

Mission: Native vs. Invasive Shrub Phenology

Teacher Resources

Research Question: How is climate change affecting the timing of seasonal changes in native and invasive shrubs?

Total class time to complete the Mission:

For the full unit: 10 to 15 class periods

For collecting and posting data only: 2 to 3 class periods

Standards Alignment: Next Generation Science Standards (NGSS):

Performance Expectations:

- Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

Cross Cutting Concepts:

- CCC5: Energy and Matter: Flows, cycles, and conservation
- CCC7: Stability and Change

Science and Engineering Practices:

- SEP 3: Designing and Carrying Out Investigations
- SEP 4: Analyzing and interpreting data
- SEP 7: Engaging in Argument from Evidence
- SEP8 Obtaining and communicating information

Disciplinary core ideas:

- LS2A: Interdependent Relationships in Ecosystems
- LS2B: Cycles of Matter and Energy in Ecosystems

Materials

For each group of 2 to 4 students:

Vital Signs Upland Species and Habitat Survey

Species ID cards for native and invasive upland shrubs (see recommended list below)

Camera, ipad, or cell phone

Ruler

Clipboard

For the class:

First aid kit

GPS

Chart paper

Before you begin:

1. Choose a field site. For this mission, it will be important that at least one of the shrubs, native or invasive, is present. Before you begin, check your area to see what is there. Plan your unit around species that are present or likely to be present at the site. Here is a list of commons native and invasive shrubs in Maine:

Invasive shrubs:

- Burning bush, honeysuckle, alder buckthorn (also known as glossy or smooth buckthorn), common buckthorn, multiflora rose, Japanese barberry

Native shrubs:

- Mapleleaf viburnum, chokecherry, sweet fern, bunchberry (also known as creeping dogwood), meadow rose, highbush blueberry, highbush cranberry, lowbush blueberry, winterberry

Note: This is not an exhaustive list. If you know of other native or invasive shrubs that you can monitor in your area, go for it!

Choose a site that you can visit regularly, ideally a short walk from the classroom, if you are planning to monitor repeatedly for changes in phenophase.

Modification: Have students explore the area around the school for the different native and invasive shrubs listed on the mission page. Based what they find and do not find, students can choose which plants to monitor for their investigation.

2. Read over Mission: Native vs. Invasive Shrub Phenology, and the teacher resources, and determine the scope of your investigation. Lessons indicated with an * are intended to support students in building background skills and knowledge, analyzing data, drawing conclusions, and communicating results. They are supplementary and not essential to the mission.

Consider timing your investigation so that you begin monitoring at least a week or two before you anticipate a change in phenophase (breaking leaves or falling leaves, for example) and allowing students to take multiple visits to the field site to look for change.

Find Mission: Native vs. Invasive Phenology here: <http://vitalsignsme.org/mission-native-vs-invasive-shrub-phenology>

Find background information on native vs. invasive plant phenology here: <http://vitalsignsme.org/blog/webinar-invasive-shrubs-eastern-us>

3. Set up a Vital Signs investigation for your class. Create fieldwork groups of 2 to 4 students. See the “How teachers set up investigations and team accounts for their students” guide for help with this process: <http://vitalsignsme.org/guides>

4. Look over assessment options. The student notebook provides multiple assessment opportunities, including a task-neutral rubric at the end. Look through the resources provided and pull out the pieces that are useful to you. You can download the student notebook from the teacher resources page.

Lesson 1: What is Phenology? (one class period)*

Bring students out to their field site to gather existing knowledge that will support their understanding of phenology and other types of ecosystem changes. Allow students 10 to 15 minutes to make observations of the current conditions at the site and then predict future changes that might occur.

Once back in the classroom, have students share their observations and predictions. Challenge students to identify or sort changes into categories of seasonal changes, day to day seemingly random changes, and long-term change over time.

Use the groups that students created to form the basis for working definitions of “phenology” (study of seasonal or cyclical change) and “phenophase” the different stages an organism goes through in a year.

In this investigation, students will be documenting cyclical change, monitoring for long-term directional change (caused by warming temperatures) and will have to consider natural variability in temperatures from year to year. Use this activity to begin to explore constancy and change.

Modification: if a site visit is not practical, have students compare photographs of a similar ecosystem in different seasons.

Introduce Mission: Native vs. Invasive Shrub Phenology: <http://vitalsignsme.org/mission-native-vs-invasive-shrub-phenology>.

Lesson 2: Build Background knowledge with an Ecosystem Modeling Game (two class periods)*

In this active and competitive game, students build background knowledge by experiencing how a community of native animals and plants changes in response to resource availability in their habitat.

Read over the full lesson plan and follow the set-up instructions detailed here: Oh Deer! With Variability Analysis: <http://vitalsignsme.org/oh-deer-invasive-species-and-ecosystem-modeling-game-data-analysis>

Modifications for Mission: Native vs. Invasive Shrub Phenology

- Use native and invasive shrubs as the species in the game (preferably species that may be present at the field site).
- For the habitat resources, use “light,” “nutrients,” and “space”
- Rather than have students run to the resources, they can take 10 steps to mimic the growth of the plants.

Lesson 3: Define the Question and Conduct background research (one to two class periods)*

Revisit the Mission page and have students review what they have learned about phenology and native vs. invasive shrubs (consider using a KWL to organize ideas).

Divide students into teams or have them work individually, or in fieldwork teams, to conduct research on a particular invasive or native shrub so they will be able to identify the shrub out in the field. Assign students to shrubs that are likely to be found at the field site.

Have students teach the information gathered to their classmates, either in small groups or to the class to prepare each other for their investigation.

Extensions: Analyze Historical Phenology Datasets

Lilac leaf out data from Acadia National Park:

Assign students to small groups of two to four and have them work together to analyze 5-year time frames to determine how leaf out has changed over time. Then, have students share their findings with the class to piece together a view of change over time. Finally, have students analyze the more than hundred-year spread of data to draw conclusions. Challenge students to articulate how looking at more data changed their thinking. Compare the lilac data to the data the class is collecting. Emphasize that even though students won't be able to see a trend over long periods of time, they do have multiple data points that provide a more complete picture of each year of data collected.

<https://tuvalabs.com/mharvey/datasets/86b31d456fd84e4d8edfdb9d86f1328b/>

Red maple leaf-out and average temperature data: Have students graph historical leaf out data for Red Maples from the National Phenology Network. Compare dates of leaf out to average spring temperatures to look for a correlation. See the full lesson plan, developed by the University of Maine cooperative extension, here: <https://extension.umaine.edu/signs-of-the-seasons/resources-for-educators/red-maple-leaf-out/>

Compare leaf-out from 2017 to other springs: Challenge students to interpret the maps produced by the National Phenology network after the 2017 season. These are complex visualizations and will take some work. Use these tools to explore ideas around why leaf-out might occur earlier or later in different areas and in different years:

<https://www.usanpn.org/data/spring/2017comparisons> ,

<https://www.usanpn.org/files/npn/maps/six-leaf-index-anomaly.png> ,

https://www.usanpn.org/files/npn/maps/USA-NPN_Status-of-Spring-Animation_MAY2017.gif

Lesson 4: Fieldwork Skills Stations (one to two class periods)*

Prepare students for fieldwork by looking at models of high quality observations and familiarizing students with Vital Signs resources.

Read over the full lesson plan and follow the instructions for set up here:

<http://vitalsignsme.org/developing-skills-preparation-fieldwork>

Modifications of the lesson plan for the Phenology Unit:

- When looking at example observations, focus on species specific to the phenology mission.
- Use species that are part of the phenology mission for “Spot the Difference.” If you don’t have specimens for the students to compare, print two photos instead (you can pull photos from the Vital Signs database). Here are some good species for comparison:
 - meadow rose and multiflora rose
 - winterberry and Japanese barberry
 - Choke cherry, glossy buckthorn, common buckthorn
- Skip “How many are there?”
- Use species cards that are part of the Phenology mission for “Preparing for scientific Observation”

Lesson 5: Collect Data (one class period)

Follow the protocol in Mission: Native vs. Invasive Shrub Phenology

Here is a protocol for timed search that you can go over with students:

http://vitalsignsme.org/sites/default/files/content/method_justlookingaround_092509.pdf

Some extra tips for data collection:

- Have students look for the shrub that they researched
- The new phenophase begins when just one leaf/bud changes. Make sure that students mark the phenophase accordingly.
- Have students take good close-ups of the leaves to show the phenophase

For tips from Vital Signs teachers on managing students in the field, see:

<http://vitalsignsme.org/forum/strategies-field>

Extension: Monitor for change in phenophase

Bring the students back to the field site regularly to look for a change in phenophase for any shrub they find. This can be a quick (less than 5 minute) visit to check to see if buds are breaking, full leaves are emerging, leaves are changing color, or leaves are falling. It is NOT necessary to complete the full Upland Species and Habitat Survey datasheet for each visit.

Lesson 6: Post Data (one class period)

Have students post their FOUND/NOT FOUND observations to Vital Signs. Make sure students add the phenophase to their field notes.

Here are some guides to support students in posting to Vital Signs:

<http://vitalsignsme.org/how-students-put-their-data-website>

Extension: add your data to a national database

Add your data to the National Phenology Network's "Shady Invaders" campaign.

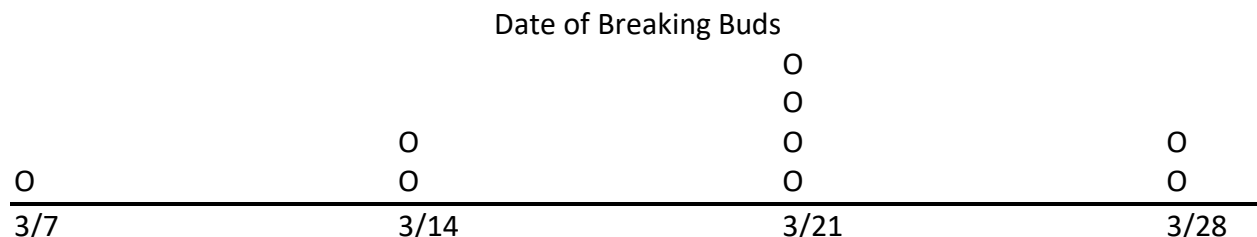
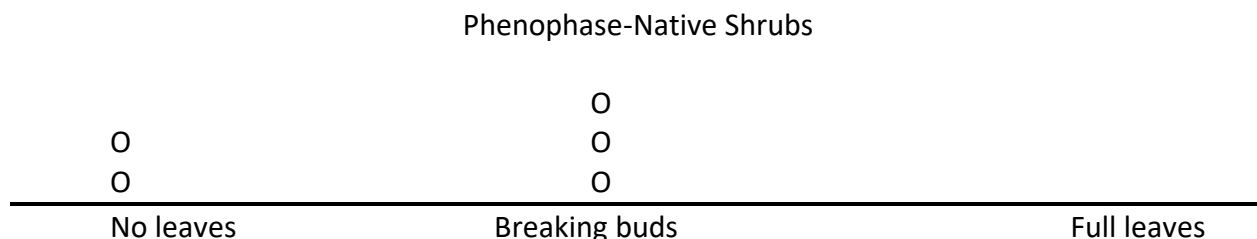
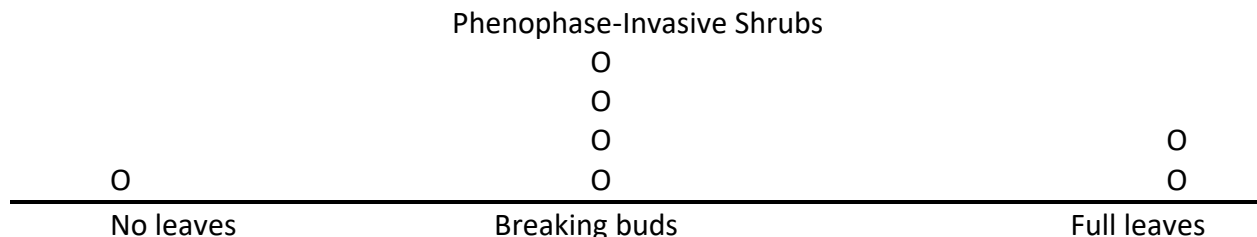
Find more information here: <https://www.usanpn.org/nn/ShadyInvaders>

Lesson 7: Analyze data (one class period)*

1. Create a dot plot to combine the data from all student groups. If you have multiple classes that collected data, have them add to the same graphs.

- If you are unfamiliar with dot plots, watch this short video from Khan Academy: <https://www.khanacademy.org/math/cc-sixth-grade-math/cc-6th-data-statistics/dot-plot/v/frequency-tables-and-dot-plots>
- If your class collected data on BOTH native AND invasive shrubs, create two dot plots, separating the data between to two types of plants.
- If your class collected data one time, set the **phenophase** as the X axis (no leaves, breaking leaf bud, full leaves for spring; full leaves, colored leaves, falling leaves for the fall).
- If you went out multiple times to monitor for a change in phenophase, set the **date** as the x axis.

Here are some examples of what your graphs might look like:



2. Have each fieldwork team place a dot over the place on the X axis for each data point they collected.

3. Look at the data for just one graph at a time:

a. Look at the spread of the data: did most students find the same phenophase or same date of phase change? Was there a lot of difference in timing between the shrubs?

b. Talk about *why* these points might be different. Why might one plant change at a different time than another? Is it possible that groups categorized the phenophases differently? Challenge students to think about *both* natural variability and human error.

c. Look at common points and at outliers: Is there any particular phase or date that has many more data points than another? Are there any points that stand out? That seem questionable?

d. Work together to pull together some tentative ideas based on this information. For example, *“Mostly, the shrubs we found were in __ phase at this date”* or *“The phenophase varied a lot between the different shrubs.”*

4. If you have a graph for both natives and invasives, have students work in groups to conduct a similar analysis on the data from the other graph. Then have students share their findings.

Work as a class to determine whether you are able to see a difference between native and invasive shrubs. Does the data from one group vary more than the other? Do you need more data to draw conclusions about either group?

Extensions: Compare data

Track changes from year to year: If you are able to collect data over multiple years, compare this group’s findings to the previous year. Is there a change in the phenophase at a particular date for either the native or invasive shrubs? Is there a difference in the date if the phase change?

Gather qualitative data from the Vital Signs database: Have students search for found observations of their species in the Vital Signs database and browse through the photos, sketches and descriptions in them. Based on the information in the observation and the date listed, do the other observations support students findings? Do any students notice differences in how the shrub looked at a particular time of year in comparison to their own observations? If so, how might they explain those differences?

Here is an example comparison:

- Beach rose-10/30/2015, Cape Elizabeth: <http://vitalsignsme.org/species-rosa-rugosa-was-found-whatch-me-whip-and-na-na-2015-10-30>
- Beach rose-10/24/2017, Cape Elizabeth: <http://vitalsignsme.org/species-rosa-rugosa-was-found-scrajam-2017-10-24>

Compare to the National Phenology Network:

Have students look up their species in the USNP database and then create a visualization of the timing of the phenophase of their shrub: <http://data.usanpn.org/npn-viz-tool/>

1. Use the search function to filter observations for the species of interest.
2. Click on the graph icon and select “calendar.”
3. Select a year and the phenophase of interest.
4. Click “visualize.”

Note: the amount of data varies widely from species to species, and students may not find much information on their specific species. We recommend playing around with the database yourself before trying this with students.

Lesson 8: Draw conclusions (one class period)*

Have students write scientific arguments based on their results. For resources, see: <http://vitalsignsme.org/formal-science-writing-and-revision-tools-discussion-and-conclusions>

A graphic organizer is also provided in the student notebook.

Lesson 9: Share Findings*

Check out the resources around *Findings from the Field: A Middle School Journal of Scientific Research* to see if creating and submitting articles of authentic research would be right for your class: <http://vitalsignsme.org/findings-field-middle-school-journal-science-research>

Look through the Vital Signs Project Bank for additional ideas for communicating results: <http://vitalsignsme.org/best-projects>. Students will need to use their Vital Signs account to post their project to the project bank.

Consider additional options for sharing student work with the community:

- Have students present their work to other classes in the school. Invite families and community members to come, too.
- Host a community night where students make presentations to community members.
 - Issue a press release to announce the event: <http://vitalsignsme.org/how-write-press-release>
- Have students put their writing into a flyer or brochure and distribute to the community.
- Post the work on the school website.
- Gather additional ideas from the class

Whatever you choose, please let Vital Signs know about it!

