

Name: \_\_\_\_\_

Date: \_\_\_\_\_

## Mission: Native vs. Invasive Plant Phenology Student Notebook

### Lesson 1: What is Phenology?

Essential Question: What types of changes happen in an ecosystem?

After completing this activity, I will be able to...

NGSS CCC7:	Level 1	Level 2: <i>all of level 1 and...</i>	Level 3: <i>all of level 2 and...</i>	Level 4: <i>all of level 3 and...</i>
Stability and Change	Identify three seasonal changes.	Distinguish seasonal change from other types of changes.	Define phenology and phenophase and give examples of both from the ecosystem I am investigating.	Explain how phenology, change over time, and day-to-day changes are all part of Mission: Native vs. Invasive Plant Phenology.

*Once you have completed the activity, circle the highest level that you achieved. Draw a star next to the evidence in the student notebook that shows that you did this.*

1. Find a spot that is at least ten steps away from the nearest student, but where you can still see your teacher or chaperon.
2. **Make observations** of the area around you. Notice what you see, hear, smell, and feel. Record as many different observations as you can in 5 minutes.

I see/hear/smell/feel...

3. **Make predictions.** Write down as many changes as you can, big and small, that you think will happen in this area.

What are changes that happen from one minute to the next?

What would be different if you came back tomorrow?

In three months?

In six months?

In ten years?

In one hundred years?

**Assess:** Define phenology and phenophase. Give an example of each from your field site or Mission: Native vs. Invasive Plant Phenology.

Phenology:

Phenophase:

How are seasonal changes different from changes that happen from minute to minute or over hundreds of years?

**Reflect:** What changes came up in conversation that you hadn't thought of before?

**Think ahead:** What kinds of change are involved in Mission: Native vs. Invasive Shrub Phenology? Explain.

**Lesson 2: Build Background knowledge with an Ecosystem Modeling Game**

Essential question: How are habitat resources, native, and invasive species related in an ecosystem?

By the end of this activity I will be able to...

<b>MS LS2-1</b>	<b>Level 1</b>	<b>Level 2: all of level 1 and...</b>	<b>Level 3: all of level 2 and...</b>	<b>Level 4: all of level 3 and...</b>
Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem	Identify one to three resources that plants need to survive.	Describe what happens to a population of a native species if it does not have access to the resources it needs.	Explain how the introduction of an invasive species impacts the population of a native species and give evidence from the game to support the explanation.	Make a prediction, supported by evidence, that shows how invasive species could impact native species in the future.

Once you have completed the activity, circle the highest level that you achieved. Draw a star next to the evidence in the student notebook that shows that you did this.

**Model Interpretation Chart**

Features of the model	(is like...) Features in the real world	They are similar because...
<i>Example: a “native species” student signaling “light” didn’t find a matching habitat resource and becomes a resource.</i>	<i>Example: A native meadow rose shrub doesn’t get enough light, so it dies. Its nutrients become part of the soil.</i>	<i>Example: When the meadow rose didn’t find light, it became nutrients in the soil. Nutrients are a habitat resource, so this is like a student’s role changing from native species to habitat resource if the student doesn’t find light.</i>

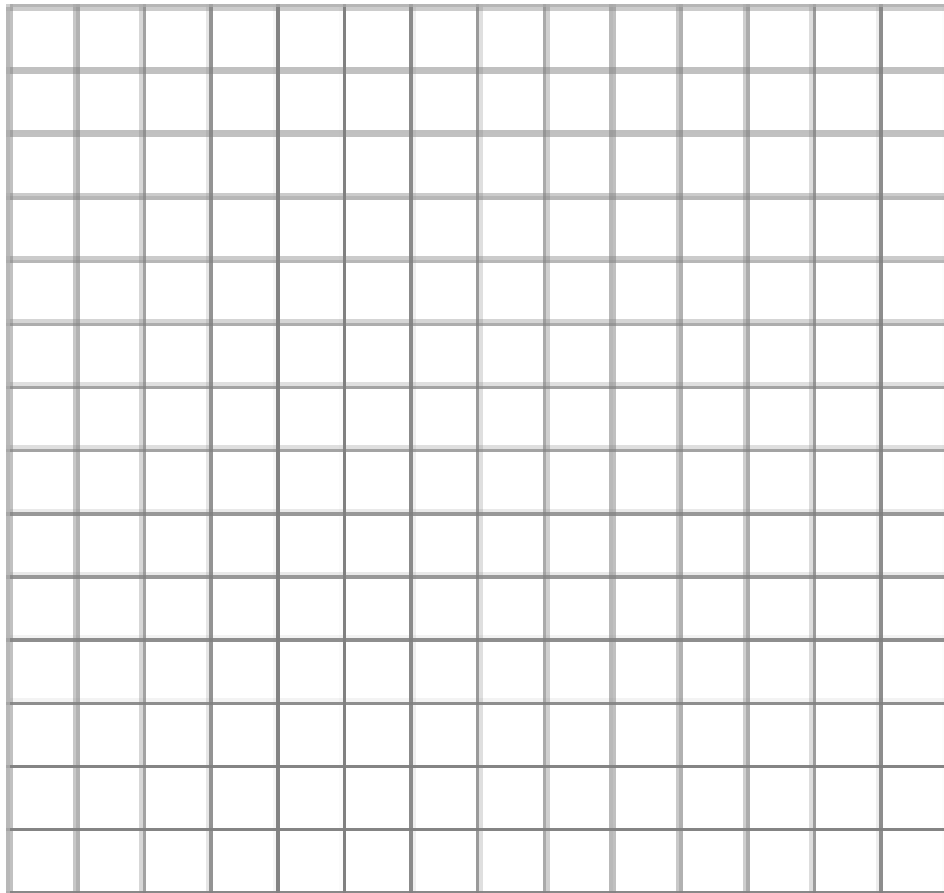
Fill in the chart below with your section of the class data. In the “Explanation of data section,” write down what happened to make the native species abundance increase or decrease.

**Data and Explanation Chart**

Year	# of Native Species	# of Invasive Species	# of Habitat Resources	Explanation of the Data
				← Copy the data for the year prior to your assigned time period here, so you can see how the populations change from year to year.

My graph of our class data:

Legend:



1. What do you notice about your data? Describe the shape of each of the lines, changes in directions, overall increases and decreases, and anything interesting you see in the data.

Habitat resource abundance:

Native species abundance:

Invasive species abundance:

2. Do you notice any relationships between the abundance of habitat resources and native species?

3. Do you see any change in the abundance of resources or the native species once the invasive species was introduced?

**Assess:** Based on your class discussion and the data in the graph above, how are habitat resources, native and invasive species related in an ecosystem? What evidence do you have to support your answer?

**Think Ahead:** Based on the data that you have, make a prediction: if you were to have continued to play the game for another 5 rounds, what would have happened to the abundance of habitat resources, native, and invasive species? Use dotted lines to draw your prediction onto your graphs for the next 5 years of data.

**Lesson 3: Define the Question and Conduct Background Research**

Essential question: What is the purpose of this investigation? How is this investigation important to people in my community and across the region?

**By the end of this activity I will be able to...**

<b>NGSS SEP 1</b>	<b>Level 1</b>	<b>Level 2: all of level 1 and...</b>	<b>Level 3: all of level 2 and...</b>	<b>Level 4: all of level 3 and...</b>
Asking questions and defining problems.	Define the research question and why it is important.	Describe how my work connects to the research of other students and scientists.	Explain how the data I will collect will help to answer the research question.	Identify gaps in existing information about my topic and explain how my investigation might help to address them.

*Once you have completed the activity, circle the highest level that you achieved. Draw a star next to the evidence in the student notebook that shows that you did this.*

**Mission: Native vs. Invasive Shrub Phenology Investigation Overview**

**My Research Question:**

This question is important to the science community because...

This question is important to my local community because...

In order to answer this question my class is going to...

Members of my fieldwork team...

1. Choose a shrub species that you will research in preparation for your investigation, or write down the species that is assigned to you by your teacher.

2. Use the following resources to help you gather information:

**Vital Signs Species ID cards:** <http://vitalsignsme.org/species-identification-resources#U>  
Look through the list of Upland Native Species Cards or Upland Invasive Species Cards):

**Vital Signs Existing Data:** <http://vitalsignsme.org/explore/map>  
If you need help searching the map, use the guide, "How Do I Find Things On The Map?"  
<http://vitalsignsme.org/guides>

**USDA Plants Database:** <https://plants.usda.gov/java/>  
Search for your species by typing in the name in the top left corner of the page. Make sure you select "Common name" from the search options.

Find your own resources by searching the internet. Be sure to record any sources that you use.

3. Share the information that you gather with your classmates so that you will be able to work together to identify this species in the field.

## Phenology Mission Shrub Fact Sheet

**Species you are researching:**

**Is this shrub native or invasive in Maine?**

**Identifying characteristics:** How will you know you have found it?

What makes this plant different from other plants?



Photos or sketches of these identifying characteristics:

**Identifying characteristics *in this season*:** What does this shrub look like in this time of year?

Around when does this plant typically grow or lose its leaves (optional)?

Photo of sketch in this season:

**Impacts:** Why should we care about this shrub? What impacts does it have on other species in the ecosystem?

What impacts does it have on humans?

**Existing data:** What other locations that are close or similar to our field site has it been found?

Sources I used:

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**Assess:** Complete the summary on page one of your notebook.

**Reflect:** What did you learn that you think will be most helpful in your investigation? What do you still need to find out?

**Think ahead:** Based on your research, do you think you will find your shrub? In what phenophase? What evidence supports your prediction?

## Lesson 4: Fieldwork Skills Stations

Essential question: What makes good data?

After completing this activity, I will be able to...

<b>NGSS Practice 7</b>	<b>Level 1</b>	<b>Level 2: all of level 1 and...</b>	<b>Level 3: all of level 2 and...</b>	<b>Level 4: all of level 3 and...</b>
Engaging in argument from evidence	Identify a claim and supporting evidence from a Vital Signs observation.	List three or more qualities of good supporting evidence.	Plan what I will need to do to collect high quality evidence during my fieldwork.	Make suggestions for improving the quality of evidence.

Once you have completed the activity, circle the highest level that you achieved. Draw a star next to the evidence in the student notebook that shows that you did this.

1. Search the *Vital Signs* database for observations of your shrub.
  - a. Go to the "Explore Data" tab.
  - b. Select "Browse Data."
  - c. Click on the blue "Change Search" button in the top left.
  - d. Find your shrub in the drop-down menu under "Choose Common Name"
  - e. Click the "Browse it" button at the bottom of the screen.
2. Explore the entries that come up. Once you have looked at a few, write an example claim supported by both written and photo evidence:

Claim (Found or Not Found?):

Written evidence:

Photo evidence (describe what is in the photo):

After you have reviewed a variety of evidence, find an example of "great" and "okay" evidence and fill out the following information:

### GREAT EVIDENCE

Species name:

Username:

What was so great about it?

### OKAY EVIDENCE

Species name:

Username:

Suggestions to improve next time:

**Fieldwork Skills Stations:**

**Spot the Difference:**

In this station, you will build skills to help you to determine whether your shrub is present at your study site. You will need keen observation skills to come up with evidence to support your claim.

**Station Instructions**

1. Set the timer to three minutes.
2. Review all the activity instructions and start the timer when the whole group is ready.
3. Compare the photos in front of you. Write down every similar characteristic that you notice. Write down each difference that you notice.
4. Put your pen or pencil down when the timer goes off.
5. Compare your lists with others in your group to give yourself a score:
  - **1 point** for every characteristic that only you wrote down.
  - **No points** for a characteristic that more than one person in the group wrote down.
6. Work together to decide whether these specimens are from the same or different species.

<b>Similarities</b>	<b>Differences</b>

Are these photos of the same or different species? Explain your answer.

**Species in Focus:**

Through a thoughtful critique of this collection of good and bad species photos, learn what it takes to take great species photographs and create your own list of "what makes a great species photo."

Station Instructions

1. Choose one photo to critique (it does not have to be a good photo).
2. Write a critique of the photo by answering the questions in the student notebook.
3. Share your critique with your group. Work together to generate a list of characteristics of a great species photo.

## Photo Critique:

- What do you like about the photo?
  
- What don't you like?
  
- What does the photo show that would help someone identify the species?
  
- What would you do differently to improve the photo?

Characteristics that make a good photo:

**Preparing for Scientific Observation**

This station will help you look closely at the *Vital Signs* Species ID cards and familiarize yourself with the species that you are searching for.

Station Instructions

1. Look over the *Vital Signs* Species ID card
2. Use the information in the card to fill in the observation tool.

Specific Features

+

Distinguishing Characteristics

+

Broader Connections to the Environment

=

Expert Observation

### SPECIFIC FEATURES

What are the specific characteristics of your plant or animal that you notice?

Example of **specific** features:

*"It is black with white spots."*

*"It has long antennae."*

*"It has six legs."*

Your species' **specific** features:

### DISTINGUISHING CHARACTERISTICS

What makes your plant or animal different from other similar looking plants or animals?

Example of distinguishing characteristics:

*"It is black with white spots with a spot at the base of its head."*

*"It does not have blue legs."*

Your species' **distinguishing** characteristics:

### ENVIRONMENTAL KNOWLEDGE & BROADER CONNECTIONS

Is there other information about the time of year, habitat, life cycle, or expected range of your plant or animal that will help you make your case?

Example of broader connections:

*"It is on a pine tree, and it is earlier in the season than I should see adults of this species."*

Broader **connections** for your species:

**Why Nothing Matters:**

Should you be disappointed if you don't find your target species? Of course not! Nothing REALLY matters to Dr. Andy Pershing - super smart ecosystem modeler shared by GMRI & UMaine. Andy explains the importance of looking for whales in places you may not find them and reporting "not found" data. Understanding where whales are NOT is equally as important as understanding where they ARE.

**Station Instructions:**

1. Watch the "Why Nothing Matters" video.
  2. Read the "When NOT FOUND is good. Really Good." Guide.
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**Assess:** Why is it important to have clear evidence to support a claim?

**Reflect:** What were the three most important things that you learned at the stations?

**Thinking ahead:** What do you predict will be the most challenging part of your fieldwork? Why?

## Lesson 5: Collect Data

Essential Question: Is my shrub present at my field site? What phenophase is it in?

After completing this activity, I will be able to...

<b>NGSS Practice 3</b>	<b>Level 1</b>	<b>Level 2: all of level 1 and...</b>	<b>Level 3: all of level 2 and...</b>	<b>Level 4: all of level 3 and...</b>
Planning and Carrying Out Investigations	Search carefully for my species, paying attention to its distinguishing features.	Take clear photos and detailed, accurate written observations.	Use the skills that I developed in class to make sure that my observations are high quality.	Take note of what is working, and what isn't, and identify potential sources of error.

*Once you have completed the activity, circle the highest level that you achieved. Draw a star next to the evidence in the student notebook that shows that you did this.*

### Prepare for data collection:

1. Go over your data collection plan with your fieldwork team. Determine who is responsible for each task:

Tasks: Record field site information (page 1 of the Vital Signs Species and Habitat Survey).  
Take field site and sampling method photos.

Students responsible:

Tasks: Search the area for your shrub. Use the Vital Signs Species ID card to help you. Look for at least 10 minutes and record the number of minutes spent searching in your field notes.

Student responsible:

Tasks: Take clear, close up photos that will help you show that you did or did not find your shrub. Record written evidence as well (pages 2A and 2B of the Vital Signs Freshwater Species and Habitat Survey).

Students responsible:

Task: Determine the phenophase of any found shrub. Search carefully—only one leaf is needed to show a new phenophase. Take a picture of the leaves or buds that shows the phenophase.

Students responsible:

2. Gather your equipment, including:

- Upland Species Survey data sheet
- Species ID cards for the species you are looking for
- Camera, ipad, or phone to take pictures
- Extra pencils
- ruler
- clipboard



**Go out to the field and collect data:** Check with your field work team mates to make sure that you have completed all of your tasks.

**Assess:** Is the Vital Signs Species and Habitat Survey complete (all sections)? Do you have clear photos to show you found or did not find your shrub? Do you have evidence to show the phenophase?

**Reflect:** What did you observe or encounter that you did not expect? Did anything surprise you?

**Think ahead:** Were there any errors that may influence your results? Describe them. Were you curious about anything else during your investigation? What new questions came up?

## Lesson 6: Post Data

After completing this activity, I will be able to...

<b>NGSS Practice 3</b>	<b>Level 1</b>	<b>Level 2: all of level 1 and...</b>	<b>Level 3: all of level 2 and...</b>	<b>Level 4: all of level 3 and...</b>
Planning and Carrying Out Investigations	Record written and photo observations of my shrub (or its absence).	Provide evidence that supports my claim of found or not found and the phenophase observed.	Provide reasoning behind my evidence, explaining how my observations compare to the distinguishing features of the shrub in this season.	During my investigation, take note of what is working, and what isn't, and identify potential sources of error.

*Once you have completed the activity, circle the highest level that you achieved. Draw a star next to the evidence in the student notebook that shows that you did this.*

### Instructions for Posting to Vital Signs from Maine:

- Go to <http://vitalsignsme.org>
- Log in using the team name a password given to you by your teacher.
- Go to the “My Vital Signs” page (the green box in the upper right corner)
- Select from the list of “Unfinished observations”
- Transcribe the written information from the Vital Signs Freshwater Species and Habitat Survey datasheet to the online datasheet.
- In the field notes section, make sure to include the number of minutes you spent searching and the phenophase observed.
- Upload your photos from the camera to the online datasheet
- **Before you submit**, use the “Quality Assurance Checklist” below to check your work.
- Optional: Have a classmate check your observation using “Peer Review Tool” to check your work.
- Once you are satisfied with your work, click “submit”

Here is a guide to help you with posting to Vital Signs: <http://vitalsignsme.org/how-students-put-their-data-website>

## Quality Assurance Check

Before you publish your data to Vital Signs, do a Quality Check to catch errors. Make sure scientists and others can use your data!

### Data Required for *Species Survey*

	Yes	No	Can't tell
<b>Field Trip Details</b>			
All information about the trip (trip name, date, habitat, etc.) is accurate			
<b>Study Site Details</b>			
Zooming way in shows that the data is in the right place on the map (correct latitude & longitude)			
Study site photo shows the big picture of where the investigation happened (no faces!)			
Study site photo is in focus			
Habitat selection is accurate			
<b>Species You Looked For – complete a checklist for each species you looked for</b>			
The correct species is selected from the pull-down list			
“I think I found it” or “I think I didn’t find it” selection is correct			
Evidence photos are in focus			
Evidence photos show just the species (no faces!)			
Evidence photos are close-up enough to show important identification features			
Written evidence clearly describes characteristics of species			
Written evidence matches and supports evidence photos			
Appropriate sampling method selected			
Sampling method photo shows how data were collected and is in focus (no faces!)			

### Additional Data Required for *Species & Habitat Survey*

<b>Species Details</b>			
Count of individual crayfish data is filled in and match the paper datasheet			
Measurement of crayfish is filled in and matches the paper data sheet.			
<b>Habitat</b>			
Habitat details (e.g. water quality) data are filled in and match the paper datasheet (optional)			

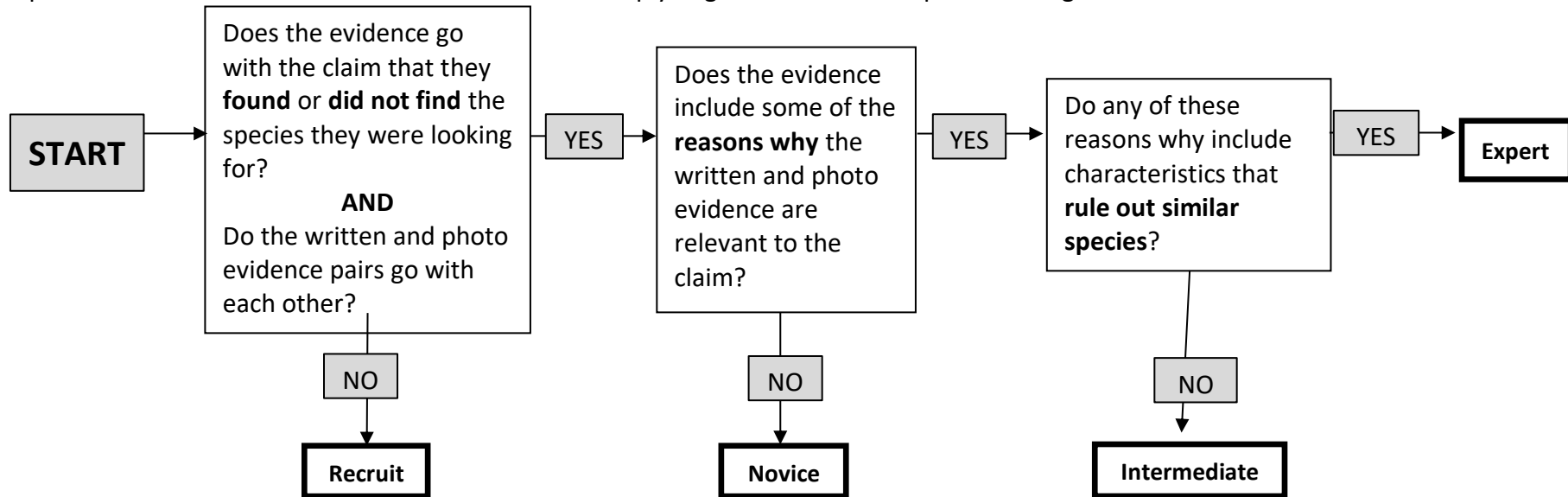
### Additional Data – What other things do you want to check before you publish?

<b>Fieldwork Notes Include</b>			
Time spent searching			
Phenophase			
Photo or sketch that shows the phenophase			
<b>Grammar</b>			

\* When all of the answers above are “Yes,” you have met the minimum review requirements to publish your data!

## PEER REVIEW TOOL: HOW EXPERT IS THE SCIENTIFIC ARGUMENT YOU'RE REVIEWING?

**FIND OUT!** Examine the FOUND or NOT FOUND claim, field notes, and written and photo evidence to answer the questions below. Use Vital Signs species ID cards or other identification resources to help you give feedback to improve the argument.



### Example of **Recruit**:

CLAIM:

"We think we **DID NOT FIND** invasive honeysuckle."

EVIDENCE:

"The stem is hollow so we **FOUND** it."

### Example of **Novice**:

CLAIM:

"We think we **FOUND** invasive honeysuckle."



EVIDENCE:

"The stem is hollow so we **FOUND** invasive honeysuckle."

### Example of **Intermediate**:

"The stem is hollow. We know that invasive honeysuckle has a hollow stem."

### Example of **Expert**:

"A hollow stem is the feature that helps us distinguish invasive honeysuckle from native honeysuckle. Because the stem is hollow and not solid like the native, we think we found invasive honeysuckle."

What category best describes the argument? (Circle One) Recruit, Novice, Intermediate, Expert

What suggestions do you have to help improve the arguments that were made?

**Lesson 7: Analyze Data**

Essential Question: What is the phenophase of shrubs at my site? How does my data compare to other years? Other shrubs?

After completing this activity, I will be able to...

<b>NGSS Practice 4</b>	<b>Level 1</b>	<b>Level 2: all of level 1 and...</b>	<b>Level 3: all of level 2 and...</b>	<b>Level 4: all of level 3 and...</b>
Analyzing Data	Create graphs to show the combined data from all students.	Explain what the data in my graphs mean and how they are organized.	Use my graphs to determine the phenophase for my site and explain how I came to my answer.	Identify aspects of the data that help to understand the data, which could include the spread of the data, any interesting points or groups of data, or outliers in the data.

*Once you have completed the activity, circle the highest level that you achieved. Draw a star next to the evidence in the student notebook that shows that you did this.*

In the space below, draw the graphs of your combined class data (place a dot over the phenophase that each fieldwork team observed):

**Phenophase at the Field Site (native shrubs)**

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Spring: No leaves (Fall) (Full leaves)	Breaking leaf bud (Colored leaves)	Full leaves (Falling leaves)
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**Phenophase at the Field Site (invasive shrubs)**

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Spring: No leaves (Fall) (Full leaves)	Breaking leaf bud (Colored leaves)	Full leaves (Falling leaves)
---	---------------------------------------	---------------------------------

Use your graph to answer the following questions:

1. How spread out is the data? Did most groups observe the same phenophase or was it different for each group?

2. What are some reasons that different groups might have observed different phenophases? List as many as you can think of.

3. Which category has the most data points? The least?

4. Are there any points that stand out because they are different from the others? Are there any seem questionable?

**Assess:** What conclusions can you draw about the phenophase of native and invasive shrubs at your field site? What evidence supports your conclusions?

**Reflect:** Did sharing results with your classmates change your thinking? Would your thinking would change if everyone in the school went out to monitor shrubs in your area? Everyone in the town? Explain.

**Think Ahead:** What would you do to find out if phenology is changing over time as our climate changes? What steps would you take to try and find out?

**Lesson 8: Draw Conclusions:**

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

After completing this this activity, I will be able to...

<b>NGSS Practice 7</b>	<b>Level 1</b>	<b>Level 2: all of level 1 and...</b>	<b>Level 3: all of level 2 and...</b>	<b>Level 4: all of level 3 and...</b>
Engaging in argument from evidence	Use the information that I gathered to make a clear claim about my research question.	Support my claim with evidence from the data and explain why I think the data supports my claim. Connect my findings to the background research that I conducted and explain the significance of my claim.	Explain how confident I am in my claim, considering factors that that might have impacted my data, possible sources or error, natural variability in the data, and/or the amount of data collected.	Explain how I ruled out other possible claims. I can pose additional questions for future study to help me investigate further.

*Once you have completed the activity, circle the highest level that you achieved. Draw a star next to the evidence in the student notebook that shows that you did this.*



**Research Question:**

*I am investigating...*

**Claim:** *Through my investigation, I found that...*

**Evidence:**

*The data that supports my claim is...  
My claim is based on the following evidence...  
I observed that...  
I noticed from the data that...*

**Evidence:**

*The data that supports my claim is...  
My claim is based on the following evidence...  
I observed that...  
I noticed from the data that...*

**Evidence:**

*The data that supports my claim is...  
My claim is based on the following evidence...  
I observed that...  
I noticed from the data that...*

**Reasoning:**

*This evidence supports my claim because...  
This evidence suggests that...  
This evidence connects to what I already know about...*

**Discussion:**

How confident are you in your conclusion? Explain.

*Even though my results are strong, some factors might have impacted my data, like...*

*I do not have enough evidence to make a strong conclusion because...*

Is there evidence to support a different claim? How can you rebut or explain opposing evidence?

*Some people might interpret my evidence to mean... but I ruled out this explanation because...*

Why are your findings important?

*These findings are important because they could impact...*

If you were continuing to investigate this topic, what would your next steps be?

*To further this investigation, I would...*

*As a result of this study, new questions to investigate have come up, such as...*

## Mission: Native vs. Invasive Shrub Phenology Rubric

	<b>Level 1 (Beginning)</b>	<b>Level 2 (Developing)</b>	<b>Level 3 (Meets)</b>	<b>Level 4 (Exceeds)</b>
	<i>I can...</i>	<i>I can do all of level 1 and...</i>	<i>I can do all of level 2 and...</i>	<i>I can do all of level 3 and...</i>
Practice 3: Planning and Conducting Investigations	Describe an investigation that addresses my research question.	Describe the data used to address my research question, the materials needed, and a procedure that is clear and detailed enough to be replicated.	Describe how to record the data, including specific measurements and observations to be collected.	Describe the thinking that went into gathering <i>reliable</i> data, including collecting data from multiple sites or multiple times, controlling variables, or random sampling.
Practice 4: Analyzing and Interpreting Data	Record the data that I collected following the mission protocol.	Create visual representation that makes my data understandable, like a graph, table, or other figure that is scaled, labeled, and accurate.	Choose an appropriate graph, table, or figure that organizes the results in a way that helps address the research question. I can explain the information in that graph, table, or figure.	Identify aspects of the data that help to understand the data, which could include the range, mean, median, mode, the spread of the data, any interesting points or groups of data, or outliers in the data.
Practice 7: Engaging in Argument from Evidence	Use the information that I gathered to make a clear claim about my research question.	Support my claim with evidence from the data and explain why I think the data supports my claim. I can connect my findings to the background research that I conducted and explain the significance of my claim.	Explain how confident I am in my claim, considering factors that that might have impacted my data, possible sources or error, natural variability in the data, and/or the amount of data collected.	Explain how I ruled out other possible claims. I can pose additional questions for future study to help me investigate further.
Practice 8: Obtaining, Evaluating and Communicating information	Gather background information on my topic.	Locate reliable information from multiple sources that connects to my research question and cite my sources accurately.	Use my research to explain how my question builds on or contributes to existing scientific knowledge and to form a prediction about my results.	Explain the importance of my research to me, my local community, or to the larger scientific community.