Science & Literacy Activity

ACTIVITY OVERVIEW

This activity, which is aligned to the Common Core State Standards (CCSS) for English Language Arts, introduces students to scientific knowledge and language related to Cuba's biodiversity, evolutionary history, and conservation.

This activity has three components:

1. **BEFORE YOUR VISIT**, students will read a content-rich article about Cuba's biodiversity, evolutionary history, and conservation. This article will provide context for the visit, and also help them complete the post-visit writing task.
2. **AT THE MUSEUM**, students will read and engage with additional texts (including printed text, digital and physical/hands-on interactives, video, diagrams, models). This information will help them complete the post-visit writing task.
3. **BACK IN THE CLASSROOM**, students will draw on the first two components of the activity to complete a CCSS-aligned explanatory writing task about what makes Cuba a biodiversity hotspot.

Materials in this packet include:

For Teachers

- Activity Overview (p. 1-2)
- Article (teacher version): "Cuba: An Example of Island Evolution, BIodiversity, and Conservation" (p. 3-9)
- Answers to student worksheets (p. 10-13)
- Assessment rubric for student writing task (p. 14-15)

For Students

- Article (student version): "Cuba: An Example of Island Evolution, BIodiversity, and Conservation" (p. 16-21)
- Student worksheet for the *¡Cuba!* exhibition visit (p. 22-25)
- Student writing task and rubric (p. 26-28)

Common Core State Standards

RST.6-8.1: Cite specific textual evidence to support analysis of science and technical texts.

RST.6-8.2: Determine the central ideas or conclusions of a text.provide an accurate summary of the text distinct from prior knowledge or opinions.

WHST.6-8.2: Write informative/explanatory texts, including the narration of scientific procedures/experiments.

New York State Science Core Curriculum

LE3.3a, LE7.2c

Next Generation Science Standards

DCI: LS2.C: Ecosystem Dynamics, Functioning, and Resilience
Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of it's health.

SEP 8: Obtaining, Evaluating, and Communicating Information
- Critically use scientific texts adapted for classroom use to determine the central ideas and/or obtain scientific information to describe evidence about the natural world.
- Communicate scientific information in writing.

1. BEFORE YOUR VISIT

Students will read a content-rich article about Cuba's biodiversity, evolutionary history, and conservation. This article will provide context for the visit, and help them complete the post-visit writing task.

Preparation

- Familiarize yourself with the student writing task and rubric (p. 26-28).
- Familiarize yourself with the teacher version of the article (p. 3-9), and plan how to facilitate the students' reading of the article.

Instructions

- Explain the goal: to complete a writing task about Cuba's biodiversity, evolutionary history, and conservation.
- Tell students that they will need to read an article before visiting the Museum, and read additional texts during the visit.
- Distribute the article, student writing task, and rubric to students.
- Review the rubric with students and tell them that it will be used to grade their writing.
- Read and discuss the article, using the teacher notes to facilitate.

2. DURING YOUR VISIT

At the Museum, students will read and engage with additional texts (including printed text, digital and physical/hands-on interactives, video, diagrams, models). The information they'll gather from these multiple sources will help them complete the post-visit writing task.

Preparation

Review the educator's guide to see how themes in the exhibition connect to your curriculum and to get an advance look at what your students will encounter. (Guide is downloadable at **amnh.org/cuba/educators**)

- Familiarize yourself with the student worksheets (p. 22-25) and the map of the exhibition (p.3 of the educators' guide).

Instructions

- Explain the goal of the Museum visit: to read and engage with texts (including printed text, digital and physical/hands-on interactives, video, diagrams, models), and to gather information to help them complete the post-visit writing task.
- Distribute and review the worksheet and map. Clarify what information students should collect, and where.

Supports for Diverse Learners

This resource has been designed to engage all learners with the principles of Universal Design for Learning in mind. It represents information in multiple ways and offers multiple ways for your students to engage with content as they read about, discuss, view, and write about scientific concepts. Different parts of the experience (e.g. reading texts, or locating information in the Museum) may challenge individual students. However, the arc of learning is designed to offer varied opportunities to learn. We suggest that all learners experience each activity, even if challenging. If any students have an Individualized Education Program (IEP), consult it for additional accommodations or modifications.

Alternate Version of Article

Another version of the same article with a lower lexile level is available for download at **amnh.org/cuba/educators**. You can use this same activity with that article.

Additional Suggestions for Facilitating the Museum Visit

- Have students explore the exhibition in pairs, with each student completing his or her own student worksheet.
- Encourage student pairs to ask you or their peers for help locating information. Tell students they may not share answers with other pairs, but may point each other to places where answers can be found.

3. BACK IN THE CLASSROOM

Students will use what they have learned from the pre-visit article and at the Museum to complete a CCSS-aligned explanatory writing task about Cuba's biodiversity, evolutionary history, and conservation.

Preparation

- Plan how you will explain the student writing task and rubric (p. 25-27) to students.

Instructions

- Distribute the student writing task and rubric. Explain that they will use it while composing, and also to evaluate and revise what they have written.

Suggestions for Facilitating Writing Task

- Before they begin to write, have students use the writing task to frame a discussion around the information that they gathered at the Museum. They can work in pairs, small groups, or as a class, and can compare their findings.
- Referring to the writing prompt, have students underline or highlight all relevant passages and information from the article and from the notes taken at the Museum.
- Students should write their essays individually.

ARTICLE: TEACHER VERSION

About this Article

Lexile: 1,090 **Wordcount:** 1,107

Key for Teacher Notes

- Green text
  specific strategies
- Regular text
  instructions for teachers
- *Italicized text*
  teacher's instructions to students
- Underlined text
  important domain-specific words

Text Complexity: The Lexile level for this text falls toward the end of the 6-8 CCSS grade complexity band. This text is suitable as a read aloud for students in grades 6 through 8. Teachers should use their professional judgement and knowledge of students' independent reading levels regarding assigning this text for independent reading.

Note: The teacher version of the text offers suggestions for facilitating interactive read-aloud. Students should be sitting with "elbow partners" for interactive read-aloud. When teacher notes suggest Think/Pair/Share, it is generally followed by instructions to "listen in" to student conversations. This enables you to select students to share out thinking that would benefit the whole group to hear. Additionally, it allows you to informally assess students' thinking about the text. You can follow up with a Think Aloud to help clarify parts of the text as needed. At times, you may want to facilitate whole class discussion after Think/Pair/Share. Alternatively, you may sometimes opt to substitute Think/Pair/Share with Stop and Jot. You can read over students' shoulders and select a student to share their thinking.

These teacher notes allow for frequent stopping for partner talk and sharing out. You should modify this interactive read-aloud in a way that suits the needs of your students. For instance, you may want to have students read parts of the text independently, depending on their reading levels. An additional strategy that you might consider using throughout this text is annotating in the margins. After stopping to talk with a partner and/or engage in whole group discussion, students can jot a phrase that expresses the main idea ("gist statement") in the margin. It is advisable to demonstrate this for the first few paragraphs and then ask students to jot gist statements in partners or independently as the read-aloud progresses.

As you guide students through this article, prompt students to use the images to help them understand what is being said in the text.

Cuba: An Example of Island Evolution, Biodiversity, and Conservation

Highlight the three topics the article will delve into based on the title.

Cuba is remarkably varied in its geography, with remote forests, deep caves, broad wetlands, and dazzling reefs. It has many well-protected ecosystems and is isolated from the mainland. This allows its species to evolve and adapt in unique ways.

Think/Pair/Share: *What factors make Cuba unique?*

(Sample response: It has varied geography, many well-protected ecosystems, and is isolated from the mainland.)

Over four thousand islands—an archipelago, with one main island—make up the nation of Cuba in the northern Caribbean Sea. It is located just 150 kilometers (94 miles) from the tip of Florida.

Think/Pair/Share: *What do you notice about Cuba's geography from the map and caption?*

ARTICLE

Cuba: An Example of Island Evolution, Biodiversity, and Conservation

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Over four thousand islands—an archipelago, with one main island—make up the nation of Cuba in the northern Caribbean Sea. It is located just 150 kilometers (94 miles) from the tip of Florida.

Island Geography and Endemism

Islands such as Cuba tend to be rich in endemic species. Endemic species are organisms that exist only in the particular area in which they evolved, and nowhere else in the world. "The island of Cuba is so large, it acts as a miniature continent," says Chris Raxworthy, curator-in-charge of the Department of Herpetology at the American Museum of Natural History. "Evolution there has produced a lot of species that can't be found anywhere else in the world." In fact, roughly half of all plants and a third of all vertebrate animals in Cuba are endemic. What could explain these high rates of endemism? "In many ways islands function as natural experiments," says Ana Luz Porzecanski, director of the Museum's Center for Biodiversity and Conservation. "They are isolated from the mainland and from one another, they have set boundaries, and they vary in size and geography. So evolution can take different paths in different islands, leading to very different plants and animals."

Think/Pair/Share: *What is endemism? Why does it tend to occur on islands?*

Coach students to paraphrase rather than read directly from the text. For additional scaffolding, prompt students to look closely at the scientist's quote and explain it in their own words. Coach as needed.

	Known Species in Cuba	Number of Species Endemic to Cuba	% Endemism
Mammals	38	12	31%
Birds	369	25	~7%
Reptiles	140	110	78%
Amphibians	59	56	95%
Fishes	57	21	36%
Spiders	1,300	761	58%
Insects	8,312	~3,000	30-40%
Mollusks	1,405	1,350	96%

Cuba has high rates of endemism. For example, out of the 59 known species of amphibians that live in Cuba, 56 species (95%) are endemic.

Think/Pair/Share: *Explain how the data represented on this chart relates to the quote from scientist Ana Luz Porzecanski in the previous paragraph.*

Evolution of organisms takes place on islands just as it does on large continents. But on islands it can have particularly unusual effects. Organisms can arrive on islands in various ways. They can cross a temporary land bridge or wash up on floating vegetation. Sometimes they hitch a ride with another species. What happens next depends on the availability of food, living space, and the presence or absence of predators. Depending on these conditions some species can develop unusual features, such as very large size (gigantism), small size (dwarfism), or the loss of the ability to fly (flightlessness).

"Island Rule"

Some of Cuba's species exhibit the effects of the "island rule." The island rule proposes that, over time, island animals tend to evolve smaller body sizes (dwarfism) when food sources are limited. Or, they tend to evolve larger body sizes (gigantism) when there is less pressure from predators. For example, the extinct flightless owl, *Ornimegalonyx*, weighed 38 pounds and is the largest owl that ever lived. Scientists think it evolved from a smaller ancestor. It may have grown so large due to the absence of natural predators and the lack of competition

This is a model of *Ornimegalonyx*, the largest owl that ever lived. This extinct giant owl may not have been able to fly.

Think/Pair/Share: *The article states that gigantism and dwarfism are attributed to "the island rule." Explain gigantism and dwarfism to your partner. Tell how the "island rule" explains why these unusual features are seen in animals on islands.*

(Sample response: high availability of food due to less pressure from predators can lead to gigantism; limited food sources can lead to dwarfism)

Prompt students to look at the photos that show examples of the unusual features explained in the text.

for food. At the other end of the spectrum, Cuba also harbors one of the world's smallest frog species, Monte Iberia eleuth (*Eleutherodactylus iberia*).

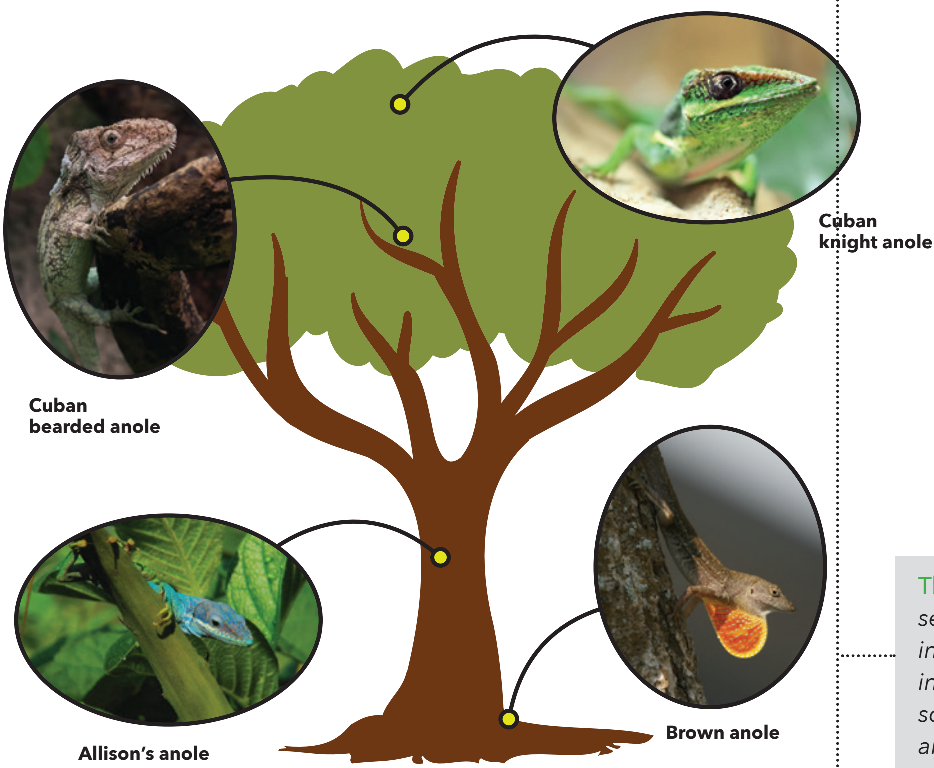
An adult Monte Iberia eleuth can fit on a human fingernail with room to spare.

Formation of New Species

When Charles Darwin arrived in the Galápagos Islands almost 200 years ago he observed small birds called finches. The finches he saw were all different species. He noted that each species had adapted to eating different kinds of food. Darwin later concluded that the finches were able to coexist on the small island because they had adapted in ways that allowed them to divide up the limited resources, and in the process, became different species. This phenomenon of organisms diversifying when there is competition among members of the same species is also well documented in a group of lizards called anoles. Many species of these lizards, some endemic to Cuba, reside in the lush forests of Cuba's Humboldt National Park.

Humboldt National Park

The first anoles in Cuba lived in the trees. At first they competed for resources with members of their same species. Over time the anoles were able to coexist by evolving strategies to divide the tree habitat vertically. By adapting, groups of anoles became specialized to live exclusively in different micro-habitats of the trees. Some lived at the ground level. Some lived in the crown of trees. While others lived in between, on trunks and twigs. Over many generations, these populations of anoles became distinct enough, morphologically and genetically, to be considered different species.



The brown anole (*Anolis sagrei*) lives near the base of a tree trunk. This small lizard has long back legs for jumping, sprinting, and moving fast. It is camouflaged—it blends in with the tree's trunk and branches.

The Allison's anole (*Anolis allisoni*) lives on tree trunks, especially on palm trees. Its big toe pads help it cling to the trunk and it can climb straight up (or straight down!) trunks in search of insects.

The Cuban bearded anole (*Anolis barbatus*) lives between the branches that form the leafy roof of the rainforest. It moves slowly, using its short legs to grasp fragile twigs.

The Cuban knight anole (*Anolis equestris*) lives near the top of the canopy. It is the largest anole, and devours tree frogs, tarantulas, and even birds.

Environmental Threats to Islands

The qualities that make islands so rich in biodiversity also make them very vulnerable to environmental threats. This makes conservation efforts challenging. Cuba is relatively isolated from the mainland and other islands. This results in many endemic organisms having limited population sizes, and

Think/Pair/Share: *The first paragraph in this section explains how species diversify, or evolve, into different species. The example of finches in the Galapagos islands is given to explain this scientific phenomena. The next paragraph gives an example of this same phenomena in Cuba. Explain what happened to anoles in Cuba over many generations.*

You may consider having students reread this second paragraph with a partner and paraphrase the more complex parts before answering the question. It is essential that students understand that these different species evolved over many generations.

being confined to small areas. For example, the Cuban parakeet (*Psittacara euops*), a bright green endemic bird, resides only in the Zapata Biosphere Reserve. Because of its small population, this bird can be severely affected by environmental threats, such as habitat loss or pet trade exploitation. Only 5,000 of the parakeets remain.

The Cuban parakeet lives only in Cuba's Zapata Biosphere Reserve.

Think/Pair/Share: *How does having a small population put a species at risk?*

Environmental threats can affect multiple species at once. Limited space often leads island animals to co-evolve. These animals come to depend on one another—they play critical roles in one another's life cycles. For example, in one study, Cuba's endemic bee hummingbird (*Mellisuga helenae*) sought the nectar of just ten flower species. Nine of those flower species are endemic to the island. With such a narrow choice of food options, a decline in plant species could spell disaster for the bee hummingbird population.

The bee hummingbird, the smallest bird in the world, is endemic to Cuba.

Think/Pair/Share: *How does having coevolved with another species put an animal at risk?*

Invasive species also pose a threat to island species. When invasive animals arrive on an island they often face no predators and can quickly establish themselves. Dr. Gilberto Silva Taboada of the Cuban National Museum of Natural History, points to the North African catfish (*Clarias gariepinus*), a particularly destructive example of an invasive species. "This large fish can survive outside of water for days, it regularly climbs onto dry land wandering and feeding on all kinds of endemic animals, even those inside caves."

The North African catfish is a threat to some of Cuba's endemic species.

Think/Pair/Share: *How do invasive species put native species at risk?*

Like in other Caribbean countries, Cuba's environments are changing. Habitat loss and fragmentation pose growing risks. Climate change also adds to environmental decline by contributing to rising sea levels; changes to disease patterns; and an increase in droughts, heat waves, and heavy rains. Island species are especially susceptible to changes in their environments and, as a result, are at high risk of extinction.

Cuban and American scientists doing fieldwork in Cuba's Humboldt National Park.

Well aware of these challenges, Cubans continue to take strong measures to protect their natural heritage. Cuba's scientists are working with colleagues around the world to study, monitor, and protect the country's flora and fauna. The government has also created protected areas, including Humboldt National Park, the Gardens of the Queen marine reserve, and the Zapata Biosphere Reserve, where human activities have to follow strict rules. Ongoing efforts to protect these areas are important to conserve Cuba's biodiversity.

Think/Pair/Share: *Based on these last two paragraphs, what environmental threats does Cuba face?*

(Sample response: habitat loss; fragmentation; climate change is causing rising sea levels, heat waves and heavy rains; changes to disease patterns)

What are some of the steps the Cuban people are taking to "protect their natural heritage"?

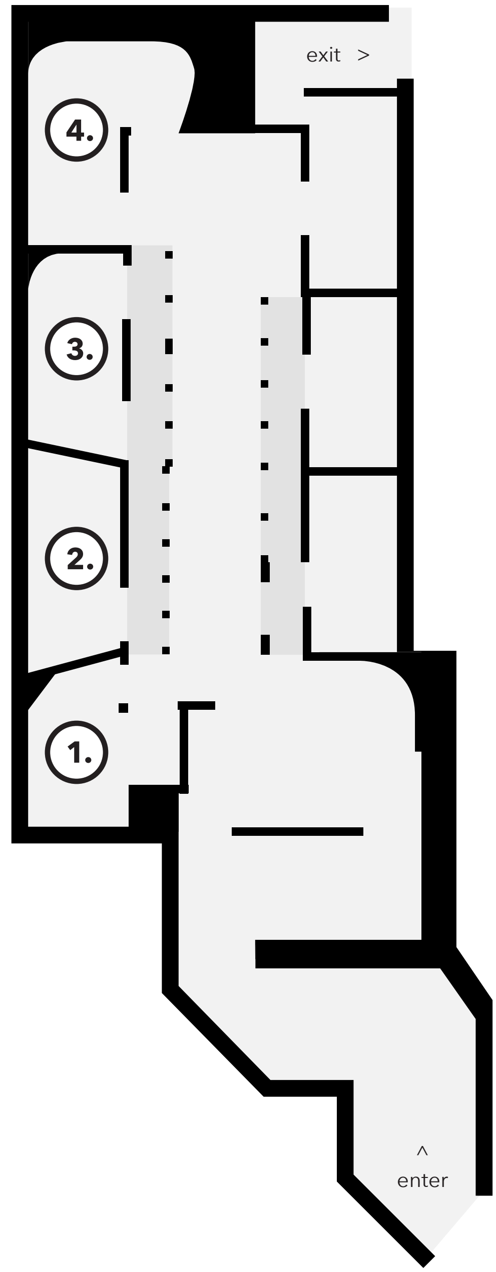
(Sample response: scientists are collaborating to study problems; there are protected areas with strict rules)

PHOTOS: map of Cuba, ©AMNH; *Ornimegalonyx*, ©D.Finnin/AMNH; Monte Iberia eleuth and Humboldt National Park, ©C.Raxworthy/AMNH; tree, dumbmichael/Vecteezy.com; Brown anole, ©H.Hillewaert/CC-BY-SA-3.0; Allison's anole, ©Lezumbalaberenjena/CC-BY-SA-3.0; Cuban bearded anole, ©L.Leszczynski/CC-BY-SA-3.0; Cuban knight anole, ©O.Shvadchak/CC-BY-SA-3.0; Cuban parakeets and bee hummingbird, ©E.Chernetsova/CC-BY-SA-3.0; North African catfish, ©P.Asman&J.Lenoble/CC-BY-SA-3.0; scientists, ©B.T. Smith/AMNH.

STUDENT WORKSHEET

Name ______________________________

Directions: In the Museum, you will visit four types of habitats in Cuba to collect information about island biodiversity.



1. Caves

Describe this habitat. (Hint: See info on the banner near the entrance to this section.)

Sample answers: Cuba has many caves created over millions of years as water dissolved underground limestone; home to animals such as bats, as well as remains of extinct animals that once lived in Cuba

GIGANTISM	Animal	Describe this extinct animal. What is unusual about it? What did it eat? List any interesting facts and information.
	Ornimegalonyx (extinct)	*Sample answers:* • *largest owl that ever lived* • *experts debate if it could fly or not* • *they ate small mammals such as hutias* • *developed large size on the island*

2. Humboldt National Park (Forests)

Describe this habitat.

Sample answers: one of the most biologically diverse island sites on the planet; it contains rainforest, pine forests, scrublands, and rivers; the park is home to many endemic animals and plants

STUDENT WORKSHEET

Name ______________________________

To find endemic species, look for this symbol in the exhibition!

ENDEMISM

Animal	Describe each animal. What does it look like? List any interesting, unusual information about it.
Cuban solenodon (endemic)	*Sample answers:* • *a mammal that secretes venomous saliva through a groove in front teeth* • *relative of shrews and hedgehogs* • *thought to have been extinct but they have been found in Humboldt National Park and studied by scientists* • *lives only in Cuba*
Bee hummingbird (endemic)	*Sample answers:* • *weighs 1/20th of an ounce* • *it is the smallest bird in the world, smaller than many bees* • *this species is only present in Cuba* • *its small size is a result of evolving over time on an island* • *only lives in Cuba*

ADAPTIVE RADIATION

Humboldt is home to 21 species of anoles. What keeps these different species from competing with each other for food?

Sample answers:

- *anoles divide up the habitat vertically*
- *some live close to the ground, others on tree trunk or branches and some high up in the canopy*

STUDENT WORKSHEET

Name ________________________________

3. Gardens of the Queen (Coral Reefs)

Describe this habitat.

Sample answers: largest marine reserve in Caribbean; very rich ecosystem with many diverse animals; coral reefs are some of the richest ecosystems on Earth

MIGRATION

Animal	Explain how these groups of animals connect Cuba's reef system with other marine life in the Caribbean and enhance Cuba's biodiversity
Corals (Hint: See the interactive and corals display case.)	*Sample answers:* • *coral larva drifts and replenishes faraway reefs as currents can carry it many miles away* • *corals build branching shapes that form foundation of coral reefs that provide home to many species*
Sharks and rays (Hint: Read the text about the mako shark, spotted eagle ray, and tiger shark.)	*Sample answers:* • *top predators that migrate between Cuba and South and North America* • *important for maintaining a healthy reef*

CONSERVATION

How are the Cuban people protecting their coral reefs?

Sample answers:

- *fishing is prohibited in protected sites, coast is not used heavily for tourism, agriculture, or industry*
- *only limited diving is allowed*

There are no endemic animals in this section of the exhibit. Why not?

Sample answer:

- *because animals that live in the ocean are not limited by island boundaries and can travel/migrate easily*

STUDENT WORKSHEET Name ______________________

4. Zapata Biosphere Reserve (Wetlands)

Describe this habitat.

Sample answers: Zapata contains the largest and most important wetlands in Caribbean; it includes marshes, peat bogs, mangroves, coral reefs; these wetlands support complex web of life including frogs, turtles, fish, shellfish, crocodiles, birds, insects, and plants; it is a conservation priority

ENDEMISM

Name 3 endemic species found in Zapata.

Sample answers: Cuban gar, Zapata rail, Cuban parakeet, Cuban tody, Cuban trogon, bee hummingbird, Cuban crocodile

MIGRATION

Why are Cuba's wetlands important to many migrating birds? Give an example.
(Hint: Visit the "Migration Way Station" display case.)

Sample answers: many birds winter in Cuba and many more use the island as a stopover between North and South America; ospreys and warblers

CONSERVATION

Why is the endemic Cuban crocodile critically endangered?
What is being done to prevent this species from going extinct?

Sample answers:

- *they have smallest population and smallest geographical range of any crocodile*
- *they breed with American crocodiles to produce hybrids; this could lead to this species going extinct*
- *Cuban scientists are maintaining a breeding population isolated from American crocodiles and reintroducing them into the wild*

ESSAY SCORING RUBRIC: TEACHER VERSION - page 1

	Exceeds	Meets	Approaches	Needs Additonal Support
	4	**3**	**2**	**1**
Research: "Cuba: An Example of Island Evolution, Biodiversity, and Conserva-tion" Article	Accurately presents information relevant to all parts of the prompt with effective paraphrased details from the article	Presents paraphrased information from the article relevant to the prompt with sufficient accuracy and detail	Presents information from the article mostly relevant to the purpose of the prompt with some lapses in accuracy or completeness AND/OR information is copied from the text	Attempts to present information in response to the prompt, but lacks connections to the article or relevance to the purpose of the prompt
Research: Research: ¡Cuba! Museum Exhibition	Accurately presents information relevant to all parts of the prompt with effective paraphrased details from the exhibition	Presents paraphrased information from the exhibition relevant to the prompt with sufficient accuracy and detail	Presents information from the exhibition mostly relevant to the purpose of the prompt with some lapses in accuracy or completeness AND/OR information is copied from the text	Attempts to present information in response to the prompt, but lacks connections to the exhibition content or relevance to the purpose of the prompt
Science Explanations	Integrates relevant and accurate science content with thorough explanations that demonstrate in-depth understanding of factors that contribute to Cuba's rich biodiversity	Presents science content relevant to the prompt with sufficient accuracy and explanations that demonstrate understanding of factors that contribute to Cuba's rich biodiversity	Presents science content mostly relevant to the prompt; shows basic or uneven understanding of factors that contribute to Cuba's rich biodiversity	Attempts to include science content in explanations, but understanding of factors that contrib-ute to Cuba's rich biodiversity is weak; content is irrelevant, inappropriate, or inaccurate
	Consistent and effective use of precise and do-main-specific language	Some or ineffective use of precise and domain-specific language	Little use of precise and domain-specific language	No use of precise and domain-specific language

ESSAY SCORING RUBRIC: TEACHER VERSION - page 2

	Exceeds	Meets	Approaches	Needs Additonal Support
	4	**3**	**2**	**1**
Development	Includes an opening section that clearly introduces the factors that contribute to Cuba's rich biodiversity	Includes an opening section about factors that contribute to Cuba's rich biodiversity	Includes an opening section that is insufficiant or irrelevant	Does not include an introduction
	Includes more than sufficient highly detailed examples to address the writing prompt	Includes sufficient examples to address the writing prompt	Includes examples, but not sufficient to fully address the prompt	Does not include any examples
	Provides a concluding section that follows from and effectively supports the information or explanation presented	Provides a concluding section that follows from and sufficently supports the information or explanation presented	Provides a concluding section that mostly supports the information or explanation presented	Provides a concluding section that does not supports the informa-tion or explanation presented OR pro-vides no concluding section
Conventions	Demonstrates and maintains a well-developed command of standard English conventions and cohesion, with few errors; response includes language and tone consistently appropriate to the purpose and specific requirements of the prompt	Demonstrates a command of standard English conventions and cohesion, with few errors; response includes language and tone appropriate to the purpose and specific requirements of the prompt	Demonstrates an uneven command of standard English conventions and cohesion; uses language and tone with some inaccurate, inappropriate, or uneven features	Attempts to demonstrate standard English conventions, but lacks cohesion and control of grammar, usage, and mechanics

ARTICLE

Cuba: An Example of Island Evolution, Biodiversity, and Conservation

Cuba is remarkably varied in its geography, with remote forests, deep caves, broad wetlands, and dazzling reefs. It has many well-protected ecosystems and is isolated from the mainland. This allows its species to evolve and adapt in unique ways.

Over four thousand islands—an archipelago, with one main island—make up the nation of Cuba in the northern Caribbean Sea. It is located just 150 kilometers (94 miles) from the tip of Florida.

Island Geography and Endemism

Islands such as Cuba tend to be rich in endemic species. Endemic species are organisms that exist only in the particular area in which they evolved, and nowhere else in the world. “The island of Cuba is so large, it acts as a miniature continent,” says Chris Raxworthy, curator-in-charge of the Department of Herpetology at the American Museum of Natural History. “Evolution there has produced a lot of species that can’t be found anywhere else in the world.” In fact, roughly half of all plants and a third of all vertebrate animals in Cuba are endemic. What could explain these high rates of endemism? “In many ways islands function as natural experiments,” says Ana Luz Porzecanski, director of the Museum’s Center for Biodiversity and Conservation. “They are isolated from the mainland and from one another, they have set boundaries, and they vary in size and geography. So evolution can take different paths in different islands, leading to very different plants and animals.”

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"Island Rule"

Some of Cuba's species exhibit the effects of the "island rule." The island rule proposes that, over time, island animals tend to evolve smaller body sizes (dwarfism) when food sources are limited. Or, they tend to evolve larger body sizes (gigantism) when there is less pressure from predators. For example, the extinct flightless owl, *Ornimegalonyx*, weighed 38 pounds and is the largest owl that ever lived. Scientists think it evolved from a smaller ancestor. It may have grown so large due to the absence of natural predators and the lack of competition

This is a model of *Ornimegalonyx*, the largest owl that ever lived. This extinct giant owl may not have been able to fly.

for food. At the other end of the spectrum, Cuba also harbors one of the world's smallest frog species, Monte Iberia eleuth (*Eleutherodactylus iberia*).

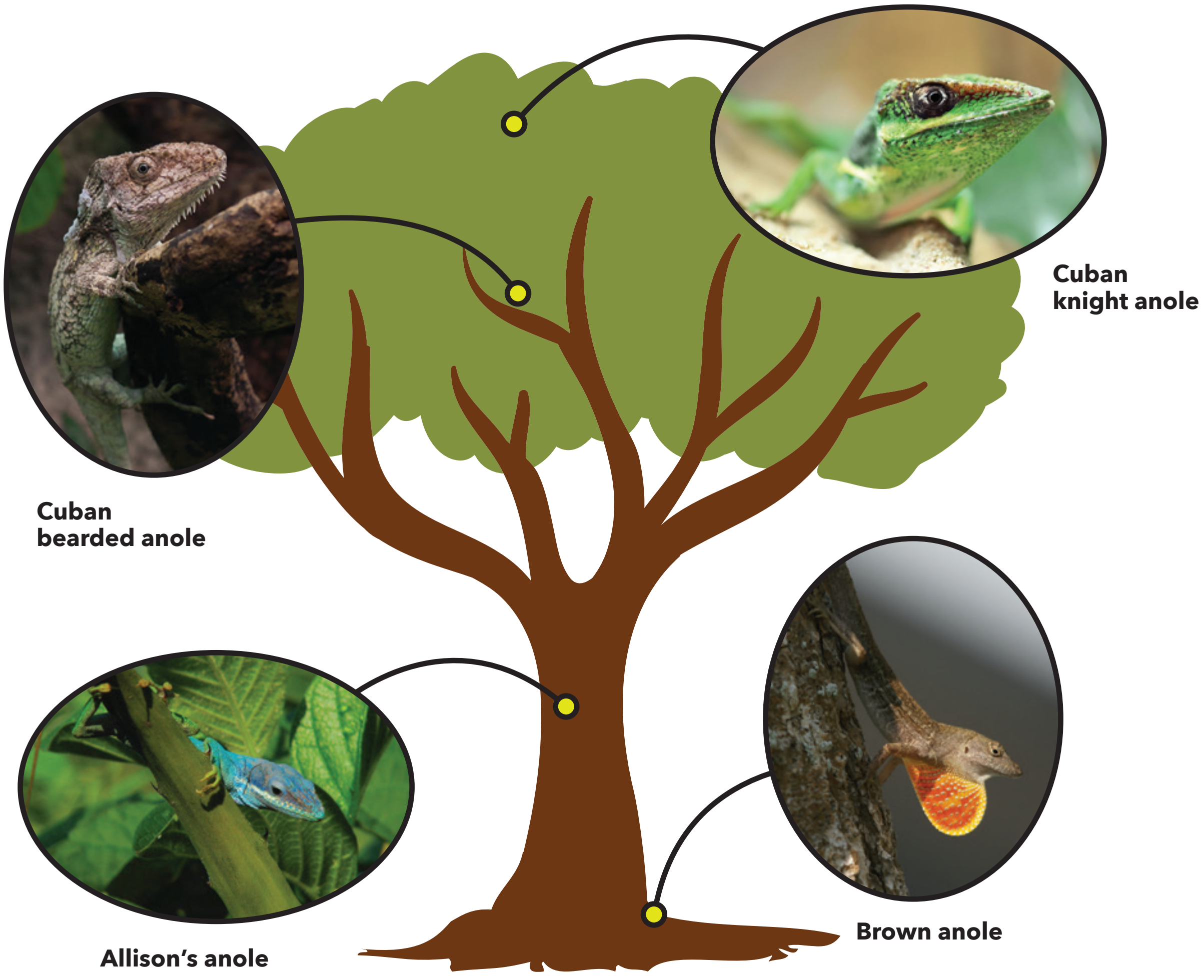
An adult Monte Iberia eleuth can fit on a human fingernail with room to spare.

Formation of New Species

When Charles Darwin arrived in the Galápagos Islands almost 200 years ago he observed small birds called finches. The finches he saw were all different species. He noted that each species had adapted to eating different kinds of food. Darwin later concluded that the finches were able to coexist on the small island because they had adapted in ways that allowed them to divide up the limited resources, and in the process, became different species. This phenomenon of organisms diversifying when there is competition among members of the same species is also well documented in a group of lizards called anoles. Many species of these lizards, some endemic to Cuba, reside in the lush forests of Cuba's Humboldt National Park.

Humboldt National Park

The first anoles in Cuba lived in the trees. At first they competed for resources with members of their same species. Over time the anoles were able to coexist by evolving strategies to divide the tree habitat vertically. By adapting, groups of anoles became specialized to live exclusively in different micro-habitats of the trees. Some lived at the ground level. Some lived in the crown of trees. While others lived in between, on trunks and twigs. Over many generations, these populations of anoles became distinct enough, morphologically and genetically, to be considered different species.



The brown anole (*Anolis sagrei*) lives near the base of a tree trunk. This small lizard has long back legs for jumping, sprinting, and moving fast. It is camouflaged—it blends in with the tree's trunk and branches.

The Allison's anole (*Anolis allisoni*) lives on tree trunks, especially on palm trees. Its big toe pads help it cling to the trunk and it can climb straight up (or straight down!) trunks in search of insects.

The Cuban bearded anole (*Anolis barbatus*) lives between the branches that form the leafy roof of the rainforest. It moves slowly, using its short legs to grasp fragile twigs.

The Cuban knight anole (*Anolis equestris*) lives near the top of the canopy. It is the largest anole, and devours tree frogs, tarantulas, and even birds.

Environmental Threats to Islands

The qualities that make islands so rich in biodiversity also make them very vulnerable to environmental threats. This makes conservation efforts challenging. Cuba is relatively isolated from the mainland and other islands. This results in many endemic organisms having limited population sizes, and being confined to small areas. For example, the Cuban parakeet (*Psittacara euops*), a bright green endemic bird, resides only in the Zapata Biosphere Reserve. Because of its small population, this bird can be severely affected by environmental threats, such as habitat loss or pet trade exploitation. Only 5,000 of the parakeets remain.

The Cuban parakeet lives only in Cuba's Zapata Biosphere Reserve.

Environmental threats can affect multiple species at once. Limited space often leads island animals to co-evolve. These animals come to depend on one another—they play critical roles in one another's life cycles. For example, in one study, Cuba's endemic bee hummingbird (*Mellisuga helenae*) sought the nectar of just ten flower species. Nine of those flower species are endemic to the island. With such a narrow choice of food options, a decline in plant species could spell disaster for the bee hummingbird population.

The bee hummingbird, the smallest bird in the world, is endemic to Cuba.

Invasive species also pose a threat to island species. When invasive animals arrive on an island they often face no predators and can quickly establish themselves. Dr. Gilberto Silva Taboada of the Cuban National Museum of Natural History, points to the North African catfish (*Clarias gariepinus*), a particularly destructive example of an invasive species. "This large fish can survive outside of water for days, it regularly climbs onto dry land wandering and feeding on all kinds of endemic animals, even those inside caves."

The North African catfish is a threat to some of Cuba's endemic species.

Like in other Caribbean countries, Cuba's environments are changing. Habitat loss and fragmentation pose growing risks. Climate change also adds to environmental decline by contributing to rising sea levels; changes to disease patterns; and an increase in droughts, heat waves, and heavy rains. Island species are especially susceptible to changes in their environments and, as a result, are at high risk of extinction.

Cuban and American scientists doing fieldwork in Cuba's Humboldt National Park.

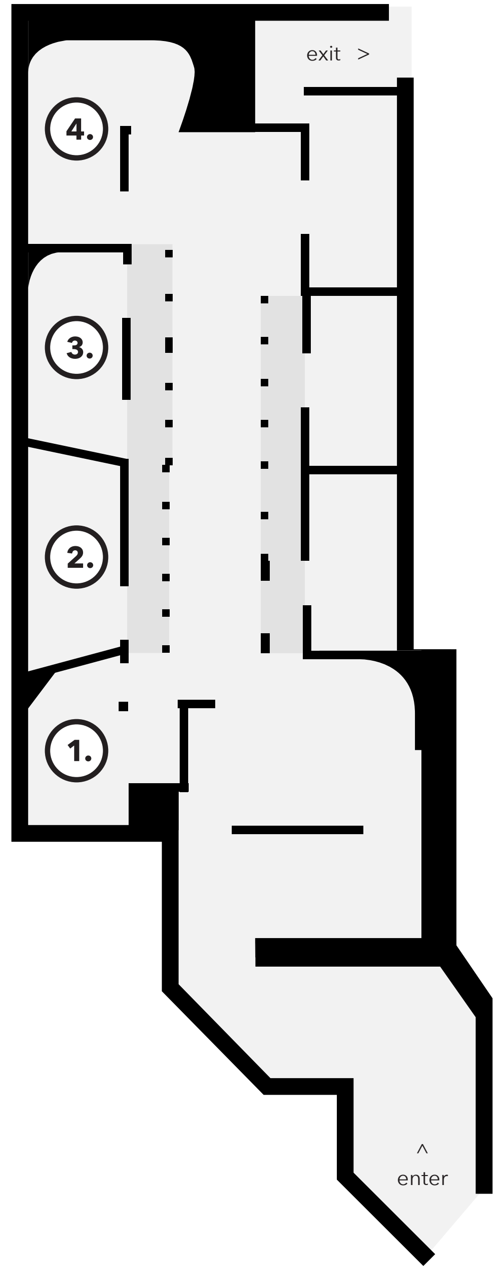
Well aware of these challenges, Cubans continue to take strong measures to protect their natural heritage. Cuba's scientists are working with colleagues around the world to study, monitor, and protect the country's flora and fauna. The government has also created protected areas, including Humboldt National Park, the Gardens of the Queen marine reserve, and the Zapata Biosphere Reserve, where human activities have to follow strict rules. Ongoing efforts to protect these areas are important to conserve Cuba's biodiversity.

PHOTOS: map of Cuba, ©AMNH; *Ornimegalonyx*, ©D.Finnin/AMNH; Monte Iberia eleuth and Humboldt National Park, ©C.Raxworthy/AMNH; tree, dumbmichael/Vecteezy.com; Brown anole, ©H.Hillewaert/CC-BY-SA-3.0; Allison's anole, ©Lezumbalaberenjena/CC-BY-SA-3.0; Cuban bearded anole, ©L.Leszczynski/CC-BY-SA-3.0; Cuban knight anole, ©O.Shvadchak/CC-BY-SA-3.0; Cuban parakeets and bee hummingbird, ©E.Chernetsova/CC-BY-SA-3.0; North African catfish, ©P.Asman&J.Lenoble/CC-BY-SA-3.0; scientists, ©B.T. Smith/AMNH.

STUDENT WORKSHEET

Name ________________________________

Directions: In the Museum, you will visit four types of habitats in Cuba to collect information about island biodiversity.



1. Caves

Describe this habitat. (Hint: See info on the banner near the entrance to this section.)

	Animal	Describe this extinct animal. What is unusual about it? What did it eat? List any interesting facts and information.
GIGANTISM	***Ornimegalonyx*** (extinct)	

2. Humboldt National Park (Forests)

Describe this habitat.

STUDENT WORKSHEET

Name ____________________

ONLY IN Cuba SÓLO EN

To find endemic species, look for this symbol in the exhibition!

	Animal	Describe each animal. What does it look like? List any interesting, unusual information about it.
ENDEMISM	**Cuban solenodon** (endemic)	
	Bee hummingbird (endemic)	

ADAPTIVE RADIATION	**Humboldt is home to 21 species of anoles. What keeps these different species from competing with each other for food?**

STUDENT WORKSHEET Name ______________________

3. Gardens of the Queen (Coral Reefs)

Describe this habitat.

MIGRATION

Animal	Explain how these groups of animals connect Cuba's reef system with other marine life in the Caribbean and enhance Cuba's biodiversity
Corals (Hint: See the interactive and corals display case.)	
Sharks and rays (Hint: Read the text about the mako shark, spotted eagle ray, and tiger shark.)	

CONSERVATION

How are the Cuban people protecting their coral reefs?
There are no endemic animals in this section of the exhibit. Why not?

STUDENT WORKSHEET

Name ______________________________

4. Zapata Biosphere Reserve (Wetlands)

Describe this habitat.

ENDEMISM	**Name 3 endemic species found in Zapata.**

MIGRATION	**Why are Cuba's wetlands important to many migrating birds? Give an example.** (Hint: Visit the "Migration Way Station" display case.)

CONSERVATION	**Why is the endemic Cuban crocodile critically endangered? What is being done to prevent this species from going extinct?**

STUDENT WRITING TASK

Based on the article, "Cuba: An Example of Island Evolution, Biodiversity, and Conservation," and your visit to the *¡Cuba!* exhibition, write an essay in which you describe some of the factors that contribute to Cuba's rich biodiversity ("biodiversity" is short for biological diversity, the rich variety of life).

Be sure to:

- Define endemism and explain why islands have many endemic species. Give an example of an endemic species.
- Describe how migratory species contribute to Cuba's biodiversity. Give an example of migratory species.
- Describe how conservation helps Cuba maintain high biodiversity. Give one example how people in Cuba help preserve Cuba's biodiversity.

ESSAY SCORING RUBRIC: STUDENT VERSION

	Exceeds	Meets	Approaches	Needs Additonal Support
	4	**3**	**2**	**1**
Research: "Cuba: An Example of Island Evolution, Biodiversity, and Conserva- tion" Article	I have used information correctly from the article to write my essay; I have given a lot of detail to explain the information in my own words.	I have used information correctly from the article to write my essay in my own words.	I have used information from the article to write my essay, but not all of my information is correct AND/OR I didn't use my own words.	I did not use information from the article to write my essay.
Research: Research: ¡Cuba! Museum Exhibition	I have used information correctly from the exhibition to write my essay; I have given a lot of detail to explain the information in my own words.	I have used information correctly from the exhibition to write my essay in my own words.	I have used information from the exhibition to write my essay, but not all of my information is correct AND/OR I didn't use my own words.	I did not use information from the exhibition to write my essay.
Science Explanations	All of the information I included about the factors that contribute to Cuba's rich biodiversity is correct.	Most of the information I included about the factors that contribute to Cuba's rich biodiversity is correct.	Some of the information I included about the factors that contribute to Cuba's rich biodiversity is correct.	None of the infor- mation I included about the factors that contribute to Cuba's rich biodiversity s is correct.
	I used relevant science vocabulary whenever possible, and I used all words correctly.	I used most science vocabulary words correctly.	I used some science vocabulary words correctly.	I did not use any science vocabulary words.

ESSAY SCORING RUBRIC: STUDENT VERSION

	Exceeds	**Meets**	**Approaches**	**Needs Additonal Support**
	4	**3**	**2**	**1**
Development	I included a clear introductory paragraph on factors that contribute to Cuba's rich biodiversity	I included a relevant introduction in the essay.	I included an irrelevant introduction to the essay.	I did not include an introduction.
	I included more than enough examples to fully explain the factors that contribute to Cuba's rich biodiversity	I included enough examples to explain the factors that contribute to Cuba's rich biodiversity	I included some examples, but not enough to explain the factors that contribute to Cuba's rich biodiversity.	I did not include any examples.
	I have written a concluding paragraph that relates to all of the information in my essay.	I have written a concluding paragraph that relates to some of the information in my essay.	I have written a concluding paragraph or sentence at the end of the essay.	I have not written a concluding sentence at the end of the essay.
Conventions	I have edited my essay for spelling, puctuation, and grammar; there are no errors.	I have edited my essay for spelling, punctuation, and grammar; there are some minor errors but the reader can still understand my writing.	I have not carefully edited my essay for spelling, punctuation, and grammar; there are errors that may make the essay hard for readers to understand.	I have not edited my essay for spelling, punctuation, and grammar; there are many errors that make the essay hard for readers to understand.