

Junior Phenologist Certification Program Implementation Guide

Learning Objectives

Students will:

- Describe the life cycle events of local plant and animal species
- Define phenology
- Explain how phenology relates to seasonal changes and climate change
- Compare the phenology of species at a site at the beginning of the program to the end of the program
- Predict what might happen with the phenology of species later in the year, during other seasons, and in future years
- Contribute observations to the growing National Phenology Database through the *Nature's Notebook* Citizen Science Program
- Learn how observations are being used to better understand how species respond to their environment

Next Generation Science Standards

Middle School	
LS: Life Science	
MS-LS1-4	Use empirical evidence and scientific reasoning to explain how behaviors and plant structures affect successful reproduction.
LS2.A: Interdependent Relationships in Ecosystems—Disciplinary Core Idea	
MS-LS2-1	Analyze and interpret data to provide evidence for the effects of resource availability on organisms and population of organisms in an ecosystem.
MS-LS2-2	Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.
MS-LS2-4	Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect population.
ESS: Earth and Space Systems	
MS-ESS3-3	Apply scientific principles to design a method for monitoring and minimizing human impact on the environment.

¹ www.nextgenscience.org

Conducting the Activity

Time Required

The activity, as written, can be done:

- Six weeks total, 1-1.5 hour lesson per week
- 1st class as introduction, subsequent classes students will explore on own
- 6th class as wrap up and reflection
- You may choose to conduct weekly observations for longer than six weeks, depending on your program

Logistics

- Divide the group into smaller groups of 3-4 youth. If your group has a mix of older and younger students, assign 1-2 older students to work with 2-3 younger students. **Depending on the age and availability of students, older students and leaders, consider how to make this work best for the composition of your group.**
- Develop weekly checklists for each group, including information about the week's tasks and materials needed for each week's activity.
- Leaders should distribute and collect these materials at the beginning and end of the designated weekly observation time.
- At the end of the six-week session, leaders should collect the datasheets and make ONE observation entry for each week in *Nature's Notebook*. For information on how to do this, reference the *Nature's Notebook* online resources for Learning How to Observe www.usanpn.org/nn/guidelines

Grade Levels

Mixed grade level, Middle School youth leading Elementary School youth, assisted by adult volunteers

- Ages 9-11 (Upper Elementary Grades 3-4)
- Ages 12 and up eligible for certification program (Middle and High School Grades 5-12)

Overview

This project has been developed as a "Junior Phenology Monitoring Certification Program" for older youth, or those leading younger youth during a 6+ week session. Ideally, older students lead a group of younger students during the program. However depending upon the ages of your students, you might consider having an older volunteer or leader help instead. At the end of the session, the older students can be rewarded a Certificate of Completion (see Appendix 1), and become a Certified Junior Phenologist. In addition to an actual certificate students may also receive a reward(s) for completing weekly observations, depending upon your budget and objectives. The activity increases science literacy by teaching about life-cycle events, encouraging people to recall experiences outdoors and spend more time observing things they may not yet have experienced. Groups with certified youths may notify the NPN to receive public recognition.

Background

Phenology—or the study of life cycle events in plants and animals, their timing, and relationship to the natural world—can be used to teach a variety of concepts in a multi-week classroom, summer or after school program. If youth are already learning about a host of nature topics, phenology can be a wonderful addition to the program because participants will learn how to hone their observation skills, take careful notes, record observations, think about what has happened in the past and, create hypotheses about what they believe may occur in the future. This activity provides a hands-on component to making observations in nature.

Real World Connection

This activity teaches the basic scientific skill of observation. Observation lays the groundwork for many aspects of scientific study, including biology, chemistry, ecology, physical science. Long-term participation in this activity connects students to the real world research project, *Nature's Notebook* (www.natures-notebook.org), data from which researchers and land managers use in decision-making.

Quick Links:

Nature's Notebook:

www.naturesnotebook.org

Learn How to Observe:

www.usanpn.org/nn/guidelines

Nature's Notebook Curriculum webpage:

www.usanpn.org/educate/nn_curriculum

Phenophase Photo Cards:

www.usanpn.org/species-template

Week One:

Phenology by Regina Brinker:

www.youtube.com/watch?v=RN53XpRmRfI

Phenology by Nina Leopold Bradley:

www.youtube.com/watch?v=OHY-c_RDMkM

Measuring Plant Phenology:

www.youtube.com/watch?v=_4uHLXL1yZA

Mini Scavenger Hunt:

www.usanpn.org/files/shared/USA-NPN_MiniScavengerHunt.pdf

The Science of Climate Change in National Parks: Tracking the timing of Natural Events:

www.youtube.com/watch?v=Ts7FDt3oqRY

Week Two:

Simplified Phenophase Definitions:

www.usanpn.org/nn/simple-pheno-data

Introduction to Journaling:

www.usanpn.org/intro-pheno-journal

Species Research Worksheet:

www.usanpn.org/species-research

Week Three:

Observation Station:

www.usanpn.org/files/shared/USA-NPN_Observation_Station.pdf

Phenology Bingo:

www.usanpn.org/PhenologyBingo

Week Four:

Phenology Word Search:

www.usanpn.org/files/shared/USA-NPN_PhenologyWordSearch.pdf

Phenology Activity Book:

www.usanpn.org/activitybook

Week Six:

Phenology Visualization Tool:

www.usanpn.org/nn/connect/visualizations

Conducting the Activity

Materials

- An adult or staff member to guide the students in discovery during each session
- Five activities from the *Nature's Notebook* Curriculum webpage (www.usanpn.org/educate/nn_curriculum), one each week as listed starting on Page 3.
- Box or bag to hold materials for each team. Contents include, enough for ONE SET per team:
 - Hand lens
 - Unlined journal for each student OR Individual sheets of paper for each student
 - Colored pencils
 - Markers
 - Pens and pencils—one for each group member
 - Clipboard
 - Datasheets for plants included on phenology walk, one day-by-day or species-by-species datasheet for each week
 - Phenophase definition sheets, laminated
 - Field guides, or pictures of species for local plants and animals
 - Forestry tape for labeling plants OR aluminum tags
 - Sharpie pen to write plant names and numbers on label
 - A map of the potential individual species available for monitoring
- Pre-determined list of native/commonly occurring species at the site. Field guides and information related to these species. Students will select individuals to monitor.
 - Consider making Phenophase Photo Cards (www.usanpn.org/species-template)
 - Map of marked plants at the site—developed before students begin, or with the students
- Certificates of Completion (Appendix 1)
- Prizes to go with certificate, such as a hat or bag, or pin
- Prizes for all participants, such as a water bottle or other similar useful item

Each week the adult leader is responsible for:

- Ensuring the boxes include needed materials for the group
- Creating a checklist of assignments and activities for that week
- Printing enough activity sheets for all group participants
- Providing one datasheet per group per week
- Collecting the datasheets at the end of each session and making an entry each week into the *Nature's Notebook* program for each team's individual plant and animal species.
- Access to and an account for the *Nature's Notebook* Citizen Science Program (www.naturesnotebook.org)

Optional Materials

- Bulletin board for:
 - Displaying phenophase photos that students take
 - Displaying simple graphs with of phenology calendars through time, created by students
 - Recording incidental observations of other species not being observed via *Nature's Notebook*
 - A map of the site with locations of marked plants
 - A check list of species that might be seen at the site, and their timing
 - Scissors
- Pre-created letters or labels for bulletin board
- Computers if students are able to add observation data themselves using datasheets
- Mobile devices such as iPads, tablets or smartphones for making observations in the field, instead of datasheets, if students are able and a group is established
- Binoculars for making observations at the top of a tree or from a distance
- Cameras for taking pictures of individual trees being monitoring and their phenophases

Note: If you have extra time, you might consider utilizing our other activities found on the USA-NPN *Nature's Notebook* Curriculum website: www.usanpn.org/educate/nn_curriculum

Conducting the Activity (continued)

Week One

Introduction to Phenology & *Nature's Notebook*

DEFINE Phenology, overview of why we are doing this project (10 minutes)

VIEW suggested short video(s) on Phenology. Visit the USA-NPN YouTube channel for more ideas.

- *Phenology by Regina Brinker* (www.youtube.com/watch?v=RN53XpRmRfI) (3:41 minutes)
- *Phenology by Nina Leopold Bradley* (www.youtube.com/watch?v=OHY-c_RDMkM) (3:17 minutes)
- *Measuring Plant Phenology from Ground to Space by NEON* (www.youtube.com/watch?v=_4uHLXL1yZA) (5:15 minutes)

DISCUSS (5-10 minutes)

1. Phenology is the study of the recurring life cycle events in plants and animals and their relationship to the environment.
2. What do students already know about this concept?
3. What, of the items located on the scavenger hunt, are phenological indicators of seasonal change?
4. For older audiences: How might having an understanding of an ecosystem's phenology tell us how our long-term climate is changing? Discuss range shift, species mismatch, etc.

DEFINE The seasons in your region (5-10 minutes)

1. Discuss the seasons in your area. What do students know about seasonal change. What are some of the indicators of each season? How do the plants and animals interact during those seasons?
2. What are life cycles? Ask students to name some life cycles of familiar plants and animals. How are they tied to the seasons in your area?
3. Discuss habitats and what is present in the local environment that makes a good habitat for a particular species.

ACTIVITY 1: Seasonal change and life cycle events (10 minutes)

1. Select several local, sentinel, plant and animal species for your region, including those species you would like for students to observe each week.
2. Locate, or take, pictures of the species during various life cycle stages throughout the year. Laminate the photos if you are able. These may become phenophase identification cards (Appendix 2). See Phenophase Photo cards for examples of photos.
3. Ask for student volunteers to hold the photos for the audience.
4. Work with the students to put the life cycle events in order.
5. Designate what time of year each phase occurs and ask students to describe when they remember seeing those cycles outside.
6. Ask students what phase they think is occurring in the species right now.
7. Repeat as many times as you like with different species.
8. At the end of today's meeting, go outside to locate samples of these plants.

ACTIVITY 2: Scavenger Hunt (20 minutes)

1. Engage the students in a short scavenger hunt. Provide worksheet with habitat and life cycle items to find in an adjacent outdoor space. You can use this Mini Scavenger Hunt Sheet to get started OR create your own (www.usanpn.org/files/shared/USA-NPN_MiniScavengerHunt.pdf). A full Habitat Scavenger Hunt Lesson Plan can be found here: www.usanpn.org/HabitatScavengerHunt.
2. Have them mark a ✓ on their sheets if they see something. Or an X if they do not see something. Discuss the importance of not seeing something in nature,

knowing when a phenophase is not present is also helpful (www.usanpn.org/nn/faq#no_change). *TIP:* when translating this experience to *Nature's Notebook*, observers are encouraged to indicate when they don't see something as well as when they do. Having a consistent series of NO observations (or what we call negative data) provides those working with the data more information about the species in nature and helps us pinpoint exactly when a phenophase may begin to occur.

3. After the group searches, reflect on what was found. What season are we experiencing now? Are any of the indicators that the class listed earlier present in the environment? What do we expect to see next?

4. If you have cameras or cell phones, consider having students take pictures of the items they find, including those in each life cycle phase. Upload the photos to a shared photo website such as Flickr or Google Photos. You can use these photos to build species identification pages.

VIEW short video (10 minutes) For older audiences

- *The Science of Climate Change in National Parks: Tracking the timing of Natural Events* (www.youtube.com/watch?v=Ts7FDt3oqRY) (8:33 minutes)

DEFINE Citizen Science (2-3 minutes)

1. Citizen science is a process by which scientists seek help in answering research questions related to topics of interest. Participants in a citizen science program can be members of the general public, of any age, or professional staff and scientists. Generally the idea is to collect enough data to adequately answer the research question. Sometimes participants, like students, can also ask their own science questions using the framework designed by the science program and answer their own questions. This benefits the participant as well as the broader community interested in the research questions.

DEFINE *Nature's Notebook* (5 minutes)

1. *Nature's Notebook* (www.naturesnotebook.org) is a citizen science program sponsored by the USA National Phenology Network (www.usanpn.org). It is designed to collect observations made on the phenology of species existing in the National Phenology Database. It is meant to be a long-term program, meaning participants will contribute observations for more than one year, on the same plants at the same location, so that the data gathered can be used by researchers and land managers to make decisions about the response of our planet's species to climate change.

2. Observations collected by your group and entered into *Nature's Notebook* will help us better understand seasonal changes in plants and animals, may help contribute to a better understanding of the local ecosystem being studied by sponsors of a "Phenology Trail" or series of observation sites, or may be used in continental or global scale research and management projects.

DESCRIBE The assignment for period you will conduct the activity (10 minutes)

1. Groups will select and mark plants to watch each week.
2. Each week they will record phenology observations on the plants, including the leaves, flowers, fruits (if any) on the chosen plants, and sightings and behaviors of animals.
3. The data will be gathered and submitted by team leaders or students to the USA National Phenology Network's *Nature's Notebook* Citizen Science Program.
4. Decide which phenophases you are going to observe for each species. Depending on the skill level of your participants, only choose to observe those you are comfortable with.
4. The data collected during this program will be used by students during the school year and future summer programs. This information will be valuable for future students to make predictions about what they might see while observing.
5. Describe the "Junior Phenologist Certification Program", demonstrate the rewards.

Conducting the Activity (continued)

Week Five

Weekly Phenology Observations

Hand out the team boxes with appropriate materials

ACTIVITY 1: Phenology Presentation (30 minutes)

Create display on bulletin board or other public presentation including: photos, drawings, reflections or whatever the students observed.

REFLECT upon the observations made so far. Has anything changed from week to week? If no, why not? If yes, why? Were any of the predictions made each week realized?

1. Compile or create new materials to display on the bulletin board describing what the group has been working on and observing over the last few weeks. Include pictures taken or drawn, general information about observations made, etc. Also include predictions about what might happen in a month, six months, and one year.

2. Be as creative as possible.

ACTIVITY 2: Phenology Observations (5 minutes)

1. Capture the occurring phenophases on the provided datasheet and return the datasheet to the team box.

2. If using cameras, take accompanying photos of the individual plant, and up close photos of each occurring phenophase.

ACTIVITY 3: Journal Entry (15 minutes)

1. Create one journal entry, in the paper journal, recording the date and time, the weather conditions (temperature, precipitation, wind, etc.), describing the individual, its location, the phenophases and what they look like on the plant (based on the earlier large group discussion), and what they think will be happening one week from today.

2. Provide younger students an opportunity to draw or describe the plants on individual sheets of paper that will be stored in the team boxes over the next week.

3. Return the materials to the team box and give to the program leader.

ACTIVITY 4: Data Entry (time may vary)

Program leader makes one entry into *Nature's Notebook* this week for each group's observations.

NOTES ON THIS WEEK'S ACTIVITY

Week Six

Elaborate on and Extend Phenology Monitoring

Hand out the team boxes with appropriate materials. Make one last set of observations on the selected species.

REFLECT upon the observation activity that was done over the last several weeks. What can our information tell someone from another state or country about our environment? What can it tell us if we look back at our information in *Nature's Notebook* next year at this time?

ACTIVITY 1: Phenology Observations (5 minutes)

1. Capture the occurring phenophases on the provided datasheet and return the datasheet to the team box.

2. If using cameras, take accompanying photos of the individual plant, and up close photos of each occurring phenophase.

ACTIVITY 2: Data Visualization (30-60 minutes)

If your space has an internet connection, log into *Nature's Notebook* and use the Phenology Visualization Tool (www.usanpn.org/nn/connect/visualizations) to share with the students their data entered online. This webpage includes information on how to use the tool.

You may find it more helpful to visualize the data using the *Phenology Calendar* (Appendix 3) for younger audiences, so they can see how their data look for the weeks that they have collected observations. If you do this activity for more than one session, season, or year, you will have the advantage of going back in time to make comparisons to that which was entered before.

ACTIVITY 3: Phenology at Home (time may vary)

Provide students with information to continue this activity at their home with their families. Encourage them to bring their families to visit the location (if appropriate) and make observations on the same marked trees the students used during their session.

REFLECT What did students like and dislike about this program? What about this program would they share with someone visiting them from out of town?

ACTIVITY 4: Data Entry (time may vary)

Program leader makes one entry into *Nature's Notebook* this week for each group's observations.

Evaluate

The use of reflective practice is critical to understanding. Examples of reflection questions include:

- Share one new thing that was learned from this experience
- Share one thing that you still have a question about
- Share something that you learned that might be useful in the future
- Share something that could have been done differently

Utilize the *General Evaluation Form* (Appendix 4) with students at the end of this session.

Attached Appendices:

- Appendix 1—Certificate of Completion
- Appendix 2—Phenophase Identification Cards
- Appendix 3—Phenology Calendar
- Appendix 4—General Evaluation Form



Certificate of Completion

The USA National Phenology Network and
recognizes

as a
Junior Phenologist

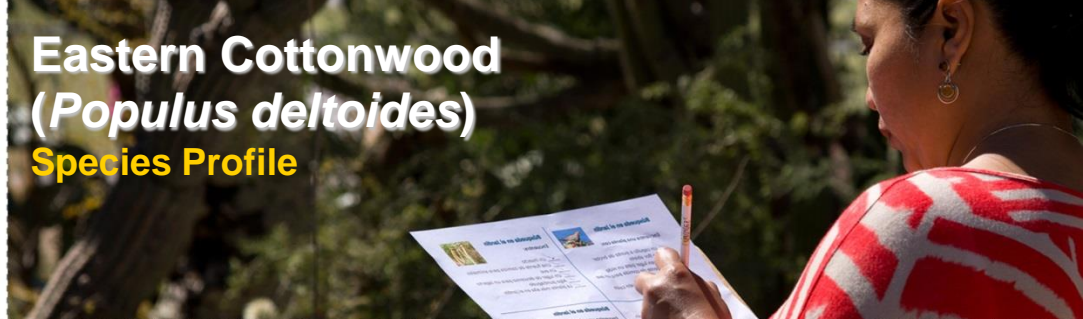
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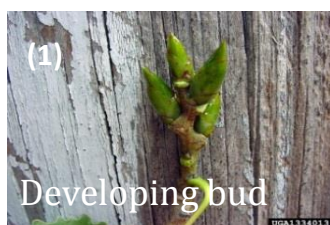
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Eastern Cottonwood (*Populus deltoides*) Species Profile



The eastern cottonwood (*Populus deltoides*) is a tree up to 80-100 ft in height and 3 to 4 ft in diameter. Leaves are 3 to 5 inches long and nearly as wide, with toothed edges. Bark on older trunks is deeply furrowed and ash-gray, though smooth and greenish-gray on younger trees. Both the male and the female inflorescence is a catkin which is initially compact, but eventually unfolds to become longer and hang loosely from the branch. Once the flowers wilt, male catkins turn gray and dry up, and female catkins turn green and lengthen as the fruits develop.



(1)
Developing bud



(2)

Breaking leaf buds:

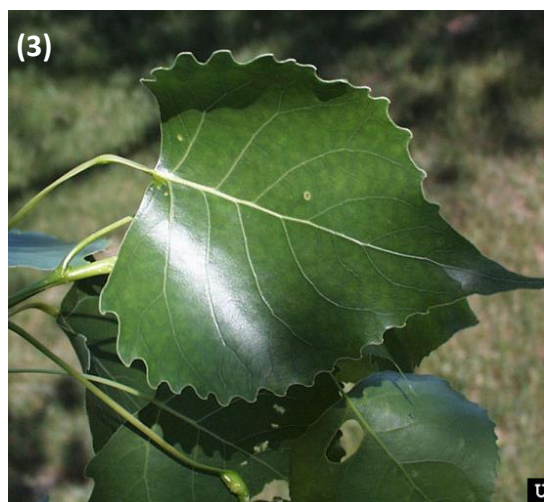
A leaf bud is considered "breaking" once a green leaf tip is visible at the end of the bud, but before the first leaf from the bud has unfolded to expose the leaf stalk at the base. Compare the developing bud above to the breaking leaf bud below with leaf tips visible.



(4)

Increasing leaf size:

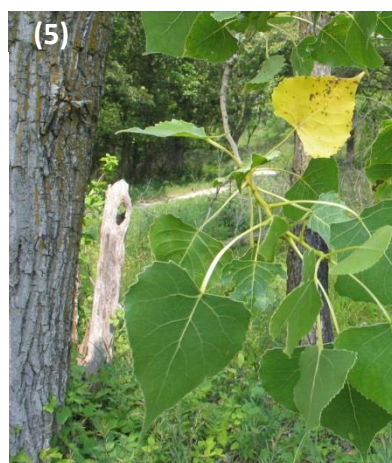
The majority of leaves on the plant have not yet reached their full size. Do not include new leaves that continue to emerge at ends of elongated stems throughout the growing season



(3)

Leaves:

One or more unfolded leaves visible; do not include dried or dead leaves



(5)

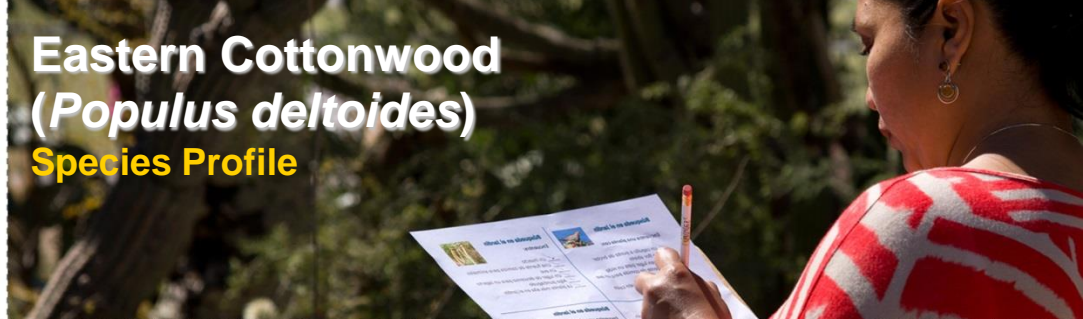
Colored leaves:

Do not include fully dried or dead leaves that remain on the plant.

*Phenophase not
pictured: Falling
leaves*

Photo credits: (1) Chris Evans, Illinois Wildlife Action Plan, Bugwood.org, (2) Axel Kristinnsson, Wikimedia commons, (3) Paul Wray, Iowa State University, Bugwood.org, (4) J.N. Stuart, (5) Ben VanderWeide.

Eastern Cottonwood (*Populus deltoides*) Species Profile



(1) Flowers or flower buds: Open or unopened flowers. Once you see open flowers (below) continue to report flowers or flower buds.

Open flowers: Flowers are open when the reproductive parts (male stamens or female pistils) are visible. Do not include wilted or dried flowers.

Note: If catkins are high in tree and hard to see, flowers are open once the initially compact catkin has unfolded and is hanging loosely.



Female flowers
(with pistils visible)



Male flowers (with
stamens visible)



(2) Pollen release: One or more flowers release visible pollen grains when gently shaken or blown into your palm or onto a dark surface.



(3) Fruits: A tiny capsule that changes from bright green to dull green, greenish-brown, tan or light brown and splits open to expose seeds with white fluff. Do not include empty capsules.



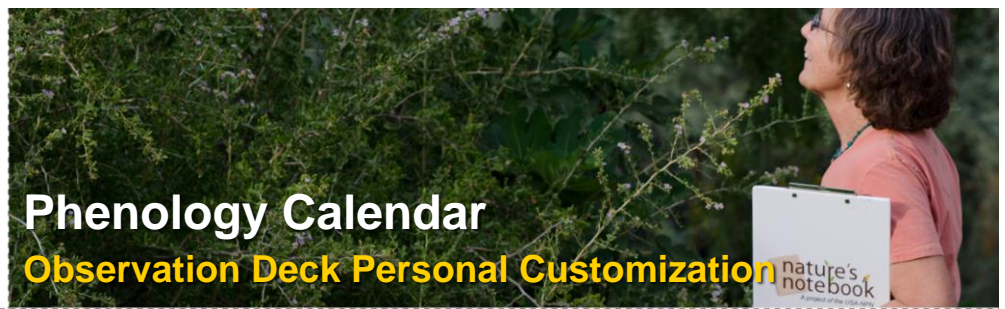
(4) Ripe fruits: When the fruit has turned dull green, greenish-brown, tan or light brown and has split open to expose seeds with white fluff. Do not include empty capsules.



(5) Recent fruit or seed drop: Mature fruits or seeds have dropped or been removed from plant since last visit. Do not include fruits that have dropped before ripening.

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Photo credits: (1) Bill Cook, Michigan State University, Bugwood.org, (2) Steven J Baskauf, (3) Nadiatalent, (4) Troy Evans, Great Smoky Mountains National Park, Bugwood.org, (5) Dave Powell, USDA Forest Service, Bugwood.org.



Phenology Calendars are tools designed to visually share when a user's reported observations in the *Nature's Notebook* Citizen Science Program.

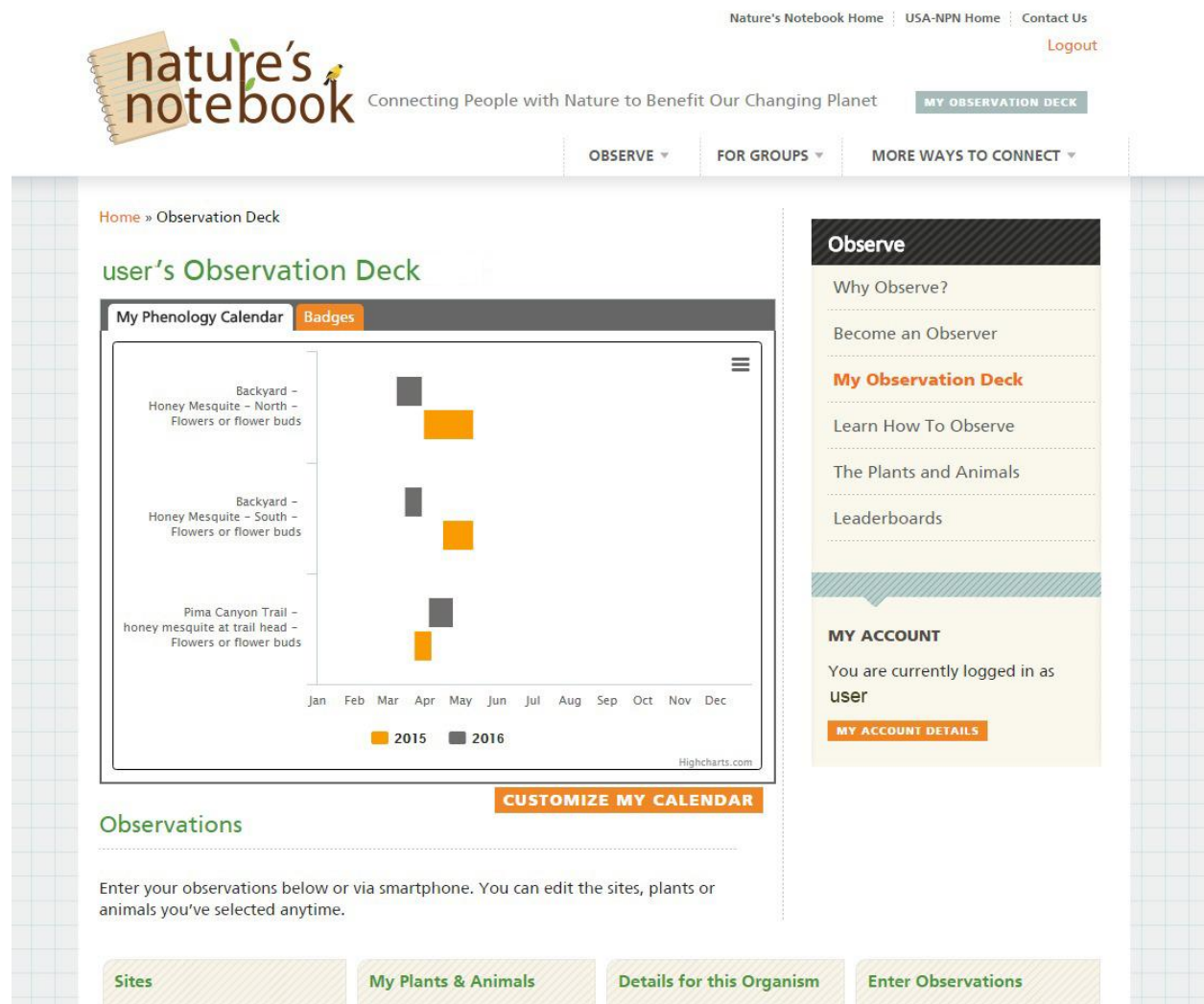


Figure 1: *Nature's Notebook* Main Observation Deck Page

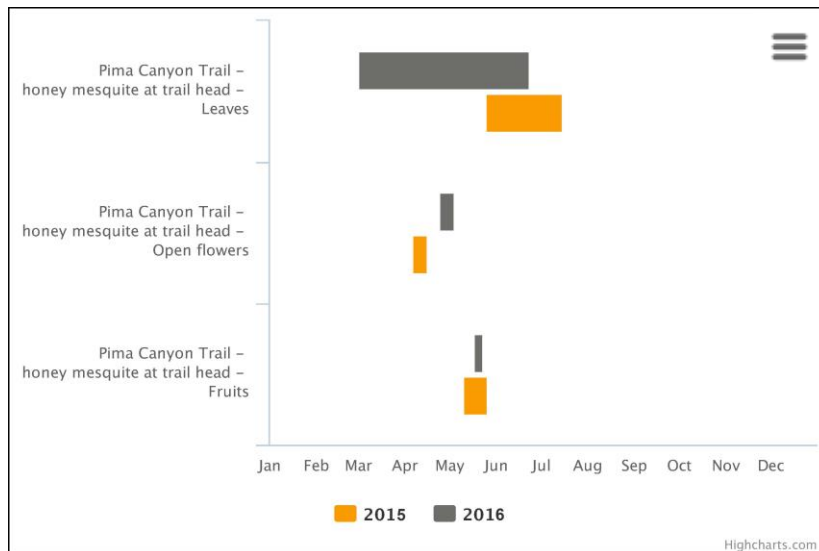
These calendars are accessible and customizable through the Observation Deck when logged in to your *Nature's Notebook* account, as seen in the picture above. You can see a comparison of flowering times for three separate honey mesquite plants, two of which are in the user's "Backyard" site and one at the user's "Pima Canyon Trail" site. The user is comparing their own data submitted for 2015 and 2016. We can see that the mesquites had reports of flowers later in 2015 than in 2016 for the "Backyard" site, but flowered earlier in 2015 and later in 2016 for the "Pima Canyon Trail" site.

The screenshot displays the 'Phenology Calendar' creation interface. At the top, there's a navigation bar with 'nature's notebook' logo and links like 'Nature's Notebook Home', 'USA-NPN Home', and 'Contact Us'. Below this, a breadcrumb trail shows 'Home » Observation Deck » Phenology Calendars'. The main heading is 'Phenology Calendar'. A descriptive paragraph explains how to create a customized calendar. The form includes three dropdown menus: 'Select Site:' (with options like Backyard, New Office, Pima Canyon Trail, Work), 'Select Individual or Species:' (with options like honey mesquite at trail head, yellow paloverde-1, blue paloverde-1), and 'Select Phenophase:' (with options like young leaves, leaves, colored leaves, falling leaves, flowers or flower buds, open flowers, pollen release, fruits, ripe fruits, recent fruit or seed drop). There are 'ADD TO CALENDAR' and 'REMOVE FROM CALENDAR' buttons. Below these, there are fields for 'Select Year 1:' (2013) and 'Select Year 2:' (2014). A 'CREATE MY PHENOLOGY CALENDAR' button is prominently displayed. The resulting calendar shows a horizontal bar chart for the months of January through December. The legend indicates that orange bars represent 2015 and grey bars represent 2016. The data points are: 'Pima Canyon Trail - honey mesquite at trail head - Leaves' (orange bar from May to July), 'Pima Canyon Trail - honey mesquite at trail head - Open flowers' (orange bar in April, grey bar in May), and 'Pima Canyon Trail - honey mesquite at trail head - Fruits' (orange bar in May, grey bar in June). At the bottom, there are links for 'Make Default Calendar', 'CLEAR MY CALENDAR', 'FAQs', 'Terms of Use', and the 'npn' logo.

Figure 2: Customizing your Phenology Calendar Page

To customize your Phenology Calendar in your Observation Deck, click the CUSTOMIZE MY CALENDAR link below the pre-loaded graphic at the top of your Observation Deck. You will be taken to a new page where you can choose the options to create your own Phenology Calendar. On the Phenology Calendar creation page, pictured above, you can choose from a list of your sites, either group sites or personal sites, and from any of the species—plant or animal. Select any phenophases to display, and click the ADD TO CALENDAR link. This can be repeated two more times, for different sites, different species, or different phenophases. Choose any two years you have submitted observations for these individuals. Click CREATE MY CALENDAR to generate a visual representation of your submitted data. If no data appears on the calendar for the series you selected, then there are no data for that individual or phenophase for the selected date range.

To watch a video clip on how to create and customize your Phenology Calendar tune into 39:10 in our previously recorded “[Observation Deck Refresher Course](#)” webinar posted on our YouTube page.



You have options to print or save the image as a png, jpg, pdf or svg vector, by clicking the icon in the top right corner. You can also set this as your default calendar that loads automatically in your main Observation Deck page by checking the box for “Make Default Calendar”.

Figure 3: Saved Image of a custom Phenolgy Calendar

Once you have set your default Calendar in your Observation Deck, hovering over the colored bars will display more data about when that phenophase was reported, and for how long, seen in Figure 4 below.

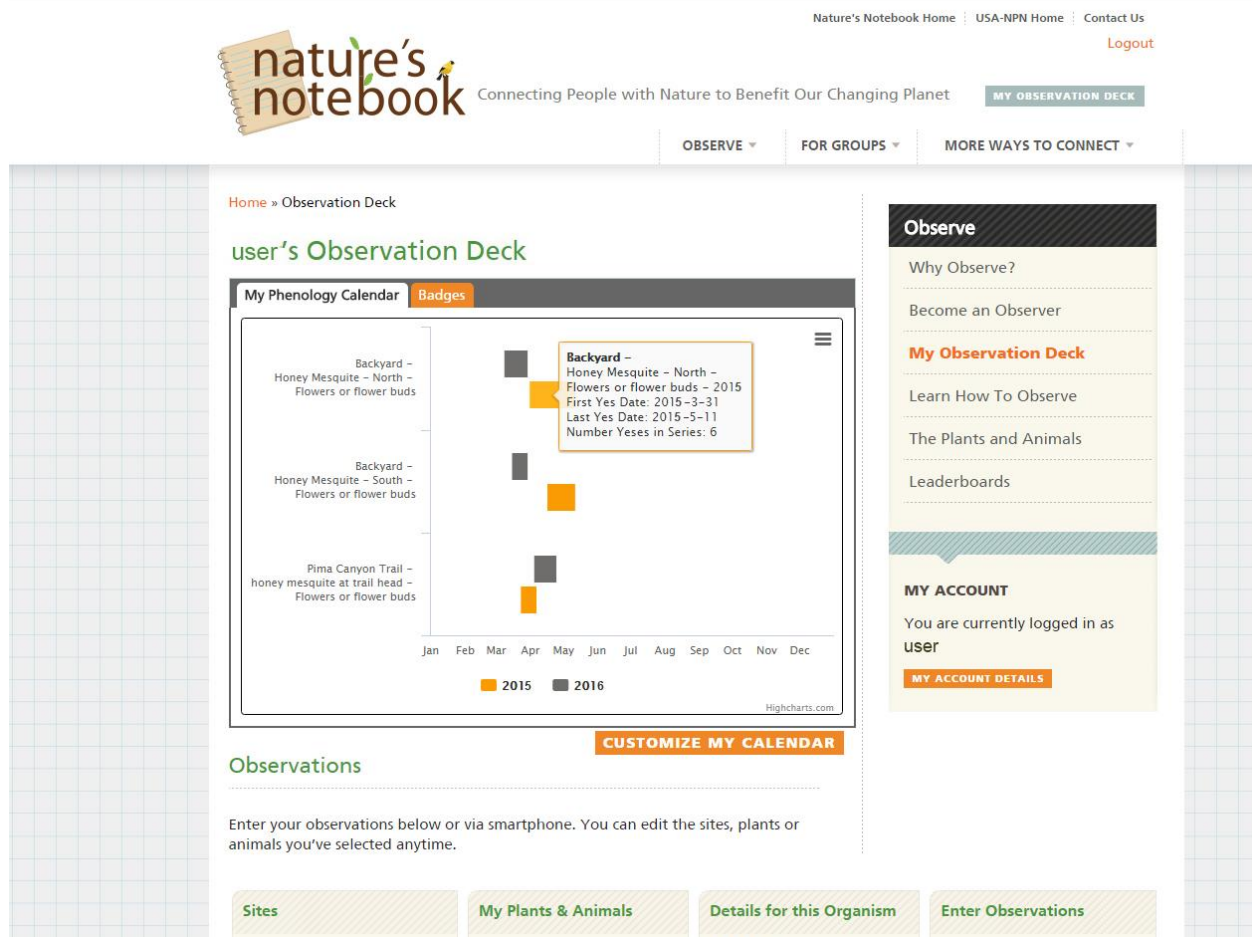


Figure 4: Nature's Notebook Main Observation Deck Page with custom Calendar



General Evaluation Sheet

Share with me one thing that you learned today:

Share with me one thing you still have a question about or are confused about:

(if you have more than one question, write it on the back of this form)

Share with me one thing you may use in the future:

Share with me something I could have done better:
