Gulf Coast Phenology Trail 2022 Annual Report

Gail Bishop, M.S., Gulf Coast Phenology Trail Coordinator
Erin Posthumus, M.S., USA-NPN Outreach Coordinator and USFWS Liaison

USA National Phenology Network

U.S. Fish & Wildlife Service

National Wildlife Refuge System

USGS science for a changing world

Community Scientist Nita Owen on the Visitor Center Trail at the Mississippi Sandhill Crane NWR Refuge in Gautier, Mississippi showing the challenges of observing. Photo credit: G. Bishop

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Executive Summary

The Gulf Coast Phenology Trail was established in 2016 to engage state and federal partners along the coastal Mississippi and southeast Louisiana in studying phenology of five selected focal plants found across the area and about 31 other common plants and 21 animals native to specific locations. The primary goal was to gather data to see if changes in climate impacted the onset of seasonal activity in these species. Six years of data have been collected by trained community scientists using *Nature's Notebook*, the online data collection platform developed by the USA National Phenology Network. Between 2017 to 2022, 200 volunteers have been trained, and 285,240 observations have been recorded despite the closure of locations caused by tropical storms, hurricane damages, and the Covid-19 Pandemic. In 2022, 32 volunteers made 53,369 observations.

While weather conditions are always local, we can see differences across the Gulf Coast in temperature and rainfall even within the two-year period of 2021-2022. The year 2021 was characterized by normal precipitation, with lower average temperatures in New Orleans and Gulfport and higher average temperatures at the Mobile Downtown Airport during the same period. In 2022, most locations experienced near average rainfall and above average maximum temperatures.

Over our six years of data collection, one of the deciduous trees we monitor, red maple (*Acer rubrum*), had consistent onset of breaking leaf buds in mid-March. The non-native Chinese tallow (*Triadica sebifera*), another deciduous species, showed more variability in onset of breaking leaf buds. These two deciduous trees have a burst of new leaves after a dormant winter period when their leaves are shed but can also produce new leaves later in the year if the trees are cut or burned. Other focal species, such as red bay (*Pereia borbonia*), yaupon holly *(Ilex vomitoria*), and wax myrtle *(Myrica cerifera*) are evergreen broadleaf species that will regrow and leaf out following fire or manual cutting. In some species, the timing of flowering was more consistent than leaves. For example, wax myrtle consistently had open flowers in mid-March for all years. This year, we also include an additional species, American beautyberry (*Callicarpa americana*), that has been observed at some Trail locations since 2018. We also focus on additional questions concerning the mismatch of animals such as Monarch butterflies with nectar sources such as Eastern baccharis, (*Baccharis halimifolia*).

Introduction

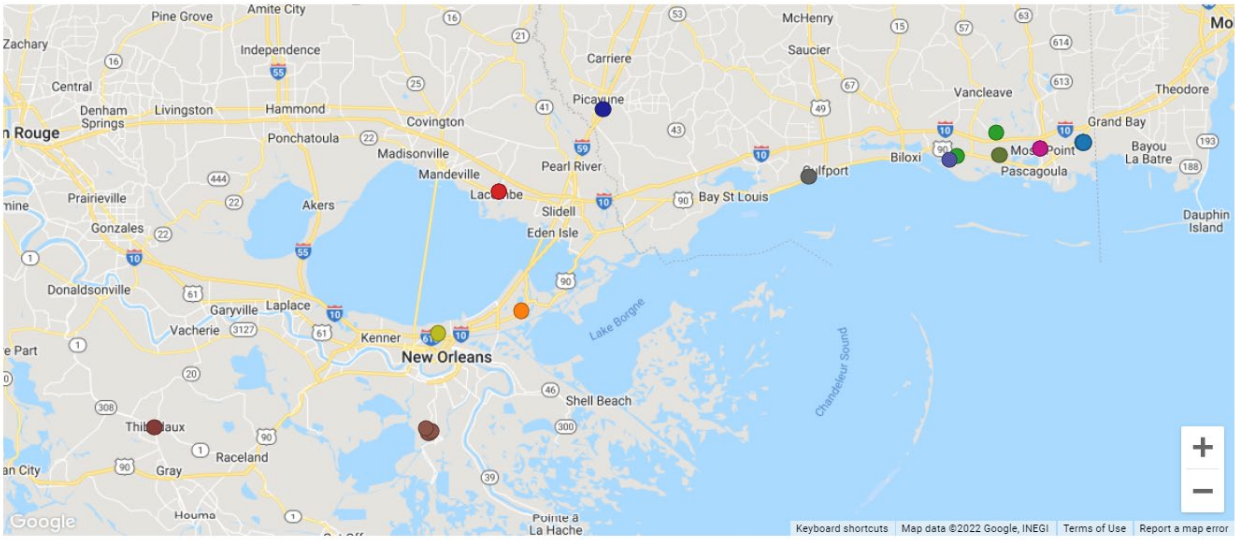
The Gulf Coast contains rich and varied ecosystems including pine savannas, forests, shorelines, and open marshes. Phenology, or the study of timing of recurring life cycle events in plants and animals and their relationship to the environment, is an important indicator of climate change. The Gulf Coast Phenology Trail, (hereafter referred to as the Trail), was established in 2016 as a community science-driven, long-term monitoring program with the goal to gain a better understanding of the effects of climate change on plants and animals along the northern Gulf Coast from Louisiana to Alabama. Funding to establish the Trail and to monitor plants was provided by the U.S. Fish and Wildlife Service's Inventory and Monitoring Initiative. Support and coordination were provided by the staff at USA National Phenology Network located at the University of Arizona.

Project Description

The Trail considers both site-specific and larger-scale questions of interest. To address regional-scale questions, a set of core species, shared by most sites along the Trail, was selected in 2017. In addition, each of the 12 partners (Fig.1) selected a list of species for a total of 36 plants, 18 birds, 2 reptiles, 1 mammal, and 4 insects (Appendices A and B) to monitor to address site-specific questions of interest. The data collected by observers can be used by researchers and land managers who are interested in understanding the effects of climate change on plants and animals. To achieve educational and outreach objectives, we invited community scientists, college students, and K-12 school students to participate in monitoring. Thirty-one volunteers monitored sites in 2022 and by their participation these individuals gained field experience and knowledge of phenology data collection. The Trail uses the USA National Phenology Network's *Nature's Notebook* platform as a tool for training, education, outreach, data collection, analysis, and reporting.

Trail Partners Commit to:

- Making repeat observations on the same individual plants or animal species at a site over time
- Making repeat observations at least once per week during the growing season
- Making observations for a least one growing season
- Making observations for more than one calendar year



Legend

- Grand Bay NWR/NERR
- Bayou Sauvage NWR
- Mississippi Sandhill Crane NWR
- Big Branch Marsh NWR
- Crosby Arboretum
- Pascagoula River Audubon Center
- Barataria Phenology Trail
- MGCCC Estaurine Education Center
- Bayou Lafourche Phenology Trail
- USM Marine Education Center
- USM Long Beach
- Couturie Forest Phenology Trail

Figure 1. Map of Gulf Coast Phenology Trail Partners active in 2022.

Methods and Results

All partner sites along the Trail follow the protocols outlined by *Nature's Notebook* (www.naturesnotebook.org). We set up partner sites in the *Nature's Notebook* interface for volunteers to use when collecting phenology data along the Trail. Individual training on how to use the *Nature's Notebook* mobile application was provided to observers by the Local Phenology Leaders or the Trail Coordinator. On rare occasions paper data collection was preferred and hard copies of data sheets were provided to citizen scientists for data collection. Data sheets were turned in and the data were entered manually by the site lead.

Primary Questions

We are guided by the scientific statements such as the one on the Environmental Protection Agency's archived Global Climate Change website, "Most plants and animals live in areas with very specific climate conditions such as temperature and rainfall patterns that enable them to thrive." (Global Climate Change" on archive.epa.gov). In 2022 we collected data for our sixth year on the Trail and we compare patterns in our data to see whether they reflect the impact of climate change.

Table 1. 2022 By the Numbers
53,369 Phenology Observations
21 Sites
36 Plant Species Observed
21 Animal Species Observed
47,628 Plant Observations
5,741 Animal Observations

Most of the trails and boardwalks at Louisiana sites including New Orleans City Park and National Wildlife Sites were repaired from the storm damages in 2019 and 2020. The managers at the Barataria Preserve in Louisiana are revamping their trails system so there were fewer observations at that location. Only a few observations were made at the Acadiana Wetlands Site in Thibodaux, Louisiana in 2022. Overall, there were 53,369 observations made in 2022 on the Trail in both states. (Fig.2)

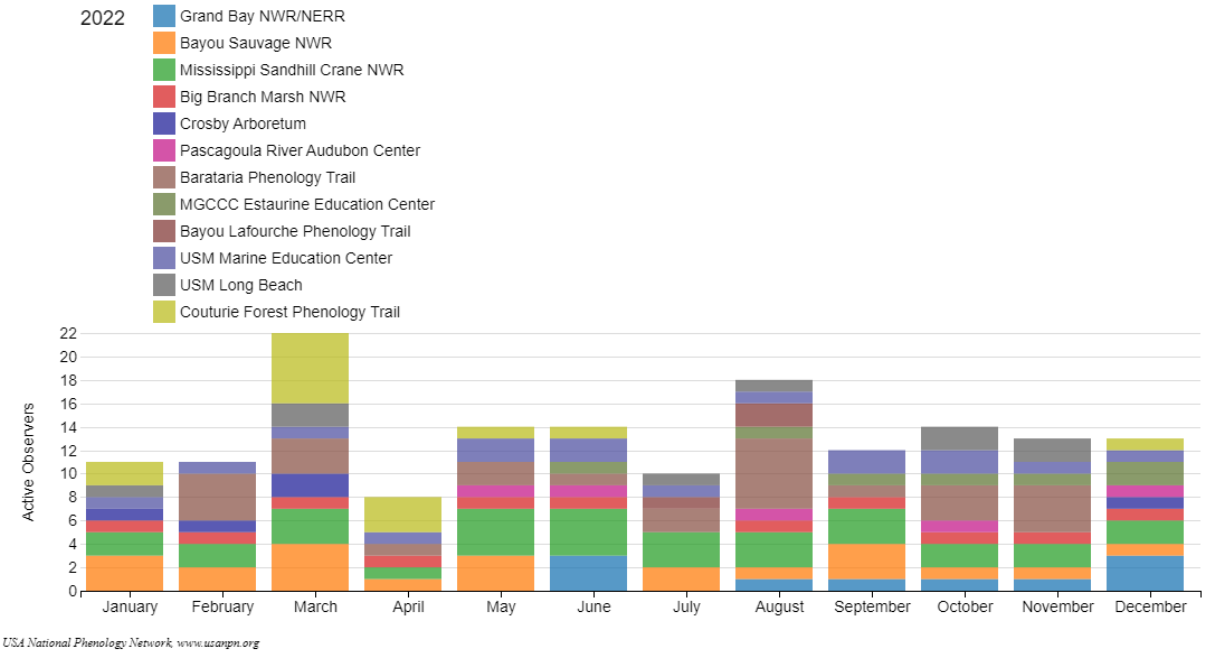


Figure 2. Active observers collecting data with each GCPT Partner in 2022.

Volunteers continued to observe both focal species and other species. Our native focal species are red maple (*Acer rubrum*), red bay (*Persia borbonia*), wax myrtle (*Morella cerifera*), and yaupon holly (*Ilex vomitoria*) and a non-native species, Chinese tallow (Sa*pium sebiferum*). This year we also include the data on American beautyberry (*Calacarpa americana*), a deciduous native shrub, that have been recorded since 2018.

Four primary questions were developed to drive the need for data collection on the Trail:

1-1. Does the phenology of native Gulf Coast plants change over time under a changing climate?

1-2. Does phenology of Gulf Coast plants differ between native and non-native plants?

1-3. Does the phenology of native plant pollinators match native plant phenology over time under a changing climate?

1-4. Is there an East-West gradient in the timing of certain focal species from Louisiana to Alabama?

Below, we describe our progress toward answering these questions.

1-1. Does the phenology of native Gulf Coast plants change over time under a changing climate?

Our ability to answer the question of how phenology is changing depends on having observations on the same individual plants over many years. In 2021, 6 sites monitored Chinese tallow (*Triadica sebifera*), 16 sites monitored red maple (*Acer rubrum*), 11 sites monitored wax myrtle (*Morella cerifera*), 8 sites monitored red bay (*Persia borbonia*), and 9 sites monitored yaupon holly (*Ilex vomitoria)* (Table 2).

Table 2. Number of individual plants and sites for each focal species in 2017-2022.

Number of Plants/Sites	2017	2018	2019	2020	2021	2022
Chinese tallow	5/7	11/7	11/7	10/5	10/6	11/5
Red maple	36/7	29/10	50/15	42/11	51/16	44/22
Wax myrtle	29/5	26/8	39/13	25/7	29/11	30/8
Red bay	18/4	17/7	29/9	23/7	28/8	24/7
Yaupon holly	13/5	22/7	33/9	34/9	29/9	31/8
American beautyberry	n/a	3/2	4/3	8/5	8/5	9/5

Chinese Tallow (*Triadica sebifera*)

Figure 3. From left to right, Chinese tallow catkins, immature seed pods and ripe seed pods. Photo credit: G. Bishop

Chinese tallow (*Triadica sebifera*; Fig. 3), also called Chinese tallow tree, gray popcorn tree, Florida aspen, chicken tree, or candleberry (from Wikipedia), was introduced to North America in the 1700s and is known to displace native plant species. Chinese tallow seeds can remain dormant for up to five years (University of Arkansas Research and Extension Service, UAEx.edu) and may be spread by birds such as Yellow-rumped Warblers (Conway 2022, Baldwin 2005).

According to the U. S. Department of Agriculture, Chinese tallow is considered one of the most aggressive and widespread weeds that grows as a large shrub or a tree in the southeastern United States. This fast-growing invasive tree alters species composition, community structure, and ecosystem processes in many native habitats. The Mississippi State Forestry Commission has a program, "Stop the Pop," to encourage landowners to get rid of Chinese tallow trees on their property and has developed an online mobile-friendly map for anyone to map locations of this species (helpstopthepop.com).

There is potential to use *Bikasha collaris* (a small beetle) and *Gadirtha fusca* (a moth) as biocontrol for Chinese tallow, those these are pending public review that was started in 2021 ("APHIS Announces Availability of Environmental Assessment on Agents to Biologically Control Chinese Tallow" Official USDA Animal and Plant Inspection Service website.aphis.usda.gov). The LSU Agriculture Center in Baton Rouge is also doing research on these two biological controls. The *Bikasha collaris* (flea beetle larvae and adults) helps to control by either feeding on the roots or the foliage of the Chinese tree. The Noctuid moth, a native of China, can cause extensive defoliation of trees.

Chinese tallow does well in drought conditions and is expected to increase under climate change conditions. The number of Chinese tallow that we are monitoring was reduced from seven to five in 2022 because of successful manage practices at the Grand Bay NERR and Mississippi Sandhill Crane National Wildlife Refuge to control the species.

Observations of Chinese tallow trees at Barataria Preserve, Acadian, Mississippi Sandhill Crane National Wildlife Refuge, Mississippi Gulf Coast Community College-Gautier Campus, and Grand Bay NERR record high number of seeds. This hardy, invasive species produces thousands of seeds and regrows from root stock despite management controls such as burning or cutting. According to the LSUagcenter.com information, ”physical and mechanical removal (as well as removal by burning) are not ideal.” The Mississippi Sandhill Crane National Wildlife Refuge successfully destroyed Chinese tallow 2 after multiple attempts.

Observers recorded a peak in Initial shoot or leaf growth in early February in 2017, mid-March in 2018 and 2019, in mid-April in 2020, peaked between mid-April to mid- May in 2021 and 2022 (Fig. 4). All years except 2019 saw continued reports of initial growth through the fall months, likely due to the plants being cut back by managers. In all years except 2021, Chinese tallow flowering peaked in mid-May, though the proportion of yes records was much lower in 2020 and 2022 (Fig. 5). First reported ripe fruit was variable in the six years, with observers reporting the earliest fall fruit in 2018 (Fig. 6.)

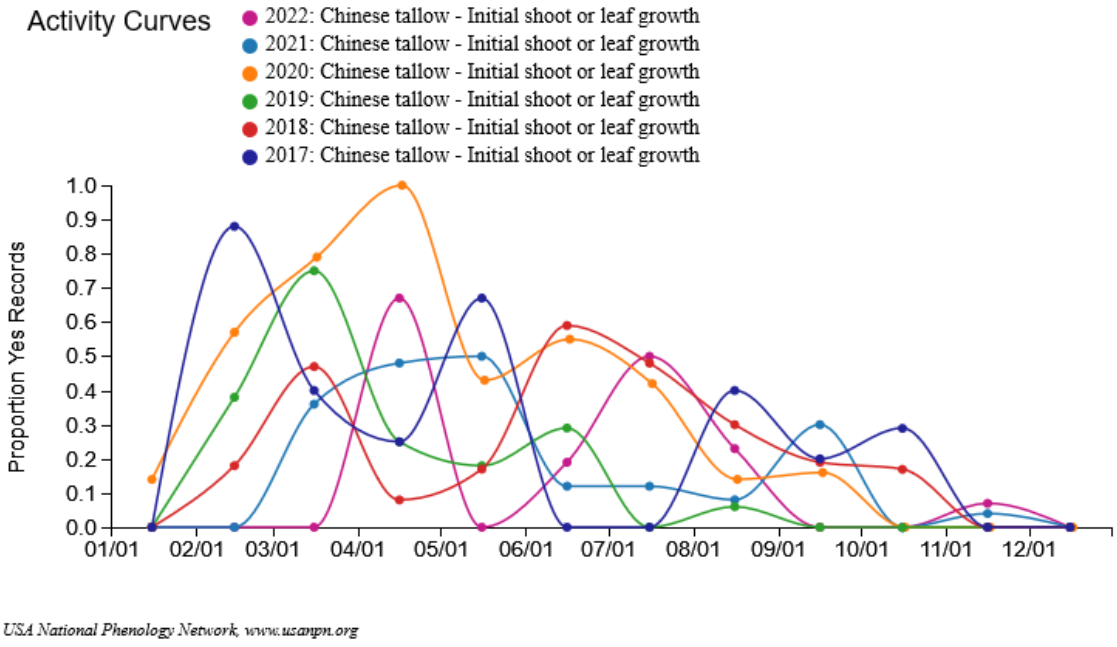


Figure 4. Activity curve showing the proportion of Chinese tallow “yes” records for initial shoot or leaf growth 2017-2022.

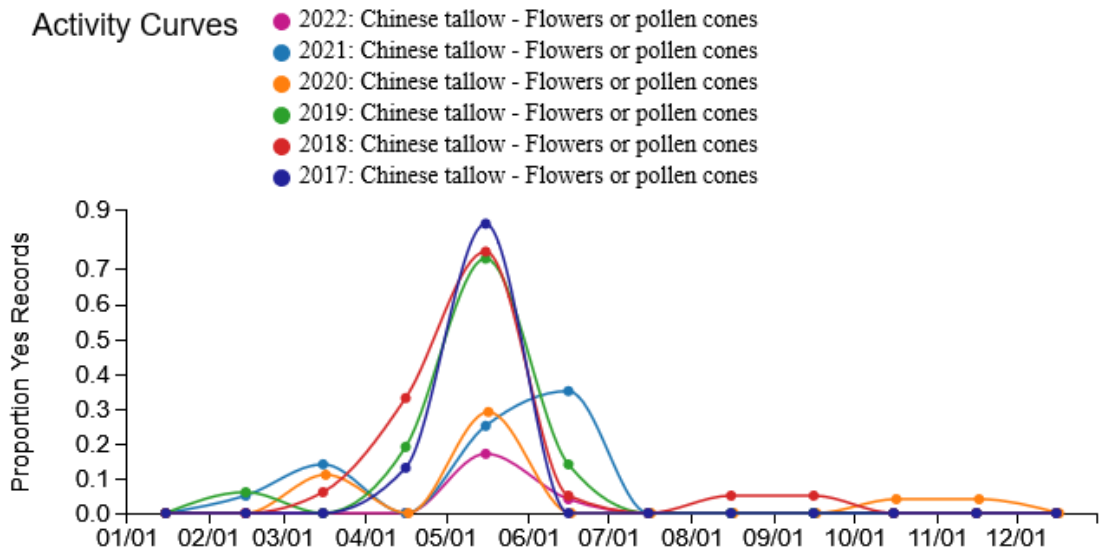


Figure 5. Activity curve showing the proportion of Chinese tallow "yes" records for flowers or flower buds in 2017-2022.

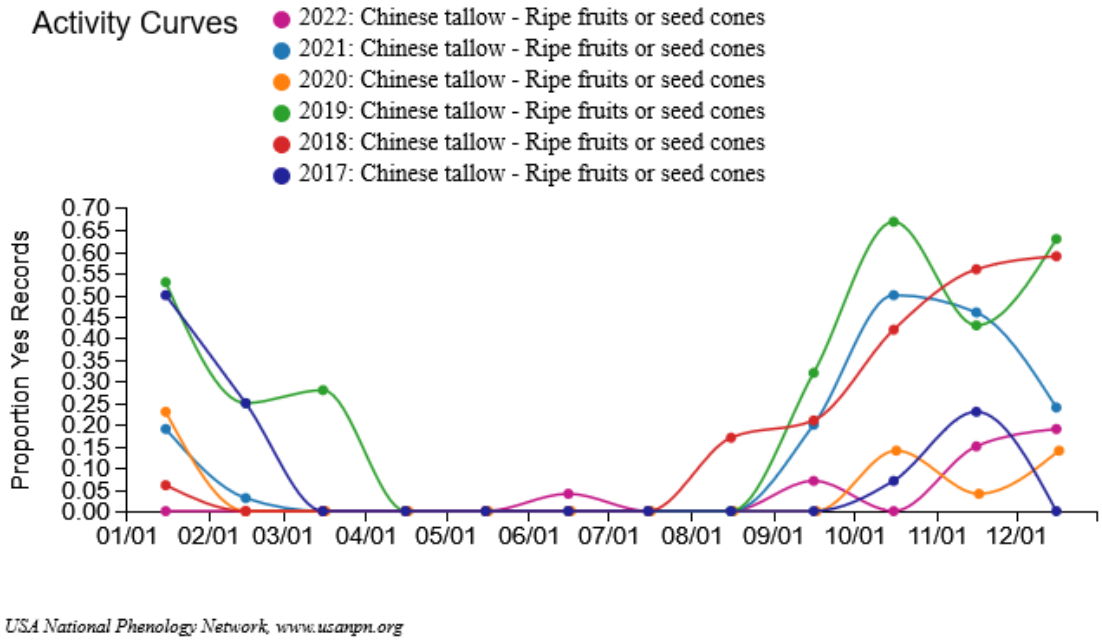


Figure 6. Activity curve showing the proportion of Chinese tallow "yes" records for ripe fruits in 2017-2022.

Red Maple (*Acer rubrum*)

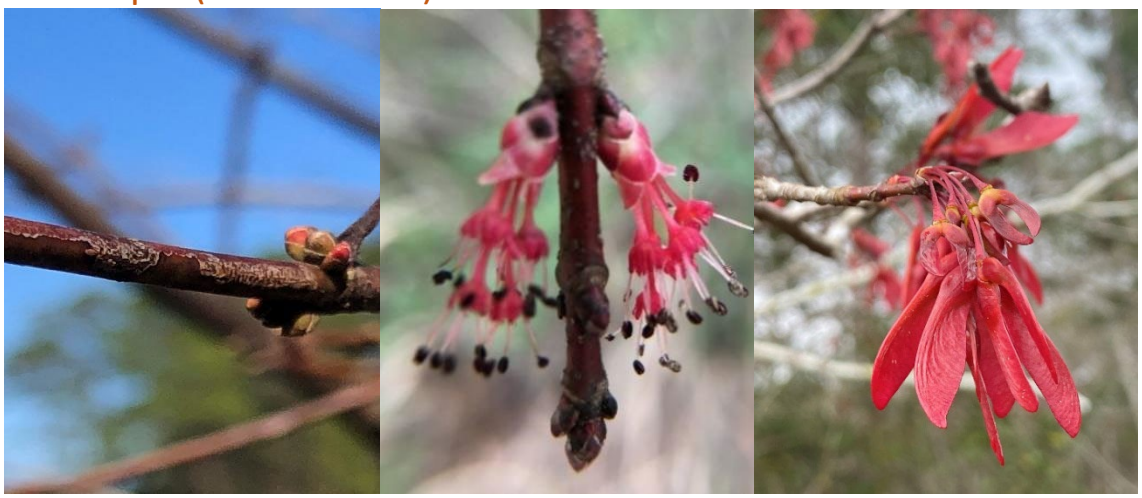


Figure 7. From left to right, red maple buds, blossoms, and winged seeds. Photo credit: G. Bishop

Red maples (*Acer rubrum*, Fig. 7) are the top observed plant species in the United States among *Nature's Notebook* observers (Fig 8). In red maple, the flower blossoms, and fruit ripens, before a tree breaks leaf buds. Red maple seeds (samaras) are consumed by wildlife (USDA NRCS 2006). While red maples observed across the US bloom primarily in April (Fig. 9), red maple flowers on the Trail typically begin flowering in mid-February (Fig. 10).

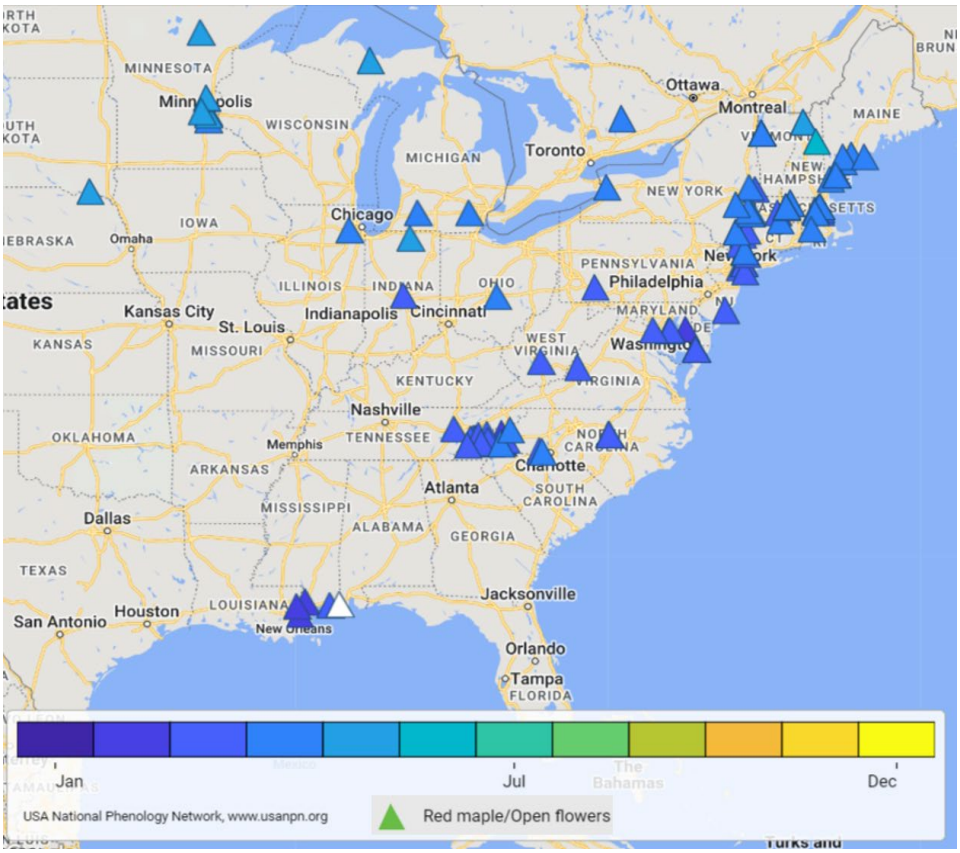


Fig. 8 Onset of red maple open flowers at *Nature's Notebook* sites across the eastern U.S. in 2022.

Fig 9. Red maples blooming in sites monitored across the U. S.

In 2020, we observed flower buds emerging as early as November on the Trail. The peak in open flowers occurred in mid-February in 2017, 2018, 2019, 2021, and 2022, but peaked in early January in 2020 (Fig. 10). The peak of ripe fruit, samara, production was in mid-March in all five years (Fig.11). Initial growth of leaf shoots in red maples peaked in mid-March in all six years but re-growth was observed following manual cutting or burning (Fig.12)

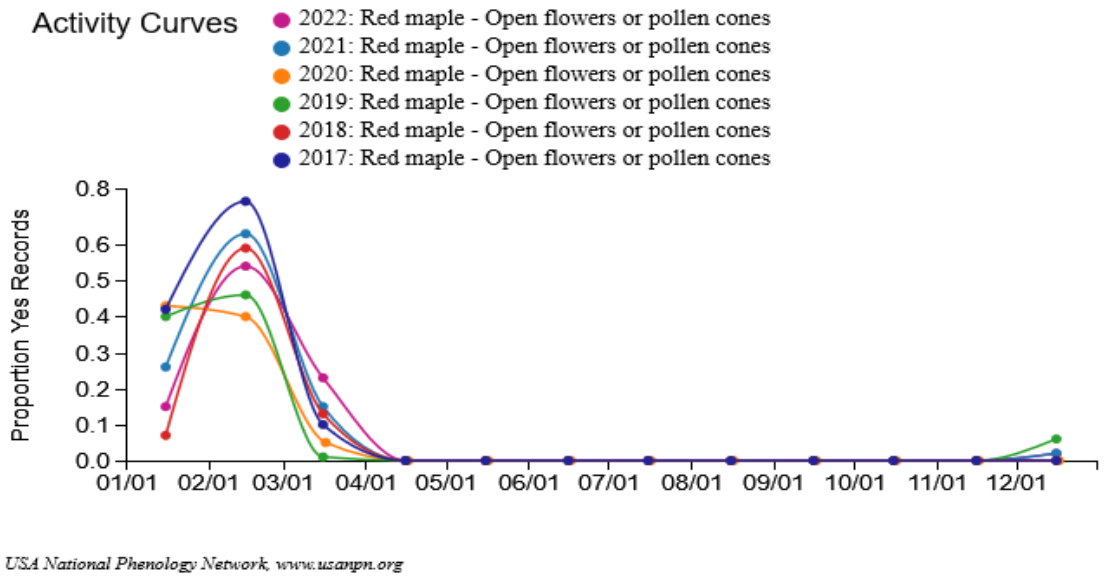


Figure 10. Activity curve showing the proportion of red maple "yes" records for open flowers in 2017-2022.

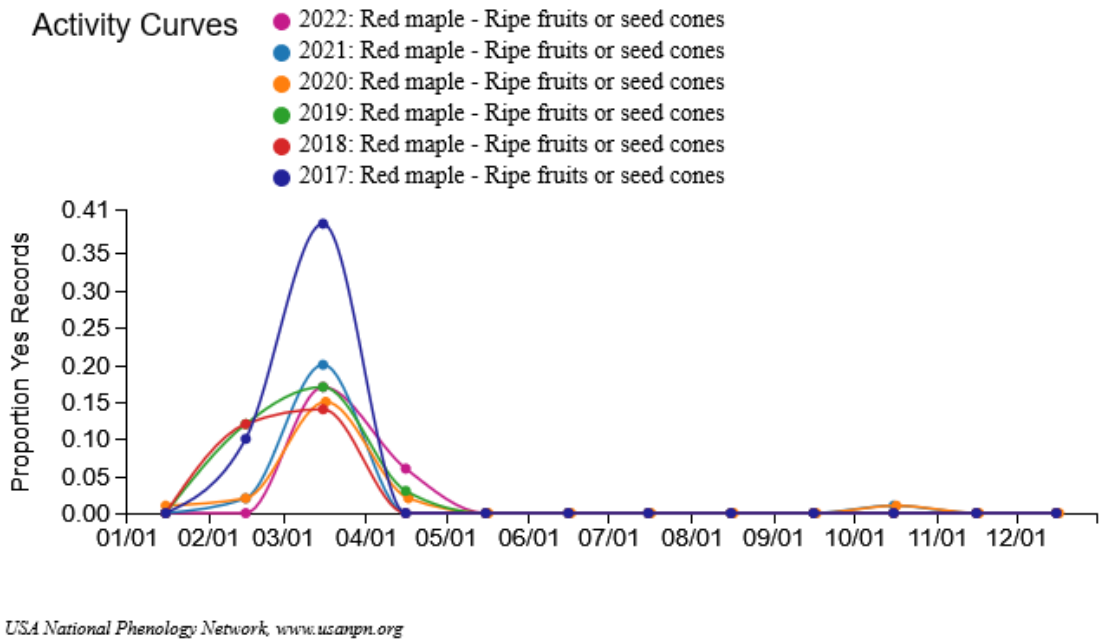


Figure 11. Activity curve showing the proportion of red maple "yes" records for ripe fruits 2017-2022.

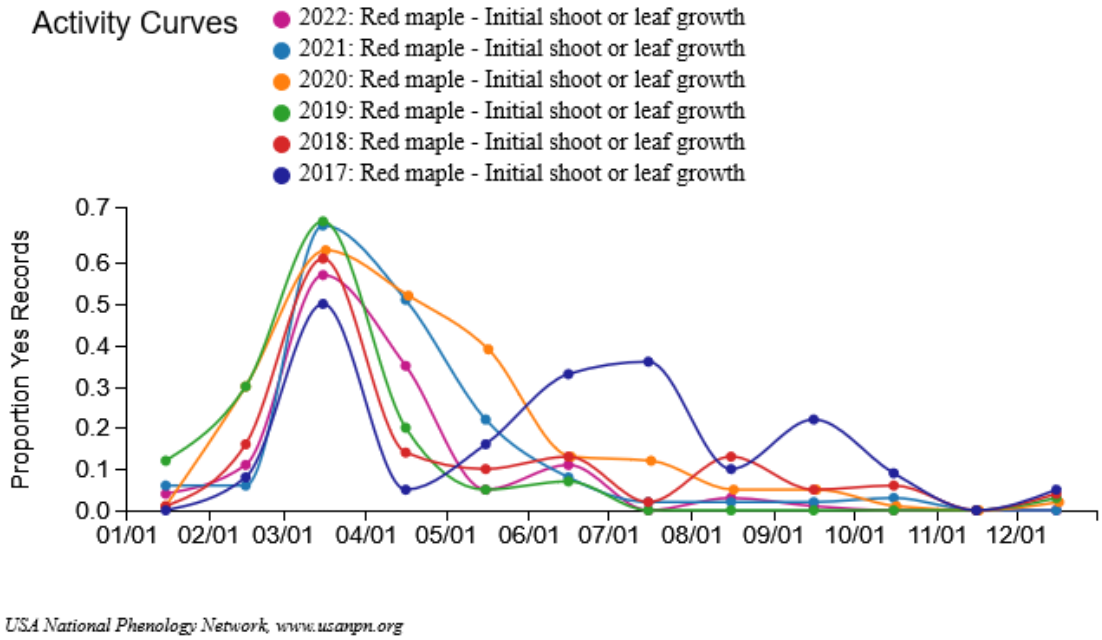


Figure 12. Activity curve showing the proportion of red maple "yes" records for initial shoot or leaf growth 2017-2022.

Wax Myrtle (*Morella cerifera*)

Figure 13. From left to right, wax myrtle male flower, female flower, immature berries, leaf buds. Photo credit: G. Bishop

Wax myrtle (*Morella cerifera*; Fig. 13) is a native evergreen broadleaf tree that grows primarily in the southeast US, Gulf and Atlantic Coastal Plains. It is vulnerable to leaf blight infections (*Phytophthora syringae*), which can cause the leaves to turn brown (homeguides.sfgate.com) It does not tolerate prolonged freezing temperatures. Wax myrtle is dioecious, with male and female flowers occurring on different plants. Only the female flowers produce berries.

We observe that leaf buds and new leaves emerge throughout the year especially when a terminal end is removed by browsers or by mechanical means. For that reason, here we focus on observations of flowering and fruiting. In all years (2017-2022) wax myrtle flowers peaked in mid-March (Fig. 14). The peak of wax myrtle ripe fruits development was mid-October in 2017, mid-November in 2018-2022 (Fig. 15).

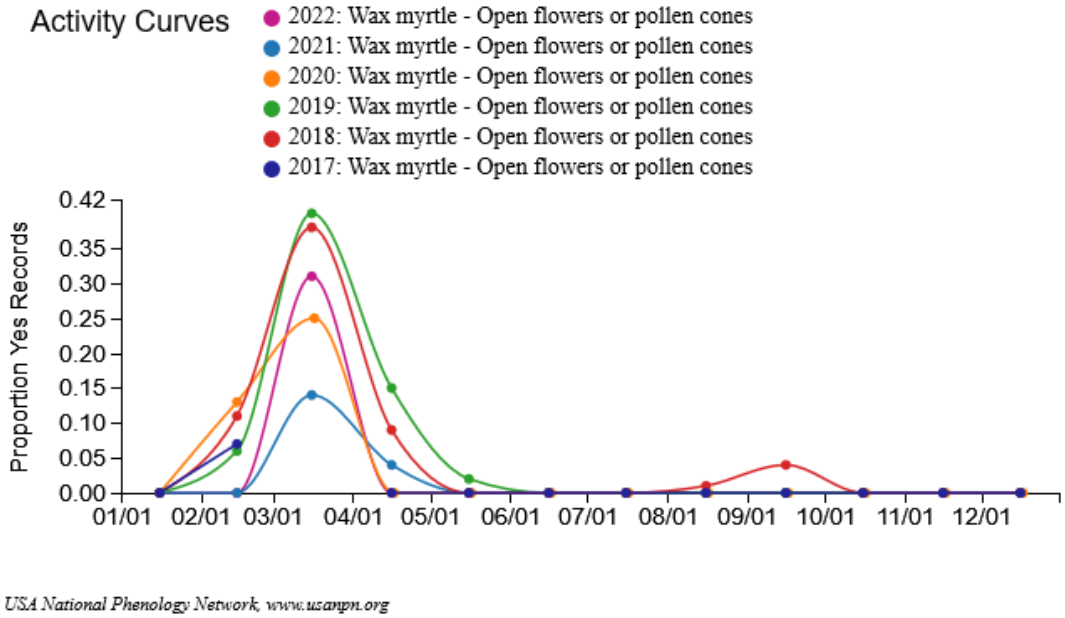


Figure 14. Activity curve showing the proportion of wax myrtle "yes" records for flowers or flower buds 2017-2022.

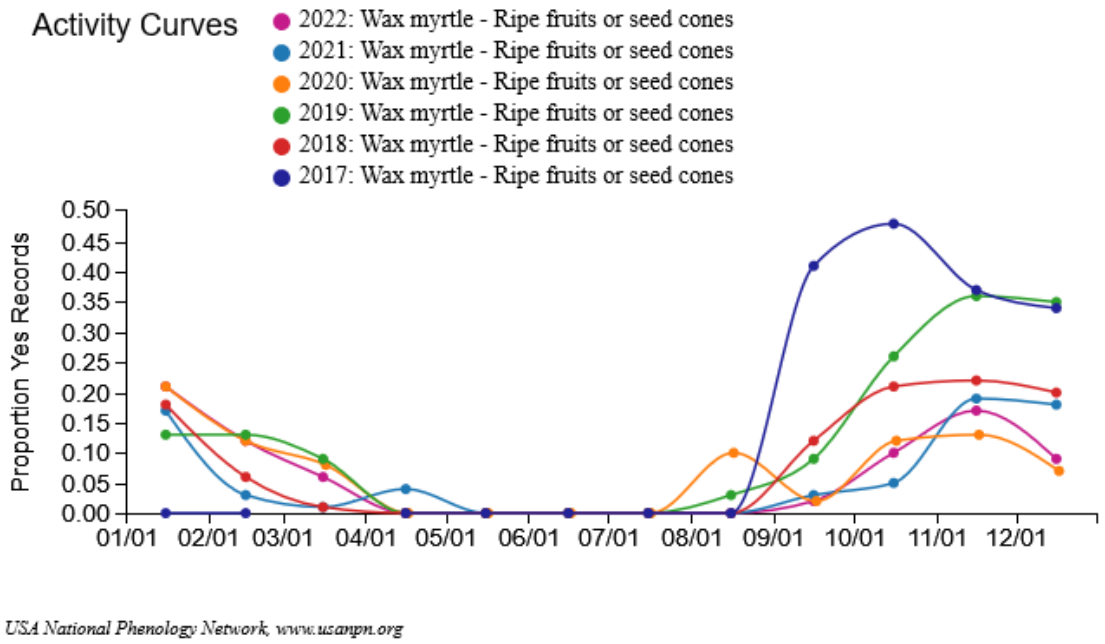


Figure 15. Activity curve showing the proportion of wax myrtle "yes" records for ripe fruits and seeds in 2017 - 2022.

Redbay (*Persea borbonia*)

Figure 16. From left to right, redbay new leaves and breaking leaf buds, redbay leaf galls. Photo credit: G. Bishop

Red bay (*Persea borbonia*; Fig. 16) is a small evergreen tree in the laurel family and native to the southeastern United States. It has simple leaves and is sometimes confused as a Sweetbay in the magnolia family. It can often be identified by leaf galls (Fig. 16) caused by the redbay psyllid (*Tioza magnoliae*). Some websites report using spicy redbay leaves to flavor soups and meats (plants.ces.ncsu.edu) but the most common bay leaf purchased commercially is from the *Laurus nobilis* which is native to Mediterranean regions.

The redbay ambrosia beetle was identified in 2002 in a survey trap in Georgia. This nonnative beetle vectors a fungus that causes a deadly wilt. By recording and observing redbays in seven locations, we can identify those redbays that are impacted by the fungus. One known infected redbay died on the Pine Forest Restoration Trail in Gautier, Mississippi. Another mature red bay was added in 2022 because it appeared healthy and was observed with over 100 drupes.

We observed the peak in initial leaf growth for redbay in mid-March in 2018, 2019, 2020, and in mid- April in 2021 and 2022; the information was incomplete for 2017 (Fig. 17). We observed a peak in open flowers in mid-April in 2017, 2018, 2020, 2021, 2022, and the end of May in 2019 (Fig. 18). The peak of redbay fruits (drupes) for 2017, 2018, 2019, and 2002 was mid-October, occurred in mid-August for 2020, and mid-December in 2021 (Fig. 19).

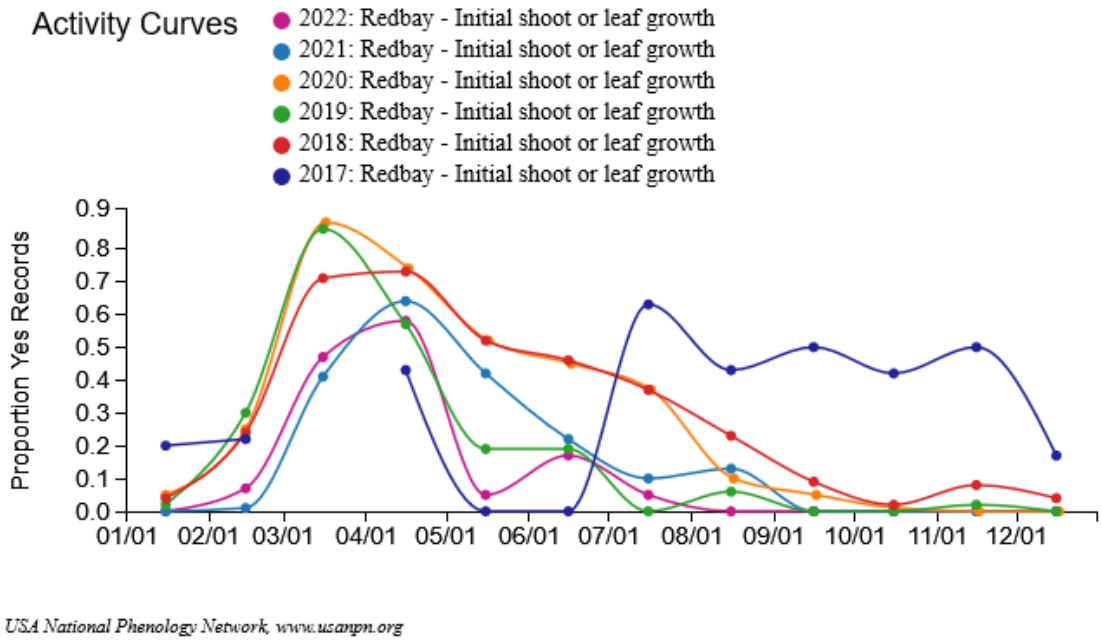


Fig. 17. Activity curve showing the proportion redbay "yes" records for initial growth in 2017 -2022.

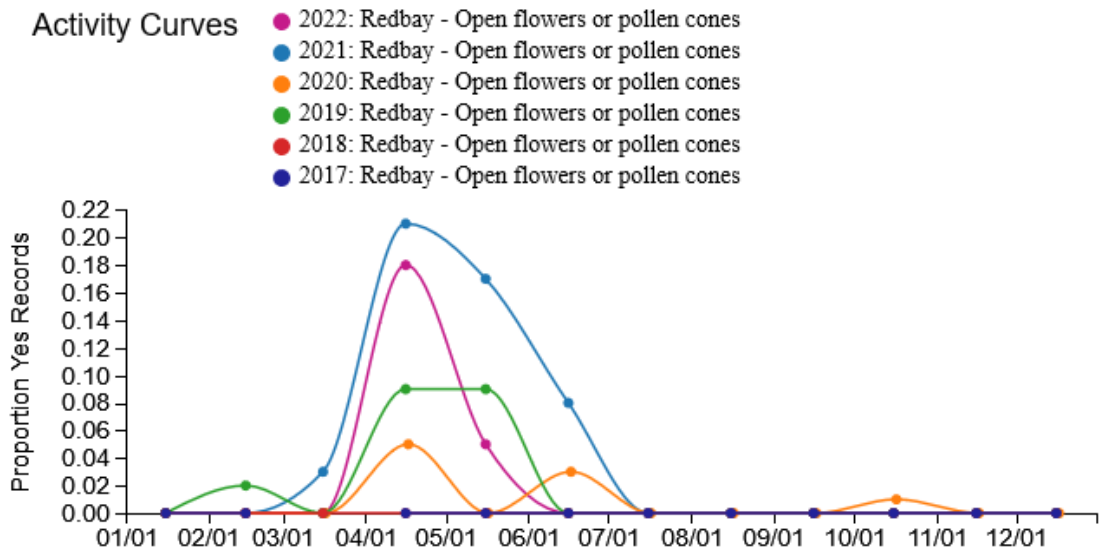


Figure 18. Activity curve showing the proportion of redbay "yes" records for open flowers or flower buds in 2017 - 2022.

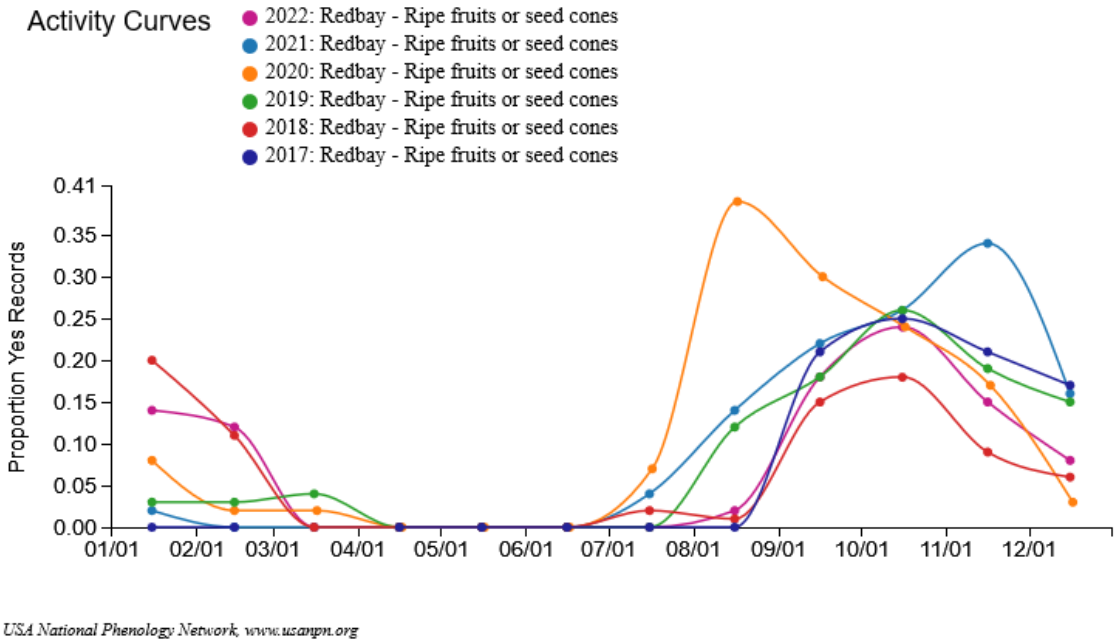


Figure 19. Activity curve showing the proportion of redbay "yes" records for ripe fruits in 2017 -2022.

Yaupon Holly (*Ilex vomitoria*)

Figure 20. From left to right, female yaupon holly in bloom and with ripe berries. Photo credit: G. Bishop

Yaupon holly is another dioecious focal plant observed on the Trail. The yaupon holly leaf development can occur almost year-round. Yaupon galls have been mistaken for leaf buds caused by the insect *Gyropsylla licis* (Texasinsects.tamu.edu). For our reports, we focus on the peak of flowering and fruiting. Yaupon holly open flowers peaked at the end of April in 2017, 2018, 2021, 2022 and in early March in 2019 and 2020. (Fig. 21). The peak of ripe fruits was from mid-January to mid-February in all six years. (Fig. 22).

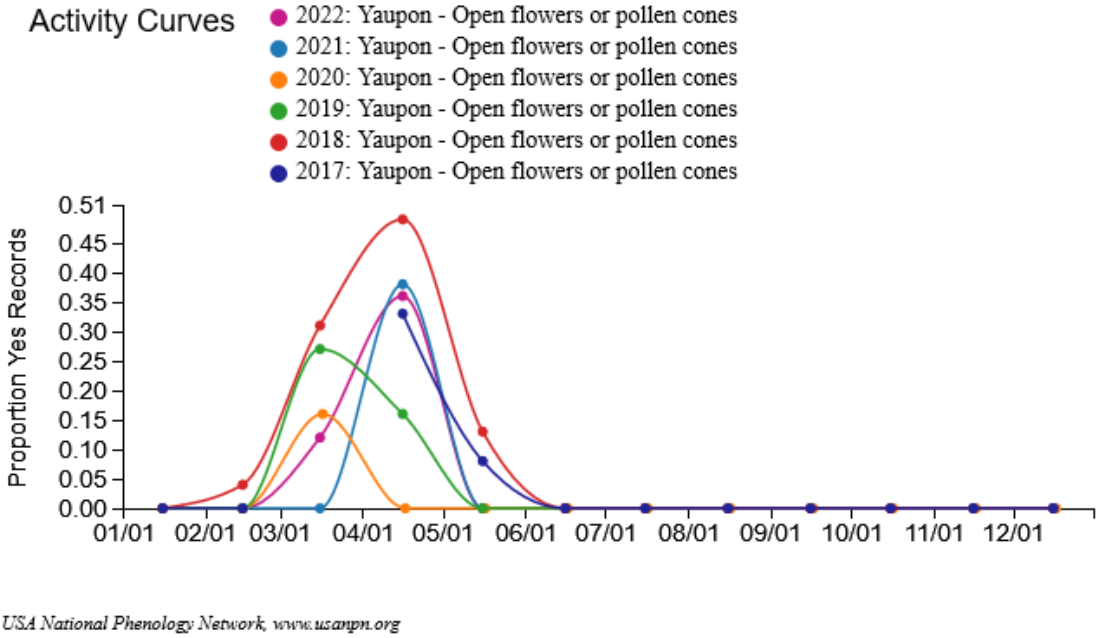


Figure 21. Activity curve showing the proportion of yaupon holly "yes" records for flowers or flower buds in 2017 - 2022.

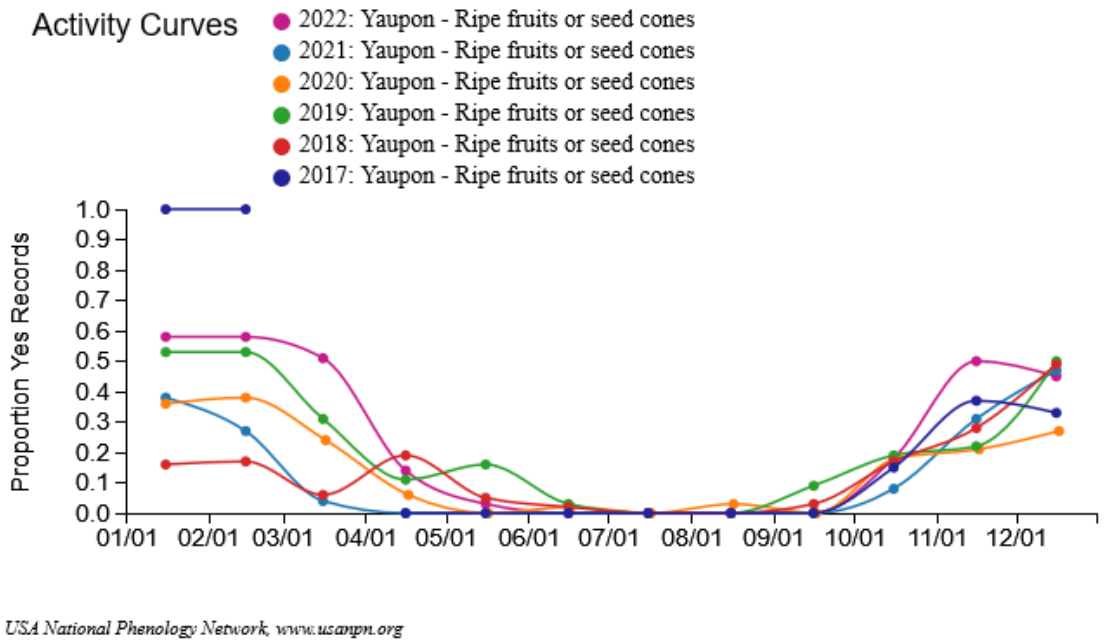


Figure 22. Activity curve showing the proportion of yaupon holly "yes" records for ripe fruit in 2017 -2022.

American Beautyberry (*Callacarpa americana*)

Figure 23. Left to right: American beautyberry blooms, Unripe berries, Ripe berries Photo credit: G. Bishop

American beautyberry was added to this year's report to summarize the observations recorded on this species on the Trail since 2018. This deciduous plant is known for its striking, fuchsia-colored berries that ripen in the fall. Crushing the leaves and rubbing them on the skin is a folk remedy to deter insects. The USDA is studying one of this plant's chemicals, callicarpenol extract, at the University of Mississippi in Oxford to learn of beauty berry's potential as a repellent.

We observed that leaves began emerging in mid-February in all years and also broke new leaves after manipulation by fire or pruning (Fig. 24). Flowers emerged in mid-April in 2018,

mid-May in 2020 and 2022, and mid-June in 2018 (a second peak), 2019, and 2021 (Fig. 25). Berries were ripe in mid-August in 2020, mid-September in 2018, 2019, 2021, and 2022, and mid-October in 2017 (Fig. 26.)

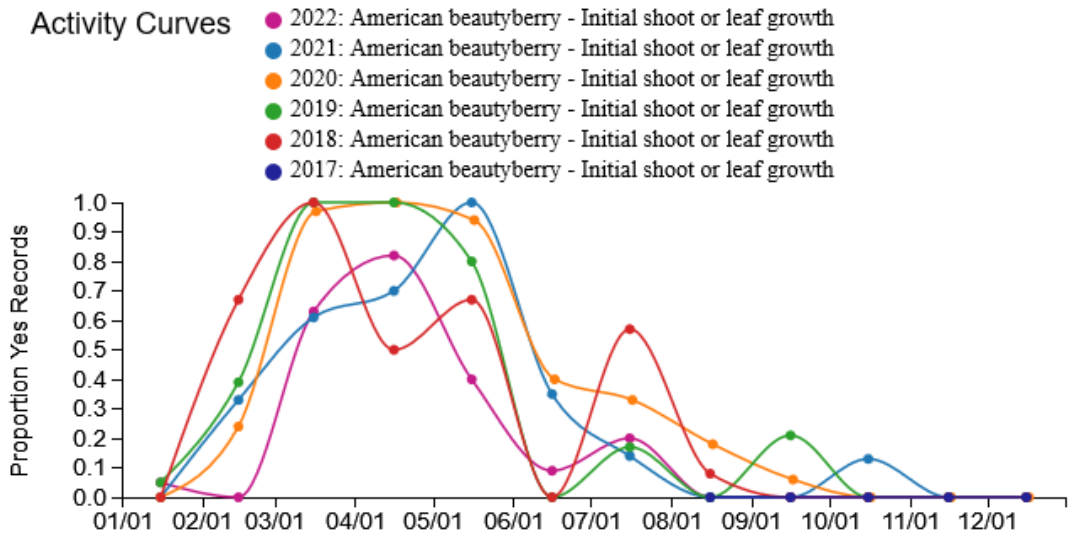


Figure 24. Activity curve showing the proportion of American beautyberry "yes" records for initial shoot or leaf growth in 2017-2022.

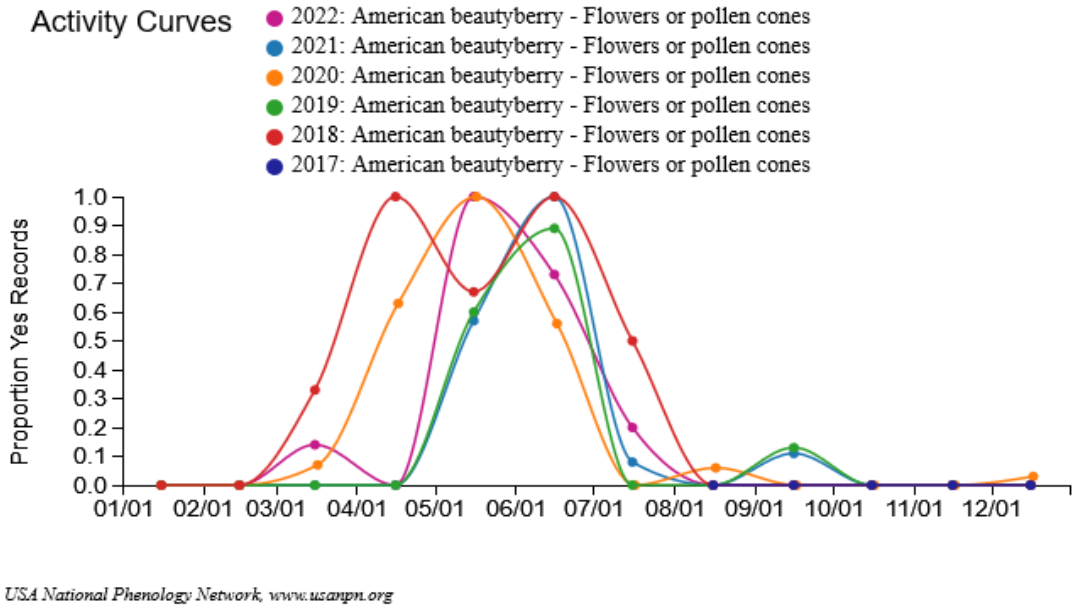


Figure 25. Activity curve showing the proportion of American beautyberry "yes" records for flowers in 2017-2022.

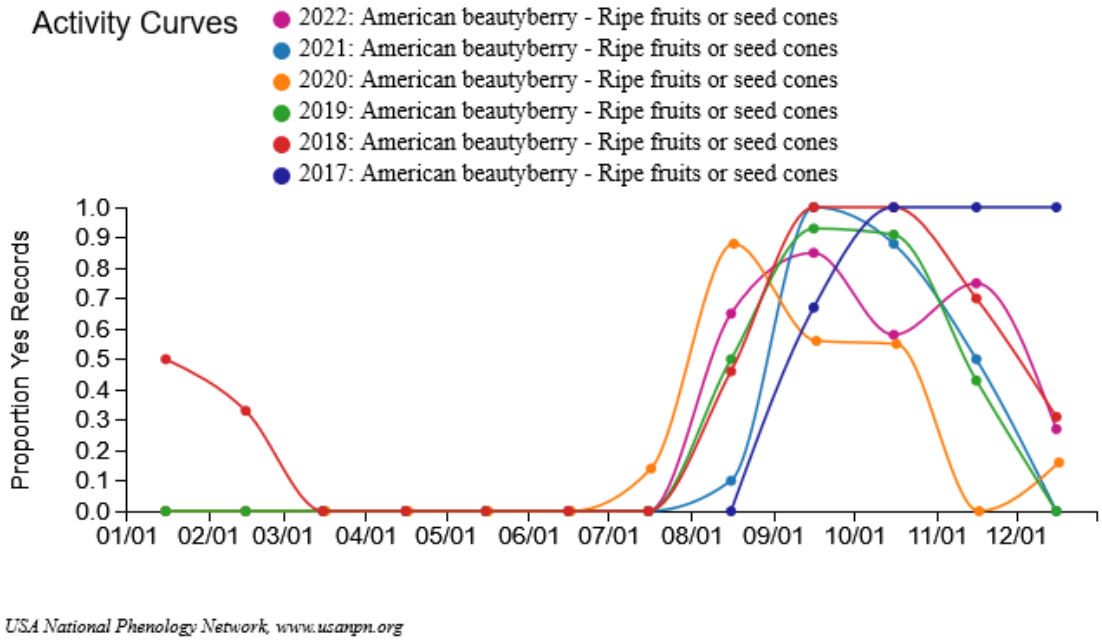


Figure 26. Activity curve showing the proportion of American beautyberry "yes" records for ripe fruits in 2017-2022.

1-2. Does phenology of Gulf Coast plants differ between native and non-native plants?

Figure 27. From left to right, red maple leaves, Chinese tallow leaves. Photo credit: G. Bishop

Our second question addresses the difference in phenology between native and non-native plants. Some invasive species can out compete native plants by leafing out earlier in the spring than native plants and holding onto their leaves longer; this phenomenon is known as extended leaf phenology. We selected two deciduous focal species, native red maple trees and nonnative Chinese tallow trees to answer this question: Is there a difference in some phenological cycles between native and non-native plants? Although the observations for these two species did not show extended leaf phenology for Chinese tallow, the data show

that this species flowered later than red maple, and the presence of seeds was observed up to six months out of twelve months.

Initial Growth

In all five years, red maple trees showed consistent initial leaf growth in mid-March while invasive Chinese tallow trees initial leaf growth occurred in mid-February in 2017, mid-March in 2018 and 2019, and mid-April to mid-May 2021 and 2022 (Fig. 28).

In all years, both plants also showed initial leaf growth later in the year after the first initial flush of leaves. Several of the red maples and Chinese tallow were cut and emerged from their root stocks and several plants were impacted by prescribed fires and later re-sprouted. Leaves on red maple trees were reported earlier than leaves on Chinese tallow trees in January for all years except in 2017 when Chinese tallow leaves were reported earlier than red maple leaves.

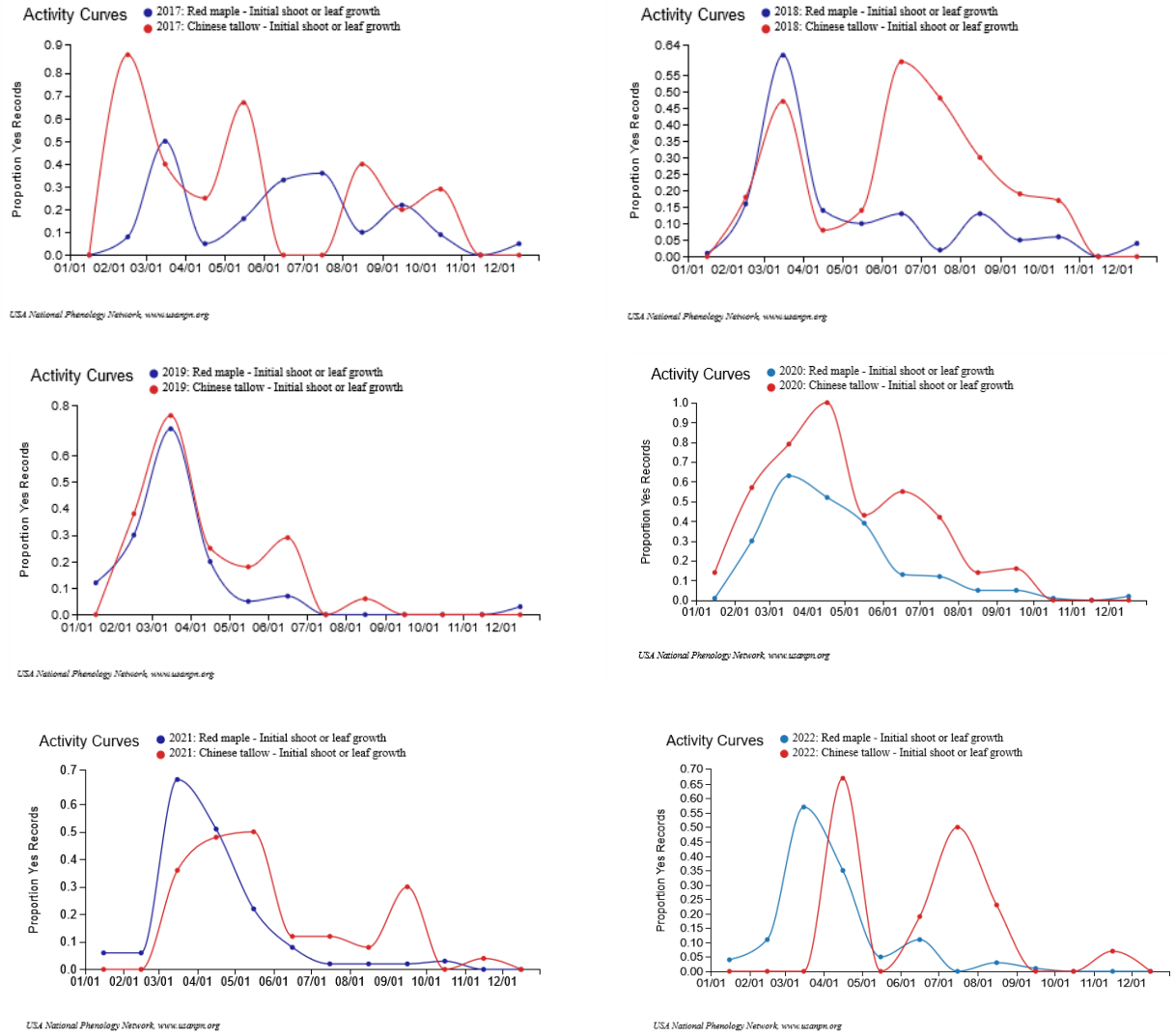


Figure 28. Activity curves showing the proportion of Chinese tallow "yes" records (red) for initial shoot or leaf growth compared to red maple (blue) in 2017-22.

Flowers

The timing of flowering was different between Chinese tallow and red maple, with the peak in red maple trees flowering occurring two to three months earlier than in Chinese tallow. Red maple flowers peaked in early January (2017, 2019, 2020) or mid-February (2018, 2021 and 2022) while Chinese tallow flowers peaked in mid-May for 2017-2020, 2022, but in 2021 first peak was in mid-March (Fig. 29).

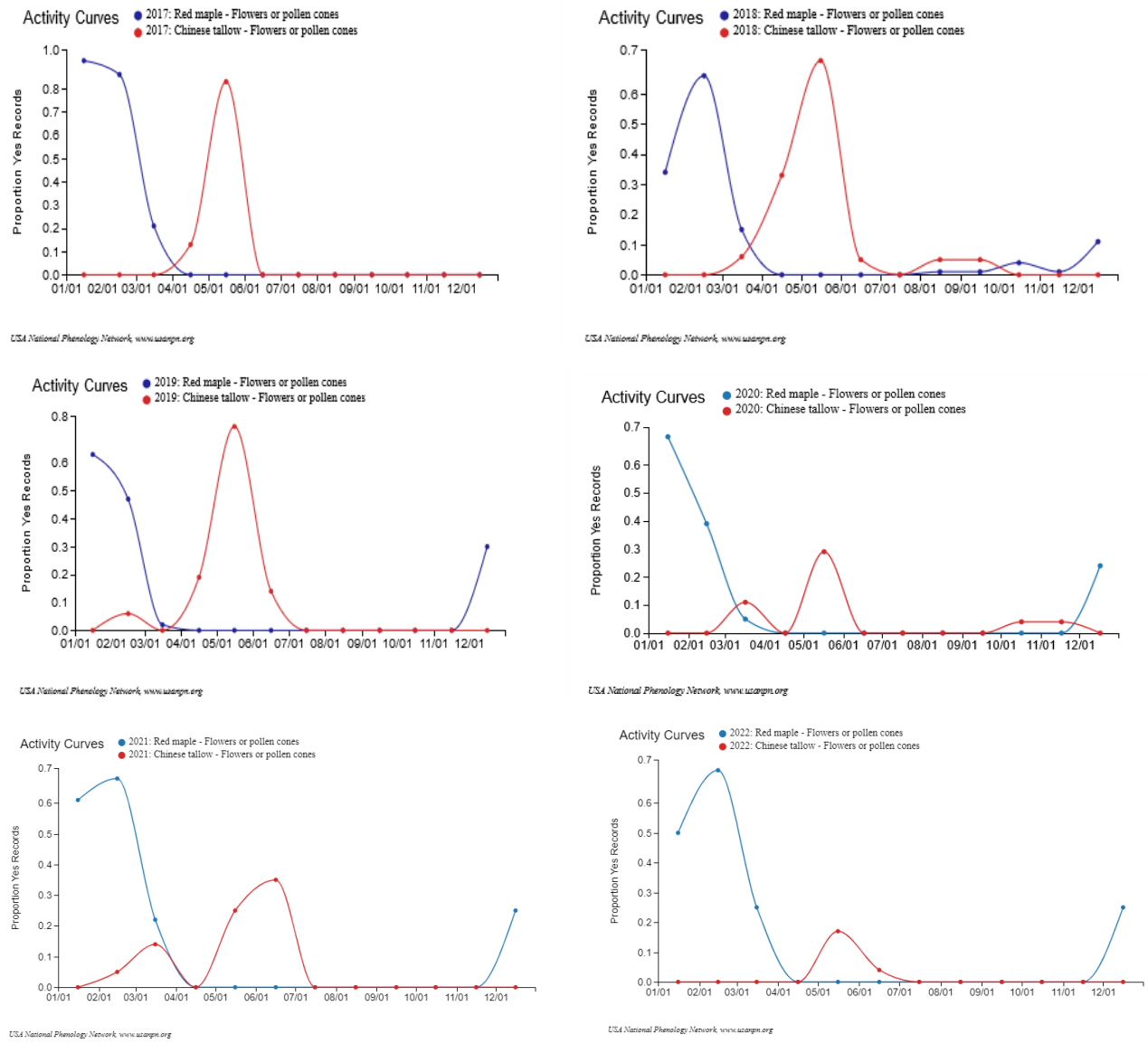


Figure 29. Activity curve showing the proportion of "yes" records for flowers or flower buds for Chinese tallow (red) and red maple (blue) in 2017-22.

Seeds

The red maple seeds were observed primarily from late or mid-February through mid-March throughout 2017-2022 and Chinese tallow seeds primarily from mid-June to end of December in 2017-2022. Although the presence of Chinese tallow seeds and red maple seeds appear at different time (Fig. 30).

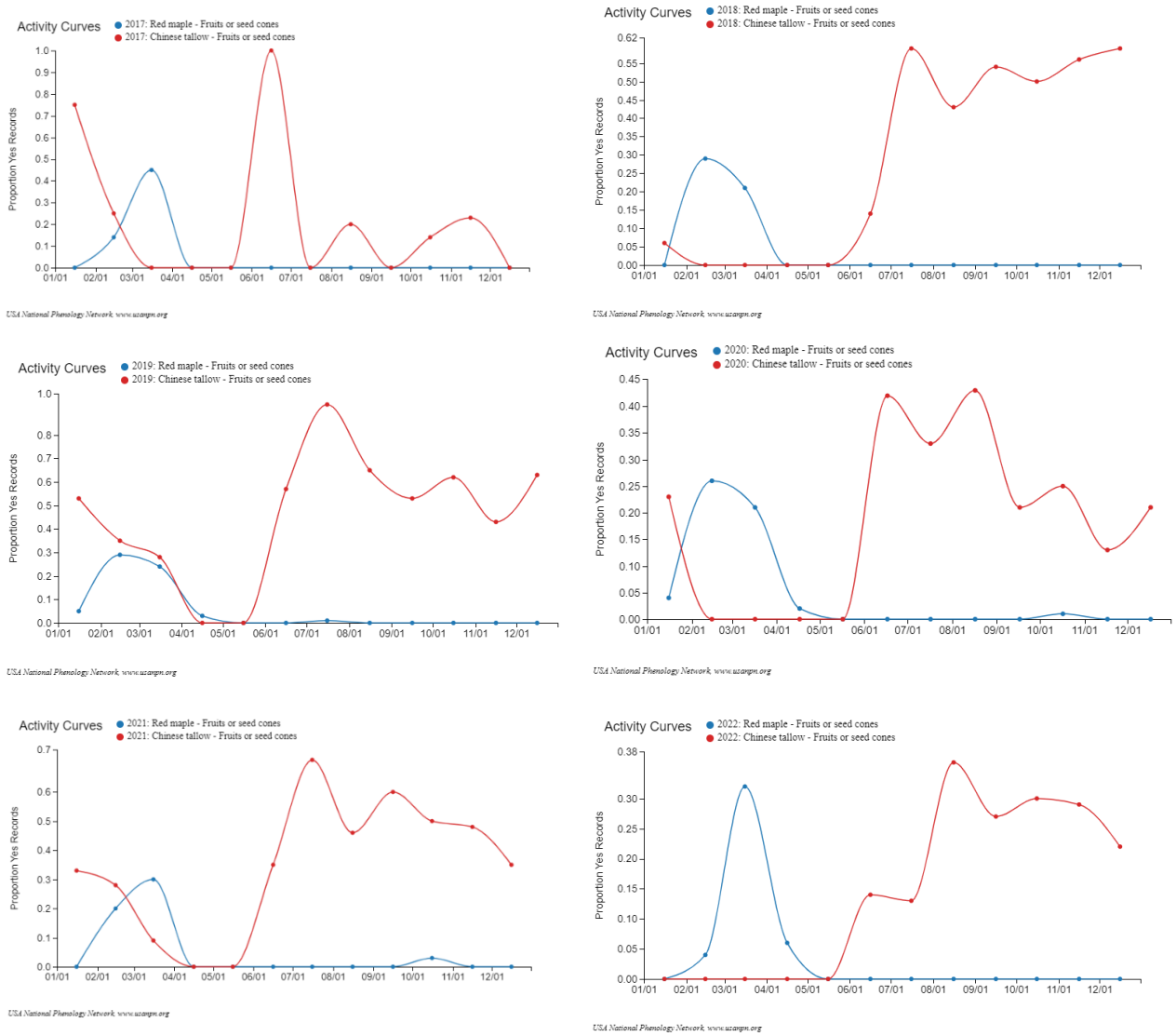


Fig. 30. Activity curve showing the proportion of "yes" records for seeds for Chinese tallow (red) and red maple (blue) in 2017-22.

Leaves

The presence of leaves on either Chinese tallow trees or red maple trees was observed from 2017-2022. Generally, the leaves appear and remain on both species about the same period from mid-March to mid-April through December (Fig. 31).

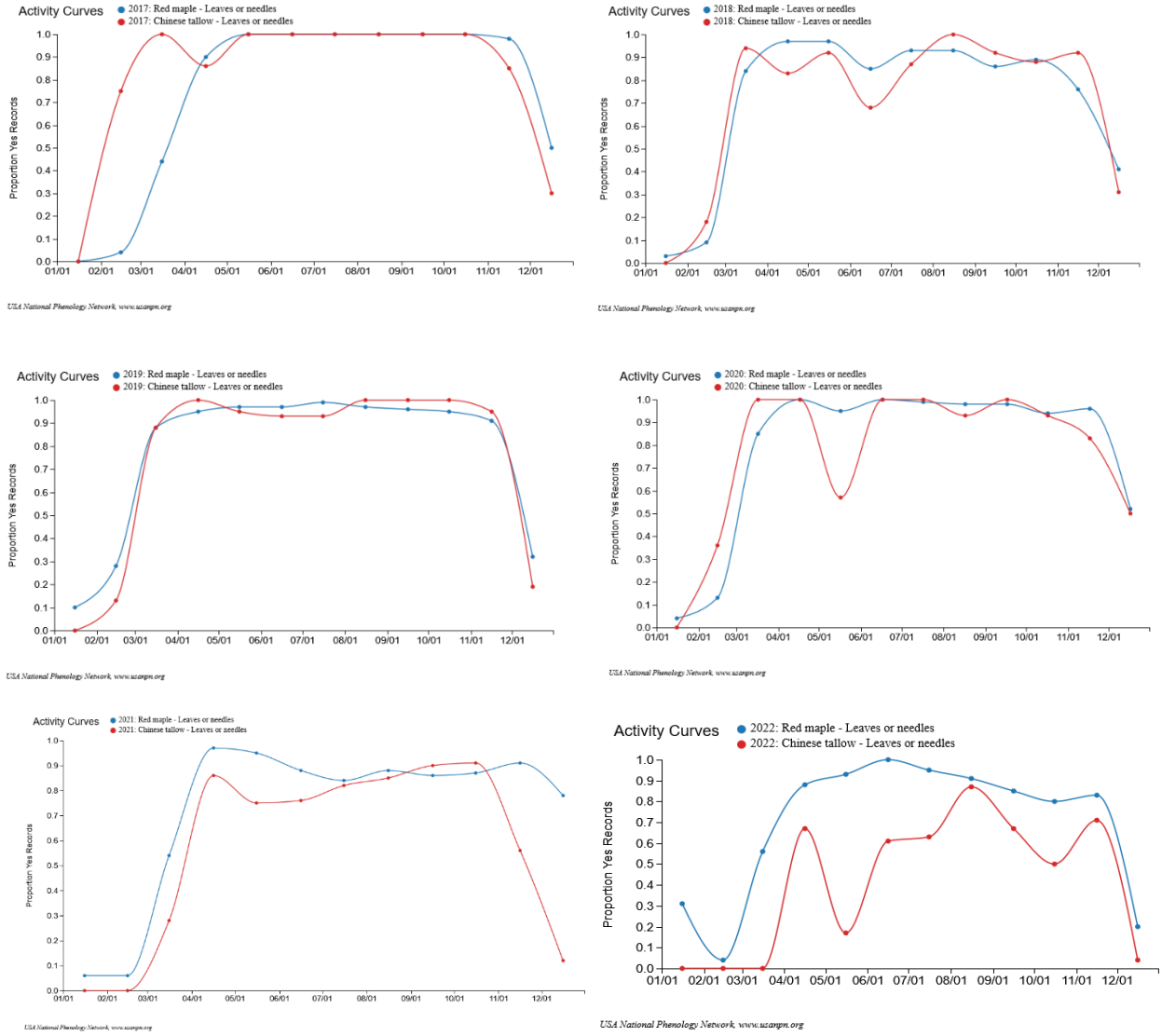


Figure 31. Activity curve showing the proportion of "yes" records for leaves for Chinese tallow (red) and red maple (blue) in 2022.

1-3. Does the phenology of native plant pollinators match native plant phenology over time under a changing climate?

Figure 32. Monarch butterflies on eastern baccharis, Grand Bay NWR/NERR on November 3, 2019. Photo credit: Chris Feurt (left). Eastern Baccharis in bloom. Photo credit: G. Bishop (right)

We looked at data on monarch butterflies and eastern baccharis, (Fig. 32) to answer the question: *does the phenology of native plant pollinators match native plant phenology over time under a changing climate?* In 2018-2022 we recorded the fall flowering of eastern baccharis (*Baccharis hamlimifolia*) and the activity of monarch butterflies (*Danaus plexippus*) at Bayou Sauvage National Wildlife Refuge, Mississippi Sandhill Crane National Wildlife Refuge, and the Barataria National Preserve. Additional sites, including Big Branch NWR, Grand Bay NEER, Crosby Arboretum were added in 2020. The fall peak in flowering of eastern baccharis overlaps with the fall activity of monarch butterflies (Fig. 33), though we did not record flowers in the monarchs' summer period of activity. No sightings of monarchs were recorded in 2020. However, it was reported in 2021 that monarch visitation occurred in mid-March when eastern baccharis flowers were blooming early and again in mid-November. In 2022 there was a match with monarch visitation on eastern baccharis flowers in March but a mismatch on baccharis flowers in the fall.

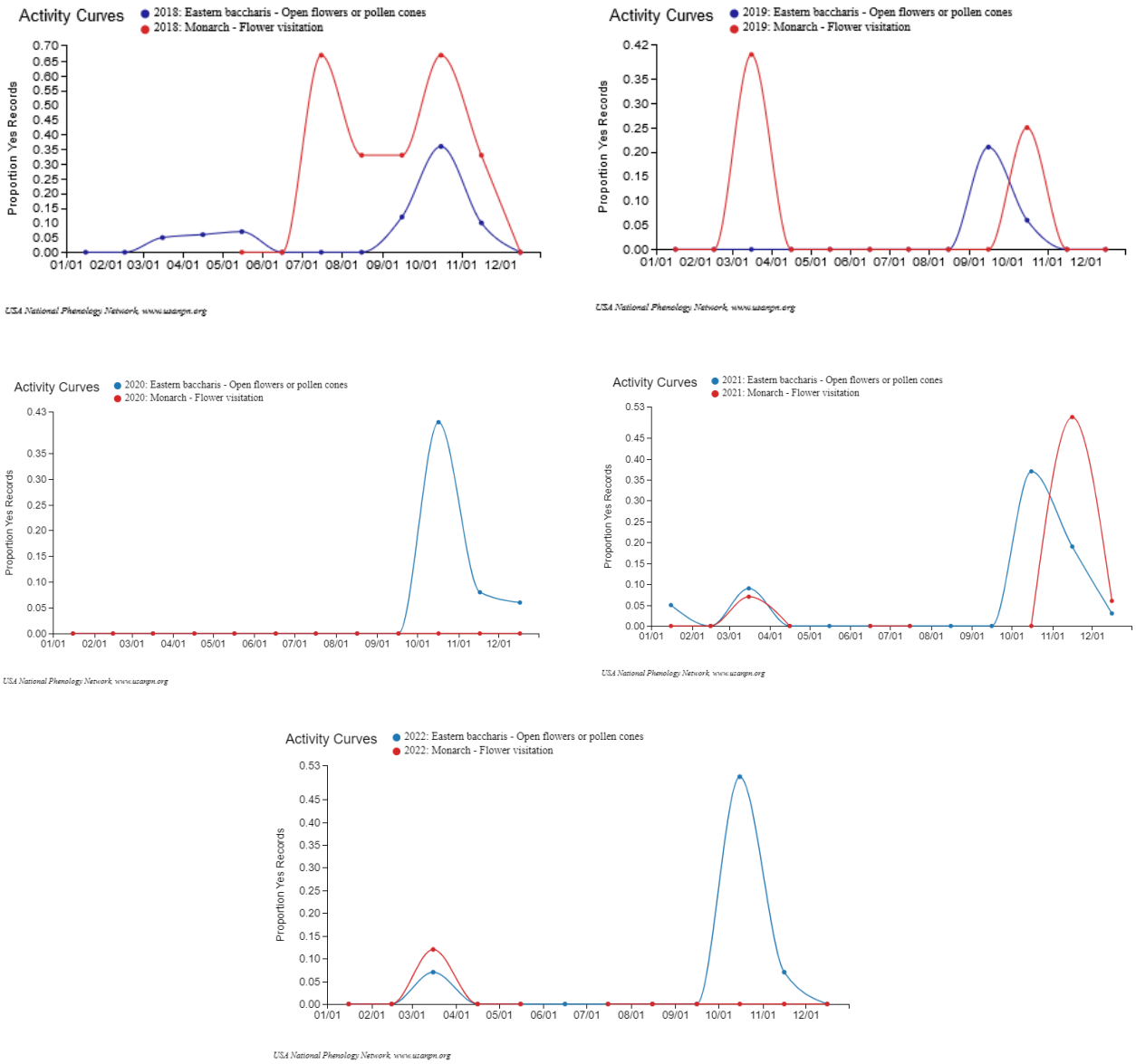


Figure 33. Activity curve showing the proportion of "yes" records for monarch butterflies (red) and open eastern baccharis open flowers (blue) in 2018-22.

1-4. Is there an East-West gradient in the timing of certain focal species from Louisiana to Alabama?

Western locations on the Trail typically have warmer winter temperatures than those at eastern locations, as reflected in the weather summary from the New Orleans National Weather Station compared with the Gulfport, Mississippi or Mobile, Alabama Weather Station. In 2022 it was reported that the average temperature at the Louis Armstrong International Airport in Louisiana was 70.7; at the Gulfport-Biloxi International Airport at 68.64; and at the Mobile Downtown Airport at 61.7 temperature. At Louisiana sites, red maple flowering peaked

in early January in 2017, 2019, 2020, 2021, and 2022, and in mid-February in 2018 (Fig. 34). At Mississippi sites, red maple flowering peaked in mid-February in 2017, 2018, 2019, 2021, and 2022 and peaked in early January in 2020 (Fig. 34).

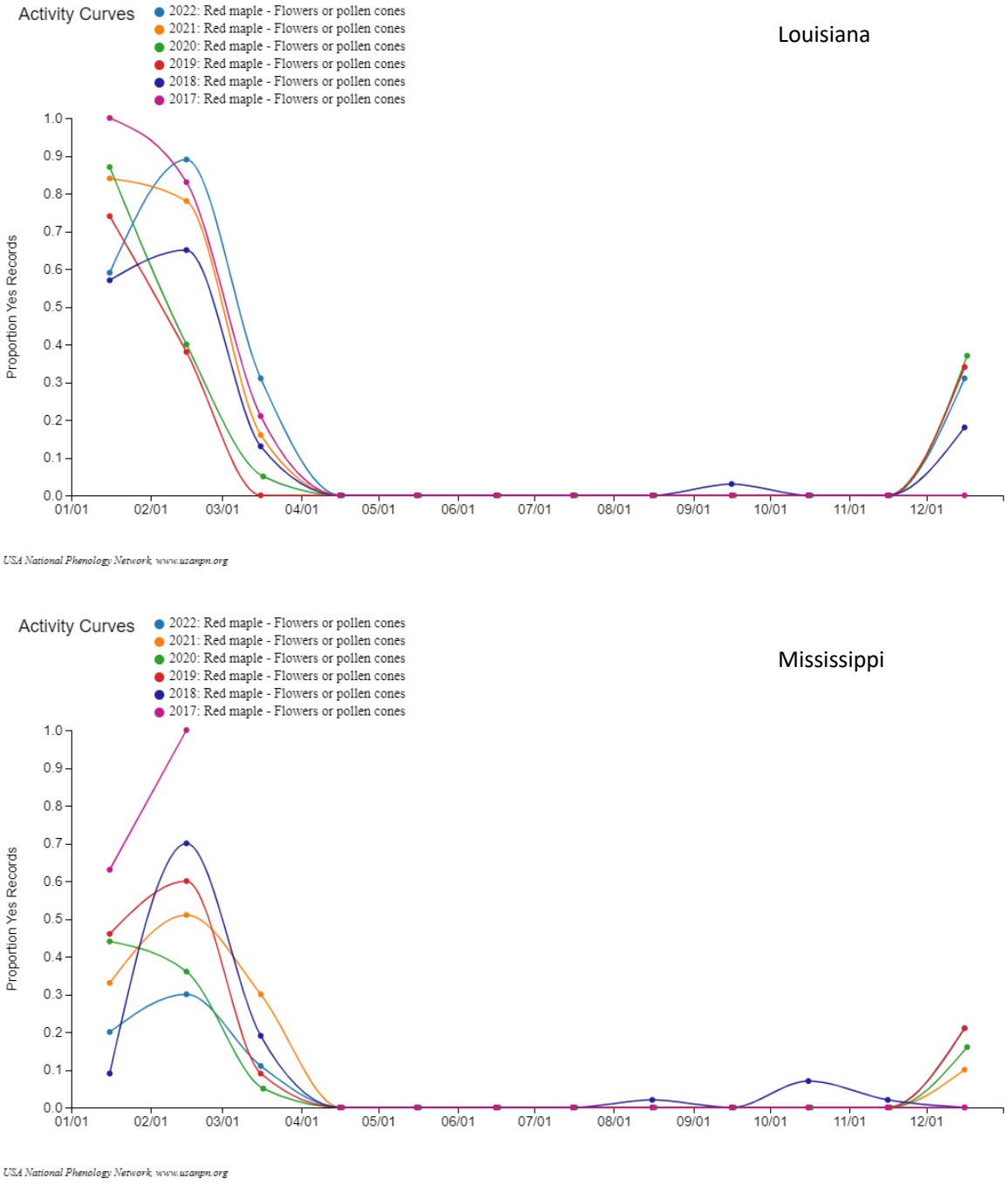


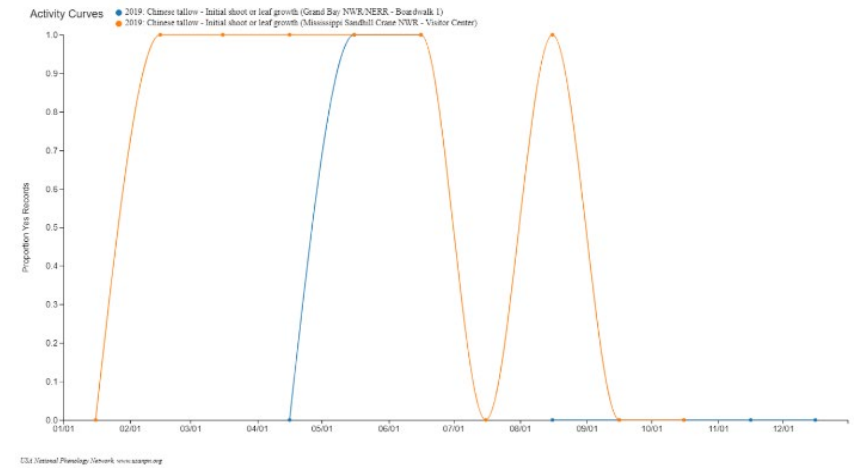
Figure 34. West-East comparison of the proportion of "yes" records reported for red maple flowers or flower buds in 2017-2022 for Louisiana sites (top) and Mississippi sites (bottom).

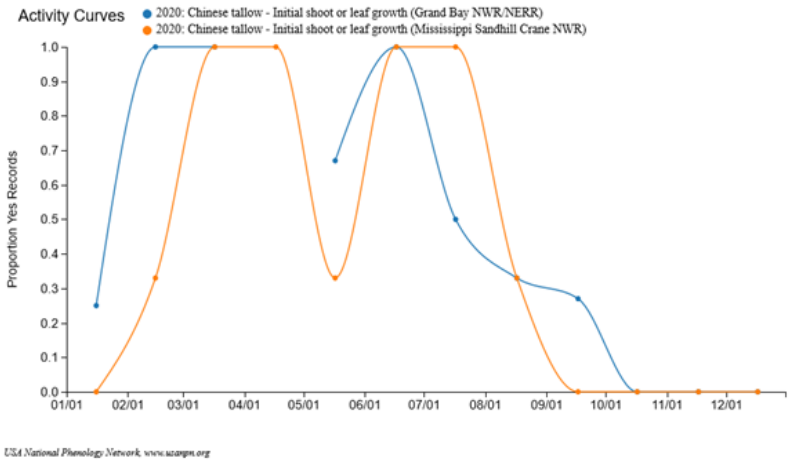
Secondary Questions

Figure 35. Mississippi Sandhill cranes and colts at Mississippi Sandhill Crane National Wildlife Refuge. Photo credit: L. McLauren

2-1. What is the variation in phenology in similar habitats across the Trail?

We are interested in the amount of variation in life cycle events including breaking leaf buds and open flowers across individual plants and sites on the Trail. A comparison of two Trail sites with savannah habitat – Grant Bay NWR/NERR and Mississippi Sandhill Crane NWR shows that the peak in initial growth in Chinese tallow varied by several months at the two different sites in 2019 and was slightly more similar between the two sites in 2020 (Fig. 36). In 2021, the peak was similar in the spring, but Grand Bay NERR did not have a secondary peak in the fall. (Fig. 36). In 2022, there were no records of Chinese tallow tree-2 at the Mississippi Sandhill Crane Refuge because it was removed by the resource managers. Information on red maples to compare at both sites was not collected in 2022 until the fall. We hope to have additional data from these sites for comparison in 2023.





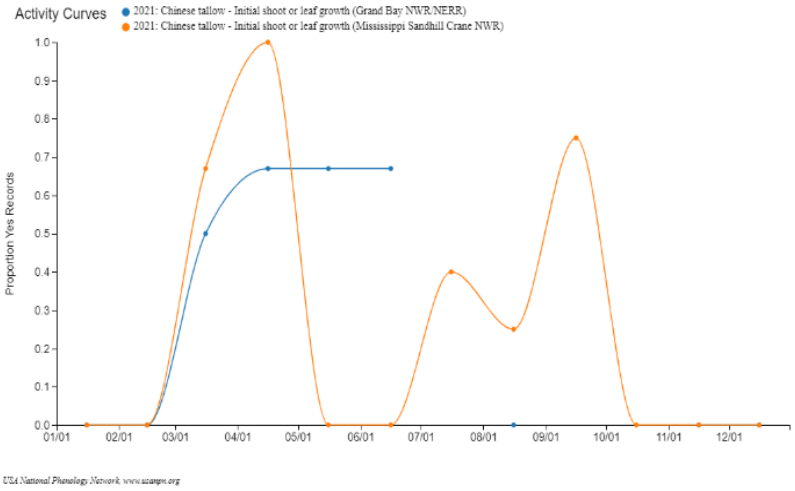


Figure 36. Activity curve showing the proportion of "yes" records for initial growth in Chinese tallow at Grand Bay NWR/NERR (blue) and Mississippi Sandhill Crane NWR (orange) in 2019-21.

For red maple, the peak in initial growth was very different between the Grand Bay NERR/NWR and Mississippi Sandhill Crane NWR sites in 2019, and more similar in 2020 and 2021 (Fig. 37).

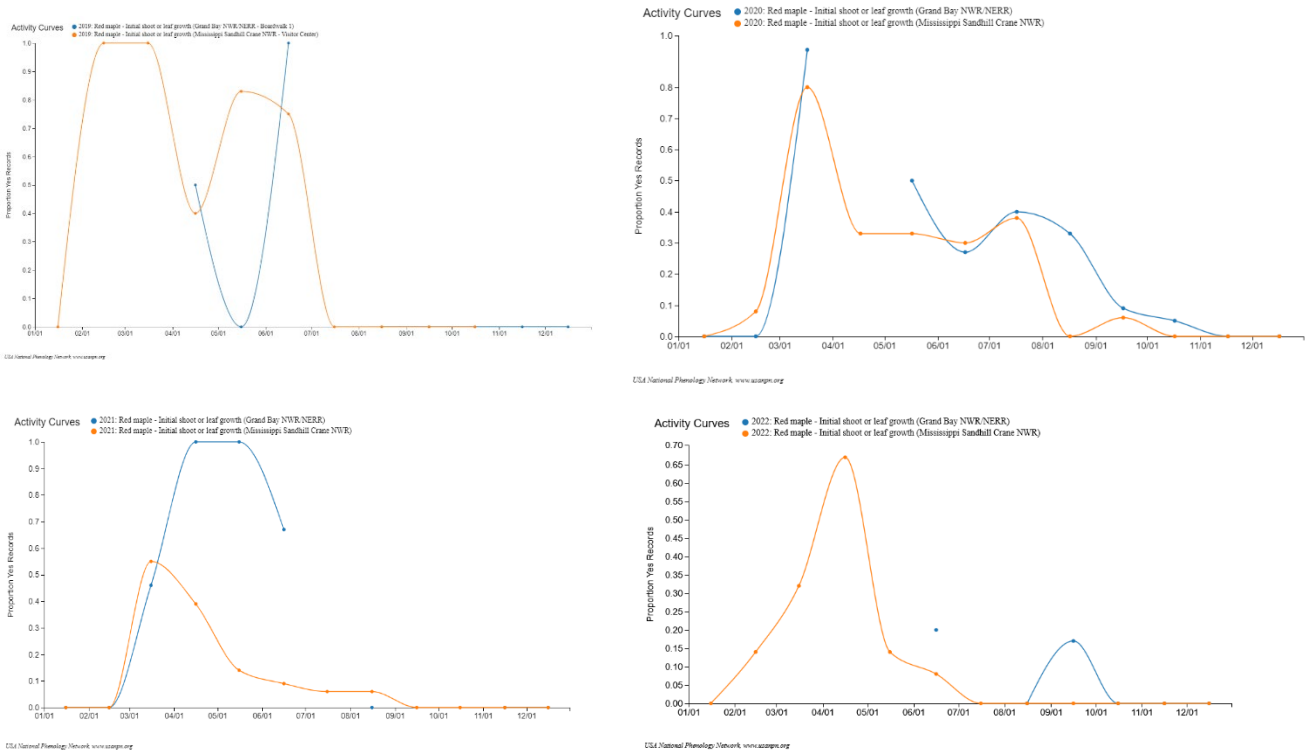
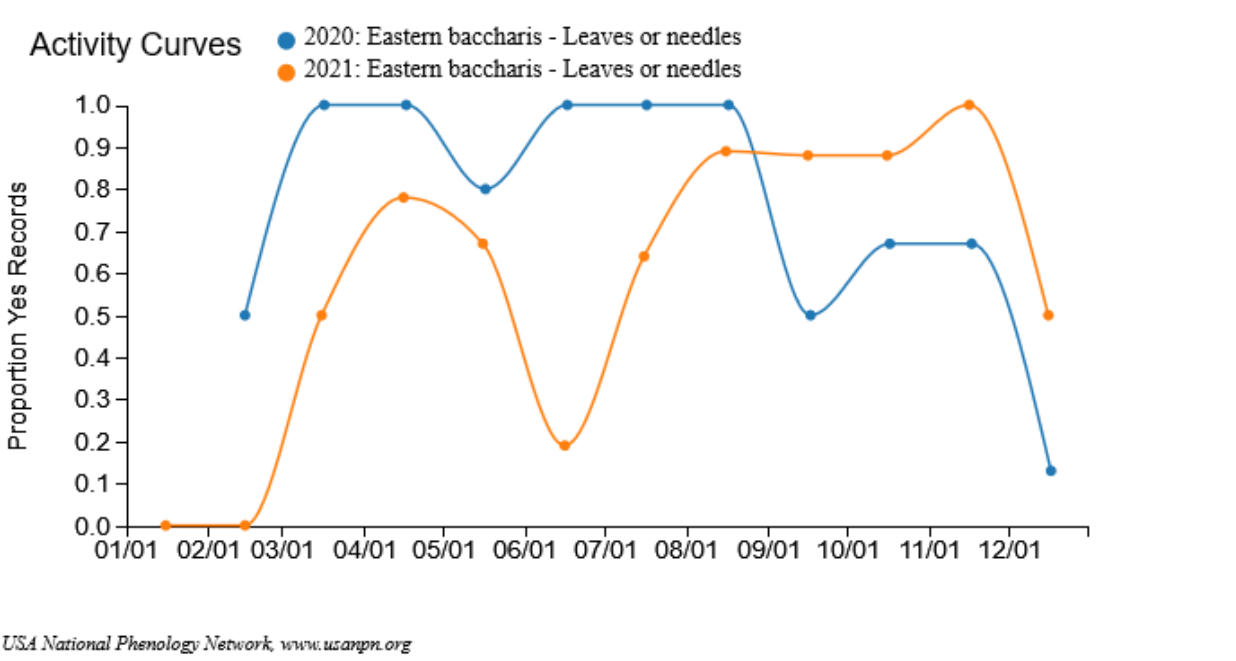


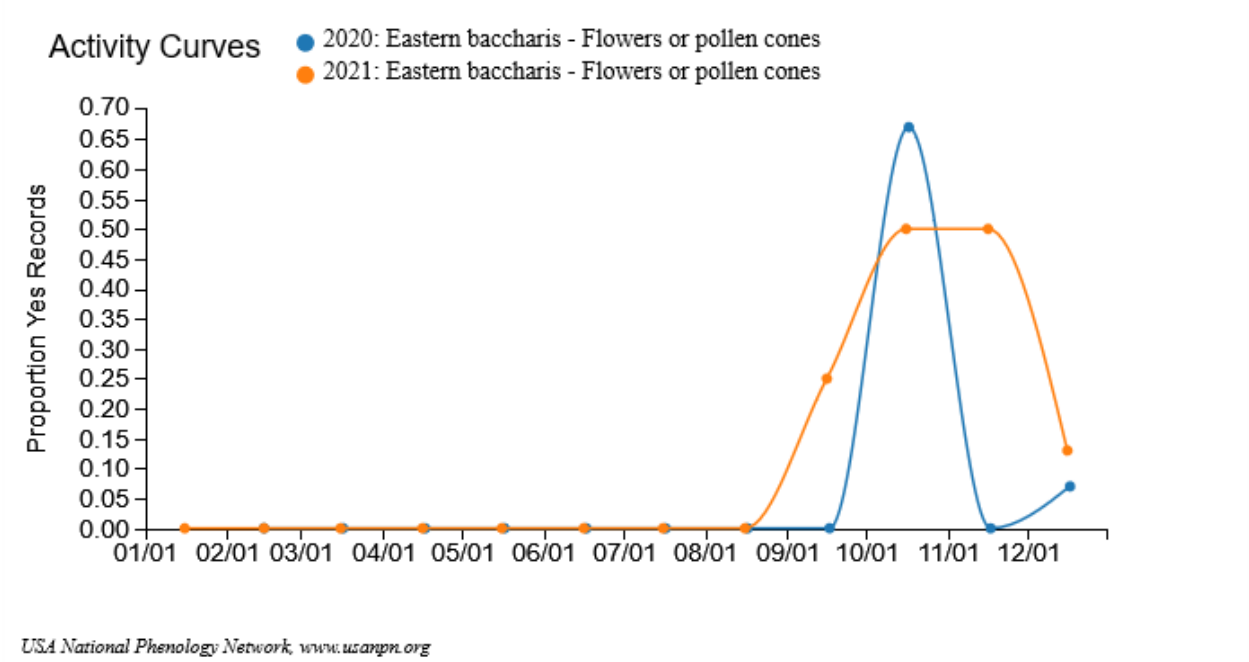
Figure 37. Activity curve showing the proportion of "yes" records for initial growth in red maple at Grand Bay NWR/NERR and Mississippi Sandhill Crane NWR in 2019-22.

2-2. Does phenology of focal species differ between areas that have been disturbed by fire, storm, etc.?

Three of the sites, Grand Bay NWR/NERR, Mississippi Sandhill Crane NWR, and The Crosby Arboretum, manage savannah habitats which include prescribed fires and mechanical clearing. There were two prescribed fires in March and May in 2020 at Grand Bay in 2020; one prescribed fire at the Mississippi Sandhill Crane NWR's Visitor Center Trail, and no prescribed fires at The Crosby Arboretum. There were no prescribed fires at the savannah locations on the Trail in 2022. For this report, eastern bacharris (See figure 38) was chosen to represent plants that were impacted by prescribed fires. In 2020, eastern baccharris 1 and 2 were burned at the Mississippi Sand Hill Crane Refuge. Both plants grew from the roots or produced additional branches and were viable months later (See figure 39.)

Figure 38. Example of Eastern baccharis #2 after a 2023 fire at the Mississippi Sandhill Crane National Wildlife Refuge. Photo credit: G Bishop





Figures 39. Activity curves showing proportion of "yes" for eastern baccharis leaves and flowers or flower buds in 2020 and 2021 at the Mississippi Sandhill Crane National Wildlife Refuge.

3-1. How is the arrival and departure of migrating animals, such as purple martin, shifting in response to a changing climate?

According to Audubon (www.audubon.org), Purple Martins are a long-distance migrant that winter in the Amazon River basin in South America before returning in February to the Southeast United States

(Fig. 40). Along the Gulf Coast, Purple Martins depend on human supplied housing, including gourds, to build their nests (Fig. 40).

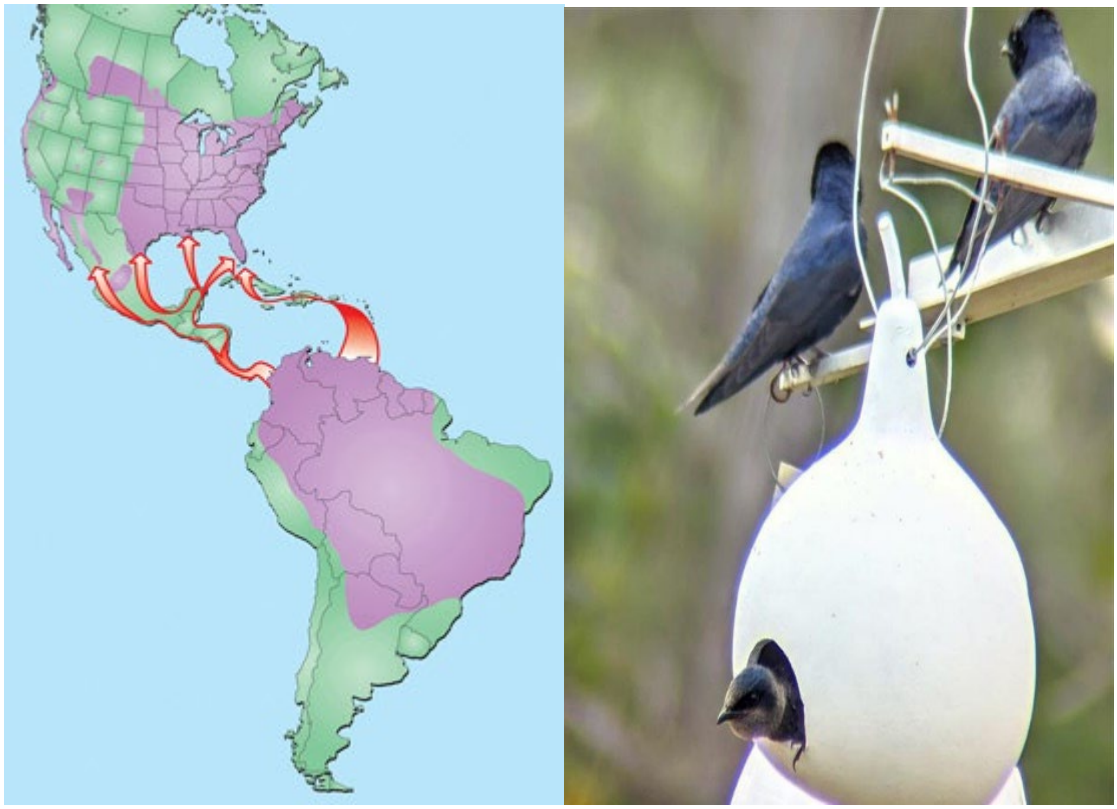


Figure 40. Map of Migration of Purple Martins from wintering grounds, from Purple Martin Conservation Association (left) and Purple Martins at Grand Bay NERR in Summer 2021. Photo credit: Jeff Goff (right).

Climate change could be one of many factors causing their numbers to decline in North America. Over the past five decades, scientists estimate a 1% annual decline in Purple Martin abundance, which may be due in part to high levels of mercury found in their bodies (Smithsonian Magazine, 2023). According to the article, “The birds likely pick up the mercury in their winter home in the Amazon Basin. After they fly up to North America, the heavy metal in their bodies likely makes them unable to store fat, leaving them without enough energy to migrate south every year. Even a small increase in the amount of the heavy metal in the birds, which are part of the swallow family, likely leads to poor health and a decreased chance of survival.”

However, Purple Martins show promise in being able to adapt to climate change (University of Manitoba Times, 2019). This information was based on 20-years-worth of records of 28,165 nests collected from citizen scientists. The lead author, Amanda Shave, stated “surprisingly, we found that martins could adjust the timing of their nesting—later in cool winters and earlier in warm spring—which is good news in that they have some flexibility to changing conditions.”

We do not yet have enough data to answer the question of how arrival and departure dates are shifting in response to a changing climate. However, according to the data we do have, Purple

Martins were recorded in mid-February in 2017, 2018, 2019, 2021, and 2022 (Fig. 41). Of the past five years, the longest duration of Purple Martin activity was recorded in 2018 (Fig. 41). Purple Martins are currently tracked at the Grand Bay NWR/NERR and observations will start again in 2023 at the Pascagoula River Audubon Center.

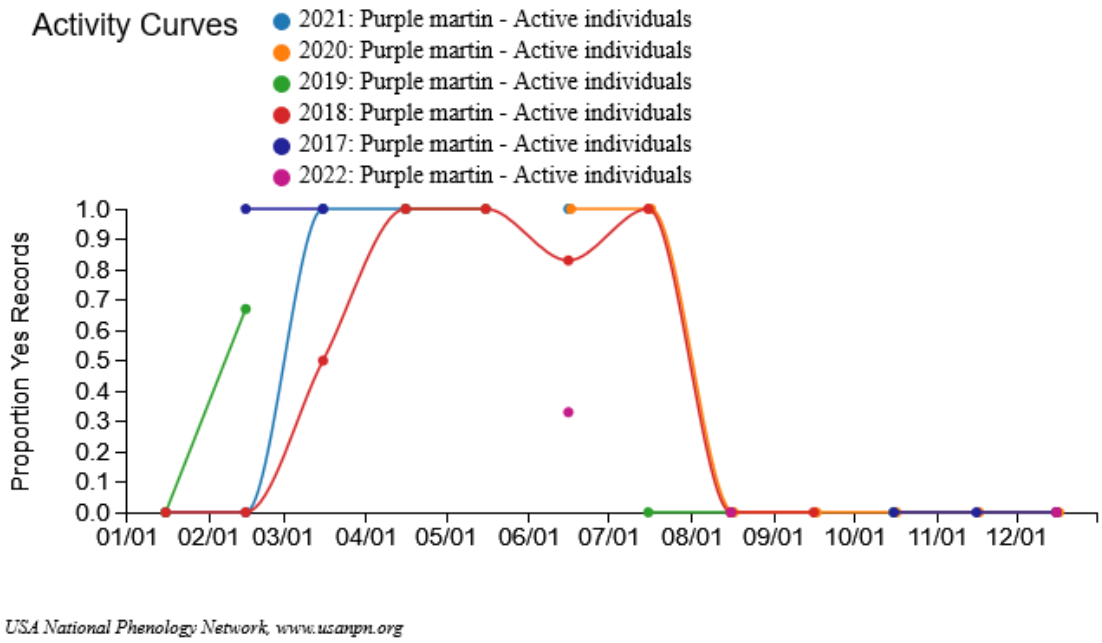


Figure 41. Activity curve for Purple Martin Active Individuals from 2017-2022.

Weather Data Summary

"Weather refers to short term atmospheric conditions while climate is the weather of a specific region averaged over a long period time. Climate change refers to long-term changes." (USGS.gov)

Figure 42. 2022 Continental United States Weather Highlights from **Mobile 2023 Weather and Marine Almanac** Courtesy University of South Alabama.

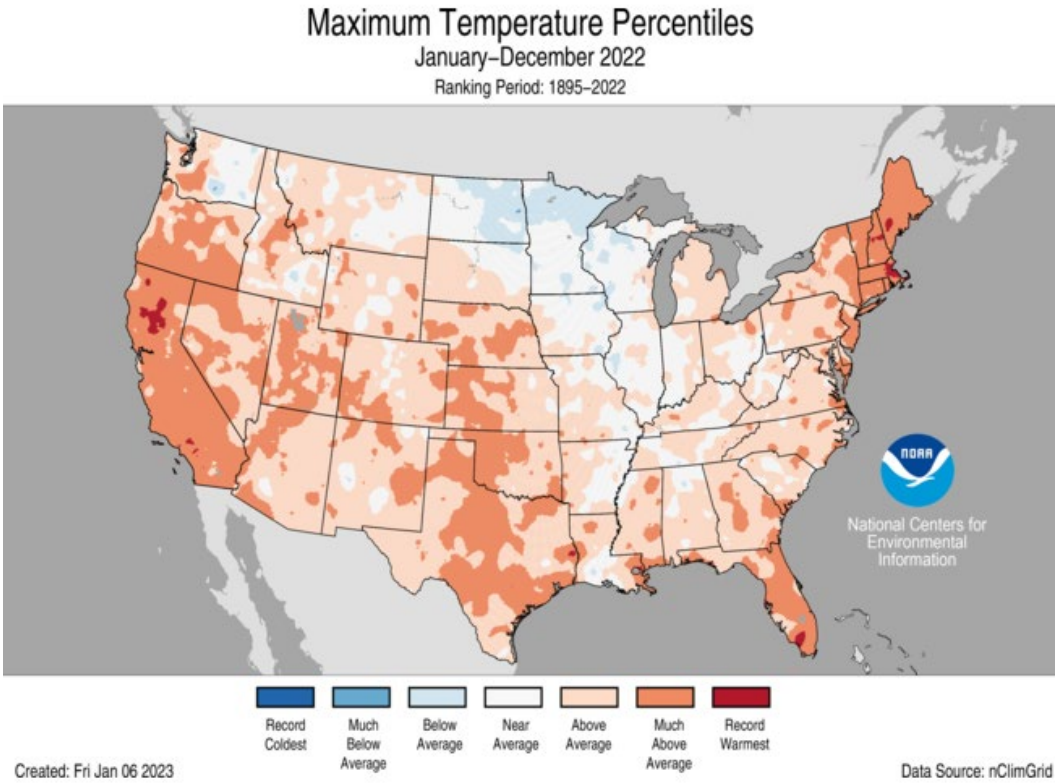


Figure 43. Map of Maximum Temperature Percentiles

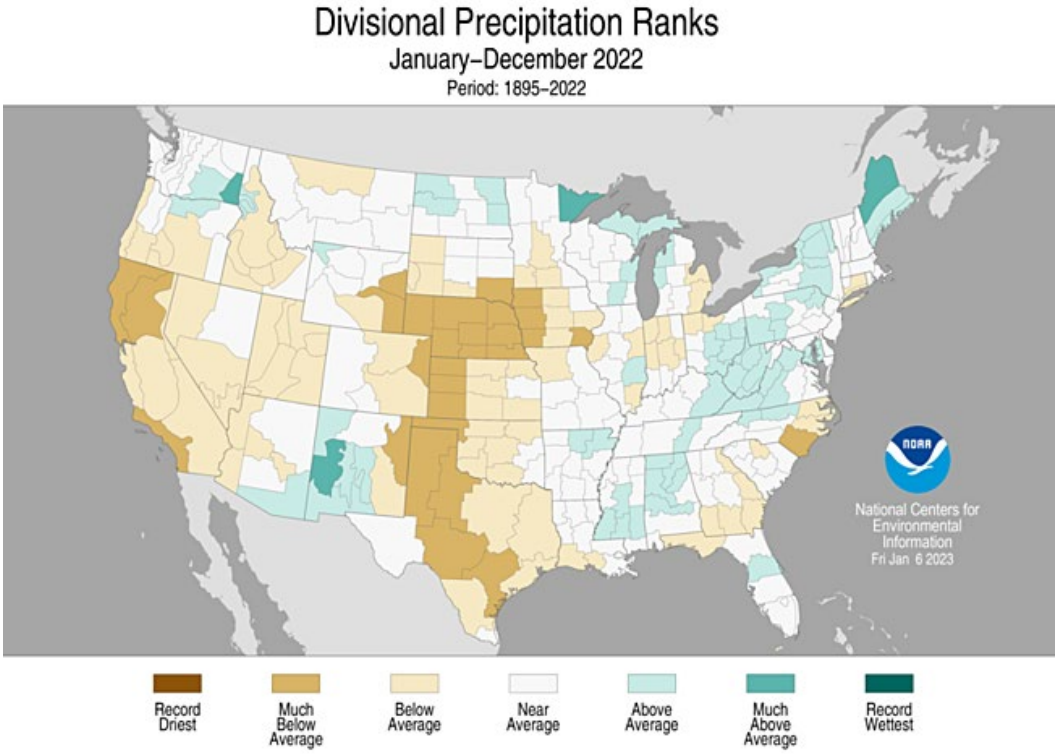


Figure 44. Map of Divisional Precipitation Ranks

Regional Weather and Climate Norms

In 2022 the most sites recording rainfall were near average in the observation areas in southeastern Louisiana and coastal Mississippi. Community Collaborative Rain, Hail, & Snow Network, (CoCoRaHS) quotes the old adage, "Rain doesn't fall the same on all" on its website. However, the National Centers for Environmental Information website shows overall for the Trail areas near average rainfall while maximum temperature percentiles much above average. New monthly climate normals were published for the period 1991-2020 so we include both this new period as well as the prior normal of 1981-2010. NOAA described the average meteorological parameters:

"The Monthly Climate Normals for 1991 to 2020 are 30-year averages of meteorological parameters that provide users the information needed to understand typical climate conditions for thousands of locations across the United States, as well as U.S. Territories and Commonwealths, and the Compact of Free Association nations. The stations used include those from the NWS Cooperative Observer Program (COOP) Network as well as some additional stations that have a Weather Bureau Army-Navy (WBAN) station identification number, including stations from the U.S. Climate Reference Network (USCRN) and other automated observation stations. In addition, precipitation normal for stations from the U.S. Snow Telemetry (SNOTEL) Network and the citizen-science Community Collaborative Rain, Hail and Snow (CoCoRaHS) Network are also available. The Monthly Climate Normals dataset includes various derived products such as air temperature normal (including maximum and minimum temperature normal, heating and cooling degree day normal, and others), precipitation normal (including precipitation and snowfall totals, and percentiles, frequencies and other statistics of precipitation, snowfall, and snow depth), and agricultural normal (growing degree days (GDDs)). All data utilized in the computation of the 1991-2020 Monthly datasets. Temperatures were homogenized, adjusted for time-of-observation, and made serially complete where possible based on information from nearby stations. Precipitation totals were also made serially complete where possible based using nearby stations. The source datasets (including intermediate datasets used in the computation of products) are also archived at NOAA NCEI."

New Orleans, Louisiana

In 2022, five months were warmer in New Orleans than the 30-year normal (1991-2021). Across months, the average temperature was 3.3 degrees higher. No tropical storms were reported in the Louisiana and Mississippi coasts. The WDSU-TV Chief Meteorologist Margaret Orr in New Orleans said in her end hurricane season report on December 21, 2022 that "this year was not our year…" In her online report Orr continued…" the dry Saharan Dust moved off the coast of African every three to five days putting a lid on rising air preventing storms causing also 1.8 degrees of cooler ocean surfaces"; we also had upper lows spinning in the Atlantic causing wind shear" (Louisiana WDSU Meterologist Margaret Orr Hurricane Season 2022 review at www.wdsu.com.) Cold air in December across Louisiana and Mississippi caused up to six days of below freezing temperatures at night; and three days of freezing temperatures during the day from December 23rd-25th.

Based on the new 30-year normal, four of the months were wetter than normal, and eight months were drier. Overall, the 2022 the rainfall for New Orleans was 10.55 inches less than the 30-year normal rainfall average (Table 3 and 4).

Table 3. Temperature summary table for New Orleans Airport Weather Station in 2022 Departure from 30-year normal is based on years 1981-2010 (NOAA 2020).

Month 2022	Mean Temperature (F)* (red indicates warmer than 30Yr Normal)	30-Year Normal Based on 1981-2010	30-Year Normal Based on 1991-2021
January	52.3	53.4	54.3
February	57.3	56.7	58.0
March	64.5	62.6	63.8
April	71.7	69.1	70.1
May	79.8	76.1	77.1
June	84.8	81.5	82.4
July	82.8	83.3	83.9
August	81.7	83.3	84.0
September	80.6	79.7	80.8
October	70.9	71.3	72.5
November	64.6	62.7	62.4
December	58.2	55.6	56.6
Annual Mean	**70.7**	**69.7**	**70.5**

*(Monthly mean temperature figures from https//nowdata.rcc-acis.org/lix/)

Table 4. Precipitation summary table for New Orleans, Lou. Airport Weather Station in 2022. Departure from 30-year normal is based on years 1981-2010 (NOAA 2020).

Month 2022	Total Precipitation (in.) (Red indicates higher than 30Yr Normal)*	30yr Monthly Normal Total Precipitation (in.) 1981-2010	30yr Monthly Normal Preciptation (in.) 1991-2021
January	2.32	5.15	5.18
February	3.95	5.30	4.13
March	3.30	4.55	4.36
April	3.71	4.61	5.22
May	8.03	4.63	5.64
June	3.21	8.01	7.62
July	8.01	5.93	6.79
August	3.71	5.98	6.91
September	2.50	4.97	5.11
October	1.18	3.54	3.70
November	5.62	4.49	3.87
December	7.97	5.24	4.82
Annual	**52.80**	**62.45**	**63.35**

*(Monthly mean temperature figures from https//nowdata.rcc-acis.org/lix/)

Gulfport, Mississippi

In 2022, six months out of twelve were warmer in Gulfport than the 30-year normal (1991-2020). The average temperature in 2022 was 1.04 degrees warmer in the period from 1981-

2010 and 0.34 degrees warmer in the new normal period from 1991-2020. (Table 5). Overall, 2022 was a drier than average year, with 8.49 inches less rain than the 1981-2010 average and 6.63 inches less rain than the 1991-2020 average. However, in August 2022, 11.47 inches of rain fell, which is almost double the normal rainfall for that month (Table 6). No tropical weather was experienced on the Mississippi Gulf Coast in 2022.

Table 5. Mean Temperature summary table for Biloxi/ Gulfport, Miss. Weather Station in 2022. Departure from 30-year normal is based on years 1981-2010 and 1991—2020 (NOAA 2020)

Months 2022	Mean Temperature (F)* (red indicates warmer than 30Yr Normal)	30yr Normal Temperature (F) 1981-2010	30yr Mean Temperature F 1991-2020
January	49.25	50.8	51.8
February	54.64	53.8	55.5
March	61.55	50.1	61.1
April	69.31	57.4	67.5
May	78.23	74.3	75.0
June	83.32	80.3	80.9
July	82.74	82.4	82.7
August	81.22	82.4	82.6
September	78.07	78.2	79.2
October	67.53	69.2	70.0
November	61.81	60.3	59.6
December	56.05	53.1	54.0
Annual Mean	**68.64**	**67.6**	**68.3**

*www.underground.com/history/monthly/US/MS/Gulfpot/KGOT/todate

Table 6. Precipitation summary table for Biloxi/Gulfport Airport, Miss. Weather Station in 2022. Departure from 30-year normal is based on years 1981-2010 and -2020. (NOAA 2020).

Month	Total Precipitation (in.) (red indicates higher than Normal)*	30yr Mean Precipitation (in.) 1981-2010	30yr Mean Precipitation (in.) 1991-2020
January	2.04	5.19	4.87
February	3.85	5.23	4.44
March	4.71	5.99	5.22
April	2.10	4.56	5.51
May	8.11	5.11	4.74
June	4.91	6.39	6.89
July	4.86	7.21	7.21
August	11.47	6.28	6.53
September	0.49	5.63	5.18
October	2.90	3.55	3.71
November	5.34	4.64	4.03
December	5.42	4.90	4.03
Annual Total	**56.19**	**64.68**	**62.82**

*www.underground.com/history/monthly/US/MS/Gulfpot/KGOT/todate

Moss Point, Mississippi

Trent Lott International Airport in Moss Point, Mississippi was added because of its general proximity to Grand Bay NERR. The Grand Bay NERR collects weather information from their RAWS station, but the weather information is very detailed, collecting temperature data every hour which is more than is needed for this report.

Table 7. Temperature Summary Table for Trent Lott Airport, Miss. Weather Station in 2022. Average Departure from 30-year normal is based on years 1991-2021 (NOAA 2020).

Month 2022	Mean Temperature F* (red indicates warmer than 30Yr Normal)	30yr Mean Temperature 1991-2020
January	48.58	51.7
February	54.23	55.5
March	60.38	61.2
April	67.92	66.6
May	76.73	73.6
June	80.73	80.3
July	82.58	82.1
August	80.26	81.9
September	76.39	78.5
October	69.96	69.2
November	59.38	59.1
December	54.45	54.0
Annual Total	**67.63**	**67.8**

*www.wunderground.com/history/monthly/us/ms/moss-point/KPQL/date/2022-7

Table 8 Precipitation summary table for Trent Lott Airport Miss. Weather Station in 2022.

Month 2022	Total Precipitation (in.) (red indicates higher than Normal)*	30yr Mean Precipitation (in.). 1981-2020	30yr Mean Precipitation (in.) 1991-2020
January	2.53	5.19	4.97
February	2.45	5.23	4.01
March	4.30	5.99	4.73
April	3.69	4.56	4.40
May	8.49	5.11	4.95
June	7.34	6.39	6.91
July	6.31	7.21	6.65
August	16.20	6.28	7.89
September	1.34	5.63	4.84
October	1.67	3.55	3.69
November	7.72	4.64	3.79
December	4.96	4.90	4.90
Annual Total	**67.00**	**64.68**	**61.73**

*www.wunderground.com/history/monthly/us/ms/moss-point/KPQL/date/2022-7

Mobile Downtown Airport, Alabama

Overall, the average precipitation in 2022 was 0.90 degrees F warmer compared to the time period 1981-2010 but cooler by 0.60 degrees when compared to the time period 2019-2020 (Table 9). The annual Mobile Downtown Airport rainfall was 64 inches, just a few inches lower than average. According to the 2023 MOBILE Weather and Marine Alamanac by Dr. Bill Williams and Corey Bunn at the Coastal Weather Research Center at the University of South Alabama there was a cold wave of Arctic cold front in January, two short track tornadoes in downtown Mobile in May, a heatwave in June with a high temperature of 101 degrees when 102° broke the daily record and matched the all-time record for June and additional tornado outbreak in October (www.southalabama.edu/departments/cwrc/gulfmarineweather/almanac/).

Table 9. Mean Temperature summary table for Mobile, Alabama Downtown Airport Weather Station in 2021. Departure from normal is based on NOWeather Online Data, www.weather.gov/lix/newnormals

Month 2022	Mean Temperature (F)* (red indicates warmer than 30Yr 1991-2020 Normal)	Mean Average Temperature Normal (F) 1981-2010	Mean Temperature Average 1991-2020
January	47.8	51.1	52.3
February	54.1	55.0	55.9
March	61.2	60.9	61.8
April	67.7	66.9	68.3
May	77.8	74.4	75.7
June	84.1	80.1	81.5
July	83.0	81.9	83.5
August	81.8	81.6	83.6
September	78.8	78.1	80.3
October	67.7	69.0	71.1
November	61.7	58.9	60.8
December	56.3	53.3	54.6
Annual Mean	**68.5**	**67.6**	**69.1**

*www.weather.gov/wrh/climate?who=mob

Table 10. Precipitation summary table for Mobile Downtown Airport, Ala. Weather Station in 2022. Departure from normal is based on NOWeather Online Data,www.weather.gov/wrh/Climate?wfo=mob

Month 2022	Total Precipitation (in.) (Red indicates higher than 30Yr Normal) Mobile Downtown Airport*	Total Preceipitation Normal (In.) 1981-2010 (Mobile Weather Station)	Total Precipitation Normal (In) 1991-2021 Mobile Downtown Airport
January	2.39	5.65	5.66
February	2.62	5.12	4.47
March	6.62	6.14	5.44
April	5.74	4.79	5.71
May	7.26	5,14	5.39
June	3.26	6.11	6.55
July	9.89	7.25	7.69
August	11.08	6.96	6.87

September	1.22	5.11	5.30
October	3.21	3.69	3.95
November	6.28	5.13	4.60
December	4.80	5.06	5.45
Annual Total	**64.37**	**66.15**	**67.08**

Education and Outreach

To provide more information on the Trail and USA National Phenology Network more generally, Trail Coordinator Gail Bishop made connections with Dr. Charles Allen at Allen's Acres, and Dr. Malcom F. Vidrine director at Cajun Prairie in Eunice, Louisiana; Dr. John P Doucet, Dean, College of Sciences & Technology and other professors and instructors at Nicholls State University; with Dr. Cynthia Petersen, Dean of College of Biology Louisiana State University (LSU); Dr. Laura Lagomarsino, Director of the Shirley C. Tucker Herbarium (LSU & NO); and Dr. Daijiang Li, Department of Biological Sciences LSU professor and researcher, who uses *Nature's Notebook* for his research.

Gulf Islands National Seashore established a Trail site at the Davis Bayou Area in Ocean Springs and Weeks Bay NERR was contacted to set up a Trail site in 2023.

Gail Bishop gave a talk at the Louisiana Native Plant Society to 80 members and wrote an article about the Trail and ways to volunteer for the society's online newsletter. *Nature's Notebook* training was provided at the New Orleans City Park for 80 master naturalists; at the University of Southern Mississippi's Ochsner Lifelong Learning Institute for 10 participants; at the Mississippi Sandhill Crane NWR in Gautier, Mississippi, and at the Barataria Unit of the Jean Lafitte National Preserve and Historical Park. A zoom training was held for the Mississippi Diocese of the Episcopal Church for their Creation Care Task Force. Exhibit booths about the Trail were set up at the Pascagoula Audubon Center in Moss Point, at the Southeastern Louisiana National Wildlife Complex, at the Monarch Festival in Pass Christian, the Earth Day Celebration in Ocean Springs, Mississippi and at the Pascagoula River Audubon Center. On-site training for new volunteers was conducted at the Grand Bay NERR, Gulf Islands National Seashore.

Because of staffing cutbacks and facility closures some Louisiana sites reduced their involvement including Acadiana Wetlands and Barataria Preserve. These locations are valued, and we hope their involvement will increase in the future.

Communications were ongoing with staff at the Grand Bay NERR, Pascagoula River Audubon Center, Mississippi Gulf Coast Community College, USM-Long Beach, USM Marine Education Center. Crosby Arboretum, Barataria Preserve, SELA National Refuges Complex, and New Orleans City Park.

Dr. Sue Wilder, who was involved from the beginning in setting up the Gulf Coast Phenology Trail, provided continued guidance for the sites affiliated with the National Wildlife Refuges in southeastern Louisiana, and, when needed, at the Crosby Arboretum, and University of Southern Mississippi—Long Beach Campus. Jennifer Buchanan, who was also involved in setting up the Trail, provided valuable assistance.

We appreciate the long- term volunteers/community scientists and were fortunate to add additional volunteers in 2022 who are dependable and interested in the project. Retaining volunteers is important and providing workshops and activities are valuable in providing opportunities and maintaining engagement.

In 2022, we deepened our focus on pollinators, especially butterflies such as monarch butterflies, as well as nectar or host plants they need to continue their life cycles or migration, due to the nearby phenology project Time to Restore: Connecting People, Plants, and Pollinators. This project is funded by the South Central Climate Adaptation Science Center and impacts our Trail sites in Louisiana. Our observations of nectar plants such as eastern baccharis will allow better understanding of any mismatch between plants with early activity and their pollinators. Gina Lloyd was hired as Louisiana State Coordinator for Time to Restore in late December 2022. New sites and additional species of nectar plants will be added in Louisiana in 2023.

Our goal to sustain the Trail for seven years will be met in 2024. According to several partner managers, educational opportunities for students and the public provided by the Trail continue to be of high value. With increasing interest in the Trail from the new sites Gulf Islands National Seashore's Davis Bayou and Week's Bay NEER, we hope managers will use the information that we produce and support the continued activities.

Next Steps

We continue to work toward the long-term goals for the Gulf Coast Phenology Trail:

- Promote the increased use of *Nature's Notebook* for collecting local phenology data along the Gulf Coast,
- Create a sustained network of citizen scientists for 7-10 years (launched in 2017),
- Provide insights through the knowledge gained from the collected phenology data,
- Develop local partnerships across the Gulf Coast to establish sites that address local climate change and conservation issues while strengthening the overall mission of the Gulf Coast Phenology Trail.

Although limited funding was budgeted for 2023, we will continue to strive to meet our long-term goals and make needed adjustments when necessary. Training will be offered for new volunteers at Weeks Bay NERR in Baldwin County, Alabama in the fall. We realize that annual reports are based on observations made by citizen scientists and not based on laboratory conditions. Using the *Nature's Notebook* protocol provides standards that are used to evaluate the reactions of species to changing climatic conditions.

Location of Project Components

All data is entered online via *Nature's Notebook* and is stored in the USA-NPN National Phenology Database, available for download at www.usanpn.org/results/data. Project documentation and resources for plant and animal identification are available at. Additionally,

Trail fliers for public distribution, NPN Botany Primers, Trail supplies, and displays are housed locally at the coordinator's office.

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Appendix A. Partner and Observation Sites 2022

Partner	Site_ID	Site_Name	State	Latitude	Longitude	# Records
Grand Bay NWR/NERR	25174	Front Lawn	MS	30.429096	-88.430626	172
Grand Bay NWR/NERR	28745	Boardwalk 1	MS	30.42939	-88.4286	2,419
Mississippi Sandhill Crane NWR	26079	Visitor Center	MS	30.45158	-88.6555	5,740
Mississippi Sandhill Crane NWR	28590	Fontainbleau Unit Nature Trail	MS	30.39778	-88.7572	5,904
Pascagoula River Audubon Center (PRAC)	28353	PRAC-Boat Launch Trail	MS	30.41477	-88.5425	816
Pascagoula River Audubon Center	28354	PRAC-Trail 2	MS	30.41479	-88.5426	216
Pascagoula River Audubon Center	28357	PRAC Front Lawn	MS	30.41472	-88.5418	337
Mississippi Gulf Coast Community College - Gautier	29265	Pine Restoration Trail	MS	30.400648	-88.64506	2,268
Big Branch Marsh NWR	25151	Main Parking Lot	LA	30.32165	-89.9369	2,068
Big Branch Marsh NWR	25168	Entrance Road	LA	30.32005	-89.936	806
Big Branch Marsh NWR	30648	BlueTrail	LA	30.3217	-89.9382	3,782
Bayou Sauvage NWR	25901	Boardwalk	LA	30.05377	-89.8805	12,034
Jean LaFitte NHP&P Barataria Preserve	27474	Visitor Center Trail	LA	29.78447	-90.1148	1,829
Jean LaFitte NHP&P Barataria Preserve	27475	Palmetto Trail	LA	29.78381	-90.1176	1,410
Jean LaFitte NHP&P Barataria Preserve	27476	Ring Levee Trail	LA	29.78527	-90.1102	1,649
Jean LaFitte NHP&P Barataria Preserve	27477	Bayou Coquille Trail	LA	29.79382	-90.1225	2, 145
Crosby Arboretum	28830	Phenology Journey	MS	30.50215	-89.6668	3,178
USM Marine Education Center	30971	Osprey Point Nature Trail	MS	30.39134	-88.776	5,032
USM-Long Beach	33862	Bayou Bear Path	MS	30.353952	-89.136215	785
New Orleans City Park	33401	Couturie Forest Phenology Trail	LA	30.004747	-90.09421	601

Appendix B. List of Observed Trail Species

- American alligator (Alligator mississippiensis)
- American beautyberry (Callicarpa americana)
- American elm (Ulmus americana)
- American goldfinch (Spinus tristis)
- American robin (Turdus migratorius)
- American sycamore (Platanus occidentalis)
- American witchhazel (Hamamelis virginiana)
- Bald cypress (Taxodium distichum)
- Bald eagle (Haliaeetus leucocephalus)
- Barred owl (Strix varia)
- Black cherry (Prunus serotina)
- Black willow (Salix nigra)
- Blue jay (Cyanocitta cristata)
- Boxelder (Acer negundo)
- Bumblebee (Bombus spp.)
- Butterweed (Packera glabella)
- Carolina wren (Thryothorus ludovicianus)
- Chimney swift (Chaetura pelagica)
- Chinese tallow (Triadica sebifera)
- Common buttonbush (Cephalanthus occidentalis)
- Common hackberry (Celtis occidentalis)
- Common persimmon (Diospyros virginiana)
- Deer fly (Chrysops spp.)
- Eastern baccharis (Baccharis halimifolia)
- Eastern bluebird (Sialia sialis)
- Eastern box turtle (Terrapene carolina)
- Eastern poison ivy (Toxicodendron radicans)
- Eastern redbud (Cercis canadensis)
- Elliott's blueberry (Vaccinium elliottii)
- Flowering dogwood (Cornus florida)
- Fox squirrel (Sciurus niger)
- Giant blue iris (Iris giganticaerulea)
- Gulf fritillary (Agraulis vanillae)
- Henslow's sparrow (Centronyx henslowii)
- Honeybee (Apis mellifera)
- Honeylocust (Gleditsia triacanthos)
- Hooded warbler (Setophaga citrina)
- Live oak (Quercus virginiana)
- Longleaf pine (Pinus palustris)
- Monarch (Danaus plexippus)
- Mountain azalea (Rhododendron canescens)
- Northern cardinal (Cardinalis cardinalis)
- Northern mockingbird (Mimus polyglottos)
- Northern parula (Setophaga americana)
- Osprey (Pandion haliaetus)
- Painted bunting (Passerina ciris)
- Possumhaw (Ilex decidua)
- Prothonotary warbler (Protonotaria citrea)
- Purple martin (Progne subis)
- Red buckeye (Aesculus pavia)
- Red maple (Acer rubrum)
- Red-bellied woodpecker (Melanerpes carolinus)
- Redbay (Persea borbonia)
- Ruby-crowned kinglet (Regulus calendula)
- Ruby-throated hummingbird (Archilochus colubris)
- Sandhill crane (Grus canadensis)
- Sassafras (Sassafras albidum)
- Siberian elm (Ulmus pumila)
- Slash pine (Pinus elliottii)
- Southern magnolia (Magnolia grandiflora)
- Sugarberry (Celtis laevigata)
- Sweetbay (Magnolia virginiana)
- Sweetgum (Liquidambar styraciflua)
- Tall blazing star (Liatris aspera)
- Trumpet creeper (Campsis radicans)
- Tufted titmouse (Baeolophus bicolor)
- Water tupelo (Nyssa aquatica)
- Wax myrtle (Morella cerifera)
- White crownbeard (Verbesina virginica)
- Yaupon (Ilex vomitoria)
- Yellow trumpets (Sarracenia alata)
- Yellow-rumped warbler (Setophaga coronata)