

# *Nature's* Notebook 2010: Data & Participant Summary

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## USA National Phenology Network

# 2010 Data & Participant Summary

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## ABSTRACT

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The USA National Phenology Network (USA-NPN) seeks to engage volunteer observers to collect phenology observations of plants and animals using consistent standards and to contribute to the USA-NPN National Phenology Database (NPDb). The commencement of 2010 marked the second functional year of *Nature's Notebook*, the online phenology observation program developed by the National Coordinating Office (NCO) of the USA-NPN. The addition of animal species for monitoring was a major enhancement to *Nature's Notebook* in 2010.

In 2010, with minimal advertising or marketing, 796 new observers registered with *Nature's Notebook* and 426 observers reported phenology observations on one or more plants or animals via the online interface. Over 200,000 data records were added to the NPDb. Observations were reported on 179 species of plants and 58 species of animals. The plant species most frequently observed include red maple (*Acer rubrum*), quaking aspen (*Populus tremuloides*), American beech (*Fagus grandifolia*), northern red oak (*Quercus rubra*), and flowering dogwood (*Cornus florida*). The animal species most frequently observed were American robin (*Turdus migratorius*), black-capped chickadee (*Parus atricapillus*), American goldfinch (*Carduelis tristis*), bumblebee (*Bombus* spp.), and white-tailed deer (*Odocoileus virginianus*).

As in 2009, participants tended to stay involved, reporting most phenophases for an average of nearly ten unique dates during the year. In addition, nearly two hundred participants who submitted observations in previous years continued to participate in 2010. This sustained participation suggests that the *Nature's Notebook* interface and the status monitoring protocols inherent in *Nature's Notebook* are both conducive to engaging the public and keeping them involved.

Data submitted by *Nature's Notebook* participants show patterns that follow latitude and elevation. Multiple years of observations now allow for year-to-year comparisons within and across species. As such, these data should be useful to a variety of stakeholders interested in the spatial and temporal patterns of plant and animal activity on a national scale; through time, these data should also empower scientists, resource managers, and the public in decision-making and adapting to variable and changing climates and environments. Data submitted to *Nature's Notebook* and supporting metadata are available for download at [www.usanpn.org/results/data](http://www.usanpn.org/results/data). Additionally, data visualization tools are available online at [www.usanpn.org/results/visualizations](http://www.usanpn.org/results/visualizations).

## INTRODUCTION

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The USA-National Phenology Network (USA-NPN) seeks to engage volunteer observers to collect phenological observations of plants and animals using consistent standards and to contribute their observations to a national data repository. To guide the effort, the USA-NPN National Coordinating Office, based in Tucson, Arizona, has developed phenology monitoring protocols and an information management system that houses a data repository, the National Phenology Database (NPDb). In March 2009, the National Coordinating Office staff implemented an online monitoring program, *Nature's Notebook*, for plants. In March 2010, animal monitoring was added to *Nature's Notebook*. This report summarizes the results of the 2010 monitoring season as well as cumulative results and patterns encompassing the 2009 and 2010 monitoring seasons.

### What is 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. The Intergovernmental Panel on Climate Change report (2007) notes that plants and animals respond to changes beyond their tolerances by shifting the timing of life-cycle events, shifting range boundaries, changing morphology, or becoming extirpated or extinct. The report states that “phenology .....is perhaps the simplest process in which to track changes in the ecology of species in response to climate change.” Understanding the phenology of a species includes understanding the influence of seasonal and interannual variation in climate on the life-cycle events and activities of the species.

People have observed and responded to phenological events long before written history as part of their day-to-day activities, yet in the contemporary era people are often unaware of or overlook the importance of phenology in their everyday lives. Current understanding of phenology is important for society to identify how species are responding to climate change and to plan for how these changes might affect activities such as resource management, public health planning, agriculture and range management, and recreational/tourism marketing.

### The USA National Phenology Network

The USA National Phenology Network (USA-NPN; [www.usanpn.org](http://www.usanpn.org)) monitors the influence of climate on the phenology of plants, animals, and landscapes. We do this by encouraging people to observe phenological events and by providing a place for people to enter, store, and share their observations. We also work with researchers to develop tools and techniques to use these observations to support a wide range of decisions made routinely by citizens, managers, scientists and others, including decisions related to allergies, wildfires, water, and conservation.

The USA-NPN is comprised of many partners including federal, state and local agencies, universities, colleges and schools, non-governmental organizations, citizen volunteers, and many others. Our participants range from individual observers making observations in their backyards to professional scientists monitoring long-term plots.

## 2010 STATUS OF *NATURE'S NOTEBOOK*

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2010 marked the second year that *Nature's Notebook* was functional. In early 2010, this program was formally named *Nature's Notebook* and significant enhancements were made to the online user interface. A second major enhancement to *Nature's Notebook* that occurred in late March of 2010 was the addition of monitoring protocols for animals. Species profile pages and protocols were released in March for 58 species representing six taxonomic groups (10 bird species, 9 mammals, 10 fish, 10 insects, 10 amphibians, and 9 reptiles). Additional details on enhancements to the user interface and the monitoring program are in the 2010 documentation for *Nature's Notebook* ([www.usanpn.org/results/nndocumentation](http://www.usanpn.org/results/nndocumentation)) and the 2010 Annual Report (USA-NPN 2011).

In the 2010 release of *Nature's Notebook*, participants could 1) register as an observer; 2) register one or more sites where they are observing plant or animal phenology; 3) register one or more individual plants under observation; 4) create a checklist of animals they intend to observe; and 5) enter phenology observations on plants and animals in an integrated online user interface. This differs from the 2009 release of *Nature's Notebook* by allowing monitoring of animals in addition to plants.

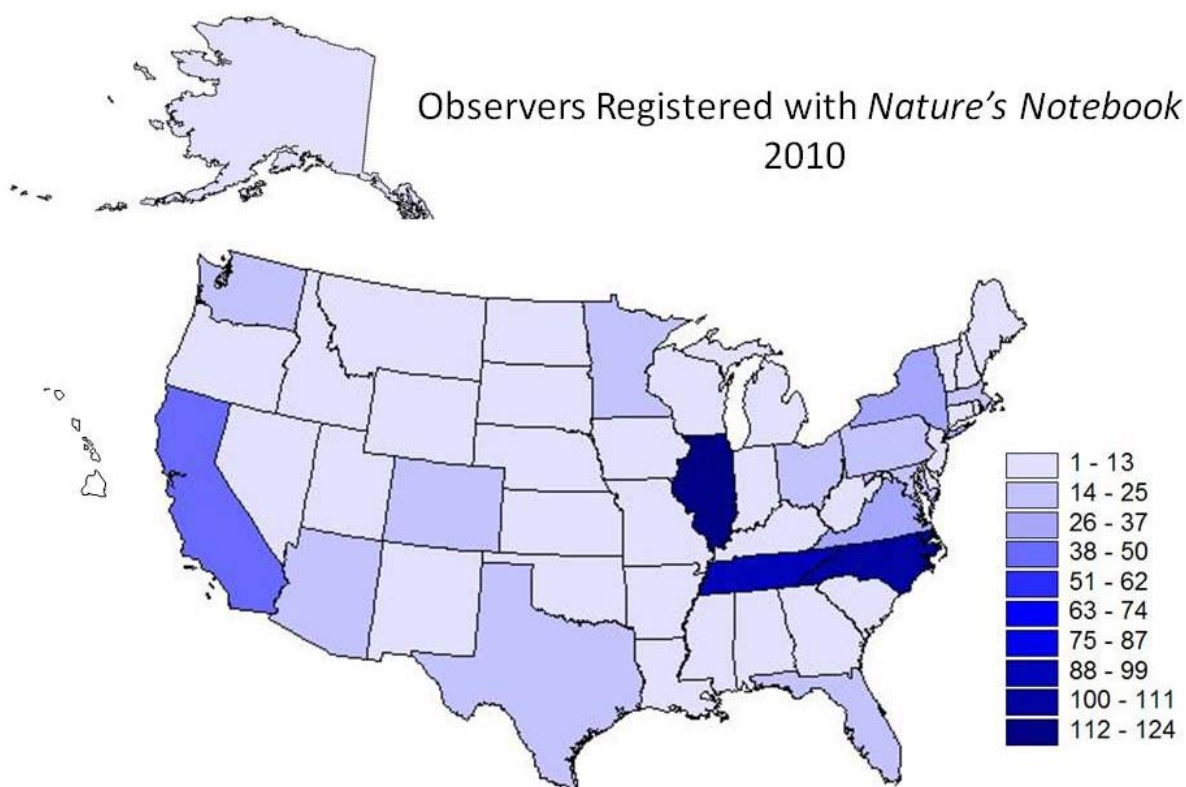
In both 2009 and 2010, individuals participating in *Nature's Notebook* followed species-specific protocols consisting of a suite of **phenophases**, or observable stages or phases in the annual life cycle of plants or animals that can be defined by a start and end point. Each organism has a suite of potential phenophases that can be observed at each sample date. USA-NPN phenology protocols employ phenological “status” monitoring, rather than “event” monitoring. On each visit to their site, the observer indicates the status of each phenophase for an individual plant or an animal species with a ‘yes’ if the phenophase is occurring and ‘no’ if it is not. Monitoring protocols, phenophases, and general species descriptions are provided via species profile pages on the USA-NPN website. Details of this system and monitoring protocols implemented for the 2010 growing season are provided at [www.usanpn.org/results/nndocumentation](http://www.usanpn.org/results/nndocumentation).

As plant and animal protocols were still expected to see modifications in advance of the 2011 growing season, both 2009 and 2010 were treated as “beta” data collection years. Accordingly, the NCO limited advertisement of the program, planning instead for a major launch in 2011. The program was advertised via email newsletters and public presentations, but no press releases or major nation-wide advertising campaigns were undertaken.

Data submitted to *Nature's Notebook* and supporting metadata are available for download at [www.usanpn.org/results/data](http://www.usanpn.org/results/data). Additionally, data visualization tools are available online at [www.usanpn.org/results/visualizations](http://www.usanpn.org/results/visualizations).

## 2010 PARTICIPATION SUMMARY

Between January 1, 2010 and December 31, 2010, **796 individuals registered** as observers with *Nature's Notebook*. While all states except Hawaii have registered participants, the states showing the greatest numbers of new participants are Illinois, North Carolina, and Tennessee.



**Figure 1.** Observers registering with *Nature's Notebook* by state in 2010.

In 2010, **426 observers reported phenology observations** for one or more plant or animal species. Thirty-three percent of the observers that registered in 2010 reported information on at least one species.

### Plants

*Nature's Notebook* participants provided phenology observations on 179 species of plants (out of a species list of 257 possible species for monitoring) (Appendix A). The top 5 plant species for which observations were most commonly submitted were red maple (*Acer rubrum*; 86 observers tracking 150 plants), common lilac (*Syringa vulgaris*; 107 observers and 140 plants), Red Rothomagensis lilac (*Syringa*

*chinensis*; 66 observers and 130 plants), American beech (*Fagus grandifolia*; 25 observers tracking 111 individual plants), common dandelion (*Taraxacum officinale*; 68 observers tracking 80 individual plants).

## Animals

*Nature's Notebook* observers across the nation provided data on all 58 species of animals for which protocols were available in 2010, indicating a great enthusiasm on the part of our participants to collect data on animals (Appendix B). The top 5 animal species for which observations were most commonly reported included American robin (*Turdus migratorius*; 59 observers reporting), bumblebee (*Bombus* spp.; 41 observers reporting); black-capped chickadee (*Poecile atricapillus*; 31 observers reporting); American goldfinch (*Carduelis tristis*; 29 observers reporting), and white-tailed deer (*Odocoileus virginianus*; 25 observers reporting).

## Plants and Animals

On average, each individual participant reported phenology observations for nearly ten unique dates in 2010. In total, USA-NPN observers submitted 27,258 observations (an observation is a report of a suite of phenophases for an individual plant or animal on a given day and includes from 3 to 10 phenophase status records, depending on the species), resulting in 200,686 phenophase status records added to the NPDb (Table 1).

## PLACING 2010 INTO HISTORICAL CONTEXT

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Tables 1 and 2 summarize several metrics of participation in *Nature's Notebook* over the duration of the program's existence. The 2010 observing period was characterized by lower numbers of observers registering and reporting than in 2009 (Table 1). In contrast, the number of days that participants logged observations increased in 2010. Likewise, the number of observations reported and the resulting total number of records added to the NPDb increased by 53% and 31%, respectively (Table 1).

The drop in individuals registering with *Nature's Notebook* in 2010, approximately 55% of that in 2009 after accounting for the lilac observers added to the system in 2009 (Table 1), was likely a function of less program advertisement in 2010. In early 2009, *Nature's Notebook* had been featured on the National Public Radio show *Science Friday with Ira Flatow*, which resulted in a large spike in registrants in 2009 (Crimmins et al. 2010). However, despite this sharp drop in registering observers, the number of observers reporting observations remained relatively steady. This combined with increases of 53% in the number of observations reported and 31% in the resulting total number of records added to the NPDb, indicates that the observers that are joining and remaining an active part of *Nature's Notebook* are participating more intensively than in previous years.

**Table 1.** *Nature's Notebook* participation summary, 2008-2010.

	2008	2009	2010	Cumulative
Registered observers	94	2,155*	796	<b>3,045</b>
Observers reporting	38	552	426	<b>865<sup>a</sup></b>
Days observed per observer	5.2±10.3	9.3±12.8	9.8±15.7	<b>11.4±20.2</b>
Registered sites <sup>b</sup>	-	-	-	<b>4,293</b>
Percent of registered observers reporting <sup>c</sup>	11%	25%	31%	<b>27%</b>
Total observations	2,521	17,825	27,258	<b>47,604</b>
Total records	18,059	152,619	200,686	<b>371,364</b>

\*Figure includes approximately 700 lilac observers imported into *Nature's Notebook*.

<sup>a</sup>Cumulative total is smaller than the sum of 2008-2010 totals due to some observers reporting in multiple years.

<sup>b</sup>Prior to 2011, the date a site was registered was not recorded in the National Phenology Database.

<sup>c</sup>Of the observers who registered in each year, this is the percent that reported observation data for that same year. The figures do not include observers who registered in a previous year and continued to report in subsequent years.

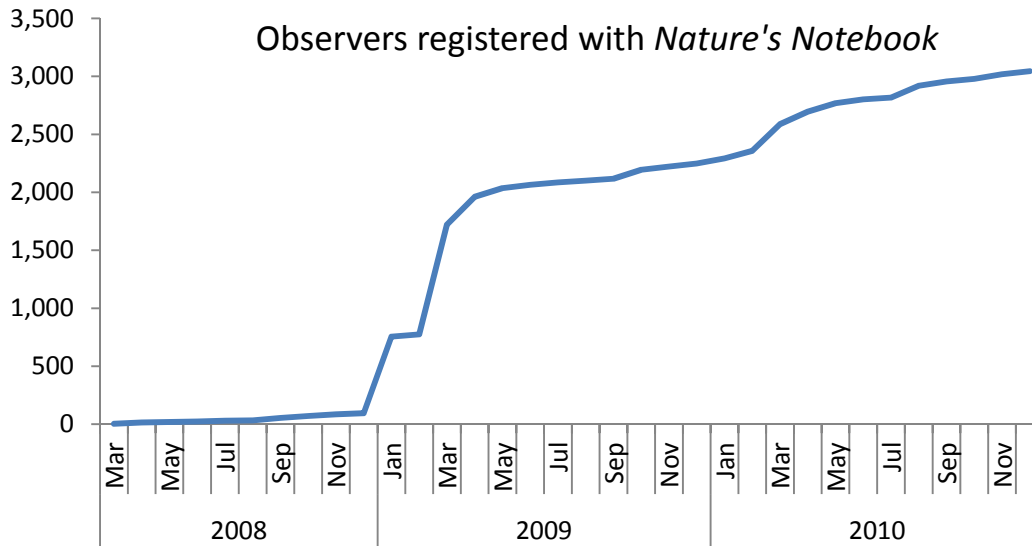
Table 2 summarizes the number of individual plants, animals, and total organisms (plant and animals combined) observed per observer. Observed organisms are those registered plants and animals which have at least one submitted observation in the given year. The high values shown for 2008 reflect very low numbers of active observers; the few observers that did enter data into the NPDb in 2008 were very engaged observers that tracked many individual plants. Data for 2009 and 2010 better reflect “typical” *Nature's Notebook* observers. The numbers of both plants and animals tracked by observers increased from 2009 to 2010 (Table 2). Interestingly, it seems that observers favor either plants or animals, rather than tracking both, as reflected in the average *total* organisms observed per observer.

**Table 2.** Active *Nature's Notebook* participant statistics, 2008-2010.

	2008	2009	2010	Average
Average individual plants observed per observer	10.7	3.8	4.9	<b>4.5</b>
Average animals observed per observer	2.0 <sup>a</sup>	2.2 <sup>a</sup>	5.2	<b>5.0</b>
Average total organisms observed per observer	10.5 <sup>a</sup>	3.9	5.8	<b>5.0</b>

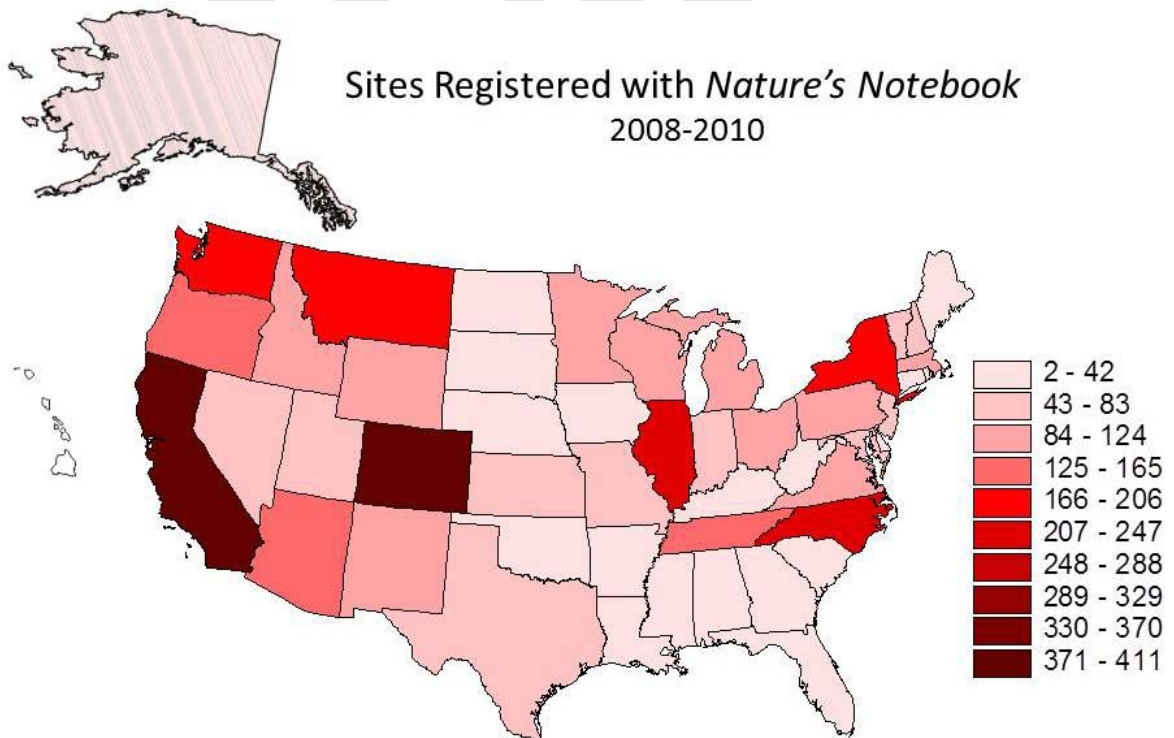
<sup>a</sup>Though animal protocols were not available until 2010, *Nature's Notebook* observers have logged observations of animals for 2008 and 2009.

Growth in observers registered with *Nature's Notebook* shows both seasonal and yearly patterns (Figure 2). The base in January 2009 represents nearly 700 observers in an historic lilac observation program ([www.usanpn.org/lilac](http://www.usanpn.org/lilac)) who were incorporated into the NPDb in January 2009. The large increase in March 2009 was primarily due to a press release and the appearance of the USA-NPN Executive Director on NPR's *Science Friday*. The program experienced steady growth over 2010, and showed the greatest rates of growth in advance of the spring (March) and fall (August) months.



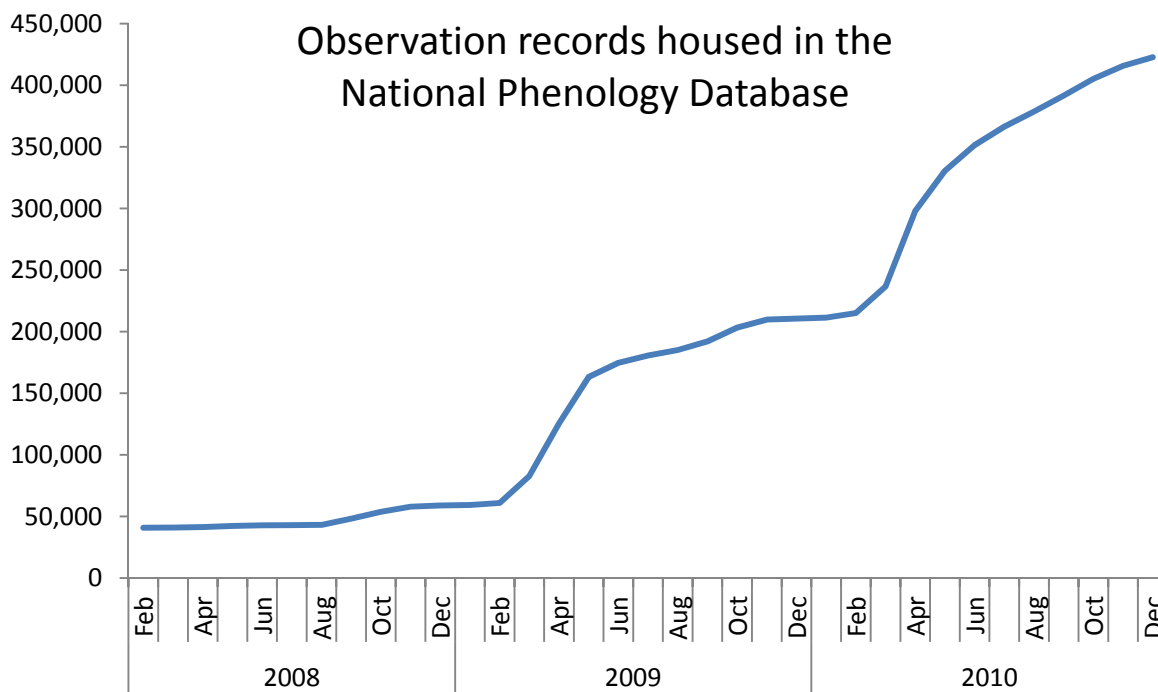
**Figure 2.** Cumulative graph of observers registered with *Nature's Notebook*. Observers registered in January, 2009 include the nearly 700 observers in an historic lilac observation program ([www.usanpn.org/lilac](http://www.usanpn.org/lilac)) incorporated into the National Phenology Database.

Figure 3 shows the spatial patterns in sites that have been registered with *Nature's Notebook* since the program's inception. The states with the greatest numbers of registered sites include California and Colorado, followed by Illinois, North Carolina, and New York.



**Figure 3.** Sites registered with *Nature's Notebook* since the program's inception.

The quantity of observations submitted to the National Phenology Database also shows seasonal patterns, with the most rapid rates of increase occurring in the spring seasons (Figure 4). The total number of records submitted each year is steadily growing.



**Figure 4.** Observation records entered into the National Phenology Database since the inception of *Nature's Notebook*.

### Partner organizations

When participants register with *Nature's Notebook*, they are given the opportunity to self-identify with some of the organizations with which the USA-NPN has an established relationship. In 2010, the USA-NPN allowed users to self-identify with a number of other organizations, ranging from citizen-science programs explicitly monitoring phenology as part of a separate affiliate program (e.g., the Great Sunflower Project, Project BudBurst), to organizations established to use *Nature's Notebook* (PennPhen, Signs of the Seasons) to projects that use *Nature's Notebook* as part of a broader programmatic focus (RMSSN Academy, National Park Service, The Nature Conservancy, The Wilderness Society; Table 3). While these numbers are low, they nonetheless suggest that *Nature's Notebook* already has attracted participants from a number of established citizen science and conservation programs. In the future, the NCO plans to conduct targeted campaigns designed to encourage broad participation from partner organizations as a way to develop and coordinate future collaborations.

Despite the small numbers of individuals affiliating themselves with various partner organizations, some of these partnerships have yielded significant amounts of data. In particular, the Rocky Mountain Science and Sustainability Network, a summer program for undergraduate students, has proven to be a very worthwhile investment for the NCO and USA-NPN, yielding over 400 phenology observations in 2010.

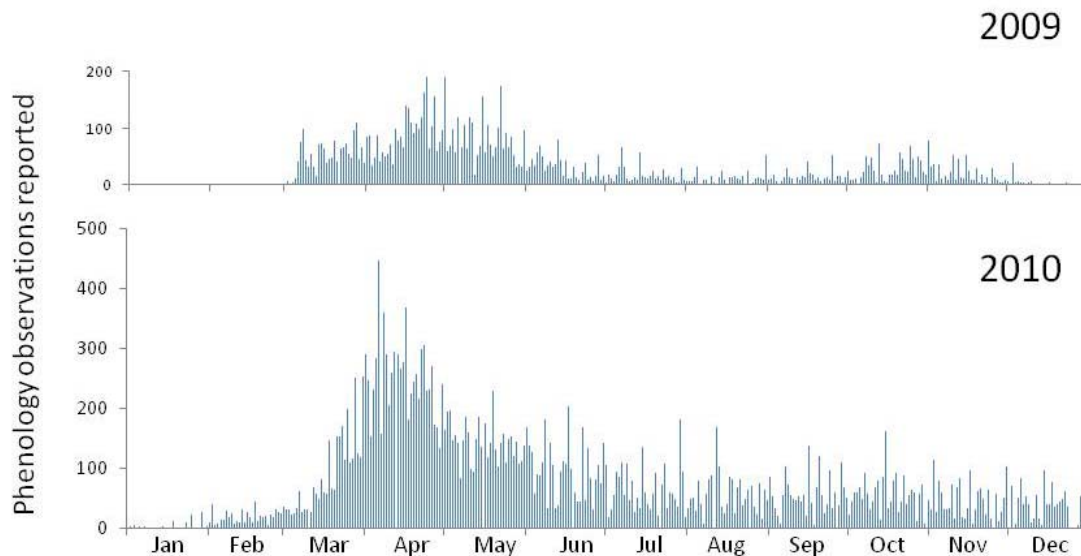
**Table 3.** Number of observers affiliating themselves with the respective partner organizations at the point of registration in 2010 and data submitted to the NPDb in 2010.

Partner organization	Affiliated observers	Observations submitted to NPDb
RMSSN Academy	17	420
Project BudBurst	13	110
Great Sunflower Project	12	27
National Park Service	8	55
The Nature Conservancy	5	0
Monarch Watch	4	47
The Wilderness Society	2	0
HoneyBeeNet	2	1
Signs of the Seasons	1	2
PennPhen	1	0

## TEMPORAL PATTERNS IN PARTICIPATION

Total observations reported by day in both 2009 and 2010 are presented in Figure 5. In both years, participants reported many observations in spring (April through early June). However, unlike 2009, a second peak in observations is not very apparent in the fall of 2010.

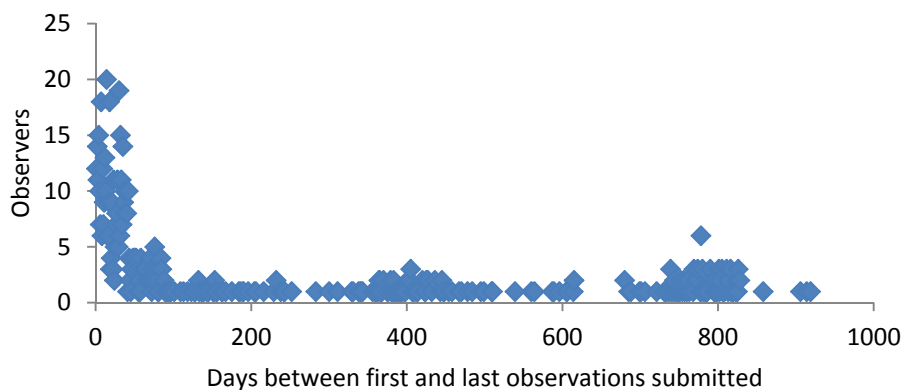
The number of observations reported in 2010 was much higher than in 2009. This could reflect both the addition of animal observations as well as a deeper commitment by observers, manifest as more data submitted to the NPDb. Alternatively, the USA-NPN observer newsletters ([www.usanpn.org/newsletters](http://www.usanpn.org/newsletters)), which were initiated in fall 2009 and perhaps kept the observing community more engaged, could explain this increase.



**Figure 5.** Phenology observations reported via *Nature's Notebook* in 2009 and 2010.

Of the 2,249 observers who registered with *Nature's Notebook* prior to 2010 (Table 1), 180 (8%) submitted observations in 2010. Though this number is small, it is not out of the range of retention rates reported for similar citizen science projects (G. LeBuhn, personal communication 2010; Gallo and Waitt 2011).

Over the period encompassing 2009 and 2010, participants remained active for 41 days, on average. Active participation was calculated as the number of days between an observer's first and last reported observation. However, 20% of participants remained active for longer than 365 days; these are observers that first participated in *Nature's Notebook* in 2008 or 2009 and then submitted subsequent observations in the following year(s) (Figure 6).



**Figure 6.** Duration over which participants remained active in *Nature's Notebook*, calculated as the duration of time (in days) between an observer's first and last reported observation over the period from January 1, 2008 to December 31, 2010.

## EXAMPLE RESULTS

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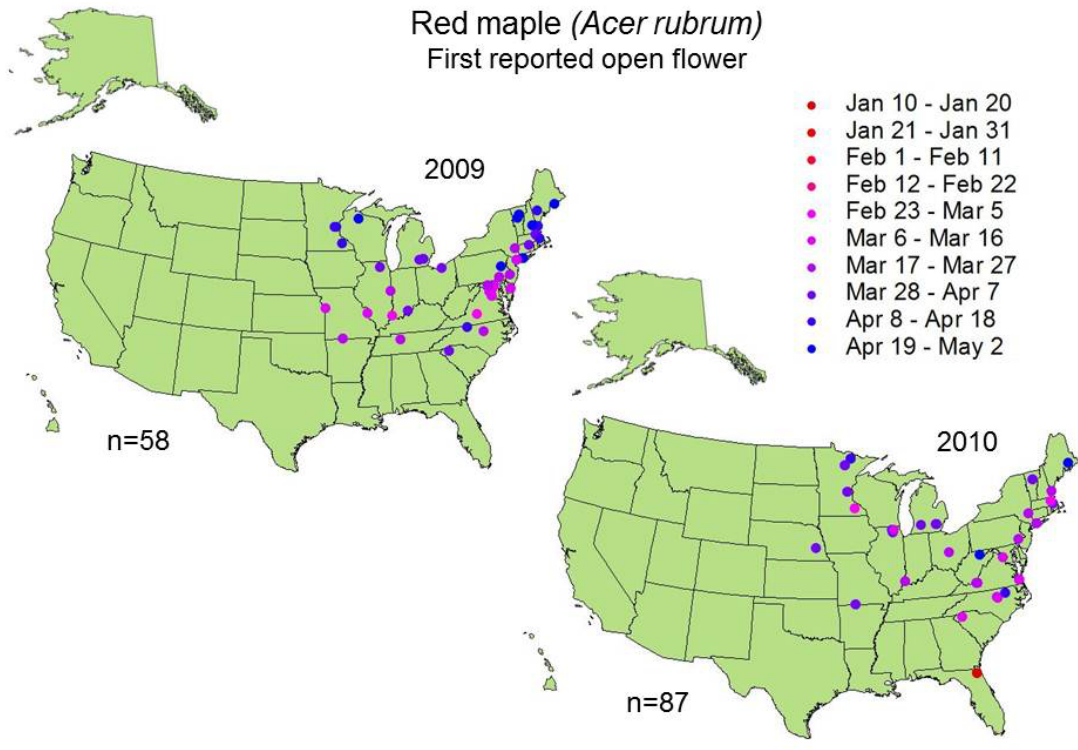
### Spatial Patterns

Figures 7 through 13 display the first reported date for selected phenophases and species by site. Figures depicting plants present data for 2009 and 2010. Overall, patterns based on latitude and elevation are apparent (Figures 7-9), with leafing and flowering occurring later at higher latitudes. Patterns in animal species are more mixed, and may reflect the later initiation of monitoring for these species in the pilot year of the animal program. Dates that occur late in the growing season are more likely an artifact of an observer not beginning observation until that date than the actual first occurrence of the phenophase. Plants and animals at sites where observations were not initiated until after the start of the growing season were not screened out for this analysis.

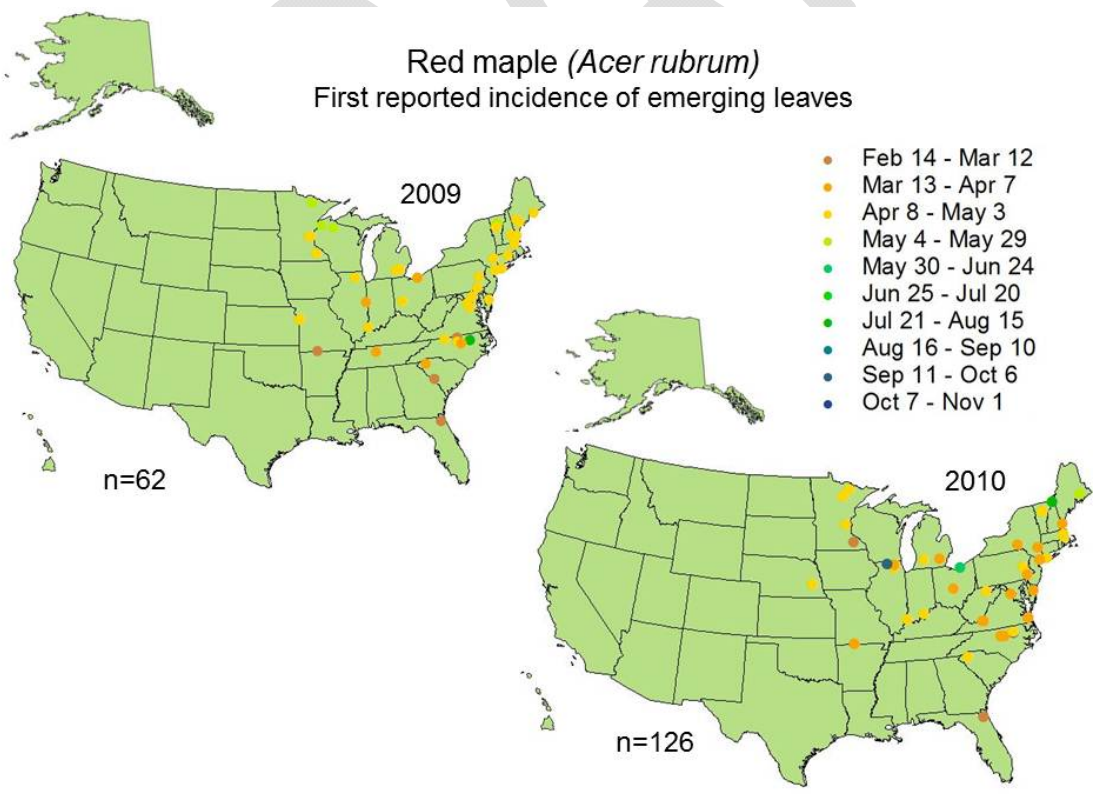
Figure 7 presents first reported dates of open flowers for red maple (*Acer rubrum*). There was no difference between dates reported in 2009 (DOY  $88 \pm 23$ ; mean  $\pm$  1SD) and 2010 (DOY  $89 \pm 18$ ; student's t-test,  $p > .05$ ). Figure 8 presents first reported dates of emerging leaves for red maple. As with flowers, there was no difference in the dates reported in 2009 (DOY  $109 \pm 23$ ) and 2010 (DOY  $102 \pm 30$ ; student's t-test,  $p > .05$ ).

The first reported incidence of open flowers in forsythia (*Forsythia* spp.) is presented in Figure 9. For the nation, dates reported in 2010 (DOY  $97 \pm 32$ ) were earlier than those reported in 2009 (DOY  $82 \pm 17$ ; student's t-test,  $p = 0.0091$ ).

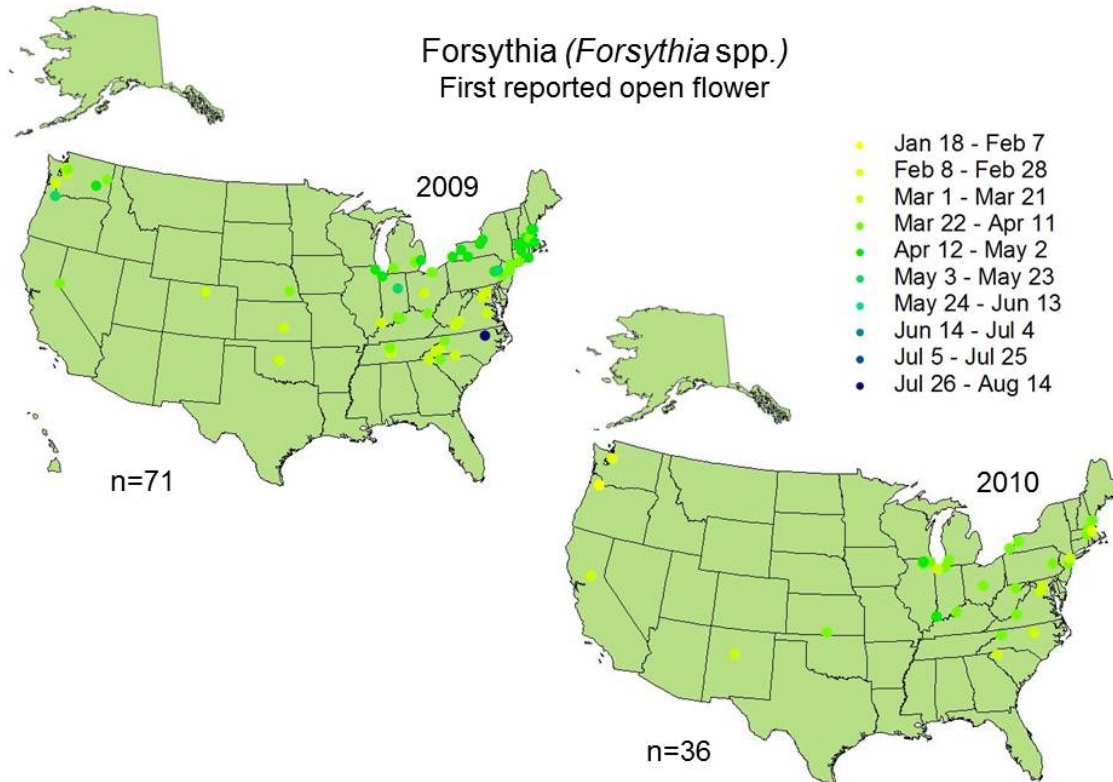
Figures 10 and 11 present first reported incidences of call or song and nest building for American robins (*Turdus migratorius*) in 2010. The first reported incidence of call or song in 2010 for black-capped chickadees (*Parus atricapillus*) appears in Figure 12. Finally, Figure 13 presents the first reported incidence of bumblebee (*Bombus* spp.) visits to flowers.



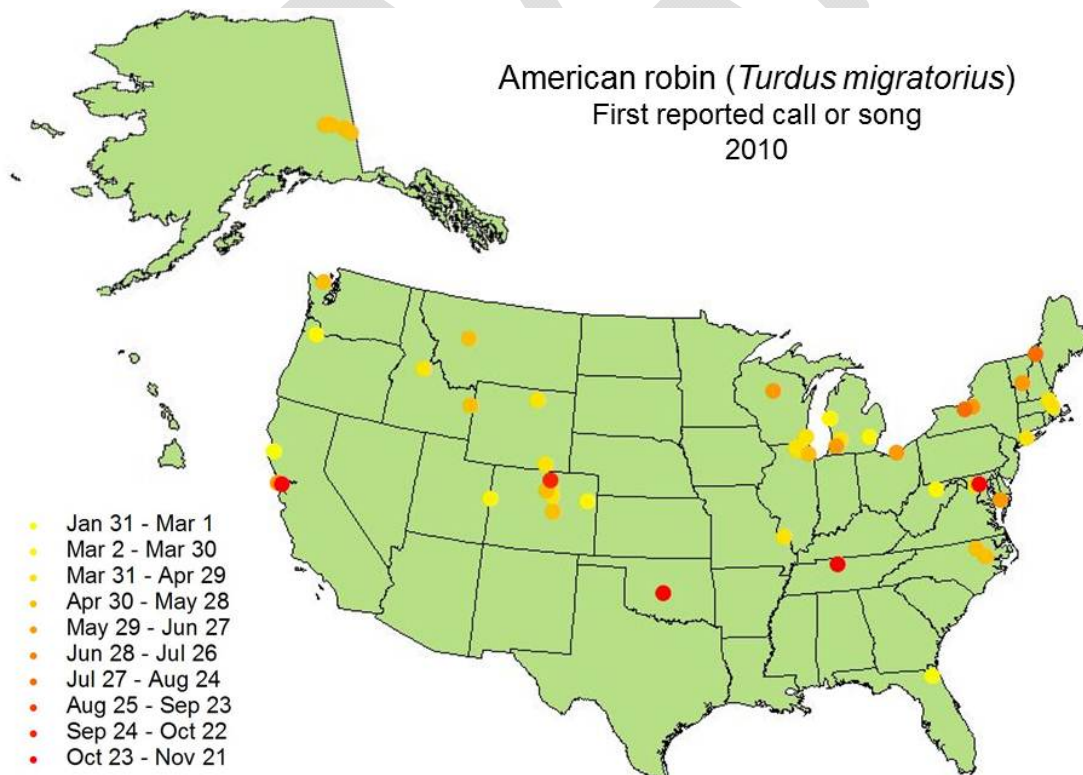
**Figure 7.** First reported date of open flowers, red maple (*Acer rubrum*), 2009 and 2010.



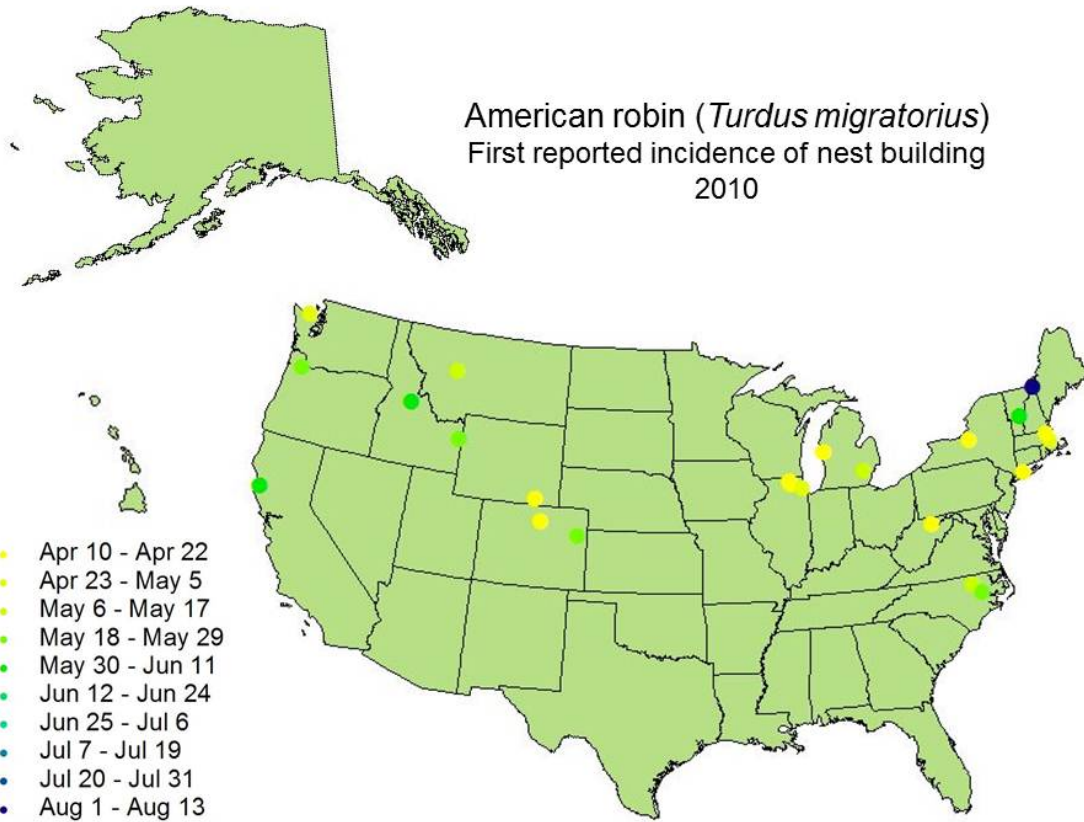
**Figure 8.** First reported date of emerging leaves, red maple (*Acer rubrum*), 2009 and 2010.



**Figure 9.** First reported date of open flowers, forsythia (*Forsythia* spp.), 2009 and 2010.



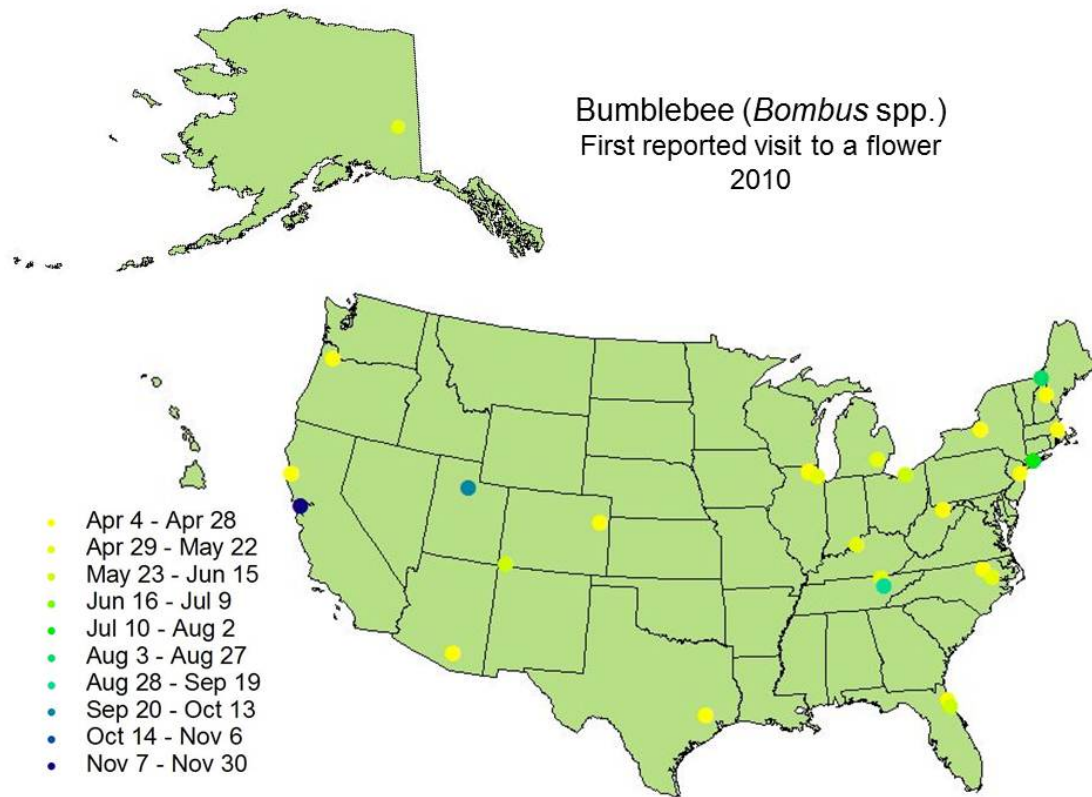
**Figure 10.** Date of first reported call or song, American robin (*Turdus migratorius*), 2010.



**Figure 11.** Date of first reported incidence of nest building, American robin (*Turdus migratorius*), 2010.



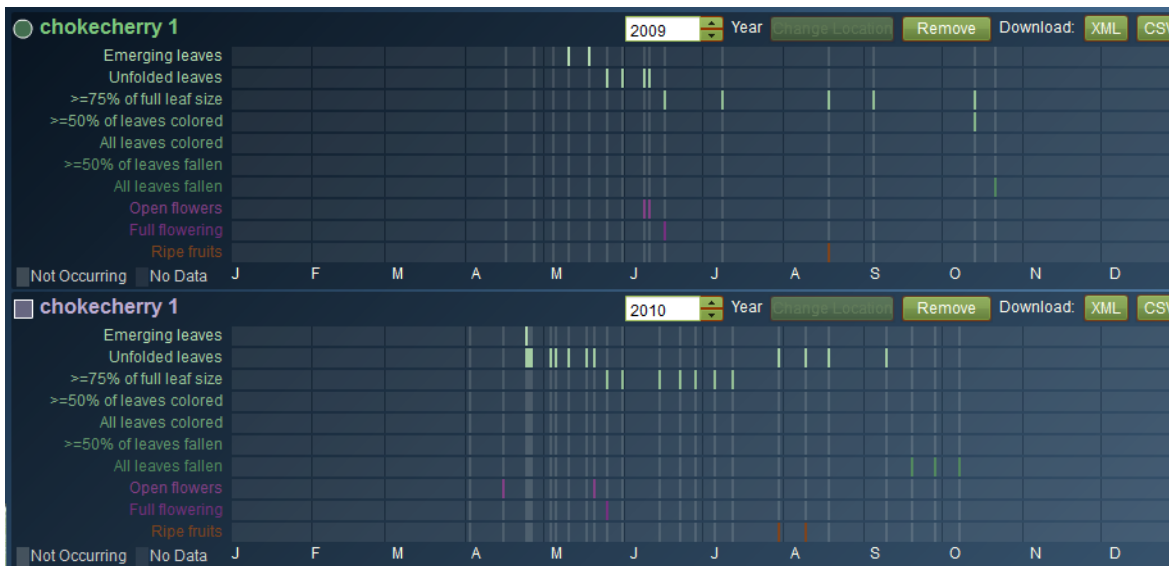
**Figure 12.** Date of first reported call or song, black-capped chickadee (*Poecile atricapillus*), 2010.



**Figure 13.** Date of first reported visit to flowers, bumblebees (*Bombus* spp.), 2010.

## Temporal Patterns

Phenology observations housed in the NPDb also reveal temporal patterns. The data shown in Figure 14, collected at a site in northern Minnesota over two years, show that this chokecherry individual put on leaves and flowers earlier in the season in 2010 than in 2009.



**Figure 14.** Visualization of data reported for a chokecherry tree in northern Minnesota, 2009-2010, at site “Wolfhaut Prairie.” Data visualizations available on USA-NPN website at [www.usanpn.org/results/visualizations](http://www.usanpn.org/results/visualizations).

## CONCLUSIONS

*Nature’s Notebook*, the online phenology observation program developed by the National Coordinating Office of the USA-NPN, continues to grow in participants, observations submitted, and species available for observation. A major enhancement to *Nature’s Notebook* in 2010 included the addition of animals.

Despite minimal advertising or marketing of *Nature’s Notebook* in 2010, nearly 800 new observers joined the program and new and existing observers submitted over 200,000 phenology records to the National Phenology Database (NPDb). In this pilot year of animal phenology monitoring, *Nature’s Notebook* observers across the nation provided data on all 58 species of animals for which protocols were available in 2010, indicating a great enthusiasm on the part of our participants to collect data on animals.

*Nature’s Notebook* participants tended to remain enthusiastic about the program throughout 2010, reporting observations for an average of nearly 10 unique dates. In addition, about 8% of observers that registered prior to 2010 reported data in 2010, a retention rate similar to that reported for other citizen science projects. This suggests that the online interface and status monitoring are both conducive to

engaging the public and keeping them involved in the project and engaged in participatory monitoring and outdoor activities.

Partnerships are essential to the long-term success of the USA National Phenology Network, in part because these partner organizations can provide participants in the USA-NPN monitoring program while also meeting their own strategic goals (e.g., engagement of public in science activities, contributing information to facilitate understanding and adaptation to climate change). Collaboration with partner organizations in 2010 resulted in generally small numbers of individuals joining *Nature's Notebook*; however some of these partnerships resulted in hundreds of observations in the NPDb. We will continue to foster partner relationships such as these, recognizing their value to contribute large quantities of data and also gain valuable insights from the data and results we can provide.

Finally, the data collected by participants show interesting patterns of plant and animal phenology on regional to national scales that are commensurate with our understanding of climatological gradients associated with latitude, longitude, elevation and degree of continentality. As such, these data should be useful to a variety of stakeholders interested in the spatial and temporal patterns of plant and animal activity on a national scale; through time, these data should also empower scientists, resource managers, and the public in decision-making and adapting to variable and changing climates and environments.

## REFERENCES

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## CONTRIBUTIONS & ACKNOWLEDGMENTS

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TMC performed data analysis and drafted the text. AHR designed data queries and output. RLM performed data queries. EGD and CFE reviewed drafts and contributed to framing questions. JFW provided revisions to the structure of the document.

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The logo for usanpn.org features the text "usanpn.org" in a lowercase, sans-serif font. The letters are colored: 'u' is green, 's' is orange, 'a' is blue, 'n' is green, 'p' is orange, 'n' is blue, and '.org' is blue. A large, faint, light-gray watermark of the letters "DNR" is visible in the background behind the logo.

## APPENDIX A. 2010 PLANT DATA SUMMARY

Number of observers, individual plants observed, observations, and phenophases status records in the National Phenology Database (NPDb) by plant species for 2010. Observers and registered plants with no reported observations are not included in the tally. An observation is a report of a suite of phenophases for an individual plant on a given day and includes from 3 to 10 phenophases status records, depending on the species.

Common Name	Scientific name	Number of observers	Individual plants observed	Observations	Phenophase status records
red maple	<i>Acer rubrum</i>	86	150	1906	19190
quaking aspen	<i>Populus tremuloides</i>	30	69	1204	12100
American beech	<i>Fagus grandifolia</i>	25	111	1125	11390
northern red oak	<i>Quercus rubra</i>	16	40	773	7810
flowering dogwood	<i>Cornus florida</i>	41	67	709	7120
common lilac	<i>Syringa vulgaris</i>	107	148	1366	7010
Red Rothomagensis lilac	<i>Syringa chinensis</i>	66	130	1252	6425
forsythia	<i>Forsythia spp.</i>	43	48	770	6160
sugar maple	<i>Acer saccharum</i>	30	53	531	5320
black cherry	<i>Prunus serotina</i>	11	26	499	5052
chokecherry	<i>Prunus virginiana</i>	19	28	465	4730
eastern redbud	<i>Cercis canadensis</i>	21	33	403	4050
paper birch	<i>Betula papyrifera</i>	18	28	374	3752
tuliptree	<i>Liriodendron tulipifera</i>	13	25	307	3170
tamarack	<i>Larix laricina</i>	2	8	314	2934
common dandelion	<i>Taraxacum officinale</i>	68	80	567	2850
highbush blueberry	<i>Vaccinium corymbosum</i>	4	10	284	2840
Virginia strawberry	<i>Fragaria virginiana</i>	14	24	550	2750
redosier dogwood	<i>Cornus sericea</i>	12	16	269	2710
white ash	<i>Fraxinus americana</i>	12	19	256	2680
Canadian serviceberry	<i>Amelanchier canadensis</i>	7	11	265	2670
white oak	<i>Quercus alba</i>	14	22	259	2590
Saskatoon serviceberry	<i>Amelanchier alnifolia</i>	4	11	249	2490
common snowberry	<i>Symphoricarpos albus</i>	6	12	213	2130
boxelder	<i>Acer negundo</i>	11	17	201	2024

pignut hickory	<i>Carya glabra</i>	3	14	191	1930
sweetgum	<i>Liquidambar styraciflua</i>	7	8	158	1650
staghorn sumac	<i>Rhus hirta</i>	1	19	160	1600
black elderberry	<i>Sambucus nigra</i>	6	15	159	1600
bunchberry dogwood	<i>Cornus canadensis</i>	8	15	351	1404
common buttonbush	<i>Cephalanthus occidentalis</i>	2	4	136	1370
balsam fir	<i>Abies balsamea</i>	6	11	268	1345
yellow marsh marigold	<i>Caltha palustris</i>	6	11	237	1210
black walnut	<i>Juglans nigra</i>	10	12	119	1190
Tatarian honeysuckle	<i>Lonicera tatarica</i>	7	12	233	1180
green ash	<i>Fraxinus pennsylvanica</i>	7	11	117	1170
black spruce	<i>Picea mariana</i>	5	9	219	1135
yellow birch	<i>Betula alleghaniensis</i>	4	9	110	1116
paradise apple	<i>Malus pumila</i>	6	9	101	1010
beaked hazelnut	<i>Corylus cornuta</i>	3	6	97	974
gray alder	<i>Alnus incana</i>	2	9	95	970
bur oak	<i>Quercus macrocarpa</i>	7	8	92	920
eastern white pine	<i>Pinus strobus</i>	11	17	182	915
American plum	<i>Prunus americana</i>	6	9	88	890
kinnikinnick	<i>Arctostaphylos uva-ursi</i>	6	9	218	872
bluebunch wheatgrass	<i>Pseudoroegneria spicata</i>	3	8	137	710
switchgrass	<i>Panicum virgatum</i>	9	12	140	700
Douglas-fir	<i>Pseudotsuga menziesii</i>	4	6	140	700
loblolly pine	<i>Pinus taeda</i>	7	9	139	695
jack in the pulpit	<i>Arisaema triphyllum</i>	10	13	172	692
jewelweed	<i>Impatiens capensis</i>	2	3	135	675
wrinkleleaf goldenrod	<i>Solidago rugosa</i>	1	15	134	670
common yarrow	<i>Achillea millefolium</i>	4	9	130	650
bluebead	<i>Clintonia borealis</i>	1	4	129	645
Canada thistle	<i>Cirsium arvense</i>	11	13	121	610
saguaro	<i>Carnegia gigantea</i>	7	18	198	594
eastern pasqueflower	<i>Pulsatilla patens</i>	5	7	117	585
buffelgrass	<i>Pennisetum ciliare</i>	1	6	117	585

leatherleaf	<i>Chamaedaphne calyculata</i>	1	3	117	585
common milkweed	<i>Asclepias syriaca</i>	6	11	115	580
bog Labrador tea	<i>Ledum groenlandicum</i>	1	3	114	570
eastern purple coneflower	<i>Echinacea purpurea</i>	12	18	112	560
Virginia springbeauty	<i>Claytonia virginica</i>	3	6	109	560
rugosa rose	<i>Rosa rugosa</i>	1	2	56	560
red columbine	<i>Aquilegia canadensis</i>	5	9	110	550
ocotillo	<i>Fouquieria splendens</i>	4	9	177	531
Virginia bluebells	<i>Mertensia virginica</i>	4	6	102	520
mayapple	<i>Podophyllum peltatum</i>	9	9	100	510
ponderosa pine	<i>Pinus ponderosa</i>	8	9	102	510
big bluestem	<i>Andropogon gerardii</i>	8	12	100	500
striped maple	<i>Acer pensylvanicum</i>	3	4	48	480
Canada mayflower	<i>Maianthemum canadense</i>	4	7	88	440
American witchhazel	<i>Hamamelis virginiana</i>	6	6	44	440
dogtooth violet	<i>Erythronium americanum</i>	5	6	88	440
common persimmon	<i>Diospyros virginiana</i>	1	2	44	440
bald cypress	<i>Taxodium distichum</i>	3	4	48	432
blue grama	<i>Bouteloua gracilis</i>	6	8	84	425
diamondleaf willow	<i>Salix planifolia</i>	2	3	42	420
white trillium	<i>Trillium grandiflorum</i>	3	5	81	405
Lewis' mock orange	<i>Philadelphus lewisii</i>	2	2	40	400
eastern redcedar	<i>Juniperus virginiana</i>	9	17	124	372
coastal plain willow	<i>Salix caroliniana</i>	1	2	35	350
common buckthorn	<i>Rhamnus cathartica</i>	2	2	34	340
creeping barberry	<i>Mahonia repens</i>	2	2	68	340
citrus	<i>Citrus spp.</i>	3	5	66	330
balsam poplar	<i>Populus balsamifera</i>	2	2	33	330
creosote bush	<i>Larrea tridentata</i>	4	9	82	328
bitter cherry	<i>Prunus emarginata</i>	3	4	32	320
dwarf birch	<i>Betula nana</i>	2	2	32	320
shagbark hickory	<i>Carya ovata</i>	6	6	31	310
Rocky Mountain maple	<i>Acer glabrum</i>	1	1	31	310

Woods' rose	<i>Rosa woodsii</i>	1	1	29	290
bigleaf maple	<i>Acer macrophyllum</i>	2	2	28	280
peach	<i>Prunus persica</i>	6	6	27	270
American basswood	<i>Tilia americana</i>	4	4	26	270
live oak	<i>Quercus virginiana</i>	1	2	38	266
red alder	<i>Alnus rubra</i>	1	1	26	260
common cowparsnip	<i>Heracleum maximum</i>	2	2	51	255
butterfly milkweed	<i>Asclepias tuberosa</i>	5	5	48	250
cuman ragweed	<i>Ambrosia psilostachya</i>	1	2	49	245
snowbrush	<i>Ceanothus velutinus</i>	2	2	44	220
button mangrove	<i>Conocarpus erectus</i>	1	2	44	220
purple passionflower	<i>Passiflora incarnata</i>	1	1	44	220
buffalograss	<i>Buchloe dactyloides</i>	6	7	42	215
desert ironwood	<i>Olneya tesota</i>	2	5	43	215
honey mesquite	<i>Prosopis glandulosa</i>	2	4	42	215
laurel oak	<i>Quercus laurifolia</i>	1	2	30	210
black mangrove	<i>Avicennia germinans</i>	1	2	42	210
American hazelnut	<i>Corylus americana</i>	1	1	21	210
greyleaf willow	<i>Salix glauca</i>	2	2	20	200
slash pine	<i>Pinus elliottii</i>	1	2	40	200
water sedge	<i>Carex aquatilis</i>	2	3	39	195
tamarisk	<i>Tamarix spp.</i>	1	3	39	195
spotted knapweed	<i>Centaurea biebersteinii</i>	2	2	39	195
cheatgrass	<i>Bromus tectorum</i>	4	5	38	190
big sagebrush	<i>Artemisia tridentata</i>	3	3	38	190
shrubby cinquefoil	<i>Dasiphora floribunda</i>	2	2	19	190
American mountain ash	<i>Sorbus americana</i>	2	2	19	190
needle and thread	<i>Hesperostipa comata</i>	3	4	37	185
red spruce	<i>Picea rubens</i>	2	3	37	185
curl-leaf mountain mahogany	<i>Cercocarpus ledifolius</i>	3	3	36	180
bog blueberry	<i>Vaccinium uliginosum</i>	3	3	45	180
longleaf pine	<i>Pinus palustris</i>	1	2	36	180
Yoshino cherry	<i>Prunus yedoensis</i>	2	2	17	170
antelope bitterbrush	<i>Purshia tridentata</i>	2	2	33	165

alfalfa	<i>Medicago sativa</i>	2	2	33	165
black locust	<i>Robinia pseudoacacia</i>	3	3	16	160
red trillium	<i>Trillium erectum</i>	2	3	31	160
white mangrove	<i>Laguncularia racemosa</i>	1	2	32	160
common sunflower	<i>Helianthus annuus</i>	3	3	30	155
cabbage palmetto	<i>Sabal palmetto</i>	2	3	37	148
California poppy	<i>Eschscholzia californica</i>	4	5	29	145
blue paloverde	<i>Parkinsonia florida</i>	1	2	28	140
lingonberry	<i>Vaccinium vitis-idaea</i>	2	3	34	136
eastern hemlock	<i>Tsuga canadensis</i>	3	3	26	135
pinkladies	<i>Oenothera speciosa</i>	2	2	26	135
white spruce	<i>Picea glauca</i>	3	3	25	125
purple loosestrife	<i>Lythrum salicaria</i>	1	1	25	125
swamp milkweed	<i>Asclepias incarnata</i>	3	3	24	120
sideoats grama	<i>Bouteloua curtipendula</i>	3	3	23	115
white clover	<i>Trifolium repens</i>	9	9	22	110
tall blazing star	<i>Liatris aspera</i>	4	5	22	110
bluejacket	<i>Tradescantia ohiensis</i>	2	2	19	105
tussock cottongrass	<i>Eriophorum vaginatum</i>	1	2	21	105
Japanese knotweed	<i>Polygonum cuspidatum</i>	2	2	19	100
annual ragweed	<i>Ambrosia artemisiifolia</i>	2	2	19	95
'ohi'a lehua	<i>Metrosideros polymorpha</i>	1	1	19	95
prairie milkweed	<i>Asclepias sullivanti</i>	1	1	19	95
fireweed	<i>Chamerion angustifolium</i>	2	2	18	90
western wheatgrass	<i>Pascopyrum smithii</i>	4	5	15	80
garlic mustard	<i>Alliaria petiolata</i>	1	1	14	70
tall cottongrass	<i>Eriophorum angustifolium</i>	1	1	13	65
arctic sweet coltsfoot	<i>Petasites frigidus</i>	1	1	13	65
scarlet globemallow	<i>Sphaeralcea coccinea</i>	3	4	11	55
Pacific trillium	<i>Trillium ovatum</i>	2	2	11	55
western columbine	<i>Aquilegia formosa</i>	2	2	10	50
darkthroat shooting	<i>Dodecatheon</i>	1	1	10	50

star	<i>pulchellum</i>				
Pacific dogwood	<i>Cornus nuttallii</i>	2	2	4	40
white fir	<i>Abies concolor</i>	2	2	7	40
Colorado blue columbine	<i>Aquilegia caerulea</i>	2	2	8	40
white heath aster	<i>Symphyotrichum ericoides</i>	2	2	8	40
Utah serviceberry	<i>Amelanchier utahensis</i>	1	1	4	40
twinflower	<i>Linnaea borealis</i>	1	1	10	40
mesquite	<i>Prosopis juliflora</i>	3	3	7	35
yellow sweetclover	<i>Melilotus officinalis</i>	2	2	6	30
wine grape	<i>Vitis vinifera</i>	1	1	3	30
common reed	<i>Phragmites australis</i>	1	1	1	25
yellow paloverde	<i>Parkinsonia microphylla</i>	1	2	4	20
kudzu	<i>Pueraria montana</i>	1	1	2	20
leafy spurge	<i>Euphorbia esula</i>	1	1	4	20
white fawnlily	<i>Erythronium albidum</i>	1	1	4	20
eightpetal mountain-avens	<i>Dryas octopetala</i>	1	1	5	20
common evening primrose	<i>Oenothera biennis</i>	2	2	3	15
field mustard	<i>Brassica rapa</i>	1	1	3	15
Rocky Mountain juniper	<i>Juniperus scopulorum</i>	1	1	5	15
Engelmann spruce	<i>Picea engelmannii</i>	2	2	2	10
sweet birch	<i>Betula lenta</i>	1	1	1	10
Great Basin bristlecone pine	<i>Pinus longaeva</i>	1	1	1	5
white cedar	<i>Tabebuia heterophylla</i>	1	1	1	5
<b>Totals</b>			<b>1,932</b>	<b>24,733</b>	<b>190,782</b>

## APPENDIX B. 2010 ANIMAL DATA SUMMARY

Number of observers, locations where observations were made, observations, and phenophases status records in the National Phenology Database (NPDb) by animal species in 2010. Observers with no reported observations are not included in the tally. An observation is a report of a suite of phenophases for an animal species on a given day and includes from 3 to 10 phenophases status records, depending on the species.

Common Name	Scientific name	Number of observers	Locations where observations were made	Observations	Phenophase status records
American robin	<i>Turdus migratorius</i>	59	63	442	3553
black-capped chickadee	<i>Poecile atricapillus</i>	31	37	229	1848
American goldfinch	<i>Carduelis tristis</i>	29	33	199	1608
bumblebee	<i>Bombus spp.</i>	41	43	369	1488
eastern chipmunk	<i>Tamias striatus</i>	19	22	261	1310
white-tailed deer	<i>Odocoileus virginianus</i>	25	29	275	1104
woodchuck	<i>Marmota monax</i>	10	12	214	642
osprey	<i>Pandion haliaetus</i>	13	15	91	455
scarlet tanager	<i>Piranga olivacea</i>	4	6	53	432
spring azure	<i>Celastrina ladon complex</i>	5	7	52	416
American toad	<i>Anaxyrus americanus</i>	10	12	82	410
mule deer	<i>Odocoileus hemionus</i>	9	9	95	380
common green darner	<i>Anax junius</i>	7	8	55	336
cliff swallow	<i>Petrochelidon pyrrhonota</i>	5	7	63	315
wood frog	<i>Lithobates sylvaticus</i>	6	8	61	310
bicolored sallow moth	<i>Sunira bicolorago</i>	3	5	48	288
killdeer	<i>Charadrius vociferus</i>	11	13	64	260
snapping turtle	<i>Chelydra serpentina</i>	9	11	65	260
seaside dragonlet	<i>Erythrodiplax berenice</i>	2	4	42	252
olive-sided flycatcher	<i>Contopus cooperi</i>	5	7	41	246
painted turtle	<i>Chrysemys picta</i>	7	9	58	232
American shad	<i>Alosa sapidissima</i>	1	3	38	228
yellow-bellied marmot	<i>Marmota flaviventris</i>	4	4	73	219
common loon	<i>Gavia immer</i>	3	5	41	205
ebony jewelwing	<i>Calopteryx maculata</i>	4	6	38	195

brant	<i>Branta bernicla</i>	3	4	37	185
spotted turtle	<i>Clemmys guttata</i>	2	4	45	180
racer	<i>Coluber constrictor</i>	5	7	51	153
white sucker	<i>Catostomus commersonii</i>	1	3	38	152
common whitetail	<i>Plathemis lydia</i>	1	3	30	150
punctured tiger beetle	<i>Cicindela punctulata</i>	4	6	46	138
tiger salamander	<i>Ambystoma mavortium-tigrinum</i>	2	4	44	132
sea lamprey	<i>Petromyzon marinus</i>	1	2	22	132
American eel	<i>Anguilla rostrata</i>	2	4	30	120
eastern tent caterpillar	<i>Malacosoma americanum</i>	4	6	51	102
northern water snake	<i>Nerodia sipedon</i>	2	4	24	96
Pacific treefrog	<i>Pseudacris regilla</i>	3	3	18	90
six-spotted tiger beetle	<i>Cicindela sexguttata</i>	3	5	41	82
yellow perch	<i>Perca flavescens</i>	2	4	26	78
rough-skinned newt	<i>Taricha granulosa</i>	3	3	13	56
Townsend's chipmunk	<i>Tamias townsendii</i>	3	3	11	55
green frog	<i>Lithobates clamitans</i>	2	2	8	40
gopher snake	<i>Pituophis catenifer</i>	5	5	13	39
bighorn sheep	<i>Ovis canadensis</i>	3	3	12	36
northern leopard frog	<i>Lithobates pipiens</i>	4	4	5	25
northern elephant seal	<i>Mirounga angustirostris</i>	2	2	2	18
pink salmon	<i>Oncorhynchus gorbuscha</i>	2	2	2	12
Cascades frog	<i>Lithobates cascadae</i>	2	2	2	10
sagebrush lizard	<i>Sceloporus graciosus</i>	2	2	3	9
western terrestrial garter snake	<i>Thamnophis elegans</i>	2	2	2	8
coho salmon	<i>Oncorhynchus kisutch</i>	1	1	1	6
chinook salmon	<i>Oncorhynchus tshawytscha</i>	1	1	1	6
green sturgeon	<i>Acipenser medirostris</i>	1	1	1	6
chum salmon	<i>Oncorhynchus keta</i>	1	1	1	6
Woodhouse's toad	<i>Anaxyrus woodhousii</i>	1	1	1	5
Couch's spadefoot	<i>Scaphiopus couchii</i>	1	1	1	5

white-tailed prairie dog	<i>Cynomys leucurus</i>	1	1	1	3
eastern collared lizard	<i>Crotaphytus collaris</i>	1	1	1	3
<b>Totals</b>			<b>475</b>	<b>3,633</b>	<b>19,130</b>

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