Cooperative Ecosystem Studies Unit (CESU): Phenology Monitoring Technical Assistance – *Nature's Notebook* Citizen Science for Engagement and Management

A multi-year agreement between the National Wildlife Refuge System of the US Fish & Wildlife Service (USFWS) Inventory and Monitoring Program and the USA National Phenology Network (USA-NPN).

Phenology for Resource Management and Decision Making
Year 1 Annual Report, January 2020

Cooperative Agreement Award F19AC00168
Project Period: February 20, 2019 – February 19, 2020
Budget: $ 174,354.00

By Erin Posthumus, PI, USA-NPN Liaison to the USFWS
January 20, 2020

In the first year of our new four-year funding agreement for 2019-2023, we increased the number of tools and resources available to our National Wildlife Refuge partners, engaged new refuges in monitoring phenology, and solicited feedback from partner refuges to create a new way to visualize data on a landscape scale. These activities directly supported the USFWS Mission to conserve wildlife and their habitats by providing information about the seasonal cycles of plants and animals, how they are changing, and how these changes can inform management, operations, and interpretation.

Below, we describe our progress toward meeting our first year objectives, as well as additional accomplishments related to our four-year objectives and our partnership as a whole.

Activities in support of first year objectives:

Objective 1: Integrate existing phenological datasets from Refuges into the National Phenology Database. Work with individual Refuges to help them adjust their current data collection method to utilize the USA-NPN's phenology protocols for future monitoring.

Our long-term goal is to have all phenology data collected on National Wildlife Refuges in a standardized format and hosted in a single, easily accessible database. The USA-NPN offers standardization and security for USFWS data. The USA-NPN also provides tools to summarize the data and deliver them side-by-side with seasonal climate data. Refuges also have access to our Visualization Tool which allows refuge staff to explore and visualize their own data as well as compare these to data collected by other refuges and data collected in areas off-refuge.

In our first year, we reached out to the refuges that are using *Nature's Notebook* to offer them the option to move historical phenology data into the National Phenology Database. The first refuge to request that

we integrate their data was Patuxent Research Refuge in Maryland (Region 5). Patuxent's Volunteer Coordinator and a volunteer attended a workshop that I led at the National Conservation Training Center in the fall of 2017. They were impressed with the rigor of the USA-NPN's data collection protocols, our visualization capabilities, and the access they would have to other data collected on their species of interest throughout the region. At the time, Patuxent was using Project Budburst (budburst.org) to collect first events of four focal plant species. They wished to transition their monitoring to use the USA-NPN's *Nature's Notebook* program, as well as integrate the data they collected from 2013-2019 with Project Budburst into the USA-NPN's National Phenology Database. Since the two systems utilize different phenology monitoring protocols, I am currently working with other USA-NPN staff to align these datasets so that we can import the data into our system later this year for this Refuge.

Plan for Second Year of Funding: Once we have a process in place for cross-walking external datasets into the USA-NPN's National Phenology Database, we can more easily ingest other datasets collected with different protocols as well as simple lists of first occurrences for species of interest. We will make a concerted effort over the next year to advertise data integration as an option available to refuges across the country.

Objective 2: Inform/advise interested refuges on implementing phenological monitoring

In 2019, our staff offered multiple opportunities for refuge staff and volunteers to learn to use USA-NPN's data collection platform, *Nature's Notebook,* as well as the other phenology tools and products that we offer. These included:

- USA-NPN Education Coordinator LoriAnne Barnett facilitates a Local Phenology Leader Certification Course three times a year that is designed to help establish a *Nature's Notebook* phenology monitoring program. The course walks participants through program planning activities to ensure sustainable, long-term programs. The 10-week online course is offered in the spring and fall; an additional 3-week summer short course is also offered for those who do not have time for the full Certification Course. We promoted the Certification Course and summer short course in each of our USFWS Quarterly Newsletters in 2019, and also shared information about the program in a webinar hosted by NCTC in July of 2019.
- I also conducted a workshop at the annual conference of The Wildlife Society in October of 2019 to teach wildlife managers how to leverage *Nature's Notebook* for data collection as well as how to use the USA-NPN's forecasting tools (e.g. Status of Spring indicator, fws.usanpn.org/status-spring; Pheno Forecasts for predicting activity of insect pests and invasive plants, www.usanpn.org/data/forecasts) to inform management activities. We advertised the course via the USFWS Quarterly Newsletter and it was also included in a newsletter of the Association of Fish and Wildlife Agencies (AFWA). Unfortunately no USFWS staff attended the workshop, likely due to travel restrictions on USFWS staff for conference travel.
- I was invited to present in NCTC's Citizen Science Course in July 2019 along with refuge staff from Valle de Oro NWR and a former USFWS staff member at the Southeast Louisiana Complex of Refuges. I shared information about how refuges and other agency partners can implement a

phenology monitoring program at their unit. Participants included staff from six NWRs across the country.

We had contact with four new refuges interested in beginning phenology monitoring programs in 2019:
1. Buenos Aires NWR, Region 2 – The Wildlife Biologist at this refuge began monitoring agave flowering to support the Flowers for Bats campaign. We created this campaign at the request of the Arizona Ecological Services Office in Region 2 to support the post-delisting monitoring plan for the lesser long-nosed bat (*Leptonycteris yerbabuenae*). I am working with Buenos Aires NWR staff to set up a Refuge Dashboard which will enable the Refuge to view the data they collect in real time. This will assist the Refuge staff to, interpret patterns in their observations, provide a quick way to visualize data for visitors, and correct any errors in their data.

2. Northern New Mexico NWR Complex, Region 2 – Their Visitor Services Manager participated in the Local Phenology Leader Certification Course in the spring of 2019. She is developing a plan for monitoring grasses at the refuges that engages refuge staff, visitors, and members of their Friends group. Rio Grande Phenology Trail Coordinator, Liz Gallagher, an employee of Valle de Oro NWR partner Bosque Ecosystem Monitoring Program, is helping her implement her program.

3. Yukon Flats NWR, Region 7 – I was contacted by a Wildlife Biologist at Yukon Flats NWR who is in the exploration phase of beginning a phenology program. He is interested in engaging the 1,200 community members who live in villages near the Refuge to collect phenology data on the Refuge. This will foster engagement and ownership in the Refuge on the part of the community members, while also assisting the Refuge with data collection in remote areas that are difficult for Refuge staff to reach. We talked through best practices for implementing a phenology program and I connected him with two partners who have conducted similar types of phenology programs involving individual observers who independently collect data. I will continue to communicate with and support the Refuge staff as they get their project up and running.

4. Bon Secour NWR, Region 4 – The Gulf Coast Phenology Trail Coordinator, Gail Bishop, a part time contractor for the USA-NPN, has begun talks with the Refuge Biologist at Bon Secour NWR in Alabama about joining the Gulf Coast Phenology Trail. We will continue to support their efforts to determine if any of the Trail focal species are relevant to their management priorities or if they have other species of interest that we can incorporate into the Trail.

Plan for Second Year of Funding: We will continue to assist these new refuges to implement phenology monitoring and create their Phenology Dashboards on the USFWS Phenology Network web portal. We are also working with staff at NCTC on a series of four webinars to be included in their Conservation Science Series between February and April. The webinars will focus on applications of phenology for natural resource management. We will advertise widely to USFWS staff to recruit additional refuges to participate in phenology monitoring.

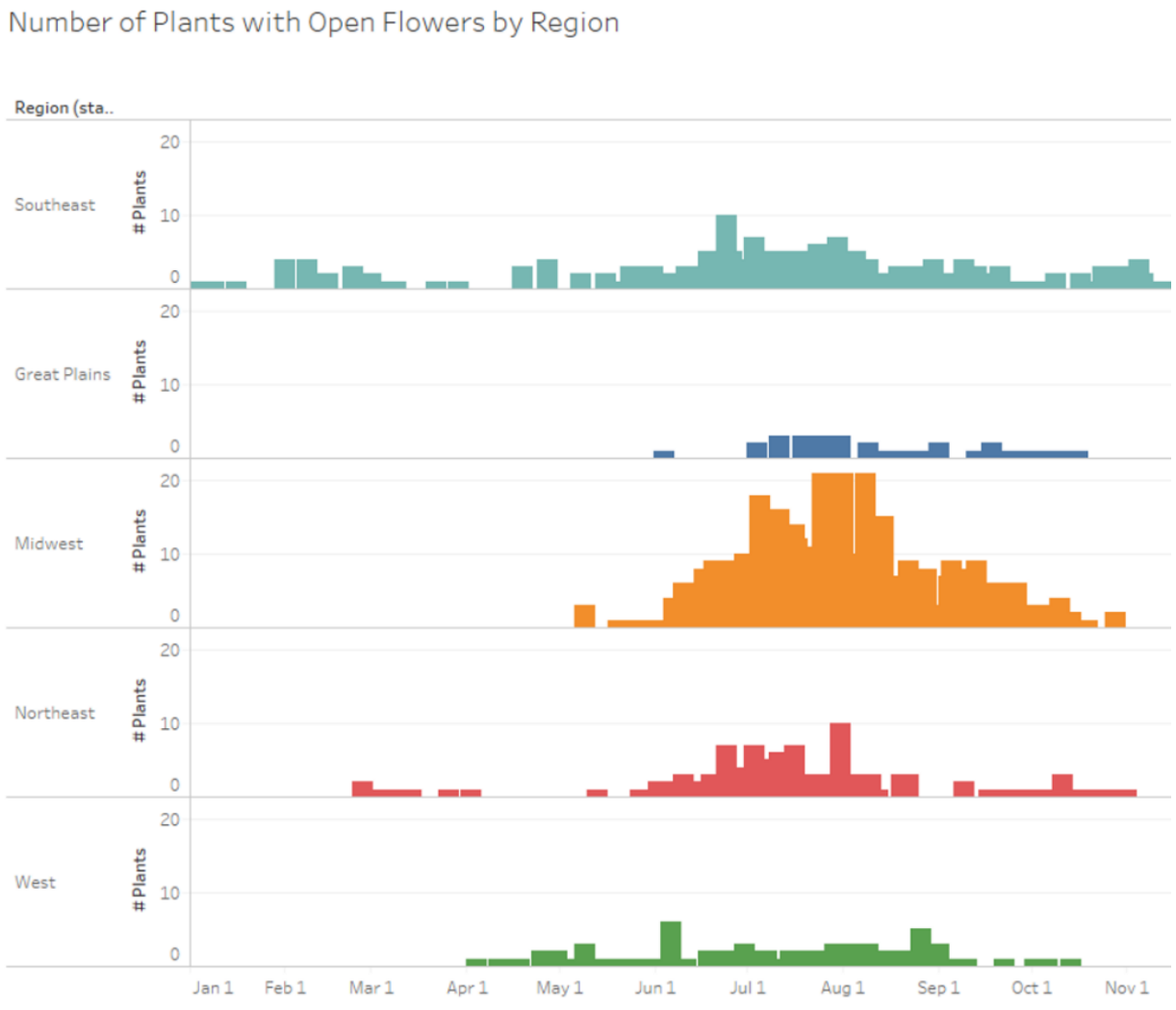
Objective 3: Provide training to Refuge staff on how to participate in Nectar Connectors (www.usanpn.org/nn/NectarConnectors) - a platform for monitoring leafing of milkweed and flowering of nectar plants in areas planted to support monarchs

Nectar Connectors is one of eight data collection campaigns run by the USA-NPN to engage observers in monitoring species of special interest to researchers and natural resource managers. Campaign participants are given instructions on how to participate, identification resources for species and life cycle stages of interest, reminders and encouragement to observe throughout the season, and results of their data collection at the end of each year.

We started this campaign in 2017 to assist the USFWS and other natural resource managers concerned about monarchs and other pollinators to better understand the temporal distribution of nectar resources across the United States. This campaign will provide an accurate picture of where and when nectar resources are located, and how this corresponds to the migration and breeding needs of monarchs and other pollinators. These data will help the USFWS evaluate habitat quality and landscape-scale connectivity in space and time.

In 2019, 289 observers representing members of forty organizations including five refuges reported on Nectar Connectors species. In Region 3, Minnesota Valley NWR in Minnesota recorded 1,616 records on 7 individuals of common milkweed and 3 individuals of wild bergamot and Neal Smith NWR in Iowa recorded 1,323 records on 3 individuals of butterfly milkweed and 2 individuals of tall blazing star. In Region 5, Canaan Valley NWR in West Virginia recorded 112 records on 1 individual of common milkweed. In Region 4 in Mississippi, Bayou Sauvage NWR recorded 1,599 records on 3 individuals of eastern baccharis, while Mississippi Sandhill Crane NWR recorded 110 records on 1 individual of eastern baccharis. Minnesota Valley NWR and Neal Smith NWR were among the top 10 groups submitting data for the campaign.

Generally, reports of first flowers in the Southeast were in either early spring or fall, corresponding with the time when monarchs are migrating through the region. In the Midwest and Northeast, observers reported onset of flowering throughout the spring, summer, and fall. In the West, reports were throughout the year.



More results are available for exploration on our Nectar Connectors Campaign Results dashboard.

Plan for Second Year of Funding: In 2020, we will work with the refuges taking part in the Nectar Connectors campaign to determine best practices for monitoring phenology of nectar plant species. We will create an example site-monitoring protocol to provide instructions on site set-up and sampling design for other refuges who wish to use Nectar Connectors to track changes in flowering phenology of nectar plants.

Objective 4: Create interactive Phenology Trail Dashboards, including dynamically updating visualizations to allow Refuges to compare phenology between Refuges and non-Refuge sites. These Dashboards will be hosted on the USFWS Phenology Network website and will build upon the current Refuge Dashboards for individual refuges.

Currently, each refuge that contributes data to USA-NPN has its own individual Refuge Phenology Dashboard (see Valle de Oro NWR example) on the USFWS Phenology Network web portal. These

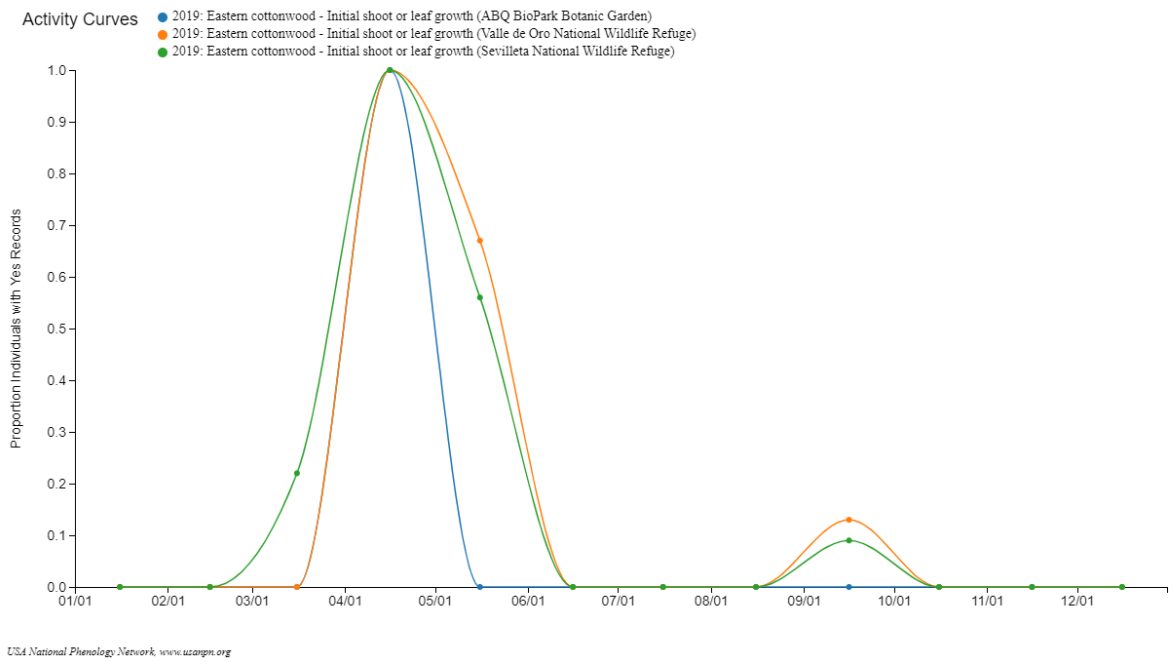
Dashboards are customized, dynamically updating sets of visualizations that display the phenology data the refuge has collected.

Currently we have two groups of refuges that are collaborating with nearby organizations in Phenology Trails, the Gulf Coast Phenology Trail and the Rio Grande Phenology Trail. These Trails allow refuges to leverage the data collected in nearby areas to assess changes in phenology of species of interest. Refuge staff can also make comparisons of phenology at their own refuge to areas surrounding their refuge to determine if the refuge is fulfilling its management goals as a sanctuary for species of concern.

The new Phenology Trail Dashboards interface will improve upon the current Dashboards by allowing comparison of phenology data between sites at a single refuge, between multiple refuges, and also compare refuge data to other *Nature's Notebook* sites within a buffered area of a set distance beyond a refuge boundary.

In August 2019, we sent out a survey to 10 individuals at 6 refuges that currently participate in Phenology Trails to determine what these new Trail Dashboards should look like and the features they should include. We received responses from 6 individuals representing 6 refuges. This feedback was invaluable in determining the functionality that would best serve refuges to answer their questions about changes in phenology on their own refuge as well as at the landscape scale. The first version will be sent to USFWS staff and partners for testing the week of January 21, 2020.

The graph below shows a comparison of breaking leaf buds of eastern cottonwood collected at two Refuges on the Rio Grande Phenology Trail as well as a nearby Botanical Garden.



Plan for Second Year of Funding: In early 2020 we will finalize the Phenology Trail Dashboards. We anticipate the Dashboards will be live on the website in early February, 2020 for the Rio Grande Phenology Trail and Gulf Coast Phenology Trail. We will then use the examples of these first two Phenology Trails to encourage additional refuges to create collaborations with partners to investigate changes in phenology at a landscape scale.

Objective 5: Generate periodic communications materials.

Newsletters:
We sent out a USFWS Newsletter each quarter of 2019 to 170 contacts, including 81 fws.gov emails. We used the newsletter to communicate achievements of refuges collecting phenology data, new tools and resources relevant for refuge staff, and upcoming training opportunities in how to use *Nature's Notebook* for phenology monitoring. USFWS Phenology Network Newsletter archive.

We also sent regular messages for the three *Nature's Notebook* campaigns we created at the request of USFWS – Nectar Connectors, Flowers for Bats, and Mayfly Watch. Participants, including over a dozen USFWS staff, received instructions on how to participate, tips on species and life cycle stage identification, encouragement to observe, and patterns in the data collected. *Nature's Notebook* Campaign archive.

Research publications:
To share how phenology monitoring was used for invasive species management on Midway Atoll NWR, I collaborated on a research manuscript with colleagues who collected data at Midway, including one refuge staff member, one former staff member of the National Wildlife Refuge Association, and a former Americorps member who worked as the technician on the project. This manuscript describes the efforts at Midway to use phenology monitoring to improve the timing of treatment of *Verbesina encelioides*, an invasive plant that hinders seabird nesting areas. The manuscript was submitted to *Ecological Restoration* and *Restoration Ecology*, but was not accepted due to the limited number of sites and length of the study. We are now reformatting for submission to a third journal, *Ecological Solutions and Evidence*.

Several colleagues at the USA-NPN as well as two colleagues at the Northeast Climate Adaptation Science Center are collaborating on a manuscript to describe our efforts around coproduction – a process where creators and users of information collaborate in its generation. The manuscript includes several case studies of knowledge coproduction including our analysis of the change in the timing of spring onset across National Wildlife Refuges and migratory flyways that we published in Plos One in 2018. We are planning to submit the manuscript to *Weather, Climate, and Society* in early 2020.

Social media:
In the spring of 2019, I assisted Susan Morse at USFWS Communications Office with a summary of spring leaf onset on refuges from the Status of Spring Tool. She shared this on USFWS social media during the week of Spring Equinox.

I also worked with the US Geological Survey Communications Team to develop a series of social media posts for the week of March 25-29, 2019. One of the posts featured the phenology monitoring work at Don Edwards SF Bay NWR.

Popular articles:
To generate more interest in the USFWS-focused data collection campaign, Flowers for Bats, I wrote an article for the winter quarterly newsletter of the Arizona Chapter of the Wildlife Society describing early results from the campaign and encouraging participation. The article should appear in the newsletter in February.

Awards:
In order to gain publicity for the USFWS Phenology Network web portal among DOI agencies, we submitted the website for a USGS Shoemaker Award in the website category. We should hear the results of our application in early 2020.

Other Communications:
I have had several conversations related to phenology and climate adaptation with Jason Goldberg at USFWS Science Applications. I have shared relevant USA-NPN-developed tools, resources, and publications with him which he has included in his Climate Adaptation Research Update newsletter.

I've also spoken with Maggie Johnson at the Association of Fish and Wildlife Agencies about opportunities to share relevant phenology data, information, and resources with managers through their channels. She shared information about my phenology training workshop at The Wildlife Society annual conference last year. She also invited me to give a webinar in early spring that will include federal and state wildlife managers.

Plan for Second Year of Funding: We will continue to add to our list of contacts for the Quarterly Newsletter by advertising it in our upcoming webinar series at NCTC. This spring, we will seek out opportunities to share the Status of Spring Tool via USFWS social media, articles in newsletters and other publications such as Fish & Wildlife News. We will continue to explore the applications of phenology data and information to Climate Adaptation.

Additional Progress toward four-year objectives:

We continued to support existing regional projects focusing on three USFWS priority areas.
1. Middle Rio Grande Bosque forest – The Rio Grande Phenology Trail continues to grow, adding on two additional sites and five new observers. Observers on the Trail collected over 55,000 phenology records on 55 species in 2019. In October of 2019, we supported a Deputy Refuge Manager at Valle de Oro NWR and the Rio Grande Phenology Trail Coordinator to attend the USA-NPN's first ever Local Phenology Leader Clinic at Grand Bay NWR/NERR, the pilot site of the Gulf Coast Phenology Trail. The purpose of this Clinic was to bring together Local Phenology Leaders to gain skills and resources for implementing *Nature's Notebook* programs. The Clinic included sessions on accessing and interpreting *Nature's*

Notebook data, program evaluation, and group-think sessions on topics such as "phenology for resource managers" and "phenology and education". The two individuals from the Rio Grande Phenology Trail who attended stated they greatly benefitted from sharing ideas and experiences with other USFWS staff and partners of the Gulf Coast Phenology Trail.

2. Mississippi River corridor for mayflies – We continued the Mayfly Watch campaign for a fourth year in 2019. The purpose of this campaign is to document large emergences of burrowing mayflies that occur along the Upper Mississippi River corridor and its tributaries. If we can establish reliable links between mayfly emergence and water or air temperature, we can warn city managers when to turn off lights on bridges and other places where mayflies can pile up and cause hazardous road conditions. Mayflies are also an indicator of water quality, which is of interest to wildlife managers along River. There is no longer a staff person at the USFWS who is interested in using the data collected by this campaign. In 2020, we will reach out to the Army Corps of Engineers to determine their interest in using mayfly predictions. We will also continue to periodically contact the USFWS in this region to determine their interest in these predictions.

3. Monarch Butterfly central flyway – In 2019, five refuges submitted 5,276 records on flowering of nectar plants important to monarchs. On the Gulf Coast Phenology Trail, four refuges continued to participate in phenology monitoring in 2019. The Trail also added three new partners in areas nearby refuges that are collecting data to provide comparison. The Trail created an Annual Report to summarize the data collected through the end of 2018. Among the 51 species observed on the Trail is eastern baccharis, a nectar plant for pollinators. One of the objectives of the Trail is to determine the importance of this species as a nectar source for monarchs as they pass through the Gulf Coast in the fall on the way to their wintering grounds in Mexico. Grand Bay NWR/NERR, the pilot refuge of the Trail, was also the host of the USA-NPN's first Local Phenology Leader Clinic, which was attended by three USFWS staff and one retired USFWS staff. Other refuges in the monarch central flyway contributing to recording nectar plant flowering included Neal Smith NWR in Iowa, Minnesota Valley NWR in Minnesota, and Canaan Valley NWR in West Virginia.

We also created new resources in 2019 that support our USFWS partners:

1. USA-NPN Visualization Tool – We created a new USA-NPN Phenology Visualization Tool that offers improved navigation to make it easier to explore patterns in phenology data. To serve our USFWS partners, we added in Refuge Boundaries and USFWS Regions as boundary layers that can be used to filter data to areas of interest. The Tool will debut on January 22, 2020.

2. Observer Certification Course – In April 2019, we released a course that offers a basic overview of the *Nature's Notebook* plant and animal observation program. The course offers instructional videos, quizzes to test knowledge, and links to helpful training resources.

3. New *Nature's Notebook* App – In June, we released a new version of our *Nature's Notebook* app to make it easier than ever to report phenology data in in the field, critical for our refuge partners in remote

locations. The new app features improved navigation, the ability to easily see the past observations entered on the app and edit them if needed, an animal checklist to quickly enter observations of animals, and improved options for our Local Phenology Program members. The app works offline and stores data locally until the user is back in service. Instructions are available via a mobile app tip sheet. The app is available in the Apple App Store and Google Play Store.

Future Directions

In the coming year, we look forward to continuing our partnership by building on our first year activities as outlined above –integrating historical phenology datasets into USA-NPN, reaching new refuges through our webinar series at NCTC as well as other channels, creating protocols for monarch nectar plants via the Nectar Connectors campaign, instructing Phenology Trail participants in how to use the new Phenology Trail Dashboards (and using the Dashboard as a recruitment tool), and continuing to explore new communication channels and mechanisms to ensure refuge staff are aware of how to use our tools and resources.

We also will convene focus groups to determine how Refuges can incorporate phenology monitoring with *Nature's Notebook* into existing monitoring activities. This will include providing example uses and success stories. We will also leverage the program planning guidance offered in the USA-NPN's Local Phenology Leader Certification Course to provide instructions to Refuge staff on how to create site-specific protocols for phenology monitoring.