



Community Science Liaison

Geological Bumblebee

Teacher's Guide





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Program Overview

The Geological Bumblebee Project gets students to engage with and work towards answering two essential questions:

- 1) How are Bumble Bees threatened in Alberta and what role do I play?
- 2) What can geology tell me about the place I live?

In part 1 of the program, our team will visit your school, provide materials, and help students construct bumblebee boxes. These boxes act as homes for bumble bee colonies and provide your students with the exciting opportunity to study local populations. Students will participate in a field trip to a local park in spring to install the bumblebee boxes and learn about the geology of that particular place.

Part 2 of the program is data collection. In fall, students will return to their local park to retrieve the boxes and find out if bumblebees occupied them. Only the juvenile queen bee leaves the colony to find a new home to hibernate over the winter. The rest of the bumblebee colony does not overwinter, so students can safely open their boxes to see the empty cells inside. While on the field trip, students will also each collect a rock to study back in the classroom.

Philosophy

The Geological Bumblebee Project has 5 aims:

- 1) Empower students through citizen science and prevent the development of science/math anxieties
- 2) Connect students with scientists who bring passion to their field and can be role models and mentors, creating strong communities between post-secondary education, K-12 education, and families
- 3) Encourage students to pursue STEM in their futures (Science, Technology, Engineering, and Mathematics)
- 4) Get children outdoors and involved in environmental stewardship
- 5) Engage students within the Alberta science curriculum



Curriculum Connections

The Geological Bumble Bee program connects to the Albertan curriculum, and we encourage teachers to extend their learning from the program with further inquiry back in the classroom. The below are applicable to the Alberta program of studies science outcomes with connecting questions to guide further inquiry.

Curricular Links

Bumblebee Component
Geology Component

Division 1

Grade	Outcome	Connecting Questions
1	Topic B: Seasonal changes 1-6-2 Identify and describe examples of plant and animal changes that occur on a seasonal basis	How does bumblebee behaviour change with the seasons?
	Topic D: Senses 1-9-3 Apply particular senses to identify and describe objects or materials.	What do my senses tell me about my rock?
	Topic E: Needs of animals and plants 1-11-10 Give examples of ways in which animals depend on plants and ways in which plants depend on animals	Why do bumblebees need plants? Why do plants need bumblebees?
2	Topic C: Magnetism 2-8-3 Recognize that magnets attract materials with iron or steel in them; and given a variety of metallic and nonmetallic objects, predict those that will be attracted by a magnet.	How do I know when a rock is magnetic?
	Topic E: Small Crawling and Flying Animals 2-10-3 Recognize that small animals, like humans, have homes where they meet their basic needs of air, food, water, shelter and space; and describe any special characteristics that help the animal survive in its home. 2-10-5 Describe the relationships of these animals to other living and nonliving things in their habitat, and to people.	What makes the bee boxes good homes for bumblebees? Why do people need bumblebees?
3	Topic A: Rocks and Minerals 3-5-2 Given a description of the properties of a particular rock or mineral, identify a sample rock or mineral that matches those properties.	What are the properties of my rock? How do I know?



	3-5-3 Describe and classify a group of rocks and minerals, based upon the above properties.	What rock group does my rock belong to?
	Topic B: Building with a Variety of Materials 3-6-5 Identify the intended purpose and use of structures to be built, and explain how knowing the intended purpose and use helps guide decisions regarding materials and design.	How will bumblebees use the bee boxes? How does that affect how they are built?
	Topic E: Animal Life Cycles 2. Observe and describe the growth and development of at least one living animal, as the animal develops from early to more advanced stages.	What is the life cycle of bumblebees?

Division 2

Grade	Outcomes	Connecting Questions
4	Topic D: Light and Shadows 4-9-5 Describe changes in the size and location of Sun shadows during the day-early morning, to midday, to late afternoon.	What effect does sunlight have on a bumblebee living in this box?
	Topic D: Light and Shadows 4-9-8 Classify materials as transparent, partly transparent (translucent) or opaque.	Which of these minerals are transparent, translucent, or opaque?
	Topic E: Plant Growth and Changes 4-10-6 Recognize that a variety of plant communities can be found within the local area and that differences in plant communities are related to variations in the amount of light, water and other conditions.	What are the native plant species here? Which ones are invasive species? How might this affect the bumblebee?
5	Topic C: Classroom Chemistry 5-7-6 Produce carbon dioxide gas through the interaction of solids and liquids, and demonstrate that it is different from air. 5-7-8 Recognize and describe evidence of a chemical reaction. Explain how the products of a reaction differ from the original substances	Why does limestone fizz when we add hydrochloric acid? What products are being formed? Why?
	Topic D: Weather Watch 12. Recognize that human actions can affect climate, and identify human actions that have been linked to the greenhouse effect.	Does climate change affect bumblebees?



	Topic E: Wetland Ecosystems 11. Recognize that changes in part of an environment have effects on the whole environment.	How would changes in bumblebee populations impact the local and extended environment?
6	Topic D: Evidence and Investigation 4. Investigate evidence and link it to a possible source	Where does my rock sample come from? How did it get here?
	Topic E Trees and Forests 6-10-1 Identify reasons why trees and forests are valued. 6-10-6- Describe and classify leaf shapes, leaf arrangements, branching patterns and the overall form of a tree. 6-10-10 - Identify an issue regarding forest use, identify different perspectives on that issue, and identify actions that might be taken.	Why does this area serve as a habitat for the bumblebee? What are the characteristics of the trees found here? How can we protect the habitats of bumblebees?

Division 3

Grade	Outcomes for Science, Technology and Society (STS) and Knowledge	Guiding Questions
7	Unit A Interactions and Ecosystems 1-3. identify examples of human impacts on ecosystems, and investigate and analyze the link between these impacts and the human wants and needs that give rise to them. 3-13. Monitor a local environment, and assess the impacts of environmental factors on the growth, health and reproduction of organisms in that environment investigate a variety of habitats, and describe and interpret distribution patterns of living things found in those habitats	In what ways are our actions impacting the bumblebee species that live here? Which location in the park had the most bumblebees use our boxes? Why might this be?
	Unit E Planet Earth 2-3. describe local rocks and sediments, and interpret ways they may have formed. 3-1. investigate and interpret patterns in the structure and distribution of mountain formations (e.g., describe and interpret mountain formations of the North American cordillera) 3-4. identify and interpret examples of gradual/incremental change, and predict the results of those changes over extended periods of time.	Where did my rock come from and how was it formed? What changes lead to my rock being discovered here? How will this area continue to change?
8	Unit B Cells and Systems 1-1. investigate and describe example scientific studies of	What species of bumblebee do we have in



	the characteristics of living things (<i>e.g., investigate and describe an ongoing scientific study of a locally-found organism</i>)	Alberta and this area?
	Unit E Freshwater and Saltwater Systems 2-4. identify evidence of glacial action, and analyze factors affecting the growth and attrition of glaciers and polar icecaps (<i>e.g., identify factors that affect the size of polar ice sheets and the Columbia Icefield</i>)	How do I know that ice sheets used to cover this area? What evidence is there?
9	Unit A Biological Diversity 1-3. identify examples of symbiotic relationships (<i>e.g., organisms that benefit other organisms by providing habitat, food, means of fertilization, or a source of oxygen</i>) classify symbiotic relationships as mutualism, commensalism, parasitism	What is the relationship between bumblebees and plants? People?
	Unit B: Matter and Chemical Change 1-2. describe and apply different ways of classifying materials based on their composition and properties	Which of these minerals are pure? How can you tell which rocks are formed from a variety of minerals?
	Unit C Environmental Chemistry 2-3. identify chemical factors in an environment that might affect the health and distribution of living things in that environment (<i>e.g., available oxygen, pH, dissolved nutrients in soil</i>) 3-5. identify and evaluate information and evidence related to an issue in which environmental chemistry plays a major role	How do we use this land? How might it affect Bumble Bees? What can we do to mitigate the effect of our actions? What factors are affecting bumblebee population? How do we know?
	Unit E Space Exploration 1-4. identify evidence for, and describe characteristics of, bodies that make up the solar system; and compare their composition and characteristics with those of Earth.	How are our rock samples similar to those found in the solar system? How are they different? What land formations do other planets have that are similar to ours?
	Unit E Space Exploration 2-5. describe the development of artificial satellites, and explain the major purposes for which they are used (<i>e.g., communication, GPS - global positioning system, weather observation</i>)	What is a GPS? How does it work? What information does it provide to us and why is it useful?



Construction, Installation, and Collection

Construction

During the classroom portion of the program, students cycle through three stations, which include a presentation about bumblebees, box construction, and a geology investigation.

Support: Students in Gr.1-3 will require support from either an older buddy (Gr.5+) or some parent volunteers to construct the boxes.

Space requirements: Construction ideally should occur outdoors, with an open classroom available as a back-up plan.

Length of each station: 45 min.

Max # of students: 20 per station.

Required materials: During the bumblebee presentation, we recommend teachers be ready with an additional activity for students, such as a read-aloud or bumblebee journaling activity in case the presentation runs faster than expected.

Installation

During installation, students will be split up into three groups, switching between box installation, rock collection and a geological nature walk. During the box installation, students will be placed into smaller groups with a parent volunteer.

Collection

In the fall, students will return to their local park to retrieve the bumblebee boxes that they installed. Students will rotate through three stations: collecting boxes, collecting a rock, and teacher-led activities. Each group will collect 1/3 of the boxes.

Logistics for Installation and Collection:

Support: Parent volunteers and/or older buddies for Gr.1-3 students.

Max size for each activity: 20 students.

Max size of small groups (within large group): 3 students + 1 buddy when necessary.

Required materials: For installation, students will require GPS worksheets, and for collection students will require questionnaires (these are found on p. 13). Students will also need a metre stick and compass during collection.



Expectations and What to Bring

Bumblebee boxes will be installed in a mix of environments. Some will be installed near walking paths, while other boxes will be installed off of paths and deeper into the trees. This allows students to collect a diversity of data, and investigate which environments bumblebees prefer. For this reason, students, teachers, and volunteers need to come prepared for the conditions.

Checklist

- ☐ Snacks and a healthy, zero-waste lunch
- ☐ Water bottle
- ☐ Rain jacket
- ☐ Layers (t-shirt, sweater, jacket)
- ☐ Hat and mitts during fall field trip
- ☐ Student journals
- ☐ Multiple pencils
- ☐ Extra activities during down-time (see Additional Activities)
- ☐ GPS for each group during installation (providing by us)
- ☐ Metre stick for collection
- ☐ Compass for collection
- ☐ Worksheets found beginning on p.13



Additional Activities

During the Geological Bumble Bee program there may be times that students are done ahead of other groups, so having backup activities that engage students with the nature around them will help the day run smoothly.

Below is a list of possible activities to conduct with students:

Journaling

Natural and man-made sounds.

- Students spread out and find a quiet spot to sit or stand. Taking 5-10 minutes, students listen to all the sounds that they hear around them, jot them down in their journal, and predict what is causing that sound. Ask students to consider what kind of sounds they hear. Natural? Living sounds (animals, insects, leaves, grass)? Non-living sounds (wind, rain)? Man-made?
- Bring students back together and discuss if any sounds were man-made. What do these sounds mean? How might they affect the animals in this place?
- Students can also organize the sounds they hear in a table:

Natural Sounds	Human Sounds	Sounds of Tools or Technology

Art

Exploring lines in nature.

- Brainstorm with students various types of lines (wavy, straight, zig-zag, curved). Students are then tasked to create a physical piece of art using the nature around them and experimenting with a variety of types of lines.

Science

Create your own park.

- Working individually or up to groups of three, each group will receive about 3-4 metres of string. Groups will use their string to create borders around an area of land that will become a mini natural park.
- Groups will take turns explaining their park to their peers, and why they chose it to put it in that place. Think: what animals might live here? What trees and plants are in your park?



Extra Lesson Plan Resources

Five Minute Field Trips: <http://www.abcee.org/five-minute-field-trips-activity-guide>

- This resource contains a variety of lesson plans to do with your students outdoors, ranging from 5 minutes to longer 30 minute tasks.

Nature Lynx App:

<https://naturelynx.ca/>

- Teachers and students can use the Naturelynx app to identify species, submit and view biodiversity sightings, create and complete missions, & collect data.

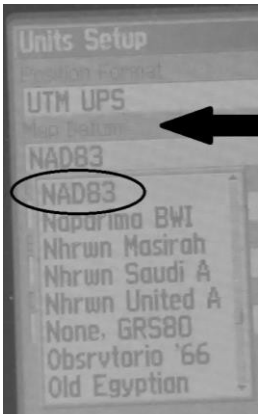


Installation and Collection Instructions

Installation

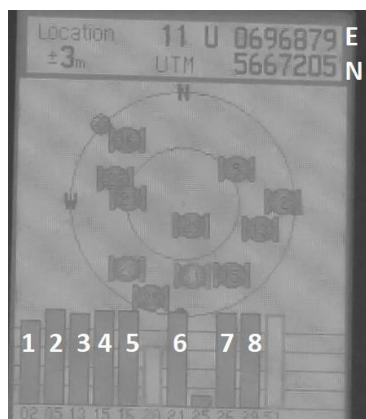
When installing the bumblebee boxes, students must find flagging tape on a tree and **ONLY** install on those trees. When students pick a spot, they must record the GPS coordinates on the worksheet below.

Setting up the GPS:

					
Turn on GPS using light bulb button.	Select the main menu by pressing the button twice.	Using the navigator, select "Set Up" by pressing the navigator.	A new page will appear. Navigate and select "Units".	Navigate down to "Map Datum" and select NAD83. Return to main menu.	Navigate to and select "Satellite"



Reading the GPS:



Once you navigate to the Satellite page, the GPS will show the Easting (E), Northing (N), and number of satellites that the GPS has picked up on.

The top number is the Easting (E) and the bottom number is the Northing (N). Count the black bars to determine the number of satellites acquired by the GPS for that reading. Do not include black bars that are 2 ½ rows in height or less. As seen in the picture, the black bar about the height of one row was skipped in the count.

Now that your GPS is ready to go, please take the time to carefully record the GPS locations for the boxes that you install and write observations in the table. As citizen scientists, this is a crucial job to ensure we keep track of the boxes. Please have a parent volunteer or older buddy keep the sheet safe and work together to fill it out.

Installation data:

To collect the installation data, input the data into Survey123 by using the QR code on the right. This will digitally capture all data from GBB box installations (including from locations across the country), and will allow for data comparisons between sites.



You can also fill in the table on the next page to have a physical copy as well.

- **Location Number (Loc #)** → number written on the flagging tape.
- **Identification Number (ID #)** → number that identifies the box (on the bottom of the box).
- **# Bars** → number of black bars at the bottom of the GPS window.
- **Description of Box Location and Observations** → describe side of tree (i.e. north side or down slope side of tree), location of box in relation to other boxes (i.e. 15m south of Box BBR-1) or edge of grove/fence (i.e. tree at edge of grove, 1m north of fence).



Table: Bumble Bee Box data for _____ (park name & area)

Loc # (tape)	ID # (bottom box)	# Bars	Easting	Northing	Description of Box Location and Observations
NS-					
NS-					
NS-					
NS-					
NS-					
NS-					
NS-					
NS-					
NS-					
NS-					



Collection

During the collection part of the GBB module, students will retrieve their boxes and record any data and observations.

For the collection data, input the data into Survey123 by using the QR code on the right.



This will digitally capture all data from GBB box installations (including from locations across the country), and will allow for data comparisons between sites.

You can also fill out the questionnaire on the next page to have a physical copy as well.

Each group will also need a meter stick to measure the height of their bumblebee box before taking it down and a compass to measure its direction. Parent volunteers and older buddies should help younger students complete the survey.

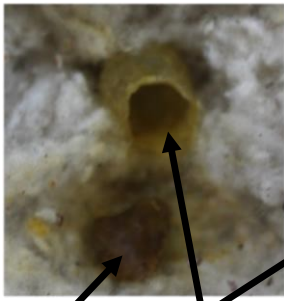
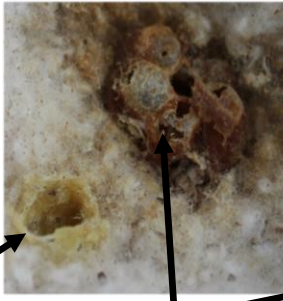
We encourage you to send along any pictures of your box, its location, your flower gardens if present, or even bees found on flowers in your yard!

If your bee box is occupied, the CSL program would very much appreciate collecting the box contents so we can analyze the contents further and determine colony size, and identify the species! We could come and collect this in person (the cotton and the colony) or alternatively, you can mail the contents to us and we will pay for this! Thank you very much for your co-operation and participating in citizen science 😊



Voluntary Bumblebee nesting box Questionnaire

1. At what height is your bee box placed? (If on the ground, please answer 0)
2. What direction is the yard your box is located in facing?
3. What direction is the entrance of the bee box facing?
4. On what date did you place your box out? This can be a rough estimate (i.e. "early May") if the exact date is not recalled!
5. Is your bee box occupied by bumblebees? Be sure to check the entire contents of your bee box as sometimes the bees will nest under the cotton or in the corners of your box.
6. If nest is unoccupied, is there evidence of anything else living inside of it? (wasps, ants, rodents (highly unlikely), etc.)
7. If your bee box is occupied, to what capacity is the bee box occupied? Please select one of the following and include pictures if possible.

Level of use: (indicated with number your colony state-as described here)	1 – Evidence of a queen investigating the box such as cotton fluffed or pushed around.	2 – The beginnings of a colony (a honey pot &/or evidence of "pollen pill" (it will look like brown earwax!)	3 – A working colony (worker cells present, but no large new queen cells)	4 – A fully successful colony (large new queen cells present) (note: bees will likely not be present in your box by now!)
	Look for 'fluffed' or 'pitted' cotton .			
		pollen pill honey pot	worker cells	new queen cells

About bumblebees

Bumblebees are among the most loved and familiar of garden insects. The sight and sound of them buzzing from flower to flower is a quintessential part of British summertime but sadly these charismatic creatures are struggling to survive. In our modern world of paved gardens and intensive agriculture our bumblebees find themselves hungry and homeless.

At the time of writing, 24 bumblebee species are found in the UK and there are plans to reintroduce the Short-haired bumblebee.

Unfortunately two UK species have become extinct in the last 80 years and others have declined dramatically. The reason for this is simple and clearly visible: there are now far fewer flowers in the countryside to provide bees with the pollen and nectar that they need to survive.

Two UK species have become extinct in the last 80 years and others have declined dramatically.

But all is not lost – you can take action today to help save these hardworking pollinators. This factsheet explains how.

Did you know that bumblebees have smelly feet?

Well they do and it's quite useful! After feeding they leave a scent on the flower which helps other bumblebees to avoid wasting energy landing – the flower will contain very little nectar or pollen.

What's so special about the bumblebee?

To most people, bees are instantly recognisable but there are distinct differences between the appearance and lives of bumblebees, honeybees and solitary bees. Bumblebees are larger and hairier than their cousins which makes them perfectly suited for colder climates. Their extra insulation allows them to venture out on cold days when honeybees stay tucked up inside. But bumblebee nests are small and they do not store large quantities of honey, so they are more sensitive to the availability of pollen and nectar-rich flowers to feed on.

Bumblebees do not swarm and are not aggressive.

Don't confuse bumblebees with wasps or honeybees. Bumblebees do not swarm and are not aggressive. Only female bumblebees can sting and they will only do so if they feel very threatened. Importantly, bumblebees will never interrupt your picnic! Bumblebees play a vitally important role which we shouldn't take for granted. They pollinate the crops that provide us with food to eat and the colourful flowers in our landscape. Without their 'free bee' service, many wildflowers could disappear.

Bumblebees play a vitally important role which we shouldn't take for granted.

Key ingredients from our diets, such as beans, peas, raspberries and tomatoes would be harder to produce and much more expensive without British bumblebees.

Buzz pollination

Only bumblebees are capable of buzz pollination. This occurs when the bee grabs the flower and produces a high-pitched buzz. This releases pollen that would otherwise stay trapped inside. Tomatoes are pollinated in this way.

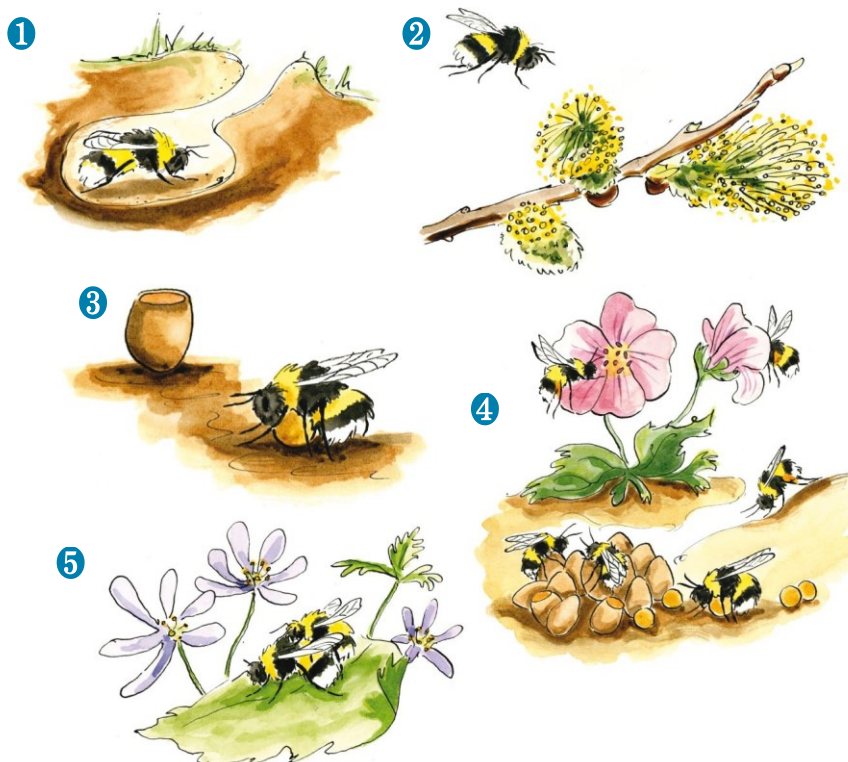
Bumblebee lifecycle

Bumblebees are social insects and live in nests of up to 400 individuals. Each nest is ruled by a queen and lasts for just one year. This is different to honeybee hives which remain active for several years.

In early spring the queen emerges from hibernation to start a new nest **1**. Her first task is to build up her energy reserves so it is really important that she can find plenty of pollen and nectar-rich flowers **2**. Once she has found a suitable nest site she will rear her first batch of eggs **3** – a group of female workers whose job it will be to feed and nurture the colony **4**. This process is repeated throughout the summer with the queen rarely leaving the nest.

Bumblebees rarely nest in the same location two-years running.

Towards the end of the summer the queen produces male offspring, along with new queens. After mating **5** the males die off, as do the old queens and workers. Only the new, fertilised queens survive to hibernate through the winter and establish their own nests the following year **1**. Bumblebees rarely nest in the same location two-years running.



Things you can do to help

British gardens cover more than 1 million acres and can be a lifeline for bumblebees. No matter how small your garden, you can contribute to our efforts to save the sound of summer by providing lots of bee-friendly flowers throughout the year. By bee-friendly we mean flowers that are rich in pollen and nectar. Many ornamental plants that are commonly found in British gardens, such as pansies and begonias, are of no value to wildlife. Years of cultivation for showy blooms mean that these colourful flowers often produce little pollen or nectar. There are hundreds of beautiful flowers that do offer these rewards though, including foxgloves, lavender, geraniums, herbs and wild roses that you can add to your collection.

British gardens cover more than 1 million acres.

You can also help by supporting our work to conserve bumblebee habitats and raise public and political awareness. There are various ways to show your support including volunteering, fundraising and becoming a member of the Bumblebee Conservation Trust. For more information on all of the above, including access to our **Bee kind** gardening tool, visit bumblebeeconservation.org

Sugar water mix

If you find a stranded or sleepy bumblebee you can help to boost her energy levels with a simple sugar-water mix. Mix equal parts white sugar and warm water then pour into a small container or sponge. Place both the bee and the artificial nectar near to some flowers.