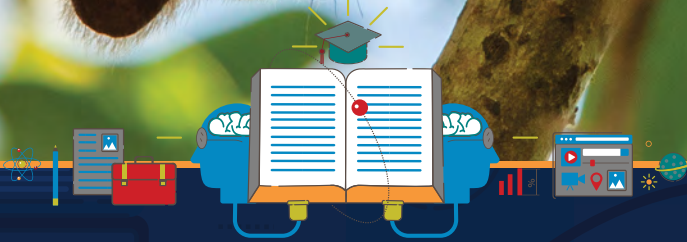


CANOPY CRITTERS

A SCIENCE 3D ADVENTURE

GRADE 4



By MIKE HEITHAUS Ph.D



symbioeducation™



KEY WORDS

Look for these words and try to figure out their meaning.

ADAPTATION

CANOPY

COMPETITION

DECOMPOSER

ECHOLOCATION

ELECTROMAGNETIC RADIATION

HERBIVORE

MUTUALISM

NATURAL RESOURCE

NOCTURNAL

NON-RENEWABLE RESOURCE

NUTRIENTS

PREDATOR

PREHENSILE TAIL

RENEWABLE RESOURCE

SENSORY SYSTEM

SPECIES

WAVE



TABLE OF CONTENTS

Welcome to Costa Rica	2
Life in the Air	4
Watch Your Step!	6
Waves in the Rainforest	7
Plant Central	11
Plants vs. Animals?	14
Canopy by Day	18
Canopy by Night	19
Kinkajous	20
Danger in the Trees	22
Human Threats	24
Leave Them Be!	26
Protecting Canopy Critters	27
Working in the Canopy	28
Glossary	31

WELCOME TO COSTA RICA

Costa Rica is an amazing country! It is part of Central America, with the Pacific Ocean to the west and the Caribbean Sea to the east. It is known for its rainforests and animal life.

Costa Rica has many amazing landforms including mountains, valleys, lakes, wetlands, and rivers. It even has an active volcano! Average rainfall in Costa Rica is around 2.5 meters (100 inches) per year. But, some places can get up to 7.5 meters (25 feet) of rain! It's no surprise that all of that rainfall has shaped the land. Flowing water creates valleys. New land and islands can appear in places where the water deposits sediment.



Most people know about Costa Rica's rainforests. But it has other amazing habitats and landforms. Arenal is an active volcano!

Water and warm temperatures near the equator allow beautiful rainforests to grow! Costa Rica has worked hard to protect its ecosystems. Much of the country is still covered by forests because of this protection. Millions of people visit Costa Rica each year to see its amazing ecosystems and animals.

There are some animals that most tourists don't see! What about the animals that come out at night? Let's learn how important these **nocturnal** animals are for the forests. We need to know how to protect them. Before we go on a mission with some incredible Costa Rican scientists, let's learn more about the rainforest and the plants and animals that live there!



Woolly opossum



Snail-eating snake

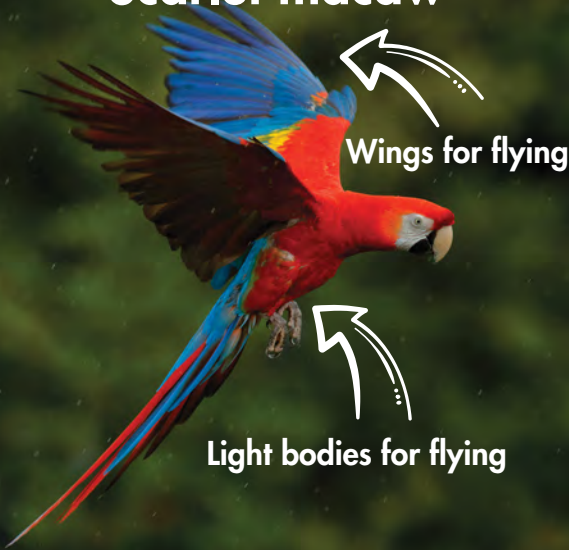


Tink frog

LIFE IN THE AIR

Thanks to the trees, some species of rainforest animals almost never touch the ground! They live in the trees. Many of them live in a place called the **canopy**. The canopy is the part of the rainforest where most of the trees have their leaves. There is plenty of food there for animals that like to eat leaves, fruit, or insects.

Scarlet macaw



Red-eyed tree frog



Three-toed sloth



Boa constrictor

NO WINGS? NO PROBLEM!

Being able to fly is helpful for animals like birds, bats and insects that live in the treetops. But some other canopy animals have another way to get around high above the ground. They glide! These rainforest animals have special flaps of skin to catch air like a parachute. It's not quite flying, but it's pretty close! Some gliders, like the flying squirrel of North America, can be found outside of rainforests.



Flying dragon lizard (Southeast Asia)



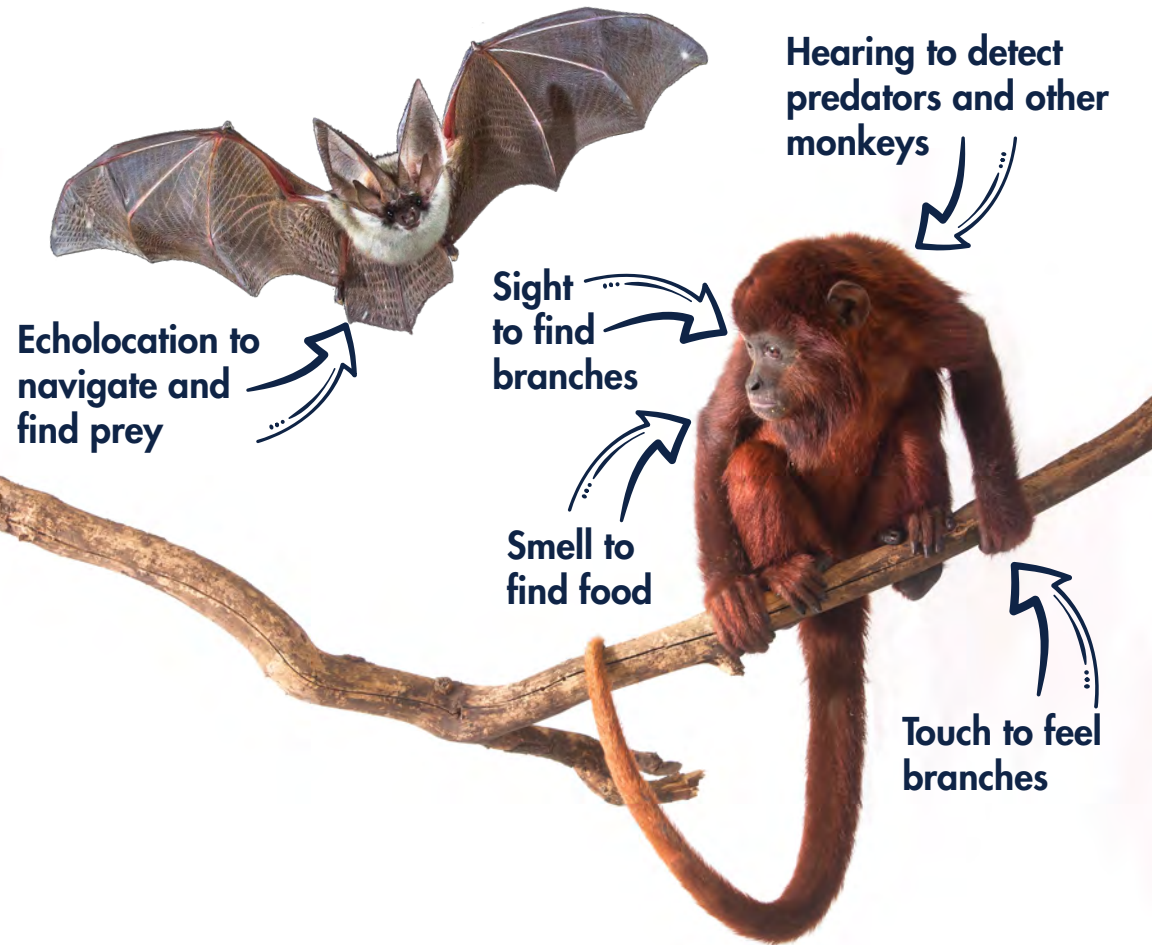
Colugo (Southeast Asia)

Wallace's flying frog
(Borneo)



WATCH YOUR STEP!

Life in the canopy isn't always easy! Falling out of a tree is a danger without wings. With all the leaves it can be difficult to see or find food. It can also be hard to see other animals, including predators. Eyesight is critical for navigating through the branches, but animals need to use all of their senses to live in the canopy. Each **sensory system** receives information from the environment. The nervous systems transmit this information to the brain. Then, the brain forms memories and signals how to respond.

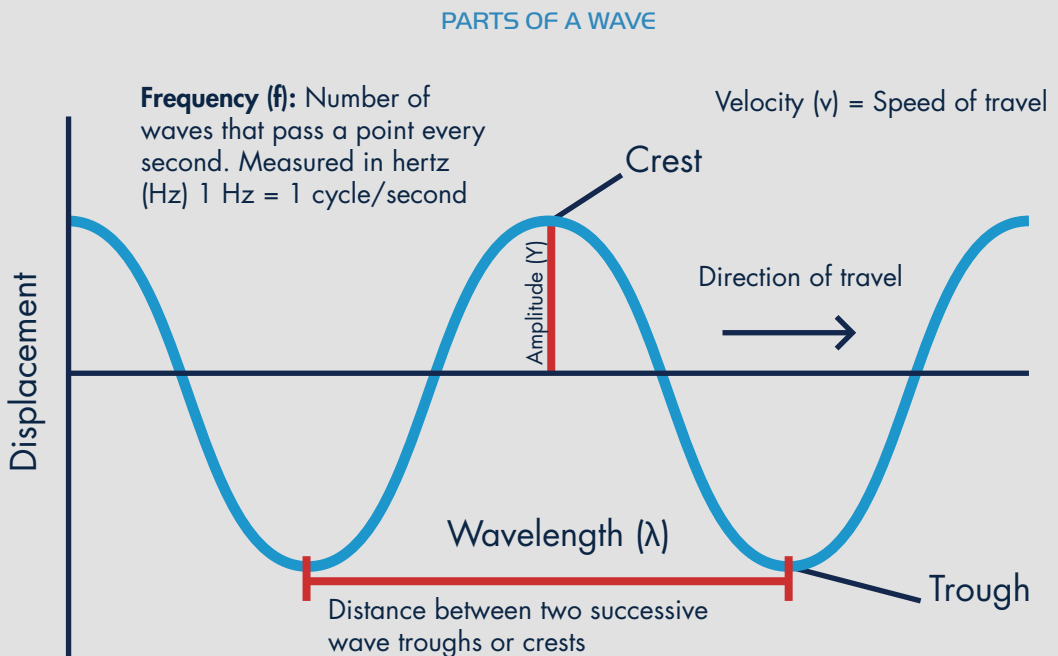


Animals need to use their senses to survive life in the trees. But, not all animals use these senses equally. Which senses do you think are most important during the day versus at night?

WAVES IN THE RAINFOREST

When you think about **waves**, you probably don't think of a rainforest! Sure, there can be waves in puddles, ponds, lakes, or rivers, but there are other kinds of waves in the rainforest. Both light and sound travel as waves! Those waves are very important for animals to sense and respond to the environment! They are also important for scientists who study the rainforest.

The amount of energy the wave has depends on things such as the wave's wavelength and frequency. Wavelength and frequency are mathematically related. If a wave has a longer wavelength, it has a lower frequency and less energy. Here's how it works:



Light waves (electromagnetic radiation) travel at incredible rates. The average speed of light in a vacuum is about 3×10^8 m/s or 300,000,000 m/s. Sound waves travel slower. They move at 320 m/s in air and 1,500 m/s in oceans!

Some waves are made when water moves up and down. Light waves and sound waves are disturbances that carry energy. Sound waves have to travel through matter. The matter can include air, water, or solids. What do you think happens to sound in space where there is no matter? There is no sound! Sound waves need to travel through matter to make sound.

Sound waves can travel a very long way in the rainforest. Many animals communicate with sound. They produce calls. The sound waves travel through the air. The waves enter an animal's ear. Signals are sent to the brain, where they are processed. The brain tells the body how to respond. Some animal calls help attract mates. Other calls communicate an animal's location. Bats use sound to "see" at night using **echolocation**. They produce a rapid series of clicks. These soundwaves travel outward. Then, they bounce off objects in the environment, like trees or a moth, and the echoes come back to the bat. The bat's ears detect the sounds and send signals to the brain. The brain uses the echoes to form a picture of the environment.



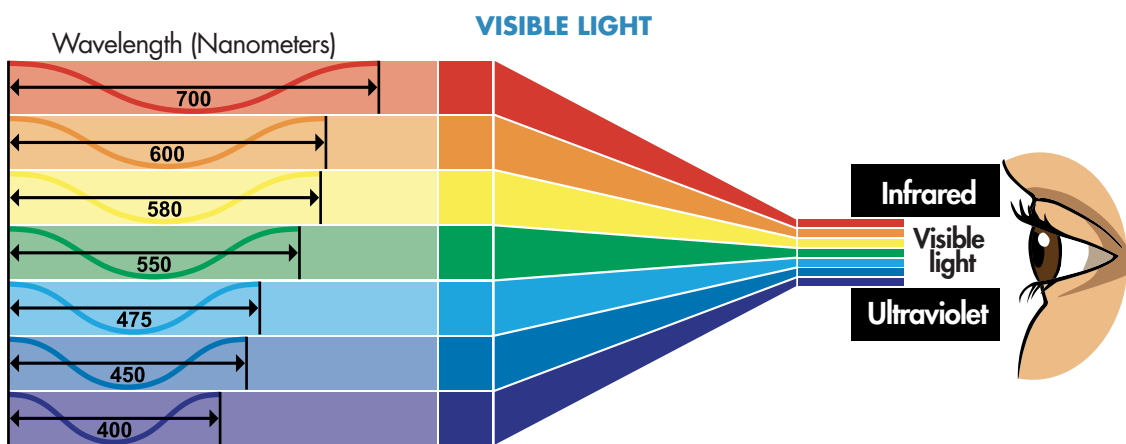


Bats create and use sound waves to navigate the forest at night and to catch prey. This process is called echolocation. Big ears help them detect echoes!

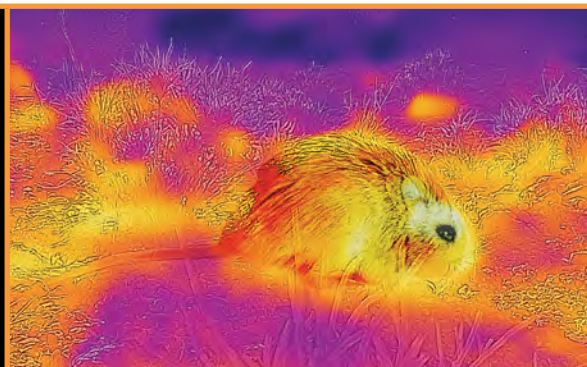
Both hearing and vision are important for many rainforest animals. In some cases, sound may be more important. The dense plant life can make it difficult for animals to see very far. But, they can use their sense of hearing to detect danger or find other individuals of their species. What senses would be most important to you if you went for a walk in the rainforest? What about if you went on a walk at night?

Electromagnetic radiation, such as sunlight, travels in a wave. Unlike sound, electromagnetic radiation does not have to move through matter. That is why light from the sun can move through the vacuum of space. When light reaches an object, it can either pass through it or bounce off it. However, some objects allow light to both pass through and bounce off. The light that bounces off objects travels into the eye and allows animals to see it. The eye sends the information to the brain, and the brain forms an image. It may also send signals to other parts of the body.

Not all electromagnetic radiation is visible to humans. Only certain wavelengths can be detected by human eyes. This is called visible light. Infrared light has longer wavelengths and lower energy than visible light. Ultraviolet light has shorter wavelengths and more energy than visible light. Even though humans can't see ultraviolet light, some insects and birds can. The world looks very different to them. Even some objects that look black, like bird feathers, burst with color when seen with ultraviolet light. Other animals, like some snakes, can detect infrared light or heat. Not all animals have the same ability to see in low light either. Many nocturnal animals can see in what looks like pitch black night to other animals and humans.



ULTRAVIOLET AND INFRARED



Some animals can see wavelengths beyond the visible light spectrum. Bees can detect ultraviolet and may see flowers differently than humans. Some snakes can see infrared, which helps them detect the body heat of their prey, like rodents.

PLANT CENTRAL

Costa Rica's rainforests are home to more than 10,000 species of plants. There are more types, or **species**, of trees in Costa Rica than in all of the United States and Canada combined! Each of these plants is built to survive and reproduce in the right conditions. Even though the temperature in the rainforest stays the same and there is a lot of rain, different plants in the rainforest have adapted for different conditions! Some of these **adaptations** are external. Others are internal.



To survive and grow, plants need a few things: sunlight, carbon dioxide from the air, water, oxygen, and nutrients. Here's how it works. The leaves of plants collect sunlight and carbon dioxide. The roots collect water and nutrients. Plants use sunlight, carbon dioxide and water to make their own food that stores the energy from the sun. They use **nutrients** to help build their bodies. Plants use oxygen to release the energy that is stored in their food.

Plants get the nutrients they need from the soil. Soil is made up of broken-down pieces of rock and dead matter from organisms. **Decomposers**, like fungi and bacteria, break down dead plants and animals. They release nutrients into the soil. Surprisingly, there are not a lot of nutrients in the rainforest soil. Rain washes some away. Plants scramble to take up the rest of them so they can grow and reproduce. That scramble is called **competition**.





Can you see differences between the plants that grow tall and have plenty of sunlight,

and the plants that grow near the forest floor?

Hint: Look at the size of the leaves!



To reproduce, plants need to make sure that pollen fertilizes eggs in flowers. Then, they need to make sure that their seeds are moved away from the parent. Why is it better if seeds move? If they drop right under their parent, they might not get enough light. Or, the parent might get all the nutrients and the offspring would die. They don't need to compete with their parent if they move to a new place.

PLANTS VS. ANIMALS?

Plants get their energy from the sun. They use this energy and matter from the air and water to make food. They use the energy in this food to build and run their bodies and reproduce. Animals can't make their own food. **Herbivores** are animals that eat plants. **Predators** eat other animals. Both predators and herbivores use energy that started with the sun. Some animals, like insects and howler monkeys, eat leaves. Since leaves don't have a lot of energy, these animals have to eat a lot. Herbivores can be a problem for plants. If too many of a plant's leaves get eaten, it might not be able to catch enough sunlight to make its food!



Howler monkey

Eats leaves



Agouti

Eats fruits

Yellow-chevroned parakeet



Eats seeds

Although herbivores eat plants, some relationships between plants and animals are good for both of them. This is called **mutualism**. Animals that eat fruits and drink nectar from flowers actually help plants!

Green hermit hummingbird



Drinks nectar

POLLINATION



1. Pollinator is dusted with pollen while drinking nectar from flower.



3. Pollen transfers to new plant and fertilizes egg.



2. Pollinator flies to new plant, carrying the pollen.

DISPERSAL




1. Animal eats fruits and seeds. Fruits are digested and seeds are not.



2. The animal, with seeded fruit inside its body, moves away from where it ate.

3. Seeds pass through the animal and are dispersed and deposited elsewhere.



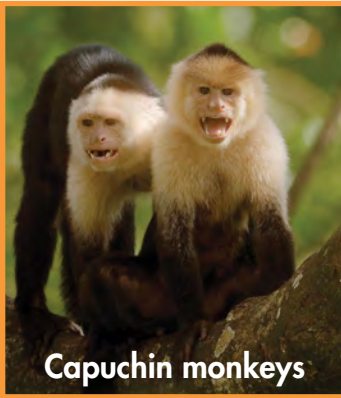
A black howler monkey is perched on a light-colored tree branch. The monkey has dark, shaggy fur and is looking directly at the camera. It is holding a long, green, cylindrical vegetable in its mouth with its teeth. The background is a lush, green forest with out-of-focus foliage.

The animals of the rainforest canopy that disperse seeds and pollinate flowers are active day and night. But, the species active during the day are very different than those active at night. They have different roles in their ecosystems.

Howler monkey

CANOPY BY DAY

During the day, the canopy is full of action! Monkeys and birds are some of the most obvious active canopy animals during the day. There are 850 species of birds in Costa Rica. That is 10% of the total number found in the entire world and twice as many species as the United States and Canada have combined!



Capuchin monkeys

In Costa Rica, capuchin, spider, and howler monkeys are commonly seen and heard. Howler monkeys can be heard calling from kilometers away! These monkeys all live in groups. The groups help the monkeys keep an eye out for danger, find food, and protect their turf from other groups.

One of the most dangerous daytime predators for canopy birds and mammals is the harpy eagle. Harpy eagles have excellent eyesight and hearing, and have huge talons. Even large monkeys have to keep their eyes and ears open to avoid becoming a meal.

Harpy
eagle



CANOPY BY NIGHT



Bats may be the most famous nocturnal rainforest animals. In Costa Rica, there are around 110 different species of bats. Some drink nectar and are pollinators. Some eat fruits and disperse seeds. Others eat insects, including moths and mosquitoes! Some even eat frogs and lizards. Why aren't bats out during the day? It's too dangerous. Predators, like hawks, would love to eat bats if they were out during the day.

Other mammals come out at night in Costa Rica's rainforest. Sloths don't move much at any time of day, but are most active at night. The three-toed sloth mostly eats leaves. Some species may be important in dispersing seeds and pollinating flowers. Woolly opossums eat fruit and occasionally nectar. Mexican tree porcupines eat leaves and fruit. Unlike their other porcupine relatives, they have a **prehensile tail**. That means that they can use it like a hand to hold onto tree branches.



KINKAJOUS

Kinkajous are important nocturnal rainforest animals. They mainly eat fruit, but sometimes eat insects and nectar from flowers. They have long tongues to sip nectar from deep flowers. The diets of kinkajous and spider monkeys are a lot alike.

They both love ripe fruit! Scientists think that kinkajous might be very important in seed dispersal. They are well adapted to life in the trees. They have a prehensile tail to grasp branches, and their hands can rotate to point backwards! This lets them climb down tree trunks headfirst. Kinkajous spend most of their time alone, including when they look for food at night. But during the day, they sleep together with members of their family.





Spider monkey



Prehensile tail

Lives in big groups

Active during the day



Eats fruit



Kinkajou

Lives alone or in small groups



Prehensile tail

Active at night



Eats fruit

Spider monkeys and kinkajous are mammals that live in the Costa Rican rainforest and share similar roles in the ecosystem. Can you think of other similarities and differences between these animals?

DANGER IN THE TREES

Predators of all sizes hunt in the canopy during the day and at night. Margays and ocelots are medium-sized cats that eat kinkajous and woolly possums. Snakes are a threat to the lizards and frogs that live in the canopy and are active at night. Owls eat small mammals, lizards, frogs and bats. Spiders hunt insects and other small animals.

A photograph of an ocelot, a medium-sized spotted cat, standing on a rock in a dark, forested environment. The ocelot has a distinctive pattern of dark spots and stripes on its golden-brown fur. It is looking towards the camera with a focused expression.

Ocelot

A photograph of a bright yellow eyelash viper snake coiled on a large, dark green leaf. The snake's body is tightly coiled, and its head is raised, showing its characteristic eyelash-like scales. The background is dark, making the yellow snake stand out.

Eyelash viper



Tropical
screech owl



Jumping spider

HUMAN THREATS

Canopy animals and their rainforest homes are in trouble. One of their biggest threats is the destruction of their habitat. People need energy and resources to build homes, vehicles, and other things they use. They also need land for agriculture. **Natural resources** are the resources that come from the Earth. They include the food, water, fuels and materials that people need and use. Taking too many natural resources can damage ecosystems. Animals and plants might need to find different places to live, or they could die out. **Non-renewable resources** are most at risk because they cannot be replaced after they are used. Fossil fuels like oil and coal are used for energy in power plants and vehicles. Burning them causes pollution to enter the atmosphere. Mining for metals, diamonds, and other resources buried underground can also cause problems for rainforests. Rainforests are cut down to dig mines. If mining isn't done correctly, toxic pollution can flow into rivers. That is bad for people and animals of the rainforest.



Costa Rica gets almost all of its power from **renewable sources**. They don't pollute the atmosphere and are replaced by nature after people use them. Most come from hydropower, or power of moving waters. Wind power and energy from the heat underground (called geothermal energy) are other major sources. People have still had an impact on the environment. For example, land has been cleared for cities and farms. Habitat loss is a major threat to rainforest ecosystems around the world.



LEAVE THEM BE!

Rainforest animals are also threatened by wildlife trade. Many are taken from their homes and hunted for food. Poachers may take animals to sell as illegal pets. These impacts can have negative effects on animals and ecosystems. Governments and scientists all over the world are working to protect rainforests and the species that live in them.



PROTECTING CANOPY CRITTERS

People need to stop over-hunting animals that live in the canopy. They need to make sure that their habitats are protected. It is also important to find ways for animals and people to exist together. For example, there may be better ways to grow crops in the rainforest without removing the habitat that canopy animals need. But, there is still more to learn about these animals and their rainforest home to help protect them.



WORKING IN THE CANOPY

It is hard work to study creatures that live in the canopy during the day. It is even more difficult at night! But scientists have many ways to work in the canopy. The research team at Tirimbina Biological Reserve in Costa Rica uses ropes and special equipment to climb all the way into the canopy. They set traps, attach sensors, and take samples. Even with climbing gear it is impossible to follow canopy critters through the forest at night. Scientists use tags that transmit radio waves. With a tag on an animal, scientists use a receiver to track animals through the forest. Tags are even small enough to be worn by bats! Scientists can learn more about habitats by following many animals. Light waves make it possible to use cameras to study canopy animals. Special cameras that can take pictures at night are placed in the trees to see what time of day animals are active.



Scientists also use sound waves to study the forest. Receivers listen for the different animal sounds and capture which species are active during the day and at night. They measure changes in these populations too.



The ability to track animals and see where they spend their time helps scientists study how important they are for plants. They can see how far they might move pollen from one plant to another. They can measure how far they might carry seeds inside their bodies. They can see if the seeds that animals poop out move more quickly. They can also see what happens to seeds that canopy animals don't disperse.

Now you are ready to join the team at Tirimbina to help study the amazing canopy critters that come out at night!







GLOSSARY

ADAPTATION

a trait of an organism that helps it survive in its environment

CANOPY

the uppermost layer of trees or tree branches in a forest

COMPETITION

an interaction in which living things fight for limited resources

DECOMPOSER

an organism that feeds on and breaks down organic material

ECHOLOCATION

the use of reflected sound to locate objects

ELECTROMAGNETIC RADIATION

waves that move through space and carry energy including light, radio waves, and x-rays

HERBIVORE

an animal that eats plants

MUTUALISM

an interaction in which both species benefit

NATURAL RESOURCE

a substance or material that occurs in nature and can be used by people

NOCTURNAL

active or occurring at night

NON-RENEWABLE RESOURCE

a natural substance or material that cannot be quickly replaced by nature

NUTRIENTS

substances that provide nourishment essential for growth and life

PREDATOR

an animal that catches and eats other animals

PREHENSILE TAIL

a tail that is able to grasp

RENEWABLE RESOURCE

a natural substance or material that can be quickly replaced by nature

SENSORY SYSTEM

a part of the nervous system that is responsible for processing information related to the physical senses

SPECIES

a particular type or group of organisms

WAVE

a disturbance that transfers energy through space and water

PHOTO CREDITS

Abbreviation Key: SS = Shutterstock.com;
NASA = National Aeronautics and
Space Administration

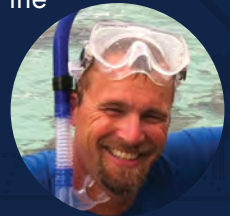
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SCIENCE 3D

Thanks for exploring with us! Our science adventures take us around the world to uncover secrets of the most amazing animals and places. Our mission and passion is to share these scientific discoveries with you. There are so many cool things to see out there, even in your own backyard, so get outside and explore!

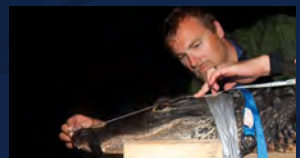
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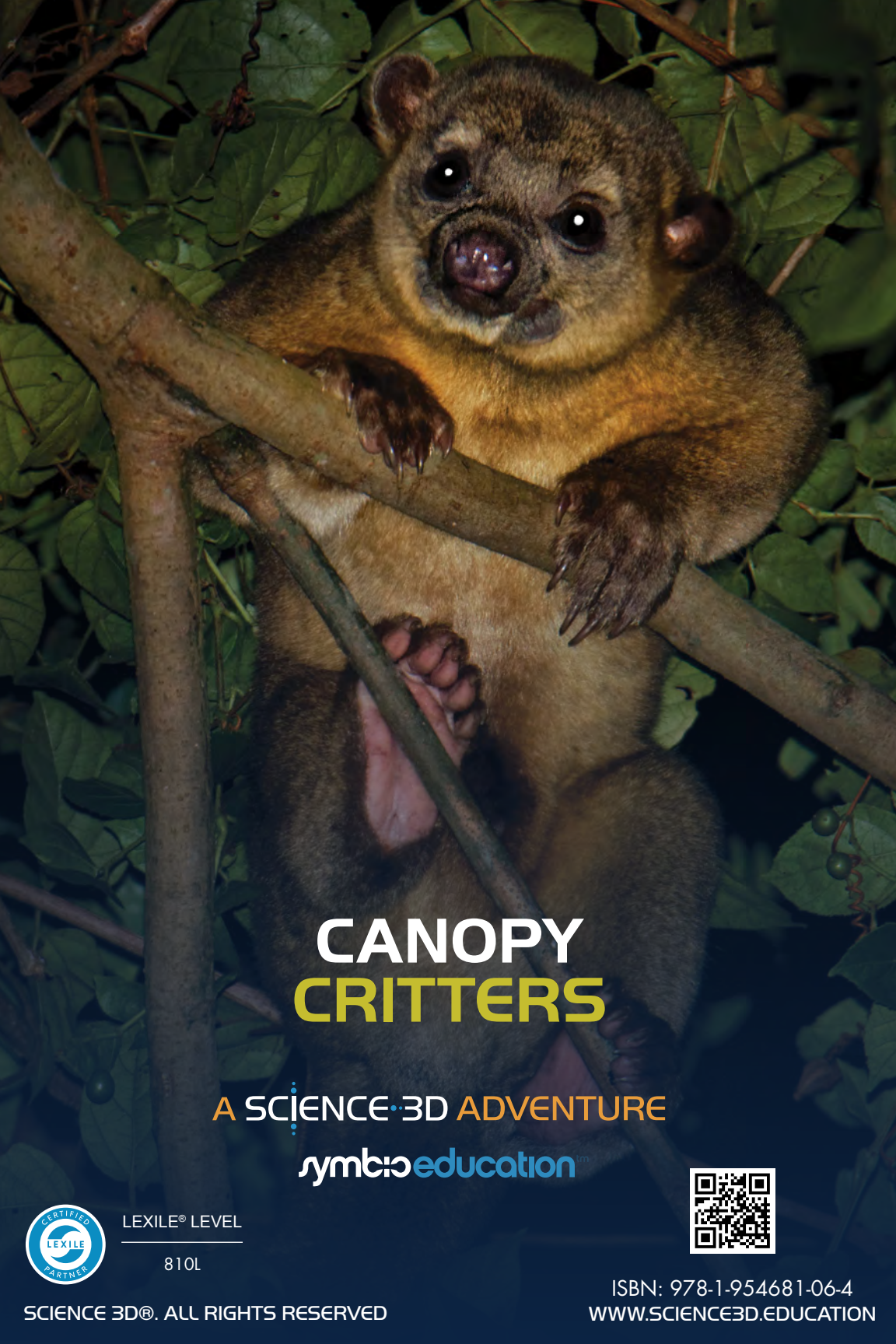
Dr. Mike Heithaus is a scientist, explorer, author, educator, and television host. He is a professor of biology and Dean of the College of Arts, Sciences & Education at Florida International University. Mike and his students study sharks, whales, sea turtles, and other large marine animals around the world. They also work with people to help protect these species. Mike loves sharing his work with others. He has written text books and helped create programs for students in elementary, middle, and high school. He has been on television programs including on PBS, National Geographic, and Discovery Channel's Shark Week.



PATRICK GREENE

As a wildlife filmmaker, Patrick has always had a passion for animals. He started to draw pictures of sharks and whales when he was just five years old. Later, he went to college to become a marine biologist and learned a lot about science. Then he got a job in television and learned how to make videos, too. Since then, he's gone all over the world studying and filming wild animals. He's made shows for National Geographic, PBS and ABC, and even won an Emmy Award. He loves making videos to teach students about science and about the many creatures that share our world.





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