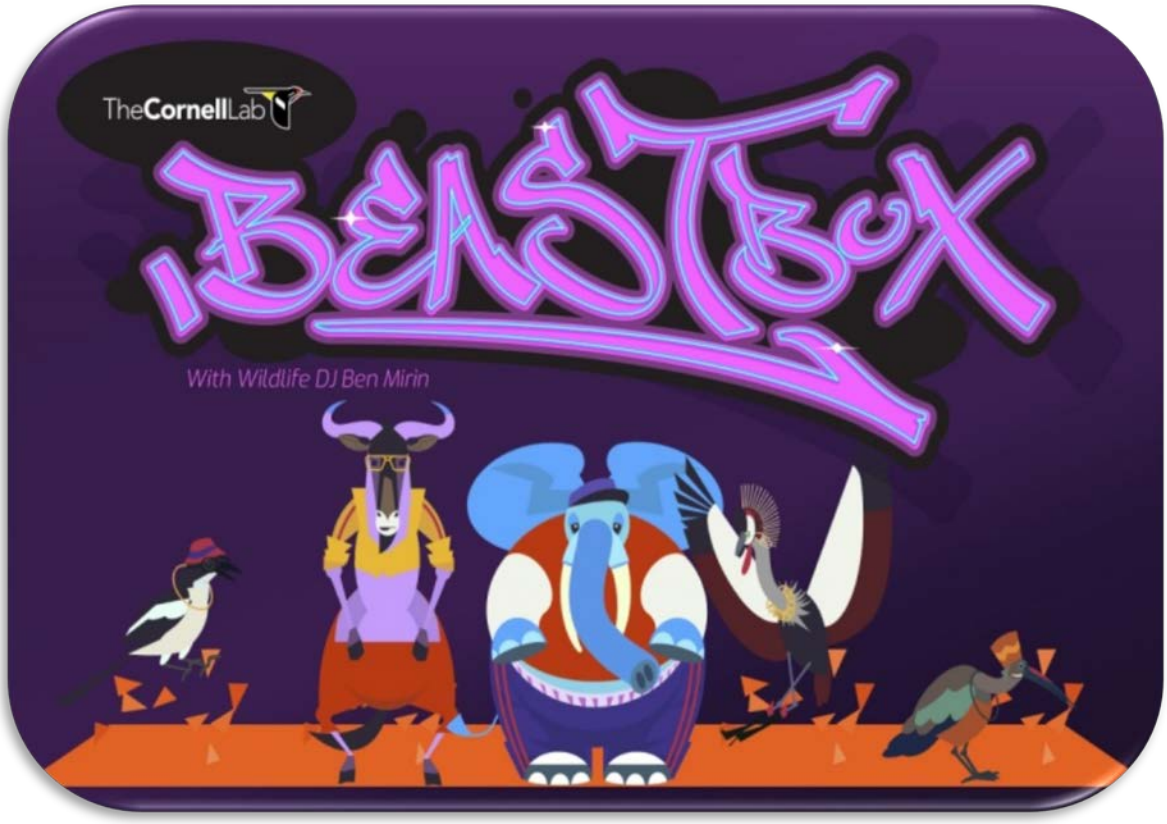
TheCornellLab

K-12 Education

Calls of the Wild

Exploring Animal Communication across Ecosystems with *BeastBox*



Cornell Lab of Ornithology K-12 Program

The Cornell Lab K-12 program provides resources and training to educators. Our curriculum kits and free resources focus on getting outdoors, participating in citizen-science projects, and doing science investigations. Visit **www.birds.cornell.edu/K12** to access opportunities and resources for all types of educators.

If you have questions about the Cornell Lab's programs for educators, please contact us.

Email: K12Lab@cornell.edu **Phone:** (607) 254-2489
Post: 159 Sapsucker Woods Road, Ithaca, NY 14850
Web: www.birds.cornell.edu/K12

For additional information, useful resources, and direct links to the resources described within this unit, please visit www.birds.cornell.edu/K12/BeastBox.

Project Manager: Jennifer Fee

Curriculum Writers and Editors
Kelly Schaeffer, Jennifer Fee, Jailene Hidalgo, Anita Michalak, Mya Thompson, Jackie Glassman

All images courtesy of *BeastBox* and Cornell Lab of Ornithology, except the taxa diagram (p. 7), courtesy Wikimedia.

The Cornell Lab of Ornithology is a nonprofit membership institution whose mission is to interpret and conserve the Earth's biological diversity through research, education, and citizen science focused on birds.

Introduction to *BeastBox*

Musicians have a long history of drawing inspiration from nature. *BeastBox* lets students become a wildlife DJs while exploring six ecosystems (Great Barrier Reef, Sonoran Desert, Chesapeake Bay, Borneo rainforest, Okavango River Delta, and Madagascar rainforest). Matching each wild animal's sounds to its ecosystem unlocks a track created with sounds recorded in the featured ecosystem. Along the way, students learn about the animals and the ecosystems they belong to while celebrating the musicality and biodiversity of our planet.

The game is the result of a three-way collaboration between the Cornell Lab of Ornithology, Ben Mirin (a sound artist and beatboxer whose career as a "wildlife DJ" inspired the project), and the Cornell Hip Hop Collection.

Introduction to the *Calls of the Wild* Activity Guide

The *BeastBox* game explores how animals use sound to communicate with each other within their ecosystems in a fun and interactive way. This activity guide will help educators engage middle school students with the game while addressing key concepts such as animal communication, animal behavior, and ecosystems.

Activity	Key Science Topics
1. Ecosystem Exploration	Ecosystems, animal diversity
2. Discover Animals with the *BeastBox* Game	Animal communication
3. Why Do Animals Communicate?	Animal communication, behavior

Meeting Standards

Calls of the Wild is aligned with the Next Generation Science Standards (NGSS) and English Language Arts (ELA) Common Core State Standards. The lessons challenge students to analyze the reasons behind animal communication, building science practices related to constructing explanations and engaging in arguments from evidence. Students also address crosscutting concepts such as patterns and structure and function as they meet disciplinary core ideas in Life Sciences. Find specific NGSS and ELA Standards at **birds.cornell.edu/K12/BeastBox**.

Getting Started: How Can My Students Use *BeastBox*?

There are three ways to play *BeastBox*:

1. **Just play!** Let students treat *BeastBox* as their own mixing board and create music from favorite animal voices. Combine authentic wild animal sounds and beatbox loops from Ben Mirin to build endless combinations.
2. **Sort Animals by Ecosystem.** Encourage students to try to unlock Beast Mode by bringing together five animals from the same ecosystem on stage. Beast Mode allows you to listen to a song composed entirely of sounds from the featured ecosystem, while controlling the animals' dance moves.
3. **Discover the *BeastBox* Animals.** Students can learn about the animals and their habitat by clicking the info button hovering over each animal's head when it is on stage. They can see a photo, hear a field recording of the animal, and learn a few facts about it.

Activity 1: Ecosystem Exploration

Big Idea: All ecosystems support both plant and animal life, and contain a diversity of interacting organisms.

Learning Objectives

Students will be able to…

- Define "ecosystem."
- Describe the characteristics of a specific ecosystem and compare them to others.

Time and Location: 30 minutes, plus research time in or out of class. Indoors.

Resources Needed

- Whiteboard and markers
- Computer lab with internet access (www.birds.cornell.edu/K12/BeastBox)
- Paper, pencils, and colored pencils
- "*BeastBox* Ecosystems" description page (printed or shown from the website)

Background Information

Ecosystems are biological communities of organisms along with their physical environments. They are composed of biotic (living) and abiotic (nonliving) factors that interact through nutrient and energy cycling. Ecosystems can be terrestrial (on land) or aquatic (in water). They can be small (like a backyard pond) or large (like the Great Barrier Reef).

Conducting the Activity

1. Ask students what they think defines an ecosystem, and make a list of characteristics on the board. Have students explain their answers. Once all thoughts have been shared, synthesize the points in your list into an accurate consensus definition that includes the idea that plants and animals interact within an environment.

2. Introduce an ecosystem found in your area or historically found there (i.e. eastern deciduous forest, desert, tall grass prairie, your local park, the schoolyard pond or garden). Brainstorm its characteristics, drawing a picture or organizer on the board. Consider:
    - What type of **climate** is typical of your area? (Rainy? Snowy? Dry? Seasonal?)
    - Is the ecosystem **type** terrestrial, aquatic, or a mixture of the two?
    - What types of **plants** do you most commonly see?
    - What common **animals** can you find?
    - In what ways do plants and animals **interact** with each other and with this environment?

3. Once students are familiar with the plants, animals, and abiotic factors of your local ecosystem, distribute the ecosystem handout to introduce students to the six diverse ecosystems featured in the game:

Borneo rainforest	Madagascar rainforest
Chesapeake Bay	Okavango River Delta
Great Barrier Reef	Sonoran Desert

4. Divide students into six groups and assign each group one of the ecosystems from the *BeastBox* game. Give them time during or outside of class to research their ecosystem using *Beastbox,* other websites, and books. Have the groups draw and describe their ecosystem using what they have learned, including:
    - The location of the ecosystem in the world
    - A general description, including typical plants and animals that live there
    - Information on abiotic factors such as climate, average temperatures, and precipitation
    - Whether their ecosystem is terrestrial, aquatic, or a combination of the two
    - The adaptations of the plants and animals that live there in these conditions
    - Threats to the ecosystem.

5. Ask students to present their findings by reading the descriptions they have written and sharing their drawings. Invite students to identify the similarities and differences they notice among the six ecosystems. You may wish to consider making a comparison chart of the key characteristics to compare your local ecosystem and the six ecosystems the game (i.e. location, temperature, rainfall, topography, types of plants, types of animals, etc.).

	Our Local Ecosystem	**Borneo Rainforest**	**Chesapeake Bay**	**Great Barrier Reef**	**Madagascar Rainforest**	**Sonoran Desert**
Location						
Temperature						
Precipitation						
Topography						
Plant Types						
Typical Animals						

Activity 2: Discover Animals with the *BeastBox* Game

Big Idea: Animals are very diverse and they communicate in different ways.

Learning Objectives

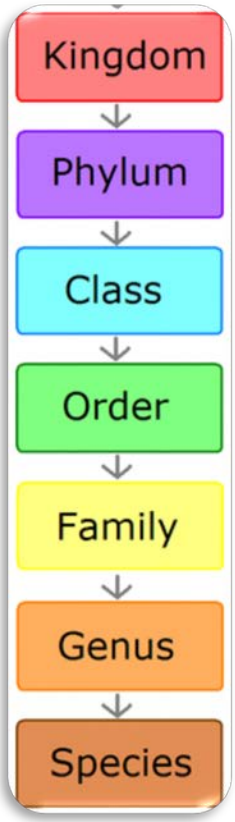
Students will be able to...

- Compare and contrast how different species of animals communicate.
- Describe some of the characteristics of at least three animal groups.

Time and Location: 60 minutes, indoors

Resources Needed

- Computer lab with internet access (www.birds.cornell.edu/K12/BeastBox)
- Whiteboard and markers
- "*BeastBox* Animal Communication" worksheets (at least one per student) and pencils



Background Information

Scientists arrange living things into different groups with other related living things. The animal kingdom is divided into 40 smaller groups, known as phyla. Two phyla your students might be most familiar with are Chordata (vertebrates) and Arthropods (insects, spiders, shrimp, etc). Phyla are divided into even smaller groups, known as classes. The five most well-known classes of vertebrates (animals with backbones) are mammals, birds, fish, reptiles, amphibians. This game features animals from four of these vertebrate classes as well as three arthropods: two insects (katydid, cicada) and one shrimp.

In this game, sorting the *BeastBox* animals into the right ecosystems unlocks Beast Mode, which allows players to listen to a song composed entirely of sounds from the featured ecosystem while controlling the animals' dance moves. The game contains a wealth of information about the diverse animals and six ecosystems found within the game.

Students may vary in how and for how long they want to explore the game. If you notice that some students finish more quickly than others, give them another worksheet and challenge them to unlock "Beast Mode" for a different ecosystem, or encourage them to read more about the animals and ecosystems within the game.

Conducting the Activity

1. Watch Ben Mirin's TED Talk (running time 6:47 minutes). Ask students:
    - What is Ben Mirin's mission in creating wildlife music?
    - What kinds of music have you noticed in nature?
    - Why do you think Ben and others have been inspired to make music with sounds from nature?
    - Ben describes himself as an "explorer." Which of the ecosystems would you most like to explore, and why?

2. Distribute the "*BeastBox* Animal Communication" worksheet for students to fill out while playing the game.
    - Explain to students that in the game, they will use wildlife recordings to create ecosystem-themed music for the six featured ecosystems. Their mission is to identify five animals who live in each ecosystem and drag them onto a "stage." If you think students need extra guidance, model how to play the game. Select one ecosystem and demonstrate how to place animals on the stage.
    - Tell students to begin by selecting one of the six ecosystems by clicking one of the microphones at the top of the screen. Ask students to write the name of their selected ecosystem on the top of their worksheet. Challenge them to use what they know about the ecosystem and the animals generally found there to try to match the *BeastBox* animals to the ecosystem on their own. Let them play for about 10 minutes. Circulate as they play, guiding them as needed. If students get frustrated and have not discovered it, they can click the "i" above the animal's head after they drag them onto the stage. This will reveal information about the animal to use within the worksheet.

    - After students have had time to play the game, show the class how to scroll down from the main game screen to find information on all of the animals (this serves as the "answer key").

3. Highlight the diversity of animals found in the game by sorting the animals by taxa and having students share information. Depending on time, you may want to call on 2-3 volunteers for each animal type, or sort the entire list. Ask:
    - Who has an animal without a backbone (Arthropod) in their ecosystem? What about the vertebrates… who has an Amphibian? (Mammal? Bird? Fish?)
        - Review key characteristics of each group as you go (see vocabulary list).
        - For each group, ask students to share any facts they discovered about how and why they use sound to communicate. (Note: For some animals, this information is not given in *Beastbox*. If time allows, let students research these animals and their communication strategies.)
        - Review the key characteristics of the groups (for example, which have backbones, which lay eggs, which are endothermic versus ectothermic)

Animal Type	Animal	Ecosystem
Arthropods	Common True Katydid	Chesapeake Bay
	Green-banded Snapping Shrimp	Great Barrier Reef
	Empress Cicada	Borneo Rainforest
Amphibians	Gray Treefrog, Cope's Gray Treefrog, and Pickerel Frog	Chesapeake Bay
Birds	Cactus Wren	Sonoran Desert
	Chestnut-winged Babbler	Borneo Rainforest
	Eastern Whip-poor-will	Chesapeake Bay
	Gold-whiskered Barbet	Borneo Rainforest
	Gray Crowned-Crane	Okavango River Delta
	Hadada Ibis	Okavango River Delta
	Lesser Vasa-Parrot	Madagascar Rainforest
	Madagascar Long-eared Owl	Madagascar Rainforest
	Northern Mockingbird	Chesapeake Bay
	Red-fronted Coua	Madagascar Rainforest
	Red-tailed Hawk	Sonoran Desert
	Souimanga Sunbird	Madagascar Rainforest
	Tropical Boubou	Okavango River Delta
Fish	Bullethead Parrotfish	Great Barrier Reef
	Weakfish and Atlantic Croaker	Chesapeake Bay
Mammals	African Savannah Elephant	Okavango River Delta
	Blue Whale	Great Barrier Reef
	Blue Wildebeest	Okavango River Delta
	Bobcat	Sonoran Desert
	Bornean Gibbon	Borneo Rainforest
	Bornean Orangutan	Borneo Rainforest
	Bottlenose Dolphin	Great Barrier Reef
	Coyote	Sonoran Desert
	Humpback Whale	Great Barrier Reef
	Indri	Madagascar Rainforest
	Javelina	Sonoran Desert

Activity 3: Why Do Animals Communicate?

Big Idea: Animals communicate in many different ways and for a variety of reasons.

Learning Objectives

Students will be able to...

- Identify at least two modes of animal communication.
- Name three reasons why animals communicate.
- Describe the communication methods of various local animals.

Time and Location: 60 minutes, plus time to research local animals. Indoors.

Resources Needed

- Paper and pencil
- Whiteboard and markers
- Computer lab with internet access
- Projector

Background Information

Animals communicate to share information with relatives, competitors, predators, and other animals of the same or different species. The ways in which animals communicate have evolved to suit their message, general anatomy, and habitat. There are four main modes of animal communication: visual, auditory, chemical, and tactile (though others exist). An individual animal may use several of these communication types, though sound is the most common because of its ability to convey complex messages across great distances. In this activity, students will become familiar with the four modes of animal communication and the reasons why animals communicate.

Conducting the Activity

1. As a group, discuss some ways that animals communicate. If students struggle, encourage them to think about ways their pets communicate and/or name some familiar animals for them to consider. Answers might include body language, dancing or posturing, growling, singing, barking, hissing, showing teeth, etc. Write the list on the board.

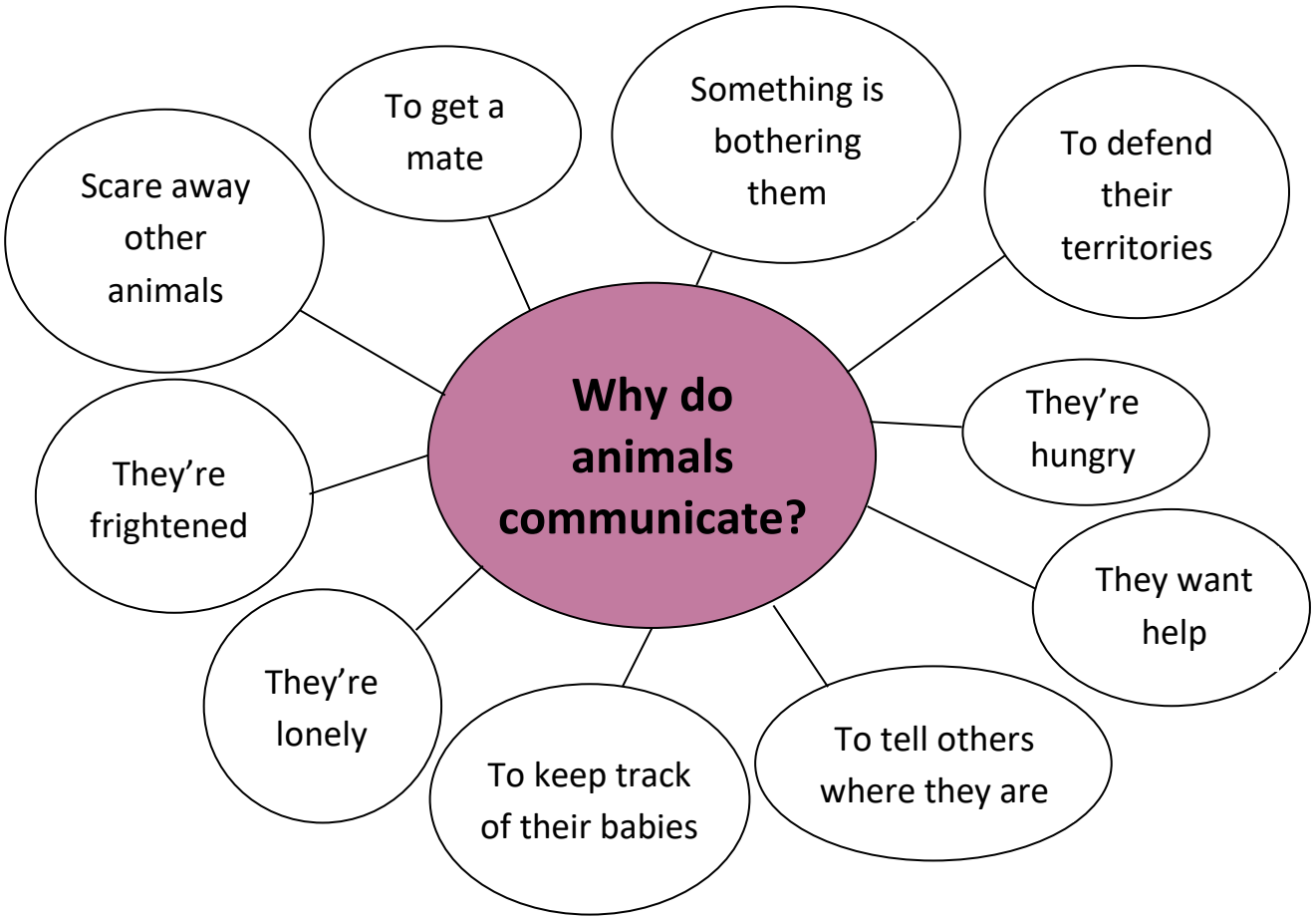
2. Ask: How can we group these modes of communication? Divide the list into four common modes of animal communication. If any categories are missing, challenge students to brainstorm examples for each:
    1. Visual – body language, facial expressions, colors, light (ex: lightning bugs)
    2. Auditory – vocal and non-vocal sounds (ex: bird song, stridulating cricket wings)
    3. Chemical – scent marking, pheromones (ex: bad smells to warn away predators)
    4. Tactile – grooming, touch (ex: bees dancing)

    Ask: Which communication mode seems to be the most common?

3. Break into small groups and give students 5 minutes to brainstorm reasons *why* animals communicate. Students should make a list of as many reasons as possible.

4. Have each group share their answers with the whole class. Write the reasons on the board in a visual organizer. Challenge students to:
    - Provide reasoning and evidence for that reason.
    - Name specific animals that communicate in that way.
    - Determine who each type of message would be communicated to (for example, an animal of the same or different species? A predator? A family member?).

    Sample student reasons can be found in the diagram below. For example, for this diagram, students might provide reasoning such as, "baby birds communicate to their parents that they are hungry via begging calls," and "skunks spray chemicals with a strong scent to scare away potential predators."



5. Tell students they will review how one group of animals, birds, uses sound to communicate. Share a clip from "The Language of Birds" video linked on the resource page (running time is 9:41 minutes). If you do not have time to watch the whole video, focus on the clip from 1:00 to 5:40. The video will review the types of messages birds communicate via sound, what information the receiver can learn from bird songs, the structure of bird vocal cords, and how different sounds suit different environments. After watching ask:
    - What messages was the Northern Cardinal in the video communicating? How many of those reasons did we come up with in our brainstorm?
    - What did the quality of the Swamp Sparrow and Northern Mockingbird song tell potential mates? (The speed of the trill for the sparrow and the size of the repertoire for the mockingbird help females judge how healthy the male is.)
    - While playing *BeastBox*, we saw that sound was a common form of communication across many animal groups. Why do you think that is? (Sound can relay messages with a wide variety of meanings from the sender to the receiver. Sound can efficiently travel long distances, in the dark, and around or through obstacles like trees. Visual, chemical, and tactile signals have a more limited range.)

6. Create a list of <u>local</u> animals that use sound to communicate. Make sure to include species from different animal groups. Some examples include: mammals (coyotes, chipmunks, whales if you are on the coast), birds (American Robins, American Crows, your local sparrow or duck), reptiles and amphibians (your local frogs, toads, and snakes), insects (crickets, katydids, and cicadas). Have your students research these animals individually or in groups:
    - Assign or ask each group of students to select a local animal on their own or from a list you provide.
    - Allow your students to research their animals in books and via the internet.
    - Ask students to answer and present their findings about the animal and its communication via a written report, presentation, poster, website, or podcast. Suggested focuses:
        - How does your animal communicate? Can you find an example of each mode (auditory, tactile, visual, and chemical)?
        - If your animal makes sound, how does it make sound and what sounds does it make? If possible, have students play their animal's sounds for the class. Macaulay Library (**macaulaylibrary.org**), the world's largest library of natural sounds, is a good resource.

Conclusion and Assessment

Communication in Ecosystems

Discussion

Start with the focus question: "What challenges do animals face communicating in each of the ecosystems we learned about? How do animals overcome these challenges?" Encourage students to think about the animals that live in the ecosystem (within both the game and the ones they discovered in their research). Encourage deeper thinking via questions such as:

- What type of communication do you think is the most common? Do you think that holds true for most ecosystems across the world?
- How do you think communication is different for animals in terrestrial ecosystems (those that live on land) versus those in aquatic ecosystems (those that live in water, such as whales and fish)?
- How do you think communication strategies might differ in various terrestrial habitats (such as in the rainforest or desert)?

Students should mention the idea that in some environments, such as underwater or in heavily forested areas, auditory communication is important because it is difficult or impossible to see visual communication.

Assessment

- Have students synthesize what they have learned related to communication in ecosystems in a written report, podcast, or other media.

Extensions

Make a Cultural Connection

Using a smartboard or projector, display the *BeastBox* game for the class to see. Scroll below the game to the "Beatboxing and Hip Hop History" section and read everything but the last paragraph out loud to the class. Return to the game and choose three animals to display on the board. Explain that the animals are dressed up to celebrate hip hop culture all the way from its start in New York City during the early 1980s to the worldwide phenomenon it is today. Ask students:

- Why do you think the game developers made these Hip Hop connections to art and music?
- How does this align with Ben Mirin's views about the importance of his work?

Much like how animals use calls and songs to communicate, people rely on music as a form of self-expression.

While humans may not communicate in the exact same ways other animal species do, our history of music and artistic expression is as diverse as the different methods of communication. Have students design their own animal reflective of a favorite artist, Hip Hop or otherwise.

Take it Outside

Take students on a short walk or let them explore a defined area. Challenge them to observe the wildlife around them and observe how the animals are communicating. Look for examples of the different modes of communication, focusing on auditory and visual communication. What parts of their bodies are the animals using to communicate? Do you see any of the animals you researched?

You may also want to download our *Explorer's Guidebook* and have students complete the **Sound Map** on page 3.

Vocabulary

ABIOTIC – describes the physical, non-living components that make up an ecosystem, such as soil types, altitude, temperature, rainfall, etc.

AMPHIBIAN – a group of animals characterized by moist, scale-less skin whose larvae are typically aquatic. Examples include frogs, toads, and salamanders.

AQUATIC – of, in, or pertaining to water; living or growing in water.

ARTHROPOD – animals that have a hard outside covering called an exoskeleton. Insects, crustaceans, and arachnids are three of the largest arthropod groups.

AUDITORY COMMUNICATION – communication via sound. The sound may be one that comes from the animal, or made by interacting with another object.

BIOTIC – relates to the living components or organisms of an ecosystem and typically refers to three groups: the producers/autotrophs, consumers/heterotrophs, and decomposers.

BIRD – a group of animals characterized by having feathers and laying hard-shelled eggs.

CHEMICAL COMMUNICATION – the process of using chemicals or pheromones to communicate, usually by giving off a unique scent or marking territories.

CLIMATE CHANGE – a significant long-term change in the expected patterns of average weather of a region (or the whole Earth) over time

COMMUNICATION – sharing that expresses or exchanges information, ideas, or feelings.

ECOSYSTEM – a biological community of organisms together with their physical environments composed of biotic (living) and abiotic (nonliving) factors that interact through nutrient and energy cycling.

ENDEMIC – native or restricted to a certain country or area.

ESTUARY – an ecosystem typically found at the mouth of a large river, where ocean tides meet streams and saltwater and freshwater combine to form a mixture called brackish water.

FISH – a group of cold-blooded aquatic animals that breathe with gills and have scales.

LARYNX –the hollow muscular organ that holds the vocal cords mammals; the voice box.

MAMMAL – a group of endothermic animals characterized by having fur and providing milk for young.

MONSOON – a periodic wind especially in the Indian Ocean and southern Asia.

RAINFOREST –forests characterized by high rainfall, including tropical and temperate forests.

REPTILE – a group of cold-blooded animals with scaly skin, such as turtles, snakes, and lizards.

SYRINX – the voice organ in birds.

TACTILE COMMUNICATION – a form of communicating through touch, and includes nuzzling, grooming, wrestling, and many others.

TERRESTRIAL – of, on, or inhabiting land.

TOPOGRAPHY – the arrangement of physical features in an area, such as hills, valleys, rivers, etc.

VISUAL COMMUNICATION – the process of conveying information through sight. Animals communicate visually through structural adaptations, such as body shape or color, or behavioral adaptations, in which they perform a visible action that is intended to convey a message.

BeastBox Ecosystems

GREAT BARRIER REEF

The Great Barrier Reef is a complex of coral reefs in the Pacific Ocean off the coast of Australia. It is the largest reef complex in the world. The reefs have formed over millions of year as living coral grows. There are at least 400 species of hard coral within the crystal-clear waters of this marine ecosystem, as well as soft corals, anemones, sponges, crabs, turtles, marine mammals, and a great variety of fishes, sharks, and rays. Climate change, water quality issues, and development threaten this amazing biodiversity.

SONORAN DESERT

This desert is located in the southwestern United States. While it is the hottest North American desert, it gets more rain than any other desert on the planet. Rain falls both during heavy thunderstorms in the monsoon season (July-September) and in the winter (December-January). These rainy seasons support high plan and animal diversity. In addition to the saguaro cactus (the desert's "signature plant") there are many kinds of cactus plus yucca and elephant tree. Animals like bighorn sheep, mule deer, mountain lions, coyotes, desert tortoises, scorpions, and a variety of snakes, lizards, rodents, songbirds, and raptors call this desert home. Fire, cattle grazing, and human development are the main threats to the area.

CHESAPEAKE BAY

In the Chesapeake Bay, freshwater and saltwater collide to provide special habitat for many species. The Bay is the largest estuary in the United States. It is a shallow but vast stretch of marshes, oyster reefs, wetlands, mudflats, and sandy beaches found in the U.S. states of Maryland and Virginia. Over 3,600 species of plants and animals can be found throughout the Chesapeake Bay area, including fish, crabs, oysters, frogs, snakes, and many wetland and water birds. Pollution, climate change, over-fishing, decreases in underwater seagrass, and human development threaten this ecosystem.

BORNEO RAINFOREST

Borneo's tropical forest ecosystem is home to the tallest rainforest trees in the world. Its plant and animal communities are well-adapted to an intense tropical climate with both a dry and wet monsoon season. Every level of the jungle overflows with unique native animals, including approximately 10,000 plants. The region is also home to some wonderful and highly endangered animals, such as hornbills, Sumatran rhinos, and primates such as proboscis monkeys, tarsiers, and orangutans. The forests of Southeast Asia are rapidly dwindling, yet contain some of the highest biodiversity in the world. These forests are cut down to support agriculture and timber used by growing populations and for export.

OKAVANGO RIVER DELTA

The Okavango Delta in Botswana is a major wetland surrounded by the Kalahari Desert. The ecosystem is a wet oasis within a generally dry area, and it supports diverse permanent and migratory wildlife species. Mammals include the African elephant, lion, wildebeest, zebra, giraffe, hippopotamus, cheetah, and spotted hyena. There are also many fish, reptiles, insects, and over 400 species of birds. Challenges to the health of this ecosystem include diverting water from the rivers that feed the delta, overgrazing in the area, and decline of the animals that live there due to hunting and climate change.

MADAGASCAR RAINFOREST

Roughly 90 percent of the species found in the lowland rainforests of the island of Madagascar are found nowhere else in the world. Forest tree canopies can exceed heights of 100 feet and are rich in evergreens, palms, bamboo, and orchids. At higher elevations, trees become shorter and have dense undergrowth. There are 15 species of lemurs and many rodents found on the island, as well as 165 species of birds (42 of which are endemic), 50 endemic reptiles, and 29 amphibians. Slash-and-burn agriculture is the main threat to the forest.

Name: _____ Date: _____

BeastBox Animal Communication

Instructions: Become an expert in an ecosystem by exploring the animals that live there! Choose one of the six *BeastBox* ecosystems and add facts about each animal's communication.

Ecosystem name: _____

Describe your ecosystem: Where is it? What is the climate like? What is the plant community like?

_____

_____

_____

	Name	Communication Facts
Animal #1		
Animal #2		
Animal #3		
Animal #4		
Animal #5		