kind of phenological datasets we want and need. Are you thinking about finding those gaps, and filling those in a strategic manner, instead of just piling it on by adding in datasets as you can find them, e.g., the Thoreau dataset?

Mark Schwartz: *We have calibration species, cloned lilac and cloned dogwood protocols and standards. A "Network" needs a plan with some design and standards. To date, we've been very inclusive and provide foundations for participation. Now we'd like to expand the Network more strategically.*

Jake Weltzin: *At this point, the observation network across the US is essentially an ad-hoc distribution of points; however, we now have the framework and structure to develop information and national-scale observations; using this, we can develop campaigns for targeting*

specific resource questions (e.g., we could pair with USFS or The Wilderness Society to track bark beetles and tree mortality, or outbreaks of gypsy moth). Is there a particular campaign we can pursue with you?

Rob Mangold: Please focus on climate change questions; we're doing gypsy moth just fine.

Bill Hohenstein: NPN provides a pathway to getting access to phenological information; we'd also like information on how climate change is affecting populations; we're moving beyond planning and research and more towards to implementation and identification of adaptation strategies. So, how do we triage the multiple risks? In short, we need access to good scientific information. In terms of engaging different groups, we need to identify how to use existing government data sets in addition to academic data sets. I'm intrigued by the citizen science component of the Network. As a contributor to Cornell Laboratory of Ornithology's ebird program, I note they have a business strategy that focuses on how to engage most people...iPod apps, etc.

Fred Lipshultz: How are you determining data quality, e.g., through peer review of data? Data used for the (US Global Change Research Program) National Climate Assessment has to be unassailable; it must be of high quality, whether it was derived from citizens or from academics. Validation is also critically important.

Jake Weltzin: *Quality of the data most important for us. Break it down into two components: Quality Assurance (QA) and Quality Control (QC); we've focused on QA, and are developing a system for QC. We are also developing Android and iPhone apps to help with validation through photos; mobile apps such as these give people more of a chance to engage as well; we haven't gotten to the point of external peer review of the dataset. So, we now have a system and tools to collect data; the next step is to determine the proper outlet for review, validation and publication of data. We can flag sources of data; want to build off the approach for QA/QC pioneered by Cornell Lab of Ornithology.*

Mark Schwartz: *We are working on tools to extrapolate and validate phenology data; for example, we link phenology data to weather data; this is similar to the National Weather Service approach of validation (e.g., estimation of a mean within a window of a number of standard deviations); thus, we have this in both principle and practice for phenological data.*

Gary Machlis: By 2020 what might the Network look like? Can you be responsive to national needs, on a near real-time basis, e.g., the oil spill? Will you be like "Google Dirt;" in other words, there is danger of being marginalized if don't include oceans; there are a number of DoD applications that could be quite important, e.g., camophenology, sustainability, global conflicts, national security apparatus; DoD can be a good source of funding. NPN seems to have little or no engagement of industry, but there are a number of industries focused on timing (e.g., vineyards and other agriculture, calendars); they might be good partners and help provide resources.

Diana Jerkins: I'm looking for some mechanism for giving (academically generated) data a longer life; this could be a mechanism for that. What mechanism can we use to engage our investigators to use NPN protocols? We can't just require that level of detail; needs to compliment long-term ecological and agricultural research protocols and datasets; we fund extension and education and consider 5-year windows; could we work together to train extension officers so that data from the county level can be integrated over space and time?

Chad McNutt: Are there lessons learned from other organizations for data quality issues? How about GenBank? And, could this be useful for drought-reporting systems? We are working on a collaboration with CoCoRaHS; we want information on drought impacts to validate drought forecasts.

Julia Washburn: We are working to utilize the resources of NPS to help educate the public and to develop the next generation of Americans to be stewards of our lands; there is a great opportunity to connect the Network with various STEM programs; Department of Education is already working on this – perhaps we can work together to develop applications and implement them with teachers and their students; we can also relate phenology to people in their own backyards as well as in parks. We could also use phenology as a communication tool or instrument to develop dialog with the public on climate change and climate change impacts in a non-confrontational way.

Frank Biasi: We at National Geographic Society (and in the geographic community) need simple compelling stories that we can use to engage hundreds of thousands of people; NGS has access to many media platforms. Is there a way to engage the agricultural and/or rural community? Can the structure of the network inform agricultural non-regulatory monitoring and or data so that this information is useful to this field?

Joe Russo: *Our company deals with this; we have a number of commercial agricultural applications; phenology is a backbone to many of these applications.*

Mark Schwartz: *The historic lilac network which forms the basis for the contemporary Network, was founded in the context of agricultural applications – this is part of why we have such a broadly distributed network with data back to 1954.*

Charlie Walthall: Phenology data would be useful for timing applications, and for adapting to climate change, e.g., by informing for decision-support tools; there is a strong need for a baseline set of data. For example, there is not much baseline for characterization of rangeland. We're engaged with the APHIS and are moving into risk management; thus, we want as much data that can help them do this; I envision needing a combination of satellite data and some species-level data; we also have folks working with NIDIS, mapping evapotranspiration and soil moisture; we could use these phenology data in a research context; we have an experimental watershed network, long term data (since 1910); thus, we could take a long-term approach to collecting and organizing ecological and agricultural data; we are already talking with NEON about this

Danielle Swallow: I was struck by public engagement aspect of the presentation; the Network could be very helpful in helping the federal government engage the public on climate change issues and help the public understand climate change impacts and how it might affect their daily lives.

Gerald (“Stinger”) Guala: USGS is in the process of re-organizing, and there is a renewed interest in biological occurrence data. OBIS and GBIF have 78 million occurrences (270 mill observations); would it be possible to link Network data with GBIF data. It should be relatively trivial to model landscapes when have a critical density of observations. Data quality is always an issue.

Peter McCartney: What’s the international interest in NPN?

Jake Weltzin: *There are a number of well-established and emerging European networks; most are based in agriculture, but are now shifting toward citizen science; we are serving as a model, e.g., by sharing our protocols and integrating them where we can with European protocols. There are few examples in Latin or South America, but Australia and Asia have some new (or very old) efforts. We are participating in international workshops to help push the field forward abroad in terms of monitoring and the sharing of information.*

Julio Betancourt: *As a general comment, we don’t have 30 years to adapt to climate change; most of us realize that we’ll need to be using phenological data and models, and that it’s going to be a while until have sufficient data. As such, we’ll have to use proxies. With these, we can conduct a series of periodic assessments, though we’ll have to build an analytical framework to do this; the Spring Index is one example of a proxy; it is validated with lilac data. We will need to understand how large-scale modes of atmospheric circulation modulate the onset of spring and how this relates to fire, biological invasions, etc. It’s in the national interest to do this, but who should do it? The NCA? The IPCC model runs can’t simulate what’s happening in annual phase of temperature, which is just seasonal timing. The growth of network will depend on the ability for us to develop predictive capability.*