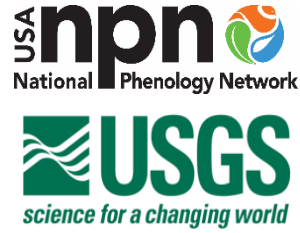


USFWS
Phenology Network
A collaboration between the USFWS and the USA-NPN



Phenology for Resource Management and Decision Making

Phase III & IV Program Evaluation and Final Report

April 2019

USA-NPN FWS Series 2019-001

Suggested citation: USA-NPN National Coordinating Office. 2019. Phenology for Resource Management and Decision Making: Phase III and IV Program Evaluation and Final Report. USA-NPN FWS Series 2019-001. Available online at www.usanpn.org/fws. 25 pp.

Cover Photos by Brian F Powell

USA National Phenology Network

Phenology for Resource Management and Decision Making: Phase III and IV Program Evaluation and Final Report

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Phenology for Resource Management and Decision Making

Phase III and IV Program Evaluation and Final Report, 2019

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

Project Period: February 15, 2017 – January 31, 2019

Phase III & IV Overall Budget: \$332,595

Overview

The partnership between the USA National Phenology Network (USA-NPN) and the US Fish and Wildlife Service's (USFWS) Inventory and Monitoring (I&M) Program was established in 2012 to assist the USFWS with phenological monitoring across the National Wildlife Refuge System (NWRS). Phenology, an important indicator of biological response to climate change, was already being observed and recorded independently and with many different data collection protocols by NWRS units as part of their localized scope of work. Refuges need standardized, recorded phenological information to meet the goal of the I&M Program's Seven-Year Plan to ensure that phenological monitoring conducted on refuge land is scientifically credible and is usable to inform climate related management questions at multiple spatial and temporal scales.

Implementing a *Nature's Notebook* phenology monitoring program makes good business sense. The USA-NPN provides a standardized methodology for collecting, storing and sharing the phenological data that can be analyzed across time and space. Refuges can collect and store data in a consistent format, use USA-NPN resources to recruit and train volunteers (who save the refuge staff time), and compare their data to those across species ranges to better understand long-term changes in phenological patterns.

Since 2014, over 254,000 observation records were collected at National Wildlife Refuges, providing roughly \$100,000 worth of information each year at a minimal cost. Over Phases III and IV (February 2017 – January 2019), 18 refuges across the country contributed 174,041 phenology observations on 175 species including migrant birds, wildlife forage species, and keystone forest species.

Refuges are using their programs to collect rigorous data to be used by managers, engage the public in science, participate in a national effort to contribute to science, and understand shifts in phenology of plants and animals. Three refuges have started using their phenology data to make management decisions on their refuge and four refuges are using phenology data to engage members of the public or student groups in learning about phenology on their refuge. Our Project Evaluation identifies clear needs that the USA-NPN can address in future years to better serve our USFWS partners.

Relevance and Need for Partnership

Both the I&M Program and the USA-NPN seek to understand and communicate patterns in the phenology of plants, wildlife, and landscapes in response to rapid environmental and climatic change. The I&M Program needed an off-the-shelf, easily accessible data collection and storage interface for phenology information. Many refuges have phenology data stored in multiple formats and locations. The refuges also lack staff time to collect all of the data needed to answer questions about regional phenological change in response to climate change and to inform general management activities.

The USA-NPN seeks long-term, well-distributed phenology observation locations with observations collected on individual plants and animal species by trained observers to build a rich National Phenology Database (NPDb) for use in decision-making and research. The USA-NPN's citizen and professional phenology monitoring program, *Nature's Notebook*, meets the phenology-related programmatic goals of both organizations and serves as the interface for entering data into the NPDb (Denny et al. 2014, Rosemartin et al. 2014). The USA-NPN's National Coordinating Office (NCO) supports partner organizations in using *Nature's Notebook* and the data in the NPDb by offering programmatic materials that benefit research, management, and educational goals (Posthumus et al. 2019). To be successful, the NCO requires input from on-the-ground researchers, managers, and participants using the monitoring program. The NCO also provides support for a network of citizen and professional volunteer observers engaged and trained to make accurate phenology observations using *Nature's Notebook*.

This report summarizes the work completed on Phase III and IV of the Project from February 15, 2017 through January 31, 2019. The Goals and Objectives for the Project, a summary of the achieved outcomes, and an evaluation of refuge staff and volunteers who are participating in the Project are covered in the subsequent sections.

Project Phase III & IV - Programmatic Goals and Desired Outcomes

Goal 1. Communicate early successes stemming from USFWS/USA-NPN partnership.

Desired Outcome:

- One-pagers highlighting 5 Refuges and how they are using *Nature's Notebook* to meet their management and outreach needs.

Goal 2. Expand existing Refuge-based phenology trail projects and continue to seek other regional opportunities, ensuring data collection on target species occurs on and off Refuge.

Desired Outcomes:

Refuges are successfully using *Nature's Notebook* to meet management and outreach objectives:

- Gulf Coast Phenology Trail
- Rio Grande Phenology Trail
- Mayfly Watch
- Other R3 Refuges (Minnesota Valley NWR, Neal Smith NWR)

- New Refuges (Midway Atoll NWR)

Goal 3. Reboot of USFWS subsite content and organization.

Desired Outcomes:

- Website with reorganized content.
- Delivery of Refuge-specific information via unique webpages with species being monitored, unit-specific activities, data display via phenology calendars other graphs, unit-specific spring index info.

Goal 4. Spring Indices within the Refuges.

Desired Outcome:

- Published manuscript analyzing spring leaf out and bloom in the National Wildlife Refuges over the last century, following Monahan et al 2016.

Goal 5. Ongoing communications with USFWS.

Desired Outcomes:

- Communications with Local Phenology Leaders at Refuges.
- Quarterly newsletter for USFWS staff and partners.
- Refuge bulletin pieces.

Project Inputs and Resources

US FWS National Wildlife Refuge System

1. Inventory and Monitoring Chief and Field Staff
2. Refuge lands and natural resources
3. Visitor Services and Science/Management Staff
4. Local Friends groups
5. Communication and connection with local community
6. Science and monitoring protocols and existing methodology
7. Refuge management plans
8. Phenology monitoring goals on a regional and local scale
9. Funding

USA National Phenology Network

1. Vetted, standardized system for recording phenology observations
2. Vetted system for data summary and visualization
3. Research and education staff
4. Program implementation and training materials
5. Network of researchers, managers, and educators
6. Time

Project Implementation

At the outset of the partnership USA-NPN NCO Staff worked with USFWS collaborators to develop a set of goals for the Project period. To achieve the stated Project goals and outcomes the USA-NPN staff worked closely with USFWS staff to better understand their needs for phenology data and information.

USA-NPN Staff

Two permanent staff of the USA-NPN NCO were responsible for facilitating the entire scope of work outlined by the Project's plan for the duration of the funding period: Erin Posthumus, Outreach Coordinator and Liaison to the USFWS (0.5 FTE on this Project) and LoriAnne Barnett, Education Coordinator (0.2 FTE on this Project).

Erin's role in the Project included serving as co-Principal Investigator on the Cooperative Agreement funding; establishing a program plan; networking with potential partners within and external to the NWRS; conducting in-person workshops for NWRS staff and partners; maintaining content on the USFWS Phenology Network website (fws.usanpn.org, initiated in a prior funding effort); conducting site-based needs analyses; developing implementation plans; engaging in regular system wide communications via emails and newsletters; writing protocols, guidance documents, and reports; conducting data analyses; supervising Phenology Trail Coordinators; and developing the Project's Evaluation and Final Report.

LoriAnne's role in the Project included serving as Principal Investigator on the Cooperative Agreement; consultant on educational content delivery (such as workshops, volunteer management, and curriculum recommendations); conducting in-person workshops for NWRS Staff and partners; overall Project management including developing task timelines and delivery of outcomes; tracking outcomes and impacts; and implementing programmatic evaluation (including survey design and focus groups).

Other permanent staff at the USA-NPN NCO on the IT and Data Product Teams assisted with developing technical resources, web design, data analysis tools and visualizations. The USA-NPN's Assistant Director provided scientific justification and consultation. In the 2016-2017 academic year, an intern through the NASA Space Grant Program conducted a summary and analysis of phenology data collected through *Nature's Notebook* across the NWRS. In the 2017-2018, and 2018-2019 academic years, an undergraduate student assistant conducted data summaries and assisted with outreach for the Flowers for Bats campaign (fws.usanpn.org/campaigns/FlowersforBats), an effort to collect data on the phenology of nectar resources for the lesser long-nosed bat (*Leptonycteris yerbabuena*). In the summer of 2018, another undergraduate student assisted with data collection for the Flowers for Bats campaign.

All USA-NPN Staff were compensated for their Project work based upon FTE status.

USFWS Staff

No USFWS staff were directly paid as part of this Project. The Chief of Inventory and Monitoring for the USFWS's NWRS, Jana Newman, was the main point of contact and Project visionary, serving to connect the USA-NPN to her field staff and the System. In the NWRS Regions where monitoring programs were

established, the most successful implementations of long-term phenology monitoring involved both Visitor Services (Education and Outreach) and Science and Management Staff. The USFWS staff who are participated in phenology monitoring programs during the Project period included six Refuge Biologists, one Refuge Manager, two Volunteer Coordinators, and five Visitor Services staff.

Contracted Work:

As part of this Project, two regional Phenology Trails (a regional series of *Nature's Notebook* monitoring sites) were established to collect observations at locations both on and off NWRS lands. The Phenology Trails include the Gulf Coast Phenology Trail in Region 4 and the Rio Grande Phenology Trail in Region 2. This Project funded a part-time Coordinator at 10 hours per week for the Gulf Coast Phenology Trail from September 2017 through January 2019. The Coordinator was supervised locally with USFWS staff at the SE Louisiana Complex of Refuges and remotely by Erin Posthumus. The Rio Grande Phenology Trail Coordinator was funded by the Bosque Ecosystem Monitoring Program, which received a partnership grant from Valle de Oro National Wildlife Refuge. The Coordinator consulted remotely on a biweekly bases with Erin Posthumus throughout the Project period. Both Coordinators benefitted from USA-NPN Staff visiting the regional locations to assist with program training and implementation, with funding provided by this Project.

We also contracted with DJ Case & Associates to develop portions of the new fws.usanpn.org web portal and associated Refuge Dashboards.

Volunteers:

The power of the *Nature's Notebook* citizen and professional science program is the volunteers. Most data are being collected by regularly visiting adult or college age student volunteers, although several locations have also engaged youth under the age of 18 in the data collection process.

Project Outputs

Data collected by Refuges

Over Phases III and IV (February 2017 – January 2019), 18 refuges across the country (Figure 1) contributed 174,041 phenology observations to *Nature's Notebook* (Table 1; **Appendix A:** [National Wildlife Refuge System data 2014-2019](#)).



Figure 1. Map of *Nature's Notebook* sites within the National Wildlife Refuge System in Phases III and IV

Table 1. Number of phenology observations and number of species on which data were collected through *Nature's Notebook* on the National Wildlife Refuge System in Phases III and IV (Feb 2017 – Jan 2019).

Region	Refuge	Observations Collected	Number of Species
Region 1	Hakalau Forest National Wildlife Refuge	199	2
Region 1	Midway Atoll National Wildlife Refuge	12,299	1
Region 2	Buenos Aires National Wildlife Refuge	89	2
Region 2	Leslie Canyon National Wildlife Refuge	434	1
Region 2	Sevilleta National Wildlife Refuge	3,415	4
Region 2	Valle de Oro National Wildlife Refuge	49,089	21
Region 3	Minnesota Valley National Wildlife Refuge	24,882	22
Region 3	Mayfly Watch/Upper Mississippi River NWR	160	2
Region 3	Neal Smith National Wildlife Refuge	7,978	10
Region 4	Bayou Sauvage National Wildlife Refuge	11,115	13
Region 4	Big Branch Marsh National Wildlife Refuge	6,847	10
Region 4	J.N. Ding Darling National Wildlife Refuge	6,110	13
Region 4	Grand Bay NWR/NERR	25,879	15
Region 4	Mississippi Sandhill Crane National Wildlife Refuge	12,637	17
Region 4	St. Marks Visitor Center	33	2
Region 5	Canaan Valley National Wildlife Refuge	4,623	17
Region 5	Patuxent Research Refuge	609	3
Region 8	Don Edwards National Wildlife Refuge	5,475	3

Three more refuges participated in data collection with *Nature's Notebook* in this Project period than in the previous Phases I and II of this funding agreement. Refuges in this Project period submitted more

than double the amount of observations submitted in the previous Phases (Figure 2). More unpaid volunteers than staff collected data in this Project period than in the previous Phases I and II (Table 2).

Table 2. Number of paid USFWS staff and interns and unpaid volunteers collecting data on National Wildlife Refuges in Phases III & IV of the Project (Feb 2017 - Jan 2019).

Group collecting data	Phases I & II (Sep 2014-Feb 2017)	Phases III & IV (Feb 2017-Jan 2019)
Staff and Paid interns	36% (30 staff and paid interns)	27% (13% by 7 USFWS staff, 8.5% by 2 paid interns, 5% by 3 paid staff of partner organizations)
Unpaid volunteers	64% (48 volunteers)	73% (55 unpaid volunteers)

Since 2014, over 254,000 observation records were collected at National Wildlife Refuges (Figure 2). This is roughly \$100,000 worth of information provided to refuges each year at a minimal cost (USA-NPN Supporting Statement for OMB Information Collection Clearance #1028-0103). Data are collected on 175 species including migrant birds such as Sandhill Crane and Swainson’s Hawks, wildlife forage species such as quaking aspen and diamondleaf willow, and keystone forest species such as cottonwood and maple.

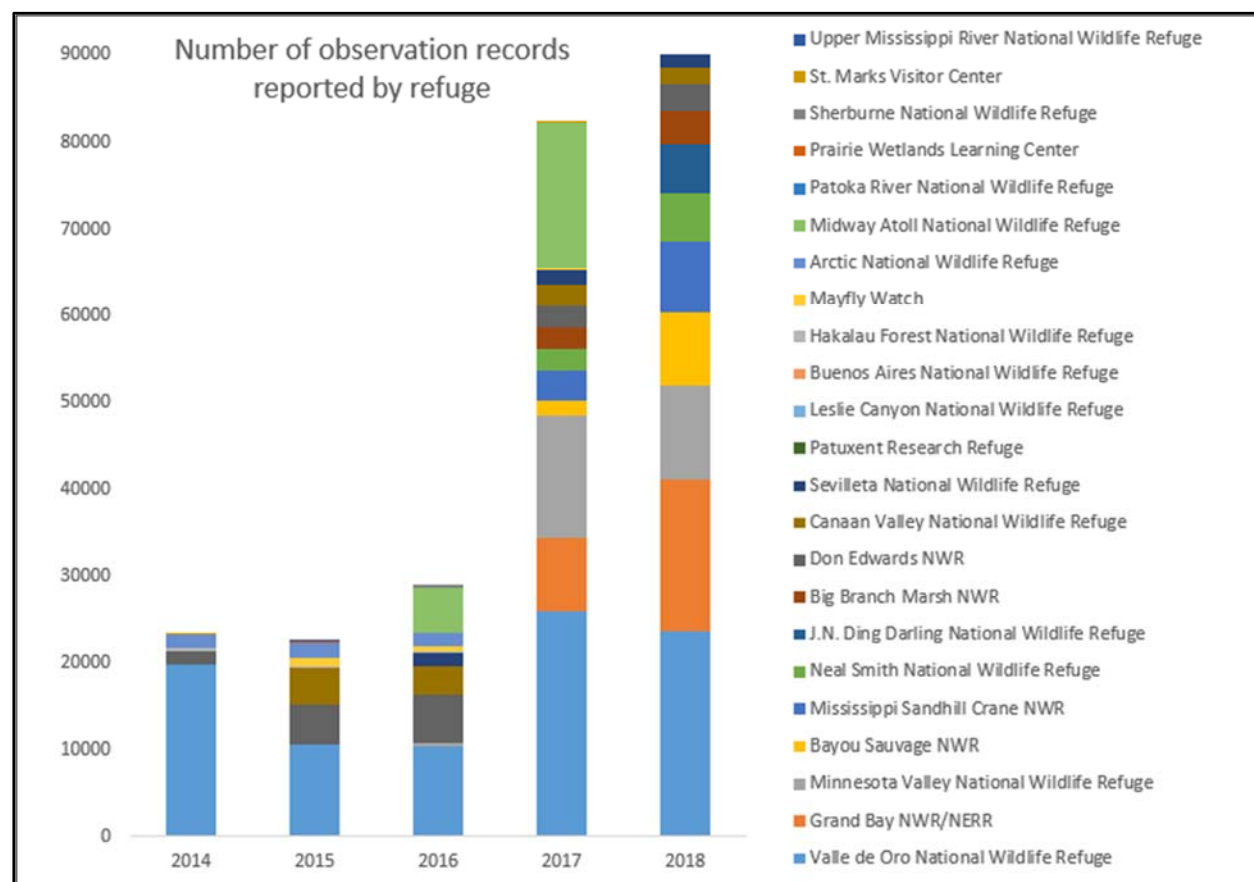


Figure 2. Phenology observation records collected through *Nature's Notebook* by National Wildlife Refuges between 2014 and 2018.

Project Outcomes and Impact

This Project provided an opportunity to continue our support for phenology monitoring at National Wildlife Refuges by providing improved tools for program planning and implementation, dynamic data visualization through customized dashboards, and educational engagement materials. We also provided a suite of tools to assist USFWS in understanding the timing of the onset of spring leaf out in the NWRS as well as the shift in the onset of spring leaf out in NWRS and in the four major migratory flyways over the last century. **Appendix B: [Outcomes and Results for EvalPhase III-IV \(2017-2019\)](#)**

Goal 1. Communicate early successes stemming from USFWS/USA-NPN partnership.

Stated outcomes	Achieved outcomes/results
One-pagers highlighting 5 Refuges and how they are using <i>Nature's Notebook</i> to meet their management and outreach needs	<p>Worked with refuge representatives to create 5 one-pagers outlining how refuges are using <i>Nature's Notebook</i> and highlighting early results from their data collection:</p> <ul style="list-style-type: none"> • Arctic NWR • Canaan Valley NWR • Don Edwards San Francisco Bay NWR • Midway Atoll NWR • Valle de Oro NWR <p>One-pagers are posted on fws.usanpn.org and were distributed via USFWS I&M and USA-NPN communication channels.</p>

Goal 2. Expand existing Refuge-based phenology trail projects and continue to seek other regional opportunities, ensuring data collection on target species occurs on and off Refuge.

Stated outcomes	Achieved outcomes/results	
Refuges are successfully using <i>Nature's Notebook</i> to meet management and outreach objectives	<p>Gulf Coast Phenology Trail</p> <ul style="list-style-type: none"> • Bayou Sauvage NWR • Big Branch Marsh NWR • Grand Bay NWR/NERR • Mississippi Sandhill Crane NWR 	<p>The Gulf Coast Phenology Trail was created following an in-person workshop by USA-NPN in 2016 at the Grand Bay NERR/NWR. The Gulf Coast Phenology Trail seeks to understand phenology of focal species along the Gulf Coast to aid management and understand climate change impacts.</p> <p>For example:</p> <ul style="list-style-type: none"> • Knowing when Chinese tallow leafs out can improve timing of prescribed burn treatments • Knowing whether pollinators like monarchs are mismatched with nectar sources will inform vulnerability assessments <p>2017 Annual Report</p>
	Rio Grande Phenology Trail	The Rio Grande Phenology Trail was established in 2014 to connect like-minded organizations in asking

	<ul style="list-style-type: none"> • Valle de Oro NWR • Sevilleta NWR 	<p>and answering questions about the health of the bosque along the Rio Grande. Phenology data contributes to informing restoration activities and understand climate change impacts on species of interest.</p>
	<p>Mayfly Watch Campaign</p> <ul style="list-style-type: none"> • Upper Mississippi River NWR 	<p>Data on mayfly emergences can help USFWS understand the health of the river. Predictions of emergence can inform local managers of when to take measures to ensure public safety, including turning off lights on bridges and encouraging drivers to stay off roads inundated with mayflies. The USA-NPN created the Mayfly Watch monitoring campaign in 2015.</p>
	<p>Flowers for Bats Campaign</p> <ul style="list-style-type: none"> • Leslie Canyon NWR • Buenos Aires NWR 	<p>The USFWS Arizona Ecological Services Office in Tucson, AZ requested information on how phenology of forage resources of the lesser long-nosed bat (<i>Leptonycteris yerbabuena</i>) are impacted by climate change. The USA-NPN created the Flowers for Bats monitoring campaign to collect these data in 2017.</p> <p>The Flowers for Bats Monitoring Protocol completed USGS Fundamental Science Practices review and is a component of the USFWS post-delisting monitoring plan for the bat.</p>
	<p>Canaan Valley NWR</p>	<p>Canaan Valley NWR began data collection in 2014. Canaan Valley NWR supports a number of species that exist at the southernmost extent of their range. Refuge staff seek to understand the environmental drivers of phenology for these species and whether the drivers different compared to other parts of the species' range.</p>
	<p>Hakalau Forest NWR</p>	<p>Hakalau Forest NWR started monitoring phenology as part of the Teaching Change program in 2014. This program, run by the University of Hawaii at Manoa, seeks to increase youth interest and participation in natural resource management.</p>
	<p>J.N. Ding Darling NWR</p>	<p>A J.N. Ding Darling volunteer representative attended a USA-NPN workshop at NCTC in Nov 2017. Ding Darling is monitoring biological phenomena of plant flowering and bird migration. Volunteers and staff track native plants and animals selected by the refuge biologists.</p>
	<p>Midway Atoll NWR</p>	<p>Midway Atoll NWR completed data collection in Aug 2017. They documented the time between initial</p>

		growth of invasive <i>Verbesina encelioides</i> and seed development to maximize herbicide treatment efficacy
	Minnesota Valley NWR	Minnesota Valley NWR began data collection following an in-person workshop by USA-NPN staff in 2015 at the refuge. They collect data on species of interest to visitors, such as birds, butterflies, and nectar plants.
	Neal Smith NWR	Neal Smith NWR began data collection following an in-person workshop with USA-NPN staff in March 2018 at the refuge. Studying impact of restoration activities on native plants and birds in prairie and savanna ecosystems
	Patuxent Research Refuge	Patuxent Research Refuge’s Volunteer Coordinator and a volunteer representative attended USA-NPN workshop at NCTC in Nov 2017. Patuxent is interested in exploring the relationship between the spring beauty plant and spring beauty bee and better understanding the phenology of invasive Japanese barberry.
	<ul style="list-style-type: none"> • Arctic NWR • St. Marks NWR • Sherburne NWR • Prairie Wetlands Learning Center 	Previously collected data but have not continued the program in the current Project phase.

Goal 3. Reboot of USFWS subsite content and organization.

Stated outcomes	Achieved outcomes/results
Website with reorganized content	Launched new USFWS Phenology Network website (fws.usanpn.org) in Feb 2018. Includes examples of how refuges are using phenology monitoring to meet management and outreach objectives. Provides tools such as Status of Spring on the Refuges (fws.usanpn.org/spring) and direct links to other USA-NPN tools such as the Phenology Visualization Tool (fws.usanpn.org/download).
Delivery of Refuge-specific information via customized webpages	<p>Launched landing pages (fws.usanpn.org/phenology-refuges) for refuges partnering with USA-NPN in Feb 2018. Each page has a Refuge Dashboard with a customized, dynamically updating set of visualizations that display the phenology data they have collected.</p> <p>Landing pages include a list of the species monitored, unit-specific activities, observer recruitment and retention information, and unit-specific onset of spring information.</p>

Goal 4. Spring Indices within the Refuges.

Stated outcomes	Achieved outcomes/results
<p>Published manuscript analyzing changes in the timing of spring leaf out and bloom in the National Wildlife Refuges over the last century, following Monahan et al 2016.</p>	<p>Manuscript published in PLOS One Sept 2018. In recent decades, spring is arriving early in three-quarters of national wildlife refuges and extremely early in half of refuges. These changes are not consistent across the latitudinal extent of the four major migratory flyways. Spring is advancing significantly faster in the north for all but the Pacific flyway.</p> <p>Tool added to USFWS Phenology Network website – Long-term changes in the status of spring (interactive map visualization with the results from the above manuscript), and Recent changes in the onset of spring (show refuges the current year’s onset of spring and how this year compares to a 30-year average).</p> <p>Promoted tool via USFWS communications channels (US Fish and Wildlife News, Inventory & Monitoring email lists, US Fish & Wildlife Service social media, etc.).</p>

Goal 5. Ongoing communications with USFWS.

Stated outcomes	Achieved outcomes/results
<p>Communications with Local Phenology Leaders at Refuges</p>	<p>All Refuge staff, volunteers, and partners are encouraged to take part in the LPL Community of Practice.</p> <p>Refuge staff, volunteers, and partners are given first priority status in the Local Phenology Leader (LPL) Certification Online Course held twice per year.</p>
<p>Quarterly newsletter for USFWS staff and partners</p>	<p>Newsletter sent to 174 USFWS staff and partners each quarter. Newsletter archive.</p>
<p>Articles in Fish and Wildlife News, other USFWS news outlets</p>	<p>Worked with USFWS’s Susan Morse on an article on Spring on the NWRS for the NWRS homepage, 3/29/2018.</p> <p>Worked with Lindsay Brady on an article on Status of Spring Tools for the USFWS for Fish and Wildlife News, 9/17/2018.</p>
<p>Other communications about USFWS Phenology Network activities</p>	<p>USFWS and USA-NPN – Helping the USFWS Achieve its Mission Info Sheet.</p> <p>Article about Flowers for Bats campaign in UA News (April 18, 2018).</p> <p>Valle de Oro NWR highlighted in The Crowd and the Cloud, PBS Series (2017).</p>

	<p>USFWS Partnership highlighted in 2017 and 2018 USA-NPN Annual Reports.</p> <p>Working with collaborators to submit manuscript on results and applications of data collection at Midway Atoll NWR.</p>
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Project Evaluation

At the conclusion of Phase IV of the Project we distributed a program evaluation to 12 staff and volunteers representing 14 different National Wildlife Refuges and 26 people representing 6 external organizations. Of those, 10 people from 8 refuges and 8 people from 5 external organizations provided feedback. We also facilitated focus group discussions and one-on-one conversations to obtain further context from participants in the field. Five refuge representatives participated in focus group and one-on-one discussions (**Appendix C: [Evaluation Results](#); Appendix D: [Focus Group Transcript](#)**).

We did not receive a response from representatives of nine other refuges, including five refuges that did not submit data and three refuges that did submit data during Phase III and IV. There is a limited amount of bias in the results of the program evaluation, due to respondents reporting only from active and marginally successful refuges and units. Regardless, the information gathered from the program evaluation will be used to determine best practices and make recommendations moving forward.

Refuge Participation

Six out of 8 USFWS Regions have active units participating in *Nature’s Notebook* Phenology Monitoring. Representatives from 8 refuge units in 4 regions submitted information for this Project Evaluation. Table 3 presents a breakdown of the Regions and number of active units who responded to the Project evaluation:

Table 3. National Wildlife Refuges and Phenology Trail Partner Organizations responding to the Phase III and IV Evaluation. *Indicates a new refuge participating in phenology monitoring in Phase III and IV.

USFWS Region	Active Refuges and Phenology Trail Partner Organizations	Number of respondents	
		Evaluation	Focus Group
1	Midway Atoll NWR	0	0
2	Rio Grande Phenology Trail: <ul style="list-style-type: none"> • Albuquerque BioPark Botanic Gardens • Bosque Ecosystem Monitoring Program • Santa Fe Botanical Garden • Sevilleta NWR • Valle de Oro NWR • Whitfield Wildlife Conservation Area 	5	1

	Flowers for Bats Campaign: <ul style="list-style-type: none"> • Leslie Canyon NWR* • Buenos Aires NWR* • Tucson Botanical Garden • Tohono Chul 		
3	Minnesota Valley NWR Neal Smith NWR*	1	2
4	Gulf Coast Phenology Trail: <ul style="list-style-type: none"> • Bayou Sauvage NWR* • Big Branch NWR* • Grand Bay National Estuarine Research Reserve and NWR* • Mississippi Sandhill Crane NWR* • St. Mark's Visitor Center J.N. Ding Darling NWR*	3	1
5	Canaan Valley NWR Patuxent Research Refuge*	3	1
7	n/a	0	0
8	Don Edwards-San Francisco Bay NWR	0	0
9	n/a	0	0

Local Program Planning and Outcomes

In order for refuges and units to be successful, USA-NPN Staff recommend developing an implementation plan for using *Nature's Notebook* to answer science and management questions and a local program plan for engaging people in the use of *Nature's Notebook*. Each of the units were provided with program planning materials either via the website or at in-person trainings. We encouraged them to conduct a needs assessment to document outcomes and plan activities to support their desired outcomes. Within the program planning process we also recommended they develop a local science or management question that *Nature's Notebook* phenology data could help to answer. A defined goal for data collection helps staff and volunteers to be invested in the program over the long term.

Of the 18 respondents, 6 stated that they were interested in using *Nature's Notebook* to achieve both local education/outreach and science/management goals. Four respondents chose to use *Nature's Notebook* specifically for a science or management purpose and four chose to use *Nature's Notebook* specifically for education alone.

Broader desired outcomes included collecting rigorous data to be used by managers (7 respondents); engaging the public in science (6); participating in a national effort to contribute to science (5);

understanding shifts in phenology of plants and animals (3). Twelve of 18 refuges participating during the Project period consulted with Refuge staff prior to selecting species for observation.

Science questions that respondents are collecting data to answer included:

- Is there an impact of climate change on our plants and animals at our refuge? (5)
- What is the overlap between the timing of bat migration and summering period and nectar food sources?
- Is there a difference in phenology of important forest tree species on the east-west gradient along the Gulf Coast?
- Is there a mismatch between plants and pollinators along the Gulf Coast?
- How do restoration activities impact populations of prairie and savanna birds over time?
- Is plant phenology changing over time along the Rio Grande? What environmental factors are causes these changes?
- What are the impacts of restoration activities at our Refuge on plant and animal phenology?
- How can we improve the timing of our control treatments of a high priority invasive species?
- When do important nectar plants for monarchs flower?
- When should we clean out nest boxes used by migrating birds?

Use of Phenology Data Collected

Most refuge representatives stated that subsequent years of collection are needed before their data will be useful to refuge staff to inform management. Three refuges have started using their phenology data to make management decisions on their refuge:

- Valle de Oro NWR is using their data to (1) update restoration plans to include additional habitat for American Kestrels, which were found to be in high abundance from phenology surveys, (2) know when to flood fields to promote germination of native Rio Grande cottonwood and avoid germination of invasive Siberian elm, (3) avoid demolition of buildings during Cliff Swallow nesting period.
- Midway Atoll NWR completed data collection in Aug 2017. They documented the time between initial growth of invasive *Verbesina encelioides* and seed development to maximize herbicide treatment efficacy.
- Don Edwards San Francisco Bay NWR has used their phenology data to guide the choice of species to plant in restoration sites.

Four refuges are using phenology data to engage members of the public or student groups in learning about phenology on their refuge:

- Mississippi Sandhill Crane NWR engages middle school students from Ocean Springs Middle School to make weekly observations on the Fontainebleau Unit of the refuge.
- Don Edwards San Francisco Bay NWR uses *Nature's Notebook* as a tool for teaching the public about climate change.
- Valle de Oro NWR engages high school students from NextGen Academy and middle and high school students from the Bosque School in making phenology observations on native cottonwood trees on the refuge.
- Minnesota Valley NWR engages visiting school groups in making observations of plant and animal phenology and weather on the refuge.

***Nature's Notebook* Activities**

Refuges are working toward long-term outcomes by focusing on annual activities including:

- Recording weekly observations (9)
- Coordinating training workshops for citizen scientists and/or teachers (5)
- Recruiting of new volunteers (3)
- Adding observation locations to their program (2)
- Providing outreach to the public at environmental festivals (2)
- Managing volunteer citizen scientists, including social activities for retention (2)
- Providing outreach to the public via social media (3)
- Providing outreach to Master Naturalist and other groups (2)
- Working with refuge biologist to select species for monitoring
- Working with volunteer coordinator to select volunteers to collect data
- Sending seasonal newsletters to program participants with results of data collection

Of the evaluations returned, 75% of respondents reported utilizing between 2 and 10 volunteers to collect observations for *Nature's Notebook*, with the remaining respondents utilizing between 75 and 2000 volunteers or students. Five of the 18 respondents indicated they involve youth under the age of 18 in their data collection.

Most Frequently Used Resources

One of our major Project activities for this period included the creation of refuge landing pages on fws.usanpn.org with a customized, dynamically updating dashboard that displays the phenology data collected by the refuge. Of the 23 refuges, 14 (61%) have created customizable Refuge Dashboards (Figure 4).

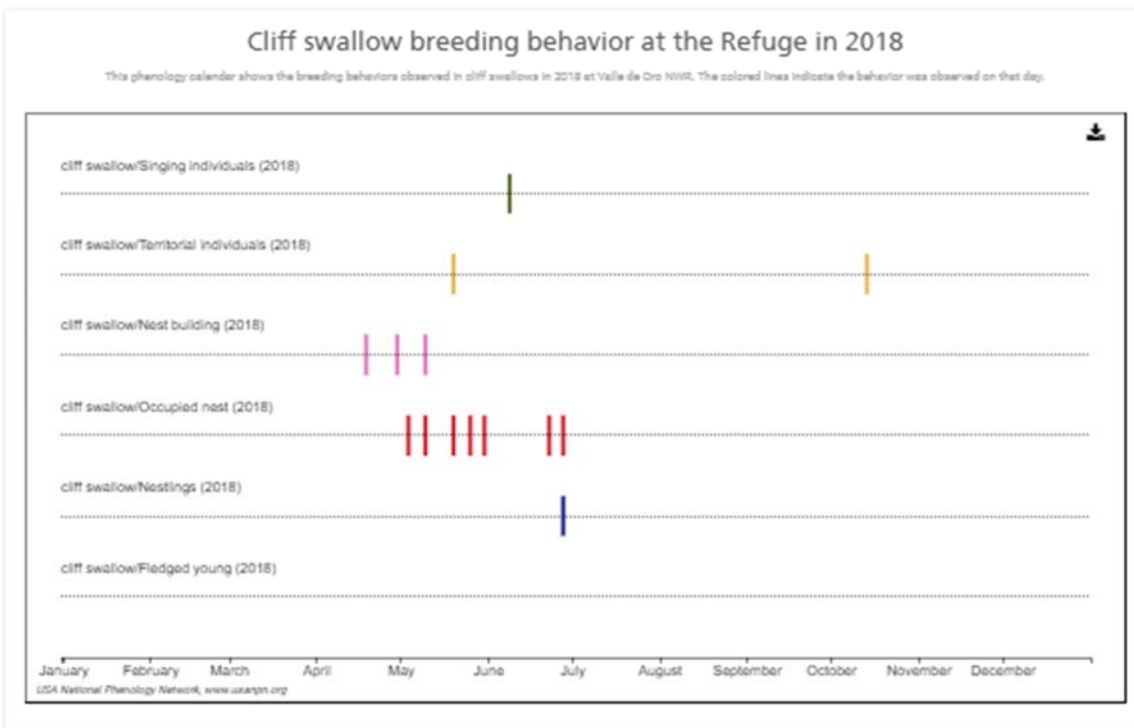


Figure 4. Customizable, dynamically updating Refuge Dashboard for Valle de Oro National Wildlife Refuge, displaying results of their phenology data collection.

Respondents indicated their most frequently used resources other than the Refuge Dashboards were the Phenology Observation Portal, *Nature's Notebook* Curricula and Activities, Botany and Phenophase Primers, and Visualization Tool.

Percent of respondents using tools provided by the USA-NPN:

- Visualization Tool (to explore data collected across the country) – 56%
- Phenology Observation Portal (for downloading data) – 81%
- *Nature's Notebook* activities and curricula – 63%
- Botany and/or Phenophase Primer – 56%
- Partner Dashboard (for metrics on number of observations by species, life cycle phase, and location and observer recruitment and retention) – 44%
- How to Guides – 44%
- Local Phenology Leader Community of Practice – 38%
- Spring leaf out and bloom models – 38%
- Technical Reports and Publications – 31%
- Host an Event Resources – 31%
- *Nature's Notebook* videos – 25%
- Program Planning Resources – 25%
- Pheno Forecasts (for predicting activity of insect pests) – 6%

Lessons Learned by Respondents

Evaluation respondents offered the following advice related to program implementation and training:

- The first year will be a learning experience. Take time to learn the plants, phenophases and other characteristics.
- Take photos of all plants quarterly and carry print outs into the field to help make estimates of canopy cover.
- It is helpful to have a trained botanist on the team.
- Have teams trade off weekly, but have some overlap in team members so that responses are calibrated.
- The app makes data collection a breeze but the website is best for analysis and QAQC.
- Have volunteers collect data in pairs – it improves reliability and validity of the data.
- It's good to have a beginner and advanced list of plants for volunteers, so that they can select the level of difficulty they are comfortable with.
- Make sure to incorporate field exercises into your trainings, so that volunteers have a chance to try out collecting data before they go on their own.
- Have your trainings close to when you begin observations, rather than the year or season before. Then the information will be fresh in the minds of your volunteers.
- The USA-NPN staff is excellent and very helpful.
- Ask USFWS partners about extra funding for program activities near the end of the fiscal year.

And the following advice related to volunteer recruitment and retention:

- Meet periodically with volunteers to make sure everyone is recording data the same way. This also builds camaraderie and enthusiasm for the program.
- We have had more success recruiting personal contacts to participate rather than at public training workshops.
- Get a great group of volunteers to help you...they are the best part of the project.
- Share your findings with your volunteers and the community.
- Give volunteers multiple job options besides collecting data – helping to set up the program take photos for photo guide resources, etc.

We also learned about the effectiveness of phenology training from our partners at the Rio Grande Phenology Trail (RGPT). The Trail Coordinator created a survey to measure the change in the skills and understanding as a result of a *Nature's Notebook* training workshop in 2018. Of the 13 surveys that were sent out, 11 were completed. Each question was framed as a “pre” and “post” about understanding: the science of phenology, the purpose and protocols of *Nature's Notebook*, the RGPT and its purpose, and their ability to collect accurate data consistent with *Nature's Notebook* protocols.

For all questions, volunteers reported an increase in knowledge and skill. On a 1-7 scale (1 being very low, 7 being very high), volunteers on average reported: a 3 point increase in knowledge of the science of phenology, a 4 point increase in purpose and protocols, and a 3 point increase in RGPT and its purpose. On average, volunteers reported a 2.5 points increase in their ability to collect accurate data. When asked what resources, training, or support had most contributed to changes in their knowledge, understanding, and skills, they responded: meetings with RGPT coordinator, RGPT site volunteer teams, in-person trainings, online materials, reference materials in the field, webcasts, USA-NPN's Phenophase Primer, and RGPT newsletters.

Barriers to Phenology Programs and Needed Resources

One challenge that arose in the evaluations was program sustainability: this continues to be an issue for phenology programs across the National Wildlife Refuge System. It takes approximately 3 years for sustainable on-the-ground phenology monitoring programs to form (USA-NPN NCO, unpublished data). Multiple participants in our focus group discussions stated that their programs were originally started by a single staff person who did not sufficiently document the long-term outcomes and short term goals of the program.

Another issue continues to be staff turnover at refuges and other units - if a Project contact using *Nature's Notebook* moves on, and there is no way to follow up with them, then NCO staff were unable to collect information from that Refuge or unit. In Phases III and IV, we had 9 new refuges implement new phenology programs (Table 3). Refuges such as Sherburne and Upper Mississippi River NWRs are no longer supporting *Nature's Notebook* programs because the sole staff person responsible for the program left their position and there was neither interest nor time available among other staff to continue the program.

In response to these challenges, we have focused our trainings on program planning and implementation in the last several years of our partnership. This includes training on how to create a program plan based on answering science questions or meeting management needs. We offer an online Local Phenology Leader Certification Course to allow refuge staff, interns, and volunteers to take part in this training remotely. Multiple participants in our focus group discussions mentioned that this course and/or in-person trainings were instrumental in teaching them about program planning and documentation.

Program documentation will ensure a successful transition from short-term program managers to staff, interns, or volunteer leaders. We also encourage staff to give volunteers more ownership of the project, helping them to become program leaders and taking the burden off of staff members. Volunteers are often lifelong residents of nearby communities who are familiar with local species and invested in their conservation and management.

One respondent stated that she has had difficulty with volunteer recruitment. Support from other staff is not available, and while interns sometimes assist in data collection, their positions generally only last a few months. Multiple refuges reported they had only one regular volunteer collecting data, in addition to staff and interns, or that they did have multiple volunteers but some left the area and were not replaced. To assist refuges with volunteer recruitment, we created a page on our new web portal (fws.usanpn.org/project) that lists ideas for where to recruit new volunteers, and resources such as a volunteer job description. We will continue to enhance this resource and seek out other ways to help refuges recruit and retain volunteers in future years of the partnership.

Another challenge revealed by the evaluations was limitations of the *Nature's Notebook* smartphone app. Multiple respondents reported that when entering data via the app, it would be helpful to be able to see entries from previous observations. Currently some observers carry a paper copy so they know what they reported the week before. They also stated they would like to be able to record a note about the plants and animals they are observing in an open text field on the app. These two features will be included in the new version of the *Nature's Notebook* app which is due out in spring 2019.

Multiple respondents reported that additional phenophase photo guides for species of interest would help their observers collect high-quality phenology data. We will endeavor to assist refuges to create these guides in future years. Refuges can assist in creating these guides by providing high-quality photos of key life cycle stages for their species of interest.

One respondent noted that the intensity component of the data collection protocol, where observers indicate the number of leaf buds, or percent of open flowers, is difficult for many observers. We currently provide multiple resources to assist observers in identifying life cycle stages of various types of plants, including the [Botany Primer](#) and [Phenophase Primer](#). We need to ensure that refuge staff and volunteers are aware of these resources. We will endeavor to make them a larger part of trainings and feature them

on the USFWS Phenology Network website. We are also launching a new Observer Certification Course in spring 2019 that will provide assistance with estimating intensity measures.

One respondent noted that working with the raw data from *Nature's Notebook* is difficult for those unfamiliar with data summary and analysis. Recognizing this issue, we created multiple types of summarized data types available in our [Phenology Observation Portal](#) that synthesize the raw data into metrics such as the start and end of a life cycle event. We hope to provide further guidance to USFWS staff in future years of the partnership on best practices for analyzing phenology data.

Multiple respondents stated that they are using other citizen science programs in addition to *Nature's Notebook*, such as iNaturalist or Cornell Lab of Ornithology's NestWatch. They feel compelled to continue programs that others started before, even if the refuge is not using the data. Sometimes there is redundancy in the data collection, such as when a refuge is using both Project Budburst and *Nature's Notebook*. While engaging in initial consultations with refuge staff, we often work with them to determine whether *Nature's Notebook* is the best fit for their phenology data collection needs, or whether a different program would be more appropriate. We will continue to provide this guidance to refuge staff in future years.

Multiple respondents stated that the government shutdown impacted some of their phenology monitoring activities over the 2018-2019 winter season. While we cannot plan for events like these, we can work to make sure that phenology programs are adaptable and can withstand gaps in data collection.

Conclusions

This Project evaluation provides clear recommendations for how we can better assist new refuge staff and volunteers in establishing long-term phenology monitoring programs with *Nature's Notebook*. Implementing a *Nature's Notebook* phenology monitoring program makes good business sense. Refuges can collect and store data in a consistent format, use our resources to recruit and train volunteers (who save the refuge staff time), and compare their data to those across species ranges to better understand long-term changes in phenological patterns.

In addition to collecting, storing, and sharing phenology data in a secure location accessible by others, the protocols and methodologies for data collection and quality assurance control have been vetted by experts in the fields of research, management, and education. A common misconception is that using *Nature's Notebook* is difficult to implement and that it will be hard to convert existing data to a new system. Rather, the NCO has guidance materials and documentation available to make the process of data collection as easy as possible. There is also opportunity to cross-walk existing data collected with external protocols and do bulk uploads (on a case-by-case basis). NCO staff are available to work directly with refuge contacts and partners to ease the transition and provide assistance to make the program a success. We work one-on-one with visitor services and management staff to obtain a clear understanding of local ecosystem management needs and local species of interest such that the monitoring program can be as successful as it can be.

Our Project Evaluation identified clear needs that the USA-NPN can address to better serve our USFWS partners. In subsequent years of the partnership, the USA-NPN will:

- Provide guidance to refuges on best practices for analyzing and applying phenology data and information, including the USA-NPN's Status of Spring tools, through guidance documentation and by working directly with refuge staff.
- Assist refuge staff to develop a scheduling system for volunteer data collection.
- Place our program planning materials into a step-by-step framework that refuges can use to develop site-level monitoring protocols.
- Continue to assist refuges to establish collaborations with nearby partner organizations to leverage their volunteer base, environment education expertise, and regional framework for management and conservation.
- Continue to provide forums to connect science and education staff who can work together to create phenology monitoring programs that are scientifically sound with strong volunteer engagement and management.
- Continue to develop resources for phenology data collection, including species phenophase photo guides for species of interest to refuges.

On their own, refuges and the Refuge System as a whole can and should:

- Determine how phenology data and information can inform their long-term goals for management and conservation, incorporating their phenology programs into their Comprehensive Conservation Plans.
- Leverage the Status of Spring tools on the USFWS Phenology Network website to inform decisions related to planning and operations activities that take place in spring.
- Seek or use existing funding for interns to serve as Local Phenology Leaders who will establish monitoring programs. If that is not possible, elect a staff person, perhaps in connection with Visitor Services (if available) to manage the project and the volunteers for consistency. The volunteers can be responsible for collecting the observations, but the staff person should manage the monitoring schedule, communication with volunteers, and data quality control. The most effective programs have a dedicated person, either a paid staff or volunteer, who is a Certified Local Phenology Leader.
- Recruit staff and volunteers to own pieces of the program. Create a list of jobs that are required for the program to be successful: data manager, researcher with a management question, volunteer engagement specialist/manager, and trail coordinator. The more staff and volunteers share the workload, the more successful the program will be.
- Support directives from regional staff for units to place existing phenology monitoring datasets into the National Phenology Database.
- Seek partnerships with off-refuge nonprofits and NGOs who can provide environmental education expertise or a regional framework for management and conservation.

Additional areas of Focus for the USFWS and USA-NPN Partnership:

Working with the Chief of Inventory and Monitoring for the USFWS's NWRS, Jana Newman, we have identified the following areas of focus for the next phase of our partnership (2019-2023):

- 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 the USA-NPN's phenology protocols for future monitoring.
- 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.
- 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.
- Convene focus groups to determine how Refuges can incorporate phenology monitoring with *Nature's Notebook* into existing monitoring activities. Educate Refuge staff on example uses of phenology data collected through *Nature's Notebook*.
- Leverage the USA-NPN's program planning process to provide guidance to USFWS on how to create Site-level Protocols for phenology monitoring. Encourage USFWS staff to enroll in the Local Phenology Leader Online Certification Course, which happens twice per year.

The Project could not have been successful without seed funding and vision provided by the Chief of the USFWS NWRS Inventory and Monitoring Program, Jana Newman. Together we seek to develop a rich resource of in-situ phenology data to be used by the refuge system and beyond for a better understanding of how species are responding to environmental and climatic change. We look forward to a continued partnership and enhancing the programmatic work being done by both the USFWS NWRS and the USA-NPN in service to science and society.

References

E.G. Denny, K.L. Gerst, A.J. Miller-Rushing, G.L. Tierney, T.M. Crimmins, C.A.F. Enquist, P. Guertin, A.H. Rosemartin, M.D. Schwartz, K.A. Thomas, J.F. Weltzin. 2014. Standardized phenology monitoring methods to track plant and animal activity for science and resource management applications. *International Journal of Biometeorology* 58(4) 591-601. <https://doi.org/10.1007/s00484-014-0789-5>.

W.B. Monahan, A.H. Rosemartin, K.L. Gerst, N.A. Fisichelli, T. Ault, M.D. Schwartz, J.E. Gross, J.F. Weltzin. 2016. Climate change is advancing spring onset across the U.S. national park system. *EcoSphere* 7(10) <https://doi.org/10.1002/ecs2.1465>.

E.E. Posthumus, L. Barnett, T.M. Crimmins, E. Stancioff, J. Einerson, P.L. Warren. 2019. Building local resilience to climate change through citizen science, environmental education, and decision-making. In: *Addressing Climate Change at the Community Level in the United States*. Eds. P.R. Lachapelle, D.E. Albrecht. Routledge, New York, NY, pp 50-64.

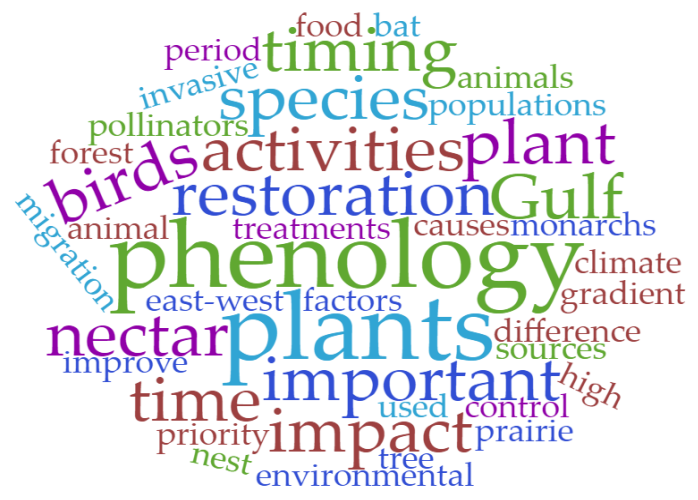
A.H. Rosemartin, T.M. Crimmins, C.A.F. Enquist, K.L. Gerst, J.L. Kellerman, E.E. Posthumus, J.F. Weltzin, E.G. Denny, P. Guertin, L.R. Marsh. 2014. Organizing Phenological Data Resources to Inform Natural Resource Conservation. *Biological Conservation*.

What questions are Refuges seeking to answer with their phenology data?



Most frequently asked question:

Is there an impact of climate change on plants and animals?



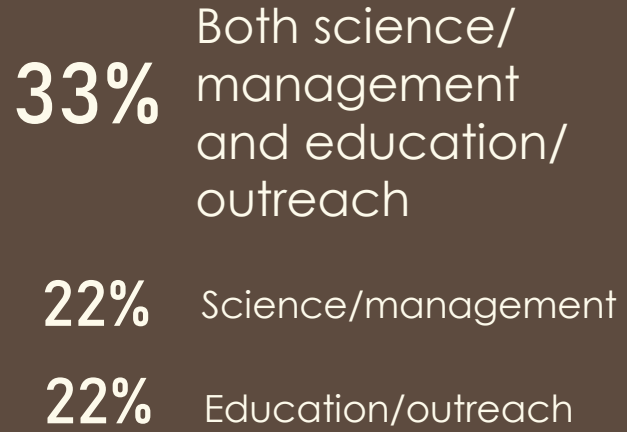
What is the purpose of refuge phenology programs?

67%

Of refuges consulted with their Refuge Biologist before selecting species to observe

33%

Of refuges plan to use their data to inform management



What progress have refuges made toward meeting their goals?

- Weekly phenology observations
- Volunteer trainings
- Recruitment of volunteers

Observations collected on refuges

