Rusty Patched Bumble Bee: A Beacon of Hope

budburst
A project of the Chicago Botanic Garden

Ecosystems Unit Overview: Plants, Pollinators, & People

Fourth Grade: Plant Structures and Functions

Driving Question(s):

How can we create a pollinator friendly garden?
Will all of the plants in our garden be attractive to the pollinators?

Nativars Research Question: Should we include nativars in our research gardens?

Time needed

Core Activities: five lessons requiring 5 to 8 45-minute periods
Supplemental Activities: five lessons requirng 6-10 45-minute periods. Supplemental activities provide additional supporting NGSS aligned content, but are not required to complete the unit.

Lesson Overview

	Lesson	# of Classes	Title	Description
Core	1	1-2	Along the Railroad Tracks	Introduce the storyline, informal observations of pollinators in the Nativars garden
Core	2	1-2	Fabulous Flowers Dissection	Flower dissection, and characteristics of flowers that attract pollinators
Core	3	1-2	Patient Pollinator Count 1	Pollinator data collection
	4	1-2	Plant-Pollinator Match-Up	Match flowers to their pollinators
	5	1-2	The Perfect Pollinator	Design challenge: students design the perfect pollinator for their chosen flower
	6	1-2	Patient Pollinator Count 2	Pollinator data collection – round two
	7	1-2	Flower Know How – The Perfect Flower	Design challenge: students design the perfect flower for their chosen pollinator
	8	2-3	How does your Garden Grow?	Observe the habits and preferences of native bees, design a bee-friendly garden based on data
Core	9	1-2	Plotting Plants and Pollinators	Data Analysis
Core	10	1-2	What will we do for the Rusty Patch Bumble Bee?	Drawing conclusions and proposing solutions

Contents

1. Storyline

Scientist Role For Your Students

For the next few weeks each of your students will take on the role of a scientist. As participants in a community science project - Budburst Nativars Research Project – your students will be collecting *real* data and contributing to *authentic* research. This provides a framework for them to see themselves as *legitimate* scientists! As the teacher, you have the unique opportunity to model the processes, resources, skills, procedures, and patience required to DO science. Consider yourself an onsite head researcher mentoring this year's crop of new scientists.

Scientists look at phenomena and ask questions about what they observe. They develop questions that can be answered by evidence, i.e., research. So let's start with a phenomenon your students have most likely heard about: declining numbers of pollinators.

NOTE: This curriculum was developed using an NGSS storyline/anchor phenomenon aligned to the NGSS (Next Generation Science Standards) standards for the fourth grade. There are resources listed in the Reference List for educators wishing more information about this method for designing a curriculum.

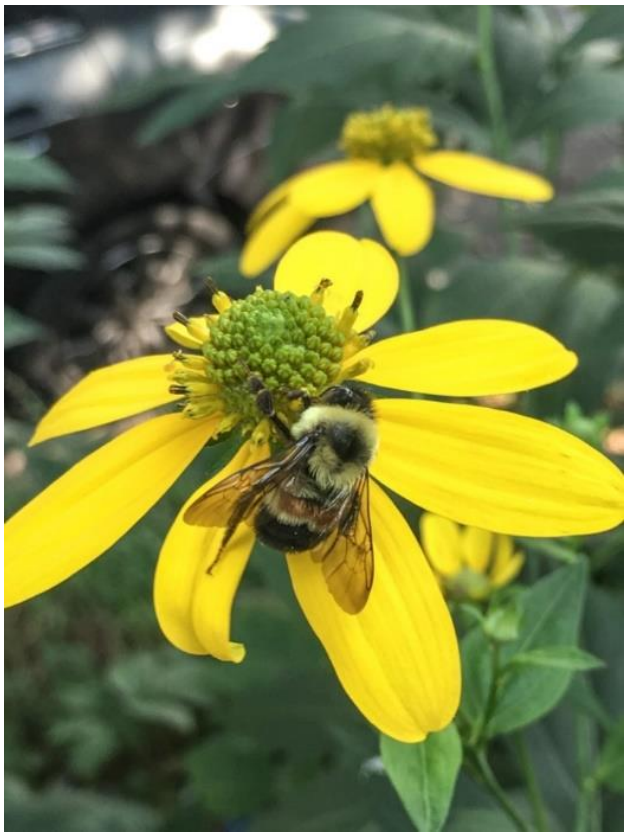
Anchor Phenomenon/Storyline

The rusty patched bumble bees live in colonies that include a single queen and female workers. Colonies produce males and new queens in late summer. They once occupied grasslands and tallgrass prairies of the Upper Midwest and Northeast. Bumble bees need areas that provide nectar and pollen from flowers, nesting sites (underground and abandoned rodent cavities or clumps of grasses, and wintering sites for hibernating queen in soil that is left undisturbed all winter). They are among the first insects to emerge in the spring and the last to go into hibernation. With the overuse of chemical fertilizers and pesticides, intensive farming, and habitat loss, we have caused the rusty patched bumble bees to decline to the point that they are now on the endangered species list. The rusty patched bumble bee was the first bumble bee listed and was officially added to the list on January 11, 2017.

When a rusty patched bumble bee is discovered, you can imagine it is huge news. This happened not too long ago in Chicagoland. A graduate student at Northwestern University is completing her research on wild bee communities and how urbanization may be influencing wild bee communities in Chicago. Andrea Gruver has been collecting data on wild bees along railroad tracks of Chicago's Union Pacific North Metra railway. She monitors eight sites that follow a perfect gradient from very urban to very suburban. On one of her 'stake outs,' she discovered the Rusty patched bumble bee living there and had survived and seemed to be thriving. **Here is her story about her discovery:**

Finding the Endangered Rusty Patched Bumblebee

By: Andrea Gruver



Over the summer of 2018, I had been conducting bee research around the City of Chicago to help us understand how cities may be impacting bees. I spent 32 days outside observing bees but there is one day in particular that will always stand out to me.

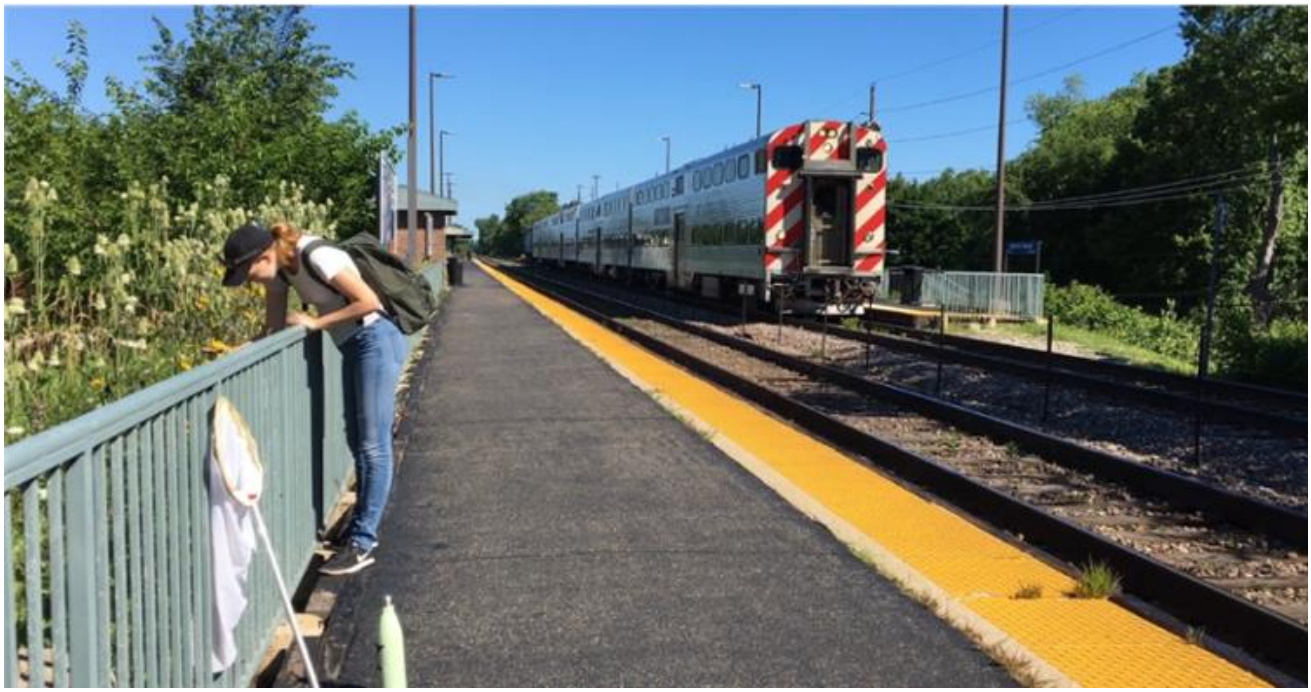
Bees today face a multitude of threats and have been declining around the world. This is what led me to do my research; I wanted to know exactly what bees we find in the city and what it is about those bees that allows them to survive in such harsh urban environments. When I was creating my research project, I heard about the rusty patched bumble bee (*Bombus affinis*), a bee that has been declining dramatically in recent years. Historically, the rusty patched bumble bee was abundant across the eastern United States, but due to habitat loss, pesticides, and disease, the rusty patched bumble bee is only found in 0.1% of its historical range. Many think the rusty patched bee may be near extinction. In 2015, the rusty patched bumble bee was the first bee species to be listed as federally endangered in the United States. I had been told that the chances of me finding a rusty patched bumble bee during my research were extremely slim, but I always thought about how amazing it would be if for some spectacular reason I came across one.

It was August 19th 2018, and my very last day of field work. Up to this point I had observed over 2,000 bees of 77 different species around Chicago, more than I ever imagined. I had one field site left to visit, Rogers Park. It was a perfect day for observing bees, the sun was out and there wasn't a cloud in the sky. Between the Rogers Park Metra train station and the road, sits a small patch of lush green plants; this was my field site. It was not a beautiful pristine garden or prairie, yet I always saw lots of bees here. The bees always managed to find plants even when surrounded by the bustling city. After my field intern and I prepared our data sheets, I took my butterfly net out and began to net bees. I swooped my net over some blooming sweet clover and looked into my net. I caught a bumble bee, and I suspected it would be a common eastern bumble bee—I always caught tons of those at Rogers Park. But as I looked in my net, I took a double take. There was a rusty orange patch on its abdomen. I paused in shock. It couldn't be a rusty patched, could it?

I called my intern over to take a look; he agreed, it had the famous rusty patch on its abdomen. I let the bee go, and it quickly returned to foraging for nectar on some nearby plants. I followed it taking photos in awe. It was what everyone said I wouldn't find, especially in the city, but here it was. When I didn't think it could get any better, I saw another rusty patched bumble bee foraging on nearby sunflowers. Against all of the odds and all of the threats, these rusty patched bumble bees found everything they needed in this small weedy patch of flowers

next to the train, and to me that was incredible. I left on that last day of field work with hope that maybe, just maybe, the rusty patched bumble bee might be able to make it in the big city.

If you would like to help the rusty patched bumble, you can plant native plants such as milkweeds, prairie clovers, coneflowers, bee balm, and blazing stars. If you think you see a rusty patched bumble bee you can report your sighting at bumblebeewatch.org.



Note: The above firsthand account provides a locally generated positive storyline for Illinois schools about the disappearing rusty patched bumble bee, its interdependence to prairie plants, and how its population is dramatically impacted from extreme habitat loss. There may be similar stories that can be found online for different areas of the country. If you are not in Illinois, consider choosing a local story about how a group or community has banded together to make a difference as 'community scientists' in order to save endangered or threatened plant and/or animal species for specific habitats.

This is the storyline that will connect the Nativars Research Garden to the NGSS Life Science standards fourth graders. The phenomenon being modeled or explained here is how vitally important prairie plants (and native plants in general) are to the survival of many pollinators (specifically the rusty patched bumble bee), and how important native plants (and potentially their nativars) are vital to the existence of pollinators as their source of food (nectar). A poster size photo of a rusty patched bumble bee and a honey bee might be hung in the classroom during this unit.

How to use this storyline in the classroom to generate interest in the unit and to engage students in becoming community scientists will be explained in Lesson One. There are 10 individual lessons in this Unit.

2. Unit Overview: Curriculum structure and standards alignment

Curriculum Structure: The curriculum is made up of ten total activities that take approximately 2-3 weeks to complete, 45 minutes/day. Activities are divided into five core activities and five supplimental activities that provide additional NGSS aligned supporting content. Core activities can be completed as a stand alone unit and will take seven-nine 45 minute periods to complete.

Grade: 4	**Time Recommendations**: class periods
Central Focus: Students will be community scientists in this unit and learn how real scientists make observations (collect data) in order to answer a research question. They will practice making observations.	**Student Objectives – students will know and be able to**: 1. Make observations of important flower and plant features. 2. Collect data on the movements of pollinators. 3. Explain why scientists need evidence to support claims made in research questions.
Essential Question: How/why do plants attract/ need pollinators?	

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Alignment with "The Next Generation Science Standards" (NGSS)

Performance Expectations

Fourth Grade: Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproductions. (4-LS1-1)

Clarification Statement(s)

Fourth grade: Examples of structures include thorns, stems, roots, colored petals, skin, legs, etc.

Assessment Boundary

Fourth grade: Assessment is limited to macroscopic structures within plant and animal systems.

Common Core Connections

Fourth Grade - ELA/Literacy - W.4.1 – Write opinion pieces on topics or texts, supporting a point of view with reasons and information. (4-LS1-1)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Fourth Grade: Engaging in Argument from Evidence 3-5 builds on K-2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). Construct an argument with evidence, data, and/or a model. (4-LS1-1)	**Fourth Grade: Structure and Function** Plants and animals have both internal and external structures that serve various functions (in growth, survival, behaving, and reproduction (4-LS1-1)	**Fourth Grade: Systems and System Models** A system can be described in terms of its components and their interactions. (4-LS1-1), (4-LS-2)

Lesson Format

Each lesson is written up in the 5 E science lesson format below (*Engage, Explore, Explain, Extend, and Evaluate*). For schools unfamiliar with the 5 E Inquiry Science Lesson Model, please see the Reference List for resources. (Also, other verbiage has been added below to provide context to other lesson plan models.)

- **Engage** (Inquiry/Anticipatory Hook/Opening/Activate Prior Knowledge/Create Interest/Orient to Content)
- **Explore** (Conceptualizing Concepts/Student Activities/Instructional Strategies and Learning Tasks/Development of the Concept)
- **Explain** (Checking for Understanding/What the students are doing to construct meaning and what the teacher is doing to facilitate the process)
- **Extend** (Applying New Knowledge/Guided Practice/Independent Practice)
- **Evaluate** (Closing/Exit Slip/Wrap Up/Tie Up the Lesson/Provide Cognitive Closure)

Each lesson will have the following components

1. Central Focus, Time Recommendations, Student Objectives, and Essential Question in the format below

Grade: 4	**Time Recommendations: Number of class periods**
Central Focus: Describes the main activities of the lesson.	**Student Objectives** – students will know and be able to…Describes student outcomes
Essential Question(s): Describes the driving questions for the lesson	**Notes:** any additional implementation information

2. Vocabulary list

Unifying Vocabulary Used throughout the Unit

Pollination, pollinator, native plant, nativar, cultivar, observation, data collection, research question, pollinator behavior, flower characteristic(s), community scientist

Every lesson will have a set of vocabulary words that will be used during that lesson's activities. Students could create vocabulary cards using index cards. Some of the terms are repeated in several lessons are listed above. The aim is **not** for students to memorize definitions and spellings, but for students to know when and how to use them in their writings and hands-on activities. Having students make vocabulary cards and practicing reviewing them on a daily basis (or playing games like Kagan's "Quiz, Quiz, Trade") will help reinforce their understandings of the concepts being learned in this Life Science Unit as well as provide familiarity with the terms to make it easier to make connections when problem-solving and using critical thinking skills.

3. Materials list

- Each lesson will have its own list of materials needed in order to conduct the activities. Some materials should be on hand for all of the activities. These include a student spiral that can be used as their science journal, writing utensils, rulers, scissors, hand lenses, construction paper and typing paper.
- Some lessons will need access to:
    - Magnifying lenses
    - Nativars School Garden or an area around the school with flowering plants, OR video clips of pollinators interacting with flowering plants.
    - For the flower dissection: Enough *Alstroemeria* (Peruvian lilies) so that each student will have an individual flower. Note: There are several flowers on each stem. They are found in the florist section of most grocery stores.

4. Advance Preparation and Teaching Tips

Every lesson will have this section completed for that specific lesson.

5. Pre-teaching/Background Knowledge/Misconceptions

Sometimes this section will have information about student misconceptions and sometimes there will be ideas for how to pre-teach the lesson.

6. Formal and/or informal assessment suggestions

- Informal Assessments are Assessments FOR Learning -Evidence of Student Learning during a lesson, using probes, questioning, quick checking for understanding strategies to help inform teaching as a lesson progresses.
- Formal Assessments are Assessments OF Learning – evidence that students mastered the student learning objectives for the lesson or unit.

7. Additional Resources

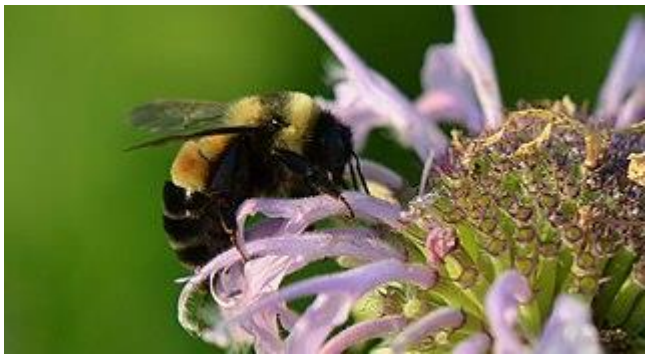
Teacher and student resources including background information, links, and references.
Every lesson will have this section completed for that specific lesson.

For more information about the rusty patched bumblebee:

- http://www.rustypatched.com/ - Twenty (20) minute documentary about the rusty patched bumblebee – Excellent introduction that could be shown in class on a day when you can't go out for an observation.
- https://www.fws.gov/midwest/endangered/insects/rpbb/pdf/RPBBFactSheet10Jan2017.pdf Descriptive handout from the Fish and Wildlife Service (FWS).
- https://news.nationalgeographic.com/2017/03/bumblebees-endangered-extinction-united-states/ - announcement that the rusty patched bumblebee is listed as 'endangered.'

Additional Background Information for Teachers: Using a real life phenomenon for the Storyline

Meet the rusty patched bumblebee!



The rusty patched bumblebee (*Bombus affinis*), which once thrived across the eastern United States, has declined to the point where it is threatened with extinction. In 2017 it was placed on the federal endangered species list. There were four confirmed sightings in Lake County (Illinois) in 2017. That's not too long ago: it might be possible to see a rusty patched bumblebee in your school garden!
Historically, the rusty patched bumblebee was broadly distributed across the eastern United States and Upper Midwest. Its range included 28 states and 2 provinces in Canada. However, in the past 20 years this bumblebee population has declined significantly. Since 2000, it has been reported only in northeastern Illinois, 12 other states, and one Canadian province.
As pollinators, rusty patched bumblebees contribute to our food security and the healthy functioning of our ecosystems. Bumblebees are keystone species in most ecosystems, necessary not only for native wildflower reproduction, but also for creating seeds and fruits that feed wildlife as diverse as songbirds and grizzly bears. Bumblebees are among the most important pollinators of crops such as blueberries, cranberries, and clover, and they are almost the only insect pollinators of tomatoes.

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- https://www.fws.gov/midwest/endangered/insects/rpbb/pdf/RPBBFactSheet10Jan2017.pdf Descriptive handout from the Fish and Wildlife Service (FWS).
- https://news.nationalgeographic.com/2017/03/bumblebees-endangered-extinction-united-states/ - announcement that the rusty patched bumblebee is listed as 'endangered.'

What can be done to help the rusty patched bumblebee? What do these bees need in order to survive? What do we need to understand about eco-systems, habitats, and how pollinators interact with the plants and animals in those habitats? How do the structures and functions of pollinators like the rusty patched bumble bee help certain native flowers and their nativars get pollinated? How have humans interfered with the pollination process? How can we help? These are just a few of the questions your students may have that will add to the interest and engagement during this unit. The main anchor phenomenon is our story from Andrea Gruver, a Master's Degree candidate, (Plant Biology & Conservation, Northwestern University, and the Chicago Botanic Garden) who tells us in her own words of her encounter with her first rusty patched bumble bee while doing her research observations out in the field. Secondary storylines will be shared from time to time as they will make connections to the Budburst Nativars Research Project, and they can be related back to this our anchor phenomenon.

Connecting Bumble bees and other pollinators to Budburst Nativars:
There are 21 species of bumblebees in the eastern United States. All of them are experiencing declining habitat or fragmentation of habitat. Scientists, naturalists, and researchers are concerned about this decline and have some suggestions for people who want to help these bees. For example, the U.S. Fish and Wildlife service (https://www.fws.gov/midwest/endangered/insects/rpbb/plants.html), publishes a list of plants that provide nectar support to the rusty patched bumblebee. Two of these plant species are included in the Budburst Nativars research project.

- *Penstemon digitalis* (Foxglove Penstemon) is one of several plants that provides nectar for bumblebees during the summer months.
- *Symphyotrichum novae-angliae* (New England aster) provides a generous display of blossoms during the fall months when the number of nectar producing plants is considerably smaller. A wide variety of pollinators feed at the aster blossoms. This is particularly important for rusty patched bumblebees, as the queen feeds vigorously prior to her winter diapause (a type of hibernation).

More information about Andrea Gruver can be found on her Northwestern website at:
https://www.plantbiology.northwestern.edu/people/graduate-students/andrea-gruver.html

Also, check out the online new article she wrote about her research at:
https://www.chicagobotanic.org/blog/plant_science_conservation/bees_big_city

The Human Connection to Plants and Pollinators:
One of the problems affecting native bee decline is destruction of their habitat. So researchers suggest we grow native plants to help the native bees. But usually when one goes to the local plant nursery, salespeople are unfamiliar with the terms native species, cultivated species, and nativars. They, perhaps unintentionally, interchange plant species using all three terms.

Here is a secondary storyline that might be included in one of the lessons for this unit:

We are Budburst scientists (students, teachers, and anyone observing plants and pollinators to collect data for the Budburst project) who have created a Nativars Research Garden. We decide to add some New England asters to our garden, so at the local garden store we tell the salesperson what we want. "Hello! Can you help us find the native New England Asters? We would like to plant some in our garden."

Salesperson: "Sure. What color do you want? We have 'Purple Dome,' 'Harrington's Pink,' and 'Vibrant

Dome.’”

You explain: “We want to help the bumblebees. Which color do they like?”

The salesperson cannot answer that question. Why? Perhaps no one knows for sure. No one has asked the pollinators! Maybe bees see colors differently from humans. Possibly bumble bees like all flowers equally. The salesperson may not even know that the names of the New England asters indicate whether they are native plants or cultivated species. That’s why we need your help. The Budburst Nativars Research Project needs you and your students to be scientists and help to answer all of the questions and especially to answer this question:

Do pollinators prefer cultivators of native plant species (nativars) or true native plants?

3. Lesson Summaries

Unit: Rusty Patched Bumble Bee, A Beacon of Hope

Lesson 1: Along the Railroad Tracks (Core)
Students will be introduced to Andrea Gruver: Master's Degree Candidate, Plant Biology and Conservation, Northwestern University and the Chicago Botanic Garden. She was doing her research on native bees in Illinois along the railroad tracks in Rogers Park, Illinois (a Chicago neighborhood), when she happened to be visited by what some scientists think is a nearly extinct species of bee – the rusty patched bumble bee. She will tell her story in her own words, and that will begin our students' thinking about how they might create those circumstances that will encourage more visits from these vanishing critters. Then students will put on their community scientist hats and learn about data collection guidelines (that will scaffold into protocols in lesson 3) as they make their first, informal observations in their Native Research Gardens, local school garden, or through observing pollinators on a video clip.

Lesson 2: Fabulous Flowers: Flower Dissection (Core)
Students will have the opportunity to take apart a complete flower in order to identify all of the main parts, and then they will make connections between plant parts and their functions especially as they learn about the process of pollination and how flowering plants need pollinators in order to create new generations of plant life. Students will start to think about how the plant flower parts are arranged and why they have available nectar, scents, colorations and markings, shapes, etc., in order to attract specific pollinators to them.

Lesson 3: Patient Pollinator Count 1 (Core)
In your school yard or Nativars Research Garden, students will watch a plant for 10 minutes to observe pollinator visits. They will follow a sequence of steps (a protocol) in order to make scientific observations to determine how many, and what types of pollinators visited their plants. They will be able to respond to questions like, "In what habitat is your Nativar Research Garden located?" Or "How have these plants and animals (animals as pollinators) adapted to your habitat?" (If the weather is inclement OR there are no flowering plants available, use the available video clips (see Unit Resources, p 13) to take the place of actual outdoor observations.)

Repeat this activity at least once a week while the plants are flowering. Later, you will use the "Plotting Plants & Pollinators" lesson activity to help students organize, visualize, and present the collected data. Students will participate in real scientific research.

Lesson 4: Plant-Pollinator Match Up
In this activity, students will match flower forms to pollinators and defend their decisions. Related files include the Plant Pollinator Cards and the Plant Pollinator Sheet (for teachers).

Lesson 5: The Perfect Pollinator Plucker
In this lesson, students will practice an engineering design process to design and build the perfect pollinator plucker –maybe even one that is phantasmagorical (a bizarre or fantastic combination, collection or assemblage- according to Merriam-Webster). This lesson lends itself to differentiation. The teacher can decide to have all of the students use the same storyline and problem to design a way to pollinate the Hawaiian Alula, or students

could be asked to make up their own narrative and think of a new pollinator/flower relationship that they want to address. Would a hummingbird AND a bee be able to pollinate the same flower? Do they want to design a stick that will be suitable for one type of flower, or do they want to create one that is able to pollinate multiple types of flowers? These considerations (constraints) should help define the design they will sketch and build. Then they will test out their prototypes to see how effective they are in transferring pollen from one flower to another. They will determine all of the constraints and criteria for success, test their prototypes, and consider changes/revisions to their initial prototypes. In this process, students will be reviewing how the process of pollination works as they consider specific pollinator characteristics.

Lesson 6: Patient Pollinator Count 2
This is at least the second time to get outside and observe pollinators while the plants are flowering. (You will use the "Plotting Plants & Pollinators" lesson activity to help students organize, visualize, and present the collected data.) Students will participate in real scientific research. In your school yard or Nativars Research Garden, watch a plant for 10 minutes. How many, and what types of pollinators come to your plant? Is that different from what other students/teams saw? Report and suggest why you saw differences.

Lesson 7: Flower Know How: The Perfect Flower
In this activity, students will build and defend a model of what they perceive to be the perfect flower to match their selected pollinator. This activity builds on their new knowledge of the parts of plants and how plants and pollinators have mutually beneficial structures and relationships.

Lesson 8: How Does Your Garden Grow?
In this lesson, students take another look at specific pollinators in their Nativars Research Garden. This time they are honing in on native bees, looking at how the bees are interacting with the various flowers. Do the bees seems to favor specific colors? Are the flowers a variety of sizes or do the bees tend to favor larger flowers or ones with odd petal arrangements? They will add these observations to their notebooks and create a new garden specifically for bees. Their personal gardens will include native flowering plants for all the growing season, so that bees will always have a source of food (nectar). They will then sketch their garden plots and label them with the plants they think will attract the most bees.

Lesson 9: Plotting Plants & Pollinators (Core)
Students make sense of collected data. Organize the data and create bar charts showing numbers of visits from which pollinator groups. Comparing native plants to the cultivated plants, students make claims and defend them using the evidence they have collected. If students will be completing the suggested final assessment, use this activity as the basis for poster sessions at a Nativars-specific, Community Science Symposium**.**

Lesson 10: What Will We Do For Rusty & Its Pollinator Friends? (Core)
This is the culminating lesson of the unit. Students have learned the parts of flowers and their preferred pollinators, how the flower parts are specialized to help specific pollinators get food, and how the pollinators' bodies have evolved to pick up pollen and deliver it to the pistils of flowers. Students learned that many native bees and other pollinators are threatened because of loss of habitat, often caused by the needs of humans for more land to farm, build homes, and start industries. This final lesson allows student to consider ways they can give nature a helping hand. They will suggest their own research questions and showcase their understandings through a poster presentation.

4. Unit Resources:

The following are extra resources that may be useful to you during completion of this unit:

1) **Pollinator Videos from Chicago Botanic Garden:**
   Students can use videos (linked below) to practice their pollinator identification skills and the Budburst Nativars data collection protocol. These videos can be used in lieu of outside observations on your Nativars gardens during bad weather, etc.
   - https://youtu.be/VfQaVDr9TGE (3 minute video)
   - https://youtu.be/xdJFXZFLOb8 (10 minute video)

2) **Life-size paper poster of the Rusty Patched Bumble Bee** (see next page)
   Hang this up in your classroom as a reference for students as they discuss the rusty patched bumble bee throughout the unit.

3) **Plant Guide with Images** (also downloadable under Unit Resources on the curriculum page)
   This page includes images of the native species and their cultivars (nativars) planted in Nativar gardens in the Midwest. (e.g. aromatic asters, black-eyed susans, etc.)

4) **Pollinator ID Activity**
   Test your ability to identify different types of pollinators with the Pollinator ID game! Review the ID guide and the characteristics of each, and then see if you can identify each of the pollinators in the photos provided. This activity can help prepare students for their observations in Lesson 3.

5) **Pollinators and Nativars: What's the Buzz (Powerpoint)**
   This Powerpoint explains why pollinators are important, how nativars are created, what characteristics appeal to different pollinators, and how to identify different pollinator types . Use as background information, or present as a lesson for your students.

Reference List

Resources for using storylines and the NGSS standards

Next Generation Science Storylines at: http://www.nextgenstorylines.org/

Questions to Guide the Development of a Classroom Culture That Supports "Figuring Out" at: https://static1.squarespace.com/static/56ef1da37da24f301fccaacd/t/594e94c659cc68f8dfc57ede/1498322119719/Five+Questions+To+Guide+3DL+Units.pdf

The next page is a life-size paper poster of the Rusty Patched Bumble Bee that can be used as a poster.

Rusty Patch Bumble Bee (*Bombus affinis)*