Phenology Report Guide

An tool for site-based community engagement using *Nature's Notebook*

naturesnotebook.org

USA National Phenology Network

Phenology Report Guide

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INTRODUCTION

Phenology refers to the study of recurring plant and animal life cycle stages, such as leafing and flowering, the maturation of agricultural plants, the emergence of insects, and the migration of birds. It also involves understanding the relationship of these life cycle stages to weather and, in the long term, climate.

The **USA National Phenology Network** (USA-NPN; www.usanpn.org) is a consortium of individuals and organizations that collect, share, and use phenology data, models, and related information. USA-NPN serves science and society by promoting a broad understanding of plant and animal phenology and its relationship with environmental change. USA-NPN encourages people of all ages and backgrounds to observe and record the activity of organisms to discover and explore the nature and pace of our dynamic world. Using this information, USA-NPN makes phenology data models, phenology maps, and related information freely available to empower scientists, resource managers, and the public in areas of decision-making and adapting to variable and changing climates and environments.

The data collected and shared by the USA-NPN are intended to be used by resource managers to inform decisions, by educators to teach about phenology and climate change, by scientists to study changes in species phenology and by the public to increase their awareness of both phenology and climate change. The USA-NPN has an online integrated animal and plant-monitoring program called ***Nature's Notebook*** (www.naturesnotebook.org) which provides standardized protocols for phenological status monitoring and data management for over 1200 animal and plant species (as of January 2017) nationwide. The program facilitates a collection of phenophases, or life cycle events of plants and animals, and descriptive

information about observation locations and individual plants. It also includes functionality for recording estimates of abundance of animals and intensity of plant phenophases.

Certain organizations or other groups of people with a shared goal have come together to form **Local Phenology Projects (LPPs),** customizing *Nature's Notebook* to suit their program. These LPPs are sponsored by organizations with an interest in using phenological data for science, management, or education. Leaders, facilitators, or owners of the LPPs are called **Local Phenology Leaders (LPLs)**. The LPPs consist of online sites in *Nature's Notebook* which are often publicly accessible and allow multiple observers to contribute observations to a "**Group**" established within the *Nature's Notebook* online system. A Group in *Nature's Notebook* may include more than one site for the sponsoring organization. For more information on LPPs and *Nature's Notebook* "Groups" visit the Start a Local Project webpage in *Nature's Notebook*: www.usanpn.org/nn/connect/project. Community groups and organizations may also link their LPPs together to create a **Regional Phenology Network**.

This document is intended to guide *Nature's Notebook* Local Phenology Leaders, Phenology Network Coordinators, and other project coordinators through the process of creating a phenology report.

WHAT IS A PHENOLOGY REPORT?

A phenology report is a document that describes the status of your phenological monitoring program, including participant statistics, data volume statistics, and patterns in the data. It can be produced for any time scale, such as quarterly on an annual or biannual basis.

WHY CREATE A PHENOLOGY REPORT?

There are many reasons to create a phenology report:

1. It keeps your program on track—conducting a regular summary of your data will help you to assess whether you are making progress in answering your science questions, and/or meeting your management or outreach/education goals.

2. It helps you to understand data quality—a summary will allow you to identify places where your data are inconsistent, and identify areas where you might need to offer further training for your observers. In addition, you can assess the frequency with which your observers are collecting data, and determine if you need to increase your efforts at particular times of year to capture phenological transitions with high precision.

3. It provides insight into observer recruitment and retention, allowing you to see areas where you need to improve your methods of volunteer engagement. Recruiting volunteers is difficult enough, so it's very important to keep them motivated and involved for many years.

HOW TO COMPILE A PHENOLOGY REPORT

You should design your phenology report to best suit the needs of your organization. You should consider the **goals** of your phenology monitoring program, and write your report to address these goals. We also recommend considering the **audience** for the report—whether it is volunteers, Local Phenology Leaders, scientists, or program managers—in order to guide your summary, interpretation and lessons learned to be most relevant to your readers.

We have outlined ideas for components that are applicable for most phenology reports. You are welcome to customize these ideas to best suit your program.

SUGGESTED COMPONENTS OF A PHENOLOGY REPORT

1. **A copy of your Program Plan or description of your purpose for monitoring phenology**—information about why you are engaging in phenology monitoring at your site as well as information about the science/management question(s) or educational/outreach objective(s) you seek to achieve with a long-term phenology monitoring program.

2. **Observation Quantity**—counts of records per species, frequency of site visits.

3. **Observer Activity**—observer recruitment and retention metrics

4. **Phenology Data Summary**—patterns in your focal species over time and space

5. **Weather Data Summary**—summaries of weather variables at your site

6. **Results and Interpretation**—meaningful context for your results

7. **Lessons Learned**—thoughts on what you can improve in the future or recommend to others

8. **Education and Outreach Activities**—a description of how you engaged your participants and the public

9. **Summary and Next Steps**—a synthesis to bring it all together and map out your future goals

10. **Location of Project Components**—a statement of where your project resources are located

1. PROGRAM PLAN AND PURPOSE

Your phenology report should begin with a statement about your purpose for collecting phenology observations. A program plan describing the reason you are interested in collecting such data will ensure that you are being as effective as possible given your resources. Whether you have created a logic model for volunteer engagement or simply have a justification of collecting long-term phenological information for science and management, the plan you develop prior to beginning should guide the information you report out.

For the next two components of the report, **Observation Quantity** and **Observer Activity**, you can use the **Local Phenology Project Dashboards page** (www.usanpn.org/nn/groups/dashboard) to explore and summarize your Local Phenology Project's data. Get a snapshot of the number of phenology records per species and phenophase, frequency of site visits, and observer activity by month and year, and more. There are two separate interactive dashboards on the page, each with a way to filter the data for your Local Phenology Project or Network. Each of the dashboards is separated by a grey box with the Tableau logo and buttons to download and share the graphs that you create. These dashboards are generally manually updated on a weekly basis. You can see the most recent update by checking the *Last updated* date on the Partner Dashboard page.

2. OBSERVATION QUANTITY DASHBOARD

The first Observation Quantity Dashboard is focused on the quantity of data, and has three Observation Quantity summaries you can customize for your Local Phenology Project (LPP) or Network. The first is a table which provides the number of phenophases status records submitted at each site of your Local Phenology Project or Network; you can summarize these data by month or year (Figure 1). You can use this table to track whether your Local Phenology Project is collecting a

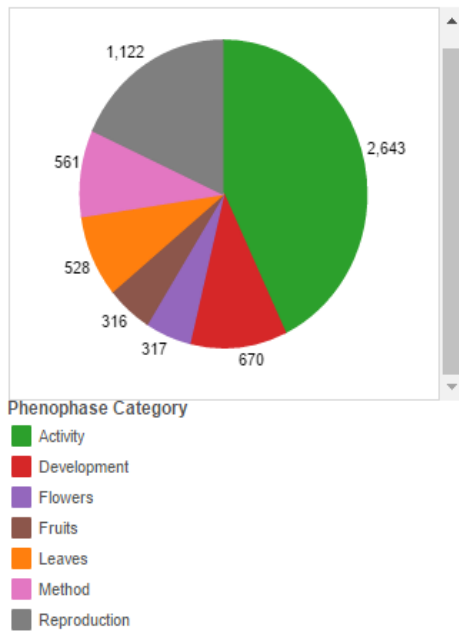**Phenology records, Valle de Oro National Wildlife Refuge, 2016**

Site Name	January	February	March ᵂ	April	2016 May	June	July	August	September	Year Total
West Refuge Pre-Wetlands (driving)	266	252	157	97	128	401	512	512	133	2,458
East Refuge Agricultural (driving)	266	266	126	24	119	512	512	512	181	2,518
Cottonwood #1	44	66	87	65	22	66	87	88	33	558
Cottonwood #2	22	44	77	66	55	66	88	88	97	603
Incidental Observations			10		5				5	20
Grand Total	598	628	457	252	329	1,045	1,199	1,200	449	6,157

Figure 1 Phenology records submitted by site, on the Observation Quantity Dashboard on the Local Phenology Project Dashboards Page.

consistent number of observations over the course of the year.

The second Observation Quantity summary is a pie chart of the number of status records by phenophase category, such as Leaves, Flowers, and Fruits, and by species (Figure 2). You can use these pie charts to see if you are collecting more data for certain phenophase categories or species.

Records by phenophase category, Valle de Oro National Wildlife Refuge, 2016

1,122
2,643
561
528
316
317
670

Phenophase Category
- Activity
- Development
- Flowers
- Fruits
- Leaves
- Method
- Reproduction

Records by species, Valle de Oro National Wildlife Refuge, 2016

273
537
431
309
105
260
624
408
141
260
391
357
371
288
302
343

Common Name
- American robin
- American crow
- American kestrel
- barn swallow
- bobolink
- Canada goose
- cliff swallow
- Cooper's hawk
- coyote
- curve-billed thrasher
- eastern cottonwood
- great blue heron
- Gunnison's prairie ...
- killdeer
- sandhill crane
- Say's phoebe
- Siberian elm
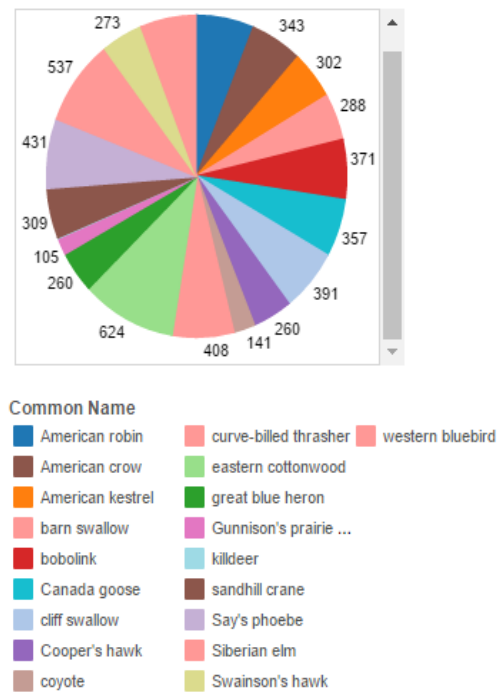- Swainson's hawk
- western bluebird

Figure 2 Phenology records submitted by phenophases category and species, on the Observation Quantity Dashboard on the Local Phenology Project Dashboards Page.

The third Observation Quantity summary is a bar graph that provides the number of site visits, by month and year (Figure 3). This graph can help you to see if there are months where you have less frequent site visits than at other times of the year.

The end of the Observation Quantity Dashboard is marked by a grey bar with the Tableau software logo. In this bar are links to share or download these graphs as a pdf or image file.

Site visits by month, Valle de Oro National Wildlife Refuge, 2016
(count of unique dates each site was visited within time period)

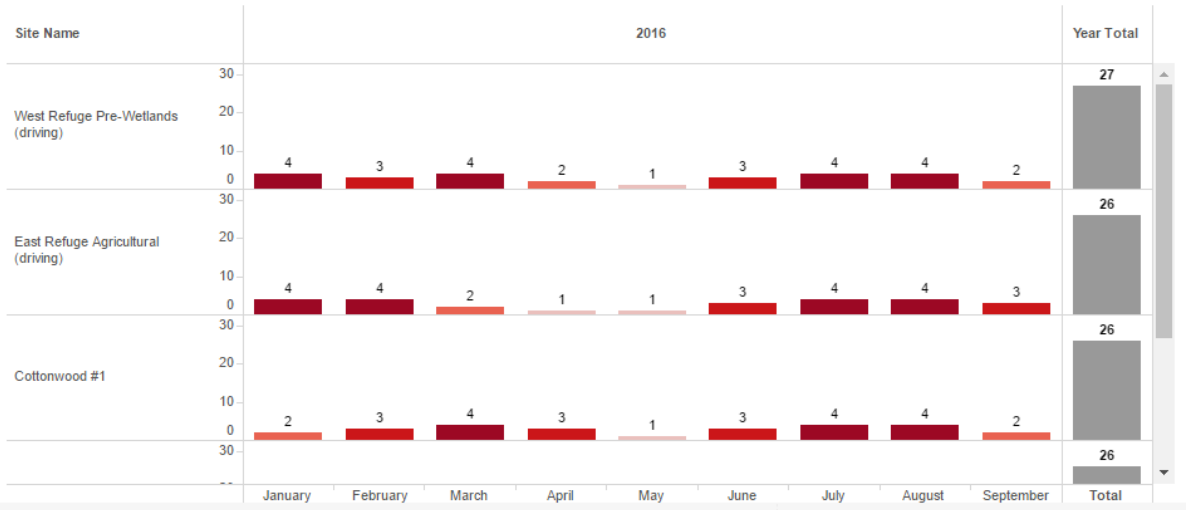| Site Name	January	February	March	April	May	June	July	August	September	Year Total
West Refuge Pre-Wetlands (driving)	4	3	4	2	1	3	4	4	2	27
East Refuge Agricultural (driving)	4	4	2	1	1	3	4	4	3	26
Cottonwood #1	2	3	4	3	1	3	4	4	2	26
										26

Figure 3 Number of site visits by month and year, on the Observation Quantity Dashboard on the Local Phenology Project Dashboards Page.

3. OBSERVER ACTIVITY DASHBOARD

The second Observer Activity dashboard has three summaries: the first Observer Activity summary gives the number of active observers, by month and year (Figure 4). You can use this graph to see whether your observer participation is lower in certain months than others.
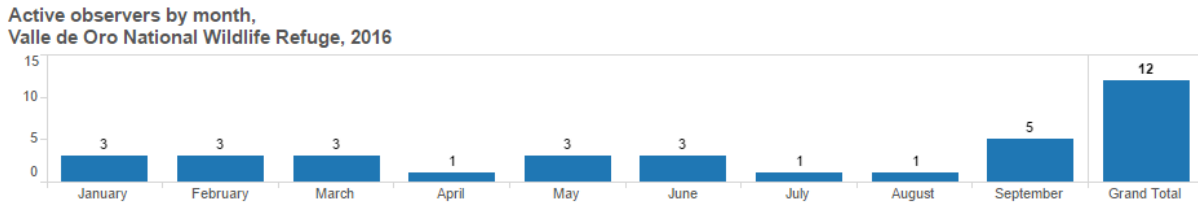

Figure 4. Active observers by month, on the Observer Activity Dashboard of the Local Phenology Project Dashboards Page.

The second Observer Activity summary gives the number of observers who have been active for 1, 2, 3, etc. years (Figure 5). This graph lets you determine the number of years observers continue to submit data to your program.
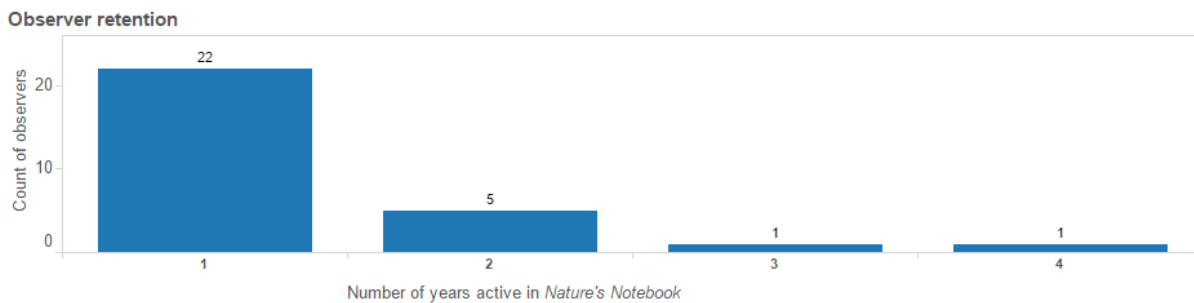

Figure 5. Observer retention, on the Observer Activity Dashboard of the Local Phenology Project Dashboards Page.

The third summary takes a closer look at individual observer activity, and plots the number of phenophases status records reported by each observer over time (Figure 6). To view the activity of a single observer, click on their Person ID in the list on the right side of the dashboard. You can view all observers at once, or one at a

time. This graphic shows the observer's unique ID, which can be cross referenced with a table you can download on the Manage Users page
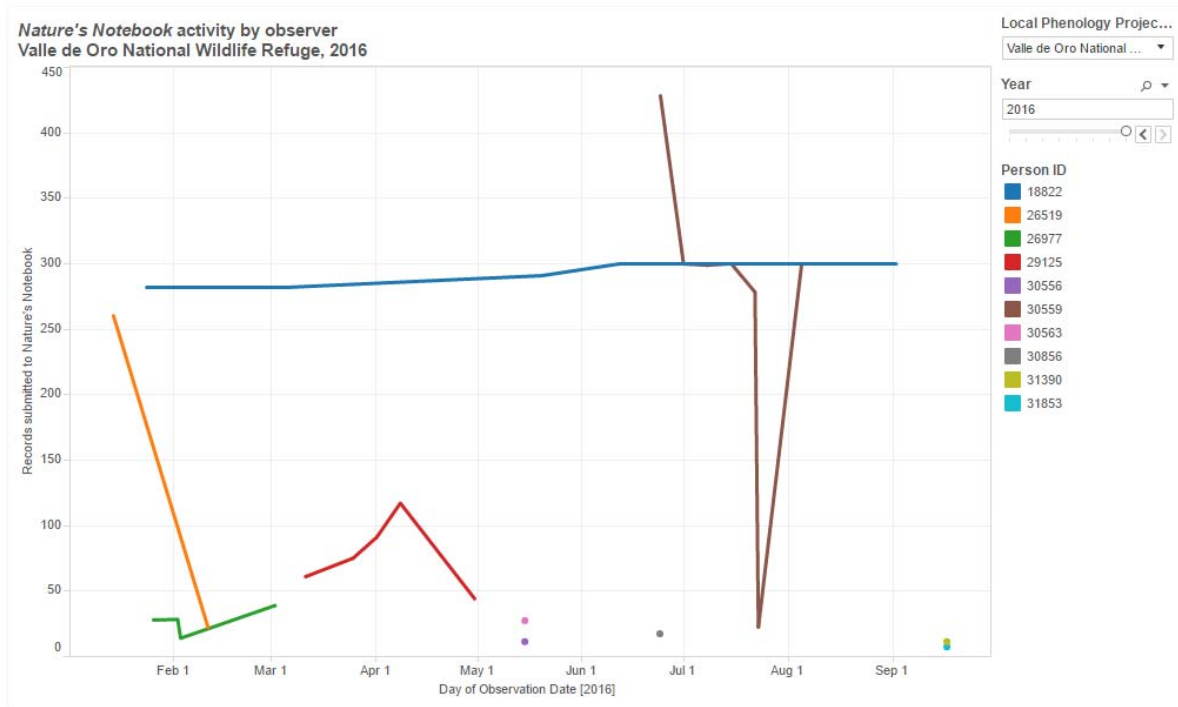

Figure 6. Individual observer activity, on the Observer Activity Dashboard of the Local Phenology Project Dashboards Page.

The end of the Observer Activity Dashboard is marked by a grey bar with the Tableau software logo. In this bar are links to share or download these graphs as a pdf or image file.

A third Observer Recruitment Dashboard with further information on Observer Registration is linked from the bottom of the Dashboards page. It has a single Observers Registered summary, which provides information on observer recruitment; here you can create a summary in the form of a bar graph of the number of observers in your Local Phenology Project who have registered in a particular year (Figure 7). This graph will help you determine if your recruitment is improving or declining across different years.
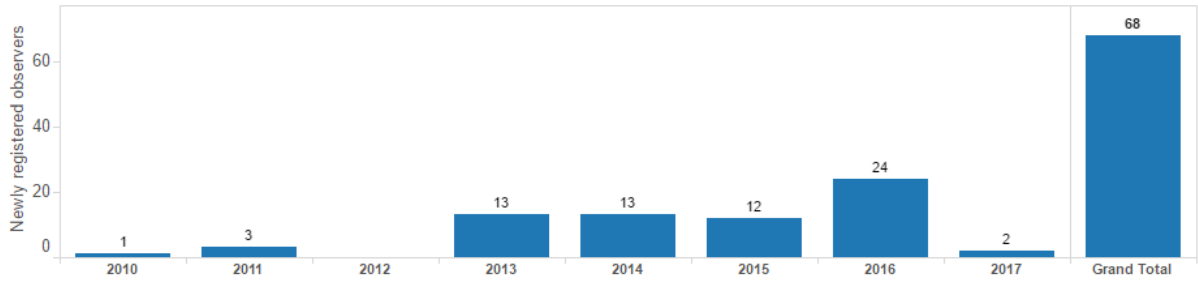
Figure 7. Number of observers in your Local Phenology Project who have registered in a particular year, on the Registered Observers Dashboard linked from Local Phenology Project Dashboards Page.

The end of the Observer Recruitment Dashboard is marked by a grey bar with the Tableau software logo. In this bar are links to share or download these graphs as a pdf or image file.

MORE ON TRACKING INDIVIDUAL OBSERVERS

The USA-NPN has created a multiple-level permissions structure in *Nature's Notebook* to allow Local Phenology Leaders to better manage their *Nature's Notebook* Groups (Box 1). To cross reference observer names, usernames, user IDs, and emails, Group Administrators can visit the Manage Users page via their *Nature's Notebook* Observation Deck (Figure 8). The link to this page is located on the bottom left of the Observation Deck, under the section *Sites*, and is only visible to **Group Administrators** (Box 1).

Administrators can download a Group Roster to link these fields. A file with all data from the Local Phenology Project (Group Data) can also be downloaded here.

The Manage Users page also contains a link to Download Filtered Data that will take the Administrator to the Phenology Observation Portal (available at www.usanpn.org/results/data). The Portal allows you to download all of the data from the National Phenology Database, with filters to specify dates, regions, species and phenophases of interest. When accessing the Portal from the Manage Users page, the Portal will be pre-set to download data from the administrator's Local Phenology Project, with optional filters pre-checked to also download the User ID of the person who submitted the data, Partner Group, and Site Name.

> Box 1. There are three levels within the *Nature's Notebook* Group permissions structure:
>
> **Group Administrators** – have the ability to create and edit sites, add plants and animals to the sites, delete members from the Group, and assign other Group Members as Group Administrators and Data Entry Technicians
>
> **Data Entry Technicians** – have the ability to enter data on behalf of other Group Members, and edit data of other Group Members
>
> **Group Members** – have the ability to view sites, plants and animals for the Group, print datasheets, and enter data for the Group sites
>
> A Group Member can be designated as both an Administrator and Data Entry Technician.

Manage Users

Figure 8. Manage Users Page, visible to Group Administrators and linked from the Observation Deck.

4. PHENOLOGY DATA SUMMARY: HOW TO VISUALIZE PATTERNS IN PHENOLOGY DATA USING THE USA-NPN'S VISUALIZATION TOOL

Visualizing your Local Phenology Project's phenology data can help you to explore patterns in the phenology of your focal species, which will help you to answer your science questions, inform your management decisions, and education your participants and stakeholders. It can also help you to identify areas where you can improve your data collection, such as fixing data entry errors and becoming more consistent in your phenology data collection. This will help you stay on track to answer your science questions and/or meet your management, outreach, and education goal(s).

You can use the USA-NPN's Phenology Visualization Tool to (a) view where your Local Phenology Project's data are being collected via a map interface, and (b) view graphical visualizations of your data, by creating a scatter plot or phenology calendar of your Local Phenology Project's phenology observations. Video tutorials are available on the Visualization Tool webpage (www.usanpn.org/data/visualizations).

To view your Local Phenology Project's data, start on the *Filter menu,* which is one of the menus located on the left hand side of the Tool and indicated by a magnifying glass icon. The blinking tabs on this menu will guide you through the steps to plot your data. First, enter the years of interest (e.g. 2012-2015), then use the *Partner box* to select your Local Phenology Project. Type the Local Phenology Project's name into the box, then click the *Add* button. The species list will now be filtered to only the species that are being monitored as part of your Local Phenology Project. To view all of your sites reporting on all species, click *Execute filter*. To view data for a limited number of your species, select the species from the

list and click the *Add* button to display only the sites that have submitted data for these species.

You can see how many status records have been submitted for your Local Phenology Project on the badge on the top right of the screen (Figure 9). To see how many status records have been submitted for each site, click on the clustering circle to separate it into sites, then click on the point on the map representing an individual site. A popup window will appear with the number of status records submitted for that site (Figure 9). You can then choose to visualize the data for only that site with a Scatter Plot or Calendar.
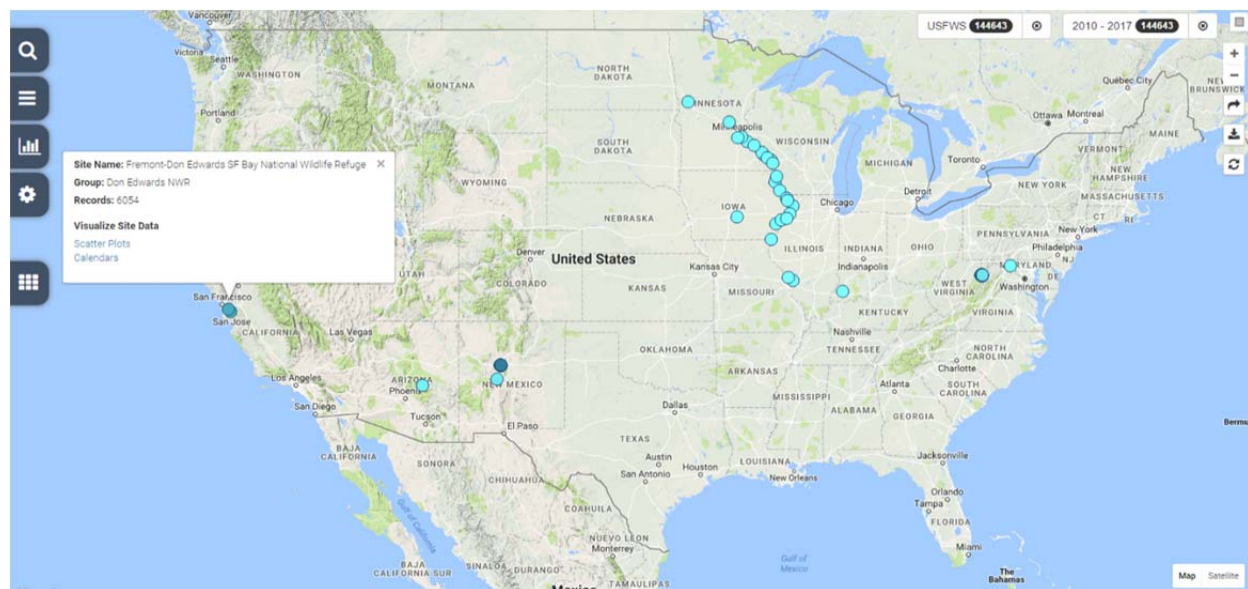
Figure 9. The USA-NPN Phenology Visualization Tool. After setting years and species or Local Phenology Project of interest, the user can select from the Visualizations Menu on the left hand side of the Tool.

To visualize the data for all the sites you have plotted on the map, use the Visualizations Menu, then choose a Scatter Plot or Calendar (Table 1). You can also use the Maps Visualization to compare your data against gridded maps of accumulated growing degree days and the Spring Indices, which represent the

biological start of spring. Learn more about these maps at

www.usanpn.org/data/phenology-maps.

To visualize data for a portion of the sites, use the Draw a Rectangle tool (small gray square icon located in the upper right of the screen) to drag one or more boxes around multiple sites, then click the Visualizations menu. To turn off the rectangle, right click the box you have drawn.

Table 1. Visualization Options in the USA-NPN Phenology Visualization Tool		
Scatter Plots		This visualization plots selected geographic or climactic variables against estimated onset dates for individual plants or animal species for up to three species/phenophase combinations.
Calendars		This visualization illustrates annual timing of phenophase activity for selected species/phenophase combinations. Horizontal bars represent phenological activity for up to two years for selected sites. The colored bars represent observed presence of the phenophase. If you choose to display negative data, gray bars represent the observed absence of the phenophase.
Map		This visualization maps ground-based observations against USA-NPN phenology maps, including Accumulated Growing Degree Days and Spring Index models.

You can also use the *Boundary Layers tool* to select a particular region of the US. Select a single region or multiple regions (Figure 10). Right click a region to turn it off. Once you have a region selected, you can then visualize the data for this region by clicking on the Visualizations Menu.

Figure 10. The Boundary Layers Menu on the USA-NPN Phenology Visualization Tool, with the USFWS Region 3 displayed. Click on a layer to turn it on, or turn it off by right-clicking the layer that is selected.

To obtain a hyperlink to share the filtered map you have created, click the *Share button*. To export the filters you have selected and download this customized dataset of phenology observations, click the *Export button*. You will be taken to the Phenology Observation Portal, where your filters will be pre-set in the tool. You can then choose either Status & Intensity, Individual Phenometics, or Site Phenometrics (defined below in Section C. Data Summaries using the Phenology Observation Portal), set other filters, and click *Download Data*.

A. Example Data Summaries using Phenology Calendars

We have included here some example uses of the Phenology Calendar Visualization that you might consider replicating in your phenology report. These are only meant to give you guidance in summarizing your phenology data; you may choose to use the phenology calendars in different ways than those we highlight below.

i. Baseline information on presence and activity of species at a single location or region

Using the **Phenology Calendar Visualization**, you can plot the activity of multiple phenophases for selected species. You can create a calendar for a single site (as shown in Figure 11), or combine data from multiple sites (as shown in Figure 13). The calendar displays the "yes" observations reported for phenophases (colored bars), and optionally can also display the "no" observations (gray bars). The calendars provide a picture of when phenophases started and ended (depicted by the first and last colored bars over the time period displayed), and whether there were multiple periods of activity throughout the year over the locations selected (depicted by colored bars interrupted by gray bars).

Figure 11. Phenology Calendar Visualization showing species presence for a single year. The colored bars represent days where a "yes" observation was reported for a particular species-phenophase combination; gray bars represent days where a "no" observation was reported.

ii. Comparison of species presence and activity between years

The Calendar visualization can also be used to compare species presence and activity between years. If you want to compare more than two years, you can create multiple calendars.
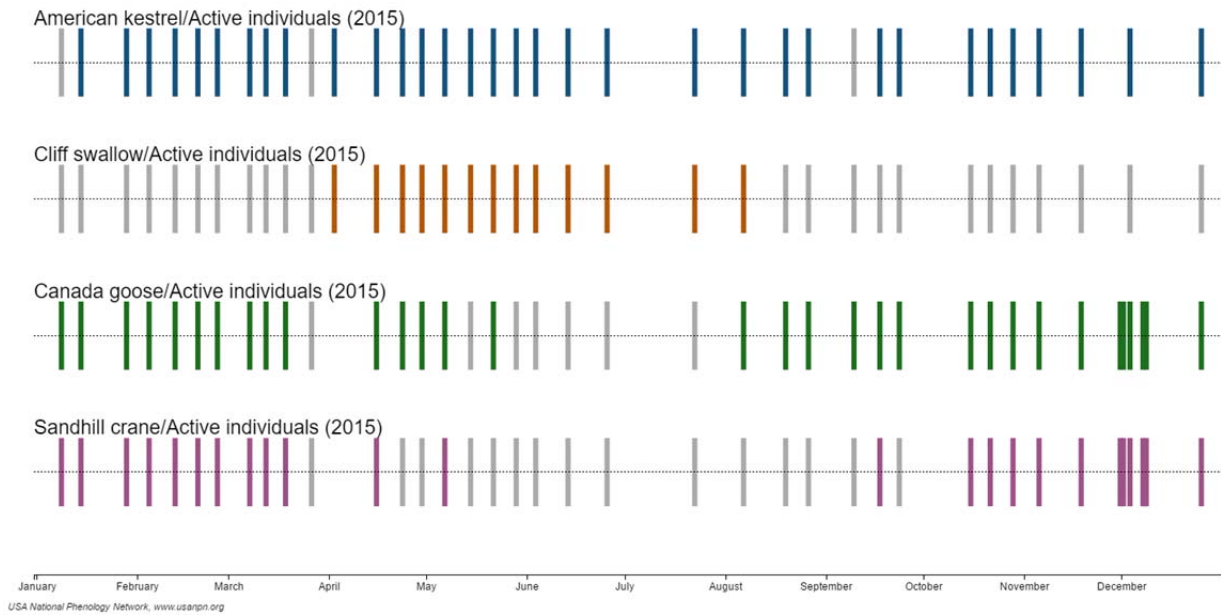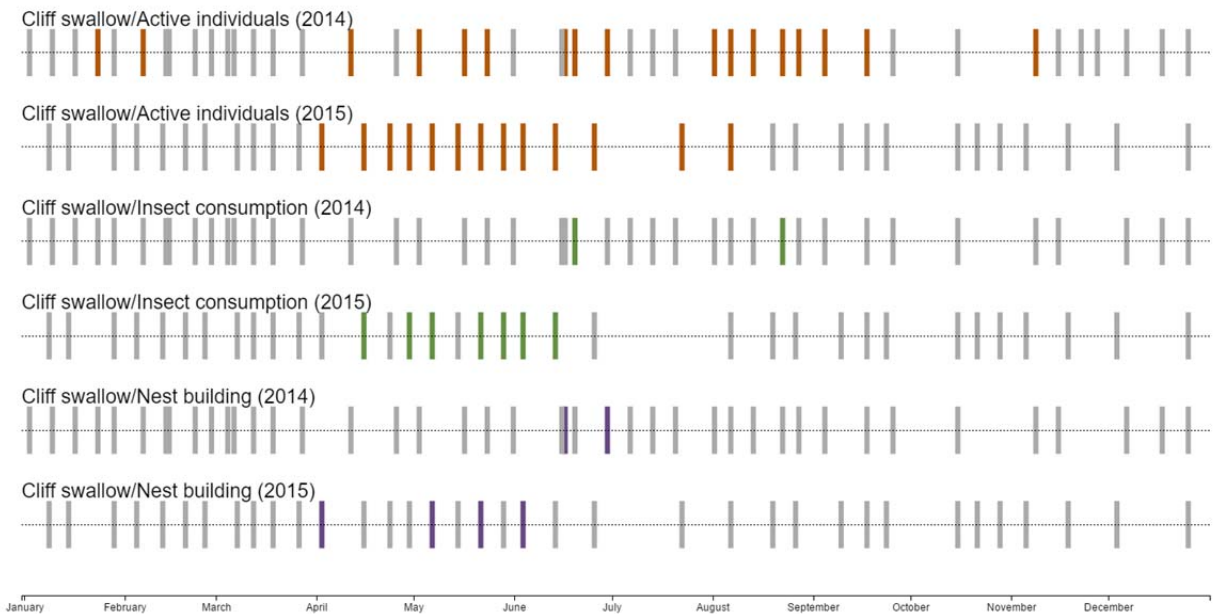

Figure 12. Phenology Calendar Visualization showing species presence and activity for multiple years. The colored bars represent days where a "yes" observation was reported for a particular species-phenophase combination; gray bars represent days where a "no" observation was reported.

iii. Comparison of species presence and activity between geographic locations

You can also use Phenology Calendars to make comparisons between multiple geographic locations. We created the calendar in Figure 13 by drawing a bounding box around one geographic area (Audubon's BirdSeasons CA sites in the San Francisco area), creating a calendar, repeating the process for another area (Audubon's BirdSeasons CA sites in the Los Angeles area). We then combined the two calendars into a single graphic using Microsoft PowerPoint.
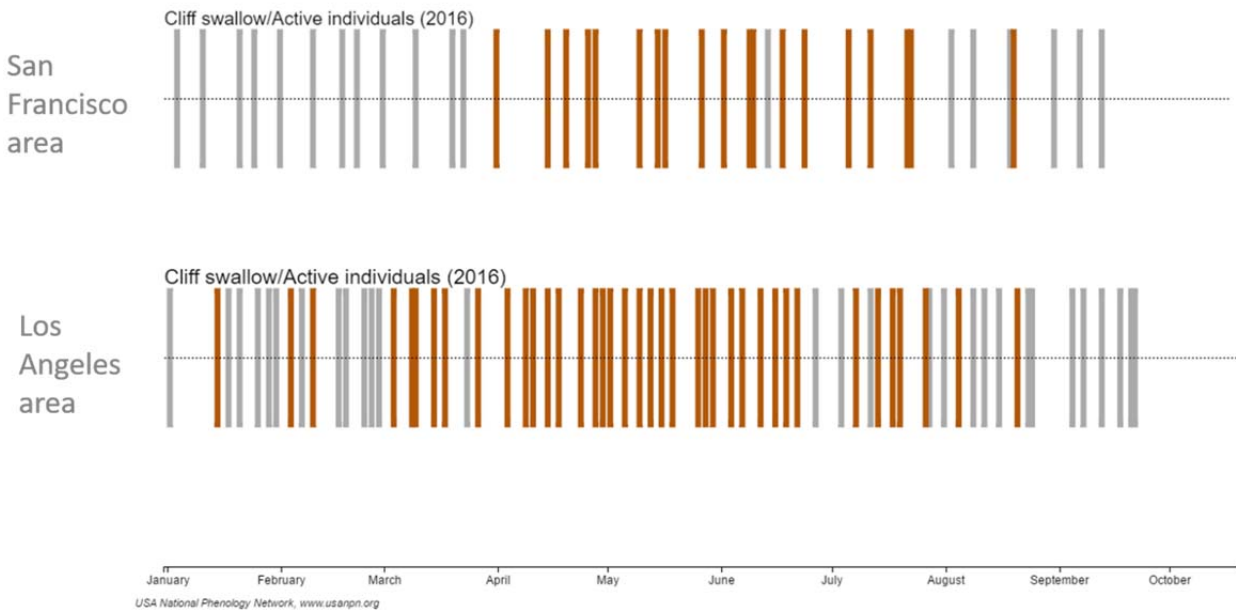

Figure 13. Phenology Calendar Visualization showing multiple geographic areas. The colored bars represent days where a "yes" observation was reported for a particular species-phenophase combination; gray bars represent days where a "no" observation was reported.

B. Example Data Summaries using Scatterplots

You can use the **Scatterplot Visualization** to look at correlations between phenophase onset dates (e.g. breaking leaf buds) and climate or other abiotic variables (e.g. latitude, elevation, or precipitation). You can add a trendline to quantify the relationship between these two variables. You can plot selected geographic or climactic variables against estimated onset dates for individual plants or animal species for up to three species/phenophase combinations.

The scatterplot visualization will automatically exclude onsets that do not have a prior "no" observation within the calendar year. If a "no" record precedes the first "yes", then the number of days between the date of last "no" and first "yes" can be used to determine uncertainty in the true onset date. This setting can be turned off, to show all onset dates by using the Settings Menu on the left side of the tool. Learn more about these settings on the Visualization Tool landing page (www.usanpn.org/data/visualizations). More robust analyses incorporating additional quality control measures can be undertaken by downloading the data via the Export button on the top right hand side of the tool and importing into a statistical software package for analysis.

We have included here some example uses of the Scatterplot Visualization that you can consider replicating in your phenology report. These are only meant to give you guidance in summarizing your phenology data; you may choose to use the Scatterplot in different ways than those we highlight below.

i. Comparison of onset dates for phenophases to geographic or climatic variables

Figure 14 shows a scatterplot of the onset of breaking leaf buds for two tree species (red maple and valley oak) in 2015 and 2016 plotted against minimum spring average temperature. For both of the species below, you see a decreasing trendline, which indicates that the onset of breaking leaf buds occurred later in the year under cooler spring minimum temperatures. Valley oak onset dates mostly appear on the right side of the graph, as these trees grow in regions that are typically not as cold compared to red maple.
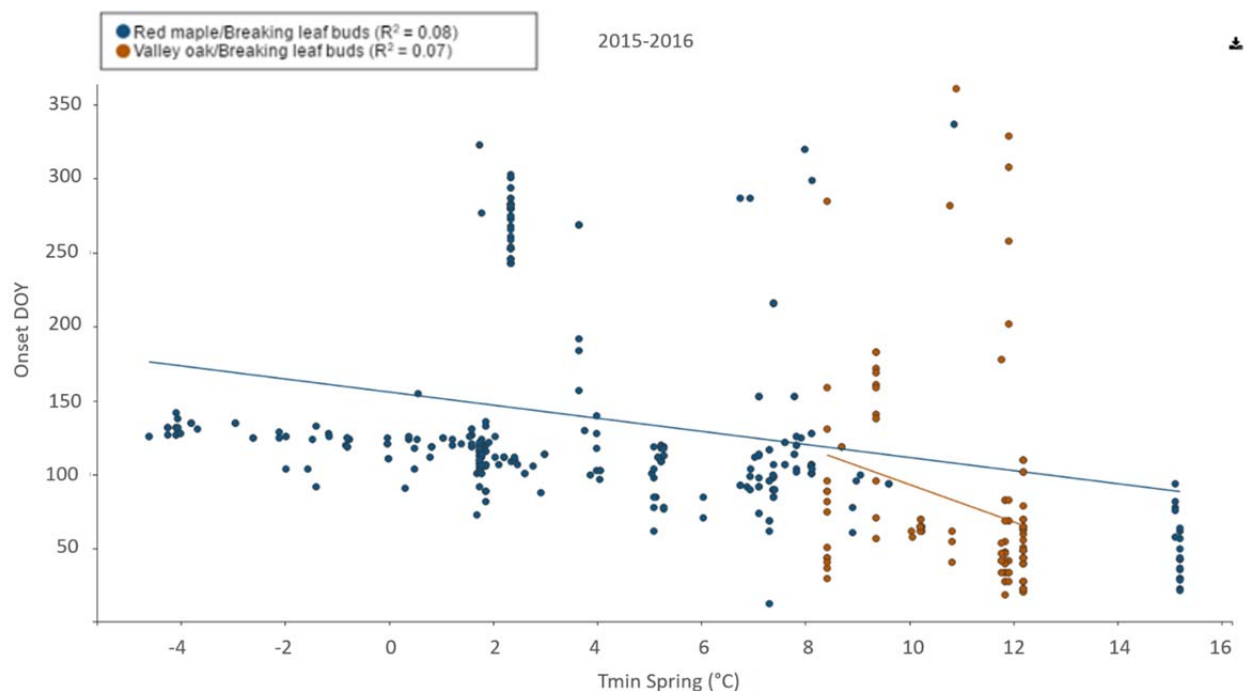
Figure 14. Scatterplot Visualization. Points represent onset dates for the species-phenophase combination. Trendlines show the relationship between the onset date and the independent variable on the horizontal axis.

You can also use the scatterplot to visualize patterns in onset dates across multiple years. You can do this by selecting year from the dropdown for the horizontal axis (Figure 15).
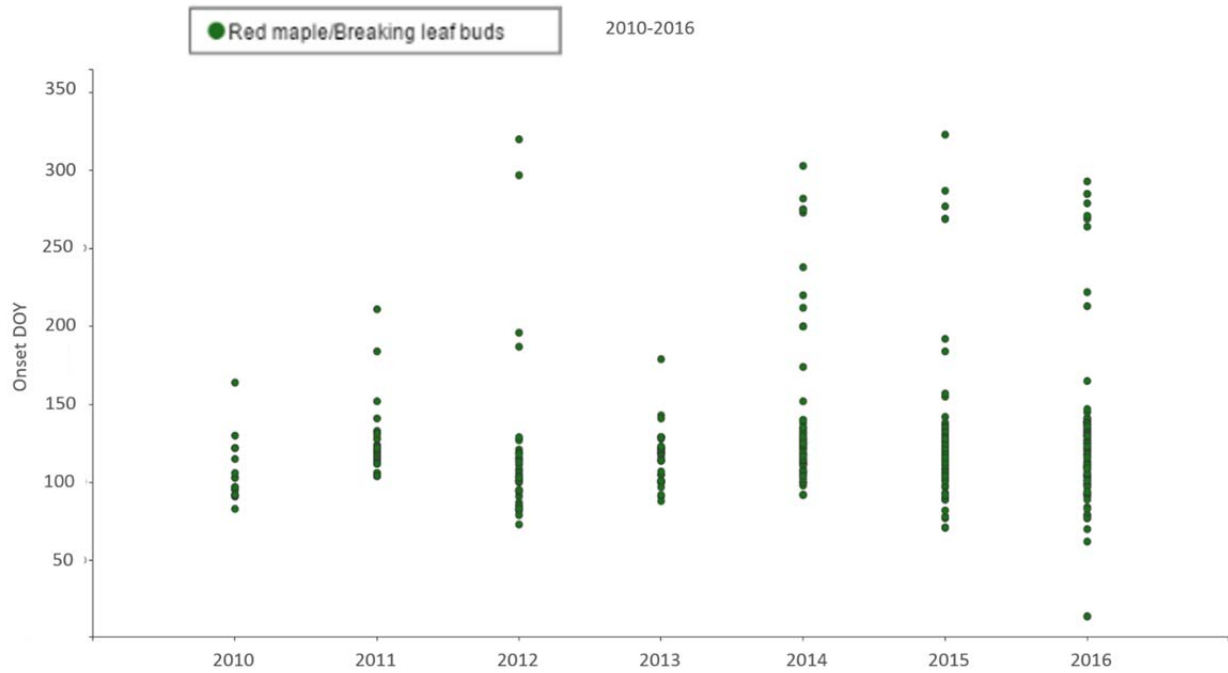

Figure 15. Scatterplot Visualization of breaking leaf buds against Year. Points represent onset dates for the species-phenophase combination.

C. Data Summaries using the Phenology Observation Portal (POP)

You can also download your Local Phenology Project's phenology data, via comma separated values (.csv) file, from the POP directly. This type of file can be viewed in Microsoft Excel or other spreadsheet programs. There are three types of data available to download from the POP, and each is suited for different types of questions. The data types available for download via the POP are more temporally precise than the summarizations available in the Visualization Tool.

i. Status and Intensity data (formerly referred to as "raw data")

The observations collected by participants in *Nature's Notebook* consist of the responses to a series of "yes" or "no" questions about the daily status and intensity of phenophases on an organism. Each row of this dataset contains the response to an individual question, such as Do you see breaking leaf buds? This type of data will indicate whether or not a phenophase was occurring on a particular day for an individual plant or animal species at a site.

This type of data also contains information about the intensity of the phenophase on an organism. If a user reports a "yes" to the phenophase question, they have an opportunity to report the degree to which the phenophase is occurring, in the form of a raw number, number bin, percentage, or qualitative description. If these data are summarized, through the use of formulas or Pivot Tables in Microsoft Excel, or other software programs, you can plot the peak in intensity over time (Figure 16).
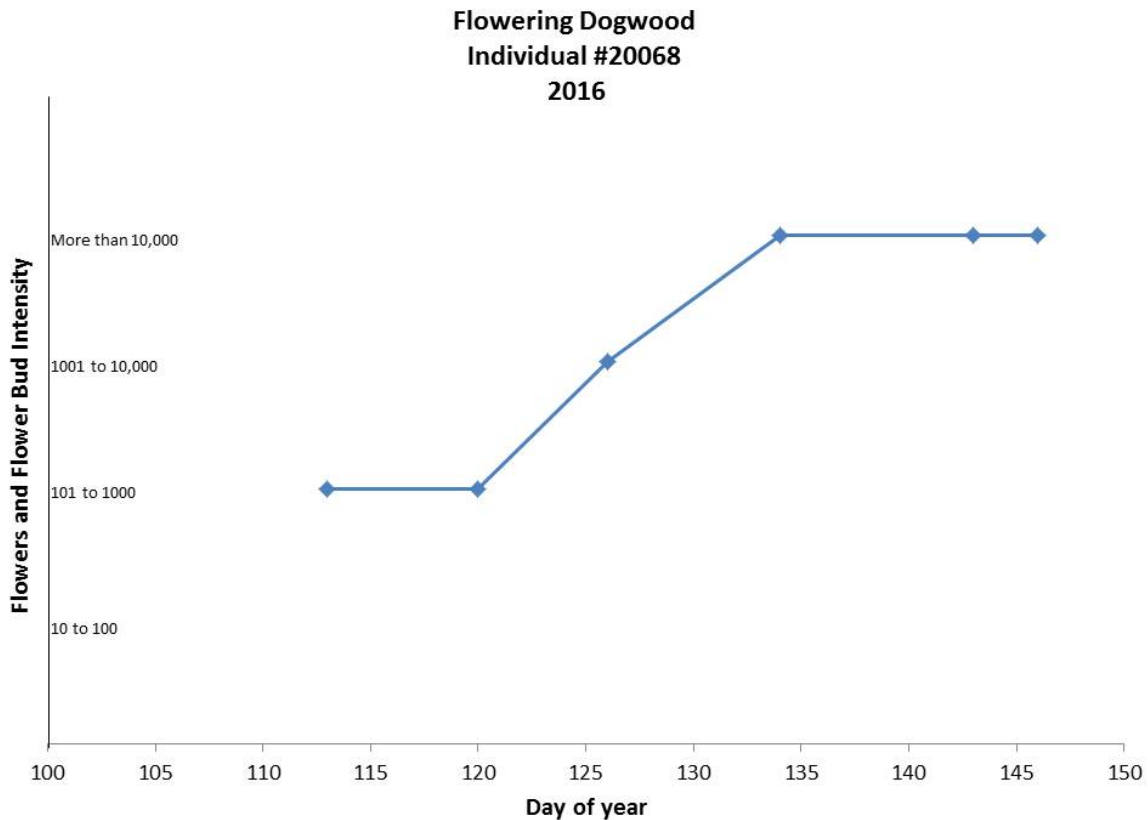
Figure 16. Intensity of flowers or flower buds in a registered flowering dogwood individual, plotted over day of year for 2016

This type of data has many applications. For example, you can compare the status of reports for the "leaves" phenophase to metrics of greenness derived from satellite imagery at the same location and on the same day. Information about the Earth's surface can be detected from satellites, including whether or not a deciduous forest or grassland has green leaf tissue that is photosynthesizing. Status and Intensity data can be used to "validate" whether the satellite really is detecting green leaves.

You can also use Status and Intensity data to evaluate the temporal "synchrony" of two or more species. For example, bees and other pollinators rely on nectar from flowers as a food source, but the phenology of these pollinators and plants might be changing at different rates due to climate

change. One can see if bees and "Open flowers" of their favorite plant are observed at a site at the same time, and whether the bees are most active when the flowers are at the peak of their bloom. You can create graphs for species and phenophases of interest to explore the extent to which they are in sync.

ii. Individual Phenometrics (formerly referred to as "summarized data")

Phenometrics, or phenology metrics, use phenophase status data to calculate derived variables such as the start and end dates of phenological activity. For plants, we currently offer these phenometrics at the individual plant or site level. For animals, they are always calculated at the site level, as animals are recorded at the species rather than individual level.

This type of data is useful for understanding patterns of activity within a species, such as quantifying how many episodes of phenophase activity occur over a period, and the duration of those episodes. For example, in many water-limited ecosystems, individual plants may have two or more periods of leaf and flower activity within a year because their phenology is triggered by rainfall. These data are the simplest way to determine the onset and end of a phenophase for an individual plant.

iii. Site Phenometrics

These data are a summarization of phenophase status data, comprised of the start and end dates of phenological activity for species at a site averaged across individuals at a site. This type of data is useful for applications such as the creation of site or regional phenological calendars and quantifying the

length of the growing season at a site or region. These data can be used to understand how phenophase onset and end dates relate to climate drivers, such as seasonal temperatures and precipitation.

5. CLIMATE DATA: HOW TO INCORPORATE CLIMATIC DATA FROM THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA)

The timing of life cycle events is often influenced by temperature and precipitation. Summarizing weather or climate data for the area at which you are observing can help you interpret your phenology data.

To create climate summaries for your observation locations, you can download monthly average temperature and total precipitation data from NOAA's National Climatic Data Center at www.ncdc.noaa.gov. This website also provides 30-year normal data, the latest three-decade averages of climatological variables for the period 1981–2010, including temperature and precipitation available at www.ncdc.noaa.gov/data-access/land-based-station-data/land-based-datasets/climate-normals/1981-2010-normals-data.

In Table 2, you can see an example summary table for average temperature data and the departure from a 30-year normal—the difference between the 30-year normal and the average temperature—for two years at a weather station near Albuquerque.

Table 2. Temperature summary table for Albuquerque VLY, NM US weather station. Departure from 30-year normal is based on years 1981-2010.

| | **2014** | | **2015** | |
	Ave Temp (F)	Departure from 30-yr Normal (F)	Ave Temp (F)	Departure from 30-yr Normal (F)
January	36.3	0.7	36.7	1.1
February	45.1	4.2	42.8	1.9
March	49.1	1.5	52.2	4.6
April	55.2	-0.2	56.1	0.7
May	62.6	-1.2	61.3	-2.5
June	74.7	2.4	76.1	3.8
July	77.7	1	75.9	-0.8
August	72.9	-2.4	76.8	1.5
September	70.3	2.5	71.6	3.8
October	59.5	3.6	60.4	4.7
November	43.5	-0.2	44.6	0.9
December	38.5	3	36.3	0.8

In Table 3, you can see an example summary table for precipitation data, the departure from a 30-year normal, and the percent of 30-year normal for two years at a weather station near Albuquerque.

Table 3. Precipitation summary table for Albuquerque VLY, NM US weather station. Departure from 30-year normal is based on years 1981-2010.

	2014			2015		
	Total Precip. (in)	Departure from 30-yr Normal (in)	Percent of 30-yr Normal	Total Precip. (in)	Departure from 30-yr Normal (in)	Percent of 30-yr Normal
January	0.00	-0.46	0%	1	0.54	217%
February	0.23	-0.30	43%	0.56	0.03	106%
March	0.37	-0.30	55%	0.13	-0.54	19%
April	0.08	-0.54	13%	0.99	0.37	160%
May	0.48	-0.06	89%	1.68	1.14	311%
June	0.03	-0.55	5%	0.56	-0.02	97%
July	3.97	2.53	276%	3.52	2.08	244%
August	1.38	-0.34	80%	1.28	-0.44	74%
September	1.06	-0.19	85%	1.33	0.08	106%
October	0.33	-0.80	26%	1.21	0.09	108%
November	0.17	-0.47	27%	0.43	-0.21	67%
December	1.23	0.60	195%	1.14	0.51	181%

Seasonal climate data are also available via the USA-NPN's Phenology Observation Portal, though data are not available until the spring following each year. These data are derived from Daymet (Daily Surface Weather and Climatological Summaries, Oak Ridge National Laboratory, https://daymet.ornl.gov/), and include maximum and minimum temperatures that are averaged over four 3-month periods to create seasonal climate fields.

6. RESULTS AND INTERPRETATION

This section of your report will focus on interpreting data and deriving conclusions. It may include a discussion of how the phenological data can be used by your organization or others, including scientists, natural resource managers, interpretive staff, and educators. For instance, you might attempt to answer a question such as:

- "During what time of year should phenology be recorded most frequently?"
- "Which species have particularly strong seasonal responses?"
- "Are there times of year that are optimal for observing leaf color changes or wildflower displays?"
- "Are there species that do not show responses to seasonal transitions or to geographic variation?"
- "How does the timing of activity in this year compare to previous years, and how does this qualitatively relate to differences in climate and weather observed between this year and previous years?"
- "Are there optimal temporal windows when invasive species should be treated or removed, seeds of native plants should be collected, or taxa of interest should be monitored?"

Your results and their interpretation should be driven by a program plan developed at your site, seeking to answer a scientific question about phenology at your location.

7. LESSONS LEARNED

This section of your report will be a summary of lessons learned and recommendations for future data collection efforts. This section should include a discussion of how the data will be used to inform future monitoring decisions and resource allocation (e.g., are there certain sites, species, or individuals that were either too difficult to monitor or, alternatively, particularly informative? Are there major gaps in the data either with respect to the number of individuals being monitored or the frequency at a given location or site?). Are there periods of time when the plant is dormant or animals are absent where frequency of observations could be reduced?

8. EDUCATION AND OUTREACH ACTIVITIES

You can use this section to report on your activities in support of outreach and education. Unless you are utilizing a small number of staff members alone to collect data, it is important that you describe the methods of engagement and training provided to those who were your observers. Such activities might include observer training, dissemination of results to observers or the public, interpretive programs, collaborations with school groups, etc. Providing a clear example of how people were trained and spent time observing will also help describe the needs that you sought to meet for engaging the community in phenology monitoring in the first place.

9. SUMMARY AND NEXT STEPS

This section is a summary of your major findings, and a statement of the next steps for your program. Are there changes you plan to make in future years, based on what you have learned from this report?

10.   LOCATION OF PROJECT COMPONENTS

You can use this section to provide a statement about the location of the data you used in creating your report. Here is an example statement:

> All data are (or have been) entered online via *Nature's Notebook* and are stored in the USA-NPN National Phenology Database, available for download via the Phenology Observation Portal at www.usanpn.org/results/data.

You may also consider listing the location of project documentation such as monitoring protocols, resources for plant and animal identification including photos of individuals, and maps of your *Nature's Notebook* sites.

LINKS TO EXAMPLE REPORTS

Here are three phenology reports that you can use as examples to guide the creation of your own report.

1. **Valle de Oro NWR 2014-2015 Phenology data report.** This phenology report spans two years, and summarizes climate data, observer monitoring effort, and phenophase activity at Valle de Oro National Wildlife Refuge. Results interpretation, lessons learned, and education/outreach activities are also included. Available at **https://fws.usanpn.org/valle-de-oro**.

2. **Sequoia and Kings Canyon National Parks California Phenology Project 2013-2014 Annual Report.** This phenology report spans two years, and summarizes climate data, observer effort information, and phenology data collected at the Parks. Results interpretation, lessons learned, and education/outreach activities are also included. Available at www.usanpn.org/cpp/resources.

3. **Tucson Phenology Trail 2011-2015 Phenology Report.** This phenology report spans five years and summarizes frequency of observations, environmental factors influencing the data, and patterns in the data for four focal species. Available at www.usanpn.org/nn/tucson-phenology-trail.