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 the island biodiversity, evolution, 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 Cuba's biodiversity, evolutionary history, and conservation.
4. **Materials in this packet include:**

For Teachers

- Activity Overview (p. 1-2)
- Article (teacher version): Cuba: An Example of Island Evolution, Blodiversity, 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, Blodiversity, and Conservation" (p. 16-21)
- Student worksheets for the *¡Cuba!* exhibition visit (p. 22-25)
- Student writing task and rubric (p. 26-28)

Common Core State Standards

RST.9-10.1: Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

RST.9-10.2: Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

WHST.9-10.2: Write informative/explanatory texts, including the narration of scientific procedures/experiments.

New York State Science Core Curriculum

LE3.1f, LE3.1g, LE7.2b

Next Generation Science Standards

LS2.C Biodiversity and Humans

- Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of new species (extinction).
- Human activity is also having adverse impacts on biodiversity through over population, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth.

SEP 8: Obtaining, Evaluating and Communicating Information

- Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/ or to obtain scientific information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
- Communicate scientific information or ideas in multiple formats (including orally, graphically, and textually).

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.

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.

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.

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. 26-28) 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 task, 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: 1,270 approx. **Wordcount:** 1,188

Note: The Lexile level of this text is at the upper end of the 11-CCR grade level band. Use your professional judgement in deciding how you will use this text. Suggestions for how to use this text include:

- as a whole class, shared experience, pausing to allow for partner and whole class talk (provides most scaffolding)
- as a partner assignment, with students having the option to stop and discuss the text with an assigned partner as they read (provides some scaffolding). If this option is selected, you may opt to provide "stop and think" questions to guide students; the italicized questions in the teacher notes can be used for this.
- as an independent reading assignment (provides least scaffolding). If this option is selected, it is advisable to have students annotate key ideas and questions in the margins as they read. Italicized questions in the teacher notes can be used for written assessment.

Sentences in *italics* indicate what you might say to students. This is not meant to be a script, but rather, to provide examples for how you might prompt students to think about this text, whether you ask the questions as you read aloud, or utilize them as written formative assessment.

Questions to pose to students are all in italics. If you read the text aloud as a shared experience, there are options for how you might use these questions. These methods can all be used throughout the read-aloud, or you can stick with one for the duration of the text.

- think/pair/share (then facilitate brief class discussion when desired)
- stop and jot (this could be followed by think/pair/share and/or whole class discussion)
- elicit student responses (followed by whole class discussion)

At points where students' comments indicate a lack of understanding of the text, use think aloud to demonstrate how you make sense of the text. For instance, if students struggle to answer a question you pose, you might show students how you would answer the question and refer to the lines in the text that helped you answer. Or, you might show students how you paraphrase a sentence that is complex, or mining a paragraph for the main scientific concept you are trying to understand.

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

Cuba: A Case Study of Island Evolution, Biodiversity, and Conservation

Cuba is remarkably varied in its geography, with remote forests, deep caves, broad wetlands, and dazzling reefs. The country's wide range of ecosystems and its isolation from the mainland offer many opportunities for species to evolve and adapt in unique ways. Many factors make Cuba a place brimming with a unique assembly of plant and animal life.

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

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

What are two important factors that make Cuba unique in the opportunities it offers for species to evolve and adapt in unique ways?

(Sample response: Its wide range of ecosystems/varied geography and isolation from the mainland.)

What do you notice about Cuba's geography from the map and caption?

ARTICLE

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Island Geography and Endemism

Islands such as Cuba tend to be rich in endemic species: organisms that exist only in the particular area in which they evolved, and that can't be found anywhere else. "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 vertebrates 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."

Paraphrase: *What is endemism? Why does it tend to occur on islands?*

For additional scaffolding, prompt students to look closely at Ana's quote and explain it in their own words.

	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.

Explain how the data represented on this chart relates to the quote from scientist Ana Luz Porzecanski in the previous paragraph.

Natural selection and other mechanisms of evolution operate on islands just as they do on large continents—but often with unusual effects. Organisms can arrive on islands in various ways: by crossing a temporary land bridge, washing up on floating vegetation, or hitching a ride with another species. What happens next depends on the specific circumstances present: the availability of food; suitable 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).

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

"Island Rule"

Some of Cuba's species exhibit the effects of the "island rule," which proposes that, over time, animals on islands tend to evolve smaller body sizes (dwarfism) when food resources are limited, or evolve bigger 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 ever known. Scientists think it evolved from a smaller ancestor and grew to enormous proportions due to the absence of natural predators and lack of competition for its diet of rodents and other small mammals. At the other end of the spectrum are 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.

Adaptive Radiation

For some organisms, competition for resources between members of their own species can play a strong role in the course of their evolutionary trajectory. Perhaps the best-studied evolutionary process on islands is called adaptive radiation. This is the same process that naturalist Charles Darwin described when he observed the Galápagos finches almost 200 years ago. When an animal arrives on an island where it has no predators, members of the same species will compete for the limited resources and will find different niches to occupy. Over time, they diversify (radiate) and become distinct species.

For evolutionary biologists, the highly diverse group of anole lizards found throughout the Caribbean is a prime example of adaptive radiation. Many species of these lizards, some endemic to Cuba, reside in the lush forests of Cuba's Humboldt National Park.

The first anoles in Cuba lived in the trees. Although they competed for resources, the anoles were able to coexist by evolving strategies to divide the tree habitat vertically. As a result of adaptation, groups of anoles became specialized to live exclusively in different micro-habitats of the trees: some at the ground level, some in the crown of trees, and some in between, on trunks and twigs. Over many generations, these populations of anoles became distinct enough, morphologically and genetically, to be considered different species.

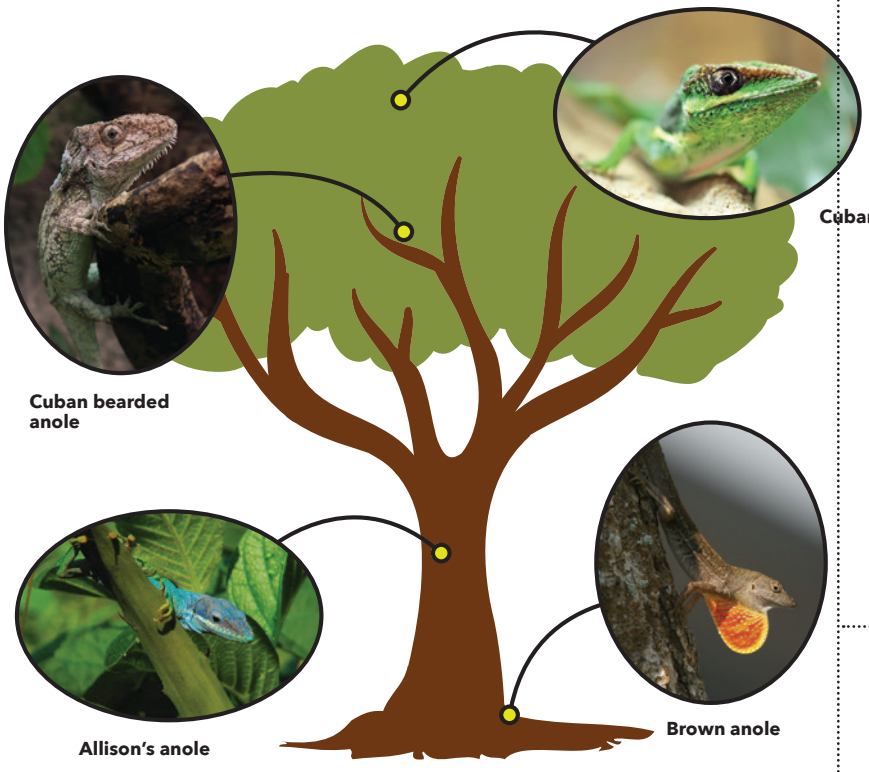
The article states that once organisms arrive on an island such as Cuba, what happens next depends on the circumstances on the island. The unusual features sometimes seen are attributed to "the island rule." Can you explain what the "island rule" is–and give two examples of how certain conditions on the island can lead to unusual features?

(Sample response: Island conditions can influence how the newly arrived species evolves: 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.

Adaptive radiation is another evolutionary process that occurs on islands. The last two sentences of the paragraph we just read explain this process. Reread them and explain the process in your own words.

Highlight that a parenthetical note defines diversify as "radiate" and clarify word meaning for students if needed.



Explain how anoles provide an example of adaptive radiation.

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. As the largest anole, it defends its territory by doing push-ups and bobbing its head up and down to scare away other lizards. Besides insects, it devours tree frogs, tarantulas, and even birds.

Environmental Threats to Islands

The qualities that make islands so rich in terms of biodiversity also make them very vulnerable to environmental threats, and, consequently, make conservation efforts both challenging and very important. The island's relative

isolation from the mainland and other islands lead many organisms to have limited population sizes, low genetic diversity, and to be confined to small areas. For example: the Cuban parakeet (*Psittacara euops*), a bright green endemic species, is limited to Zapata Biosphere Reserve where only about 5,000 individuals remain. Because of its small population, this bird can be profoundly affected by a host of environmental threats, such as habitat loss, or pet trade exploitation.

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

The isolation of islands, while contributing to their biodiversity, also poses threats to organisms. Identify three examples of how Cuba's isolation threatens the organisms that live in it.

(Sample response: limited population size, low genetic diversity, and confinement to small areas)

Facilitate brief discussion to explore why these factors threaten organisms/biodiversity on Cuba, if needed.

Environmental threats can reverberate through an island community and affect multiple species at once. Limited space often leads island animals to co-evolve and play critical roles in one another's life cycles. For example, a 2012 study found that Cuba's endemic bee hummingbird (*Mellisuga helenae*), looking for a meal of nectar, visited just ten species of flowers, nine of which were endemic to the island. With such a narrow choice of food options, a decline of these plant species could spell disaster for the hummingbird population.

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

Identify and explain the environmental threat described in this paragraph. How does the bee hummingbird show an example of this threat?

(Sample response: Co-evolving species can be quite dependent on one another. This can lead to a very limited food source, as shown in the example of the bee hummingbird, which only feeds on certain flowers)

Island species are particularly vulnerable to the threat of invasive species. Often introduced through human activity these non-natives can lead to the extinction of highly specialized island species. When invasive animals arrive on the island, just like any other animal, they often face no predators and take advantage of the open ecological niches. Dr. Gilberto Silva Taboada of the Cuban National Museum of Natural History, points to the North African catfish (*Clarias gariepinus*) as a particularly destructive example of an invasive species, and not just in the Zapata Biosphere Reserve wetlands where it was introduced. "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

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

Explain how invasive species pose a threat to Cuba's native species.

(Sample response: There are often small populations of native species and they are highly specialized. Invasive species often face no predators–this makes the native species very vulnerable.)

inside caves." Endemic species tend to have small populations and are highly specialized, thus they are often very vulnerable to population declines due to predation from invasive species.

Like other Caribbean countries, Cuba's environments are changing. Habitat loss and fragmentation pose growing risks. Climate change also contributes to environmental decline by contributing to rising sea levels; an increase in droughts, heat waves, and heavy rains; and changes to disease patterns.

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, where human activities have to follow strict rules, including Humboldt National Park, the Gardens of the Queen marine reserve, and the Zapata Biosphere Reserve. Ongoing efforts to protect these areas are important to conserve Cuba's diverse species and allow us to continue to learn about them.

Identify the environmental threats that are described in the last two paragraphs.

(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?"

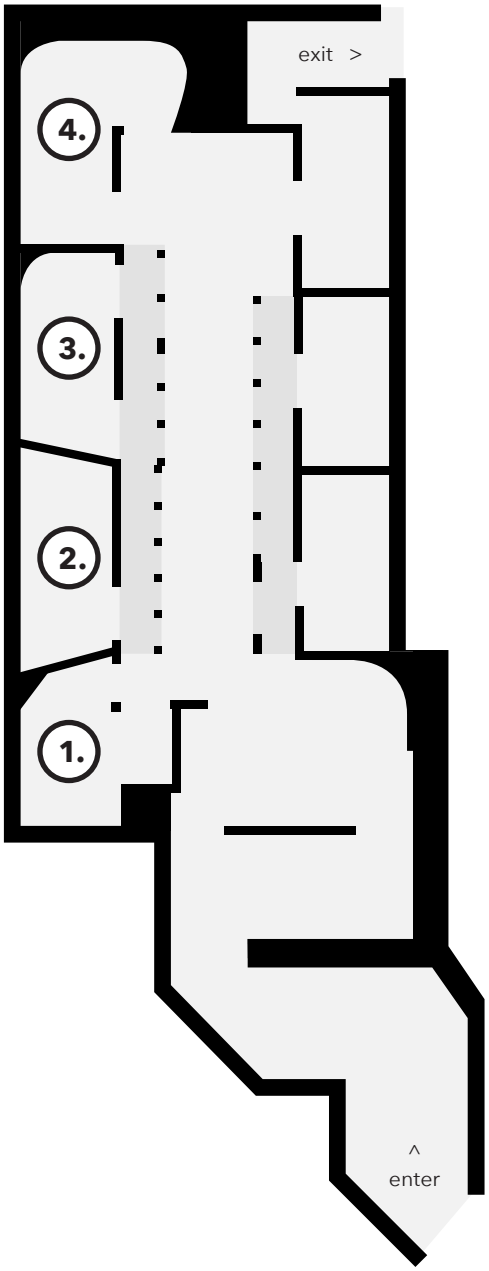
(Sample response: scientists are collaborating to study problems; there are protected areas with strict rules)

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 _____

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*

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

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	Describe this extinct animal. What is unusual about it? What did it eat? List any interesting facts and information.
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 Conservation" 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: ¡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	Develops the topic thoroughly by selecting the most significant and relevant facts and details to extensively describe the factors that contribute to Cuba's rich biodiversity	Develops the topic by selecting the relevant facts and details to sufficiently describe the factors that contribute to Cuba's rich biodiversity	Choice of facts and details is ineffective or lacking descriptions of the factors that contribute to Cuba's rich biodiversity	Does not describe the factors that contribute to Cuba's rich biodiversity OR the descriptions are minimal
	Provides thorough explanations that demonstrate in-depth understanding of the factors that contribute to Cuba's rich biodiversity	Provides sufficient explanations that demonstrate understanding of the factors that contribute to Cuba's rich biodiversity	Provides some explanations the factors that contribute to Cuba's rich biodiversity Explanations are incomplete or contain minor errors	Does not provide any explanations of the factors that contribute to Cuba's rich biodiversity OR explanations are mostly innaccurate
	Consistent and effective use of precise and domain-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 paragraph that clearly introduces the topic and previews what is to follow	Introduces an opening paragraph that clearly introduces the topic	Includes an opening section that sufficiently introduces the topic	Includes an opening section that is insufficiant or irrelevant OR does not include an introduction
	Includes more than sufficient highly detailed examples of the factors that contribute to Cuba's rich biodiversity	Includes sufficient examples of the factors that contribute to Cuba's rich biodiversity	Includes examples of the factors that contribute to Cuba's rich biodiversity	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 support the information or explanation presented OR provides 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

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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.

Natural selection and other mechanisms of evolution operate on islands just as they do on large continents—but often with unusual effects. Organisms can arrive on islands in various ways: by crossing a temporary land bridge, washing up on floating vegetation, or hitching a ride with another species. What happens next depends on the specific circumstances present: the availability of food; suitable 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).

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

"Island Rule"

Some of Cuba's species exhibit the effects of the "island rule," which proposes that, over time, animals on islands tend to evolve smaller body sizes (dwarfism) when food resources are limited, or evolve bigger 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 ever known. Scientists think it evolved from a smaller ancestor and grew to enormous proportions due to the absence of natural predators and lack of competition for its diet of rodents and other small mammals. At the other end of the spectrum are one of the world's smallest frog species, Monte Iberia eleuth (*Eleutherodactylus iberia*).

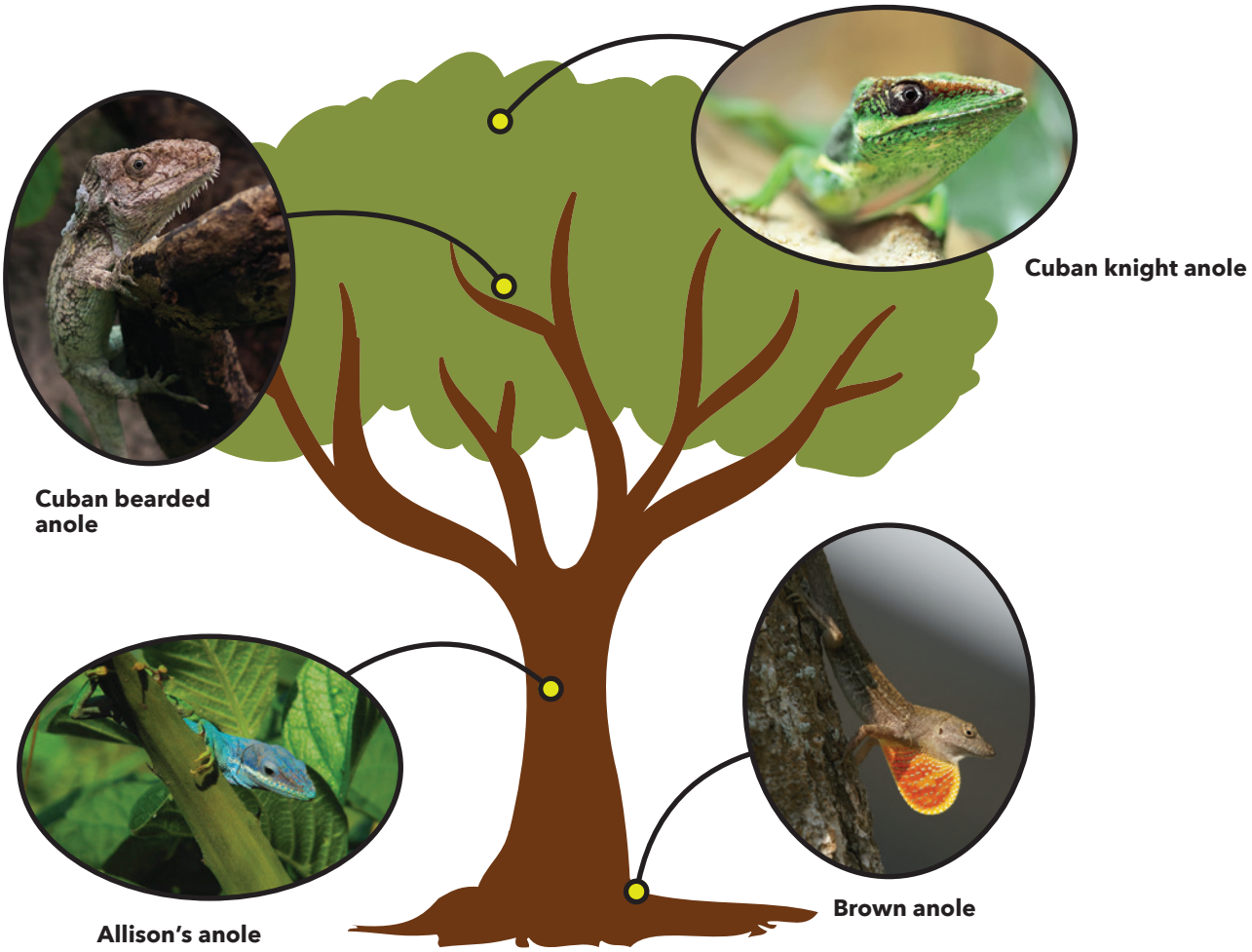
An adult Monte Iberia eleuth can fit on a human fingernail with room to spare.

Adaptive Radiation

For some organisms, competition for resources between members of their own species can play a strong role in the course of their evolutionary trajectory. Perhaps the best-studied evolutionary process on islands is called adaptive radiation. This is the same process that naturalist Charles Darwin described when he observed the Galápagos finches almost 200 years ago. When an animal arrives on an island where it has no predators, members of the same species will compete for the limited resources and will find different niches to occupy. Over time, they diversify (radiate) and become distinct species.

For evolutionary biologists, the highly diverse group of anole lizards found throughout the Caribbean is a prime example of adaptive radiation. Many species of these lizards, some endemic to Cuba, reside in the lush forests of Cuba's Humboldt National Park.

The first anoles in Cuba lived in the trees. Although they competed for resources, the anoles were able to coexist by evolving strategies to divide the tree habitat vertically. As a result of adaptation, groups of anoles became specialized to live exclusively in different micro-habitats of the trees: some at the ground level, some in the crown of trees, and some 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. As the largest anole, it defends its territory by doing push-ups and bobbing its head up and down to scare away other lizards. Besides insects, it devours tree frogs, tarantulas, and even birds.

Environmental Threats to Islands

The qualities that make islands so rich in terms of biodiversity also make them very vulnerable to environmental threats, and, consequently, make conservation efforts both challenging and very important. The island's relative

isolation from the mainland and other islands lead many organisms to have limited population sizes, low genetic diversity, and to be confined to small areas. For example: the Cuban parakeet (*Psittacara euops*), a bright green endemic species, is limited to Zapata Biosphere Reserve where only about 5,000 individuals remain. Because of its small population, this bird can be profoundly affected by a host of environmental threats, such as habitat loss, or pet trade exploitation.

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

Environmental threats can reverberate through an island community and affect multiple species at once. Limited space often leads island animals to co-evolve and play critical roles in one another's life cycles. For example, a 2012 study found that Cuba's endemic bee hummingbird (*Mellisuga helenae*), looking for a meal of nectar, visited just ten species of flowers, nine of which were endemic to the island. With such a narrow choice of food options, a decline of these plant species could spell disaster for the hummingbird population.

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

Island species are particularly vulnerable to the threat of invasive species. Often introduced through human activity these non-natives can lead to the extinction of highly specialized island species. When invasive animals arrive on the island, just like any other animal, they often face no predators and take advantage of the open ecological niches. Dr. Gilberto Silva Taboada of the Cuban National Museum of Natural History, points to the North African catfish (*Clarias gariepinus*) as a particularly destructive example of an invasive species, and not just in the Zapata Biosphere Reserve wetlands where it was introduced. "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

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

inside caves." Endemic species tend to have small populations and are highly specialized, thus they are often very vulnerable to population declines due to predation from invasive species.

Like other Caribbean countries, Cuba's environments are changing. Habitat loss and fragmentation pose growing risks. Climate change also contributes to environmental decline by contributing to rising sea levels; an increase in droughts, heat waves, and heavy rains; and changes to disease patterns.

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

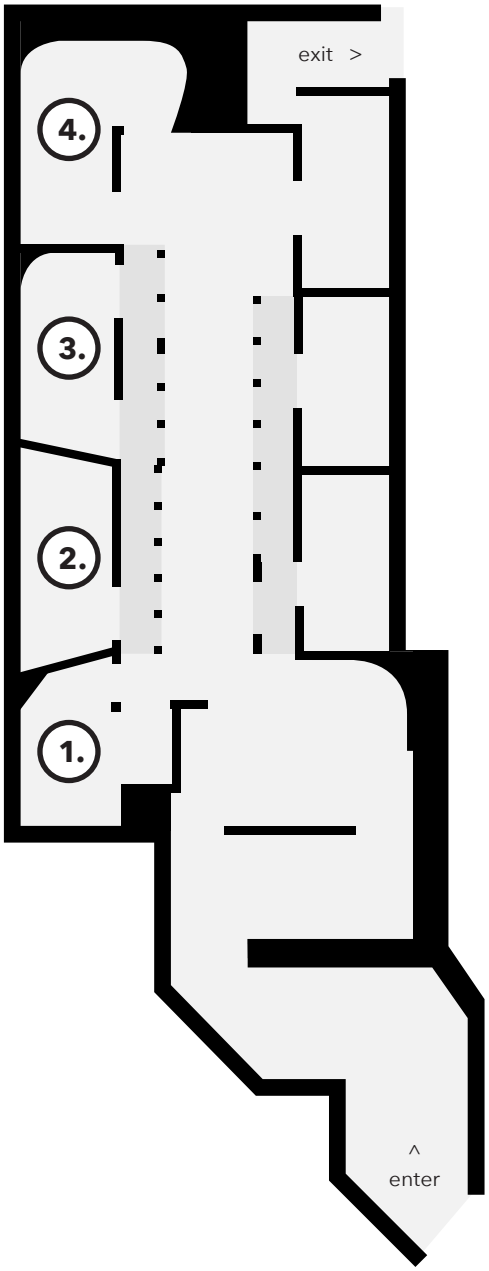
Well aware of these challenges, Cubans continue to take strong measures to protect their natural heritage. Cuba's scientists are working with colleagues around the world to study, monitor, and protect the country's flora and fauna. The government has also created protected areas, where human activities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

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.)

GIGANTISM

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

2. Humboldt National Park (Forests)

Describe this habitat.

STUDENT WORKSHEET

Name _____

ENDEMISM

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

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

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	Describe this extinct animal. What is unusual about it? What did it eat? List any interesting facts and information.
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:

- Describe how endemism contributes to Cuba's biodiversity. Provide an example.
- Describe how the "island rule" contributes to Cuba's biodiversity. Provide an example.
- Describe how adaptive radiation contributes to Cuba's biodiversity. Provide an example.
- Describe how migratory species contributes to Cuba's biodiversity. Provide an example.
- Describe how conservation contributes to Cuba's biodiversity. Provide an example.

ESSAY SCORING RUBRIC: STUDENT VERSION

	Exceeds	Meets	Approaches	Needs Additonal Support
	4	3	2	1
Research: "Cuba: An Example of Island Evolution, Biodiversity and Conservation" 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: *¡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	Develops the topic thoroughly by selecting the most significant and relevant facts and details to extensively describe the factors that contribute to Cuba's rich biodiversity	Develops the topic by selecting the relevant facts and details to sufficiently describe the factors that contribute to Cuba's rich biodiversity	Choice of facts and details is ineffective or lacking descriptions of the factors that contribute to Cuba's rich biodiversity	Does not describe the factors that contribute to Cuba's rich biodiversity OR the descriptions are minimal
	Provides thorough explanations that demonstrate in-depth understanding of the factors that contribute to Cuba's rich biodiversity	Provides sufficient explanations that demonstrate understanding of the factors that contribute to Cuba's rich biodiversity	Provides some explanations the factors that contribute to Cuba's rich biodiversity Explanations are incomplete or contain minor errors.	Does not provide any explanations of the factors that contribute to Cuba's rich biodiversity OR explanations are mostly innaccurate.
	Consistent and effective use of precise and domain-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: STUDENT VERSION

	Exceeds	Meets	Approaches	Needs Additonal Support
	4	3	2	1
Development	Includes an opening paragraph that clearly introduces the topic and previews what is to follow	Introduces an opening paragraph that clearly introduces the topic	Includes an opening section that sufficiently introduces the topic	Includes an opening section that is insufficiant or irrelevant OR does not include an introduction
	Includes more than sufficient highly detailed examples of the factors that contribute to Cuba's rich biodiversity	Includes sufficient examples of the factors that contribute to Cuba's rich biodiversity	Includes examples of the factors that contribute to Cuba's rich biodiversity	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 support the information or explanation presented OR provides 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