Studying Mammals on Barro Colorado Island

Focus *questions*

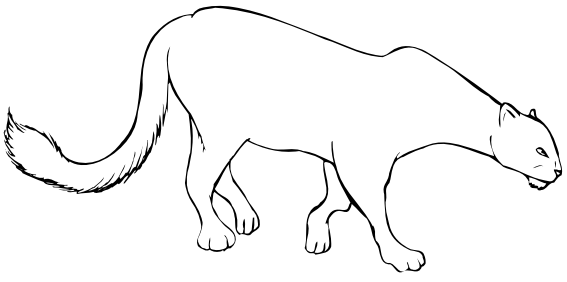
Why do scientists study rainforest mammals?

What tools and techniques do researchers use to study mammals on Barro Colorado Island?

How does the research on Barro Colorado Island's mammals help scientists to better understand rainforests?

Late one rainy night on Barro Colorado Island (BCI), a long gray-brown animal slips out of the trees and begins stalking down a forest trail. The animal, a meter long with short legs and a sleek whip of a tail, moves quickly and silently, stopping here and there to sniff the ground and the lowest branches. Passing beneath two wild almond trees, the animal pauses. Suddenly there is a flash of light as an automatic camera goes off, triggered by the animal's body heat and movement. Startled, the animal darts into the underbrush.

A few days later, in her lab on BCI, JASON host researcher Dr. Jackie Willis reviews the film from the camera and makes an extraordinary discovery. Among dozens of other photographs she finds a picture of this long, gray-brown animal. It looks at first like a large weasel, but Dr. Willis knows better. It is a jaguarundi, a **predatory** cat, and this is the first one ever photographed on BCI.



Brian Moore, ERG

A meter long, with short legs and a whip-like tail, the jaguarundi is sometimes referred to as the "otter cat" or "weasel cat."

Why do scientists study rainforest mammals?

Dr. Willis has studied **mammals** on BCI for 20 years, but she has never seen a jaguarundi in person. Neither have most of the other researchers who work there. The presence of jaguarundis on the island has long been more rumor than fact, since no one knows how many of the cats live on BCI or whether they really live there at all. (It could be that jaguarundis sometimes swim over to the island from the mainland.)

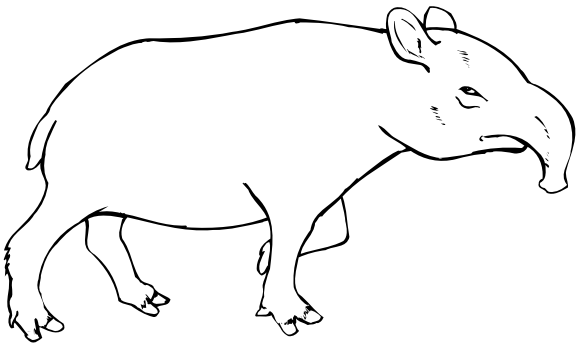
For Dr. Willis and the other researchers who study mammals on BCI, it is this element of mystery that makes the island such an exciting place to work. Scientists have been studying mammals for nearly 80 years on BCI. Yet even today, new mammal species are being recorded on the island and scientists are learning new things about the way mammals interact in their natural environment.

Only 15 square kilometers in area, BCI is home to roughly 110 mammal species. Among bats alone, 72 species have been recorded on BCI. (In comparison, there are only about 40 bat species in all of United States and Canada.) BCI's incredible **biodiversity**—the number and variety of species on the island—is not unusual for tropical forests, which are among the most diverse and complex ecosystems on earth. Yet BCI offers scientists unmatched opportunities to study tropical mammals in their natural setting.

Since 1923, the forests on BCI have been protected as part of a nature reserve. Hunting is not allowed on the island. Trees may not be cut. Visitors may not change or disturb the forest environment. For the scientists who work there, BCI is a living laboratory where they can study the interactions of animals and plants.

Mammals pose a number of challenges for researchers who hope to study them through direct observation. Some mammals are active during the day and are often seen. These include monkeys, squirrels, and large, forest-dwelling rodents called

Research *article*



Brian Moore, ERG

Tapirs are large, stocky, hoofed animals, distantly related to horses and rhinoceroses. The Baird's tapir stands about 1 meter (3 feet) tall and is about 2 meters (6 feet) long. It is the largest land mammal in Central America, yet humans rarely see it.

agoutis. But many rainforest mammals are rarely seen. Some, like the three-toed sloth, are **arboreal** animals that spend most of their time high in the forest canopy, where they are hidden from sight. Others—like bats, opossums, kinkajous, and silky anteaters—are primarily **nocturnal** (active at night) or **crepuscular** (active at dusk and dawn), and sleep away their days in hiding. Finally, there are mammals so secretive and sneaky that they are almost never observed, day or night. These include the predatory cats (ocelots, pumas, jaguarundis, margays) and the large, hoofed animals known as tapirs.

Because rainforest mammals can be so elusive and hard to study, scientists on BCI are still answering basic questions. Dr. Willis has spent much time on BCI trying to determine what mammals live there and how their **population** levels change over time. But she and other researchers are also tackling more complicated questions.

Today, much of the research on BCI is focused on trying to understand how rainforest ecosystems work. How can so many species live together in a relatively limited space? For mammal researchers, there is much to learn about how different animals interact as they compete for food and space. What are the **home ranges** of different species? What are their **habitat** needs? And what eats what?

What tools and techniques do researchers use to study mammals on BCI?

Early studies of mammals on BCI often involved capturing animals and observing them in captivity. Though this is still sometimes done, most mammal research today is focused on studies of animals in their native habitats. To understand how rainforest ecosystems work, scientists must be able to monitor mammals as they move about in their habitat, looking for food, hiding from predators, raising their young, and defending their territory.

But this type of research can be extremely difficult, especially when the mammals being studied are nocturnal and rarely seen by humans. As the following paragraphs show, scientists have developed innovative tools and techniques to help them in their work.

Conducting long-term studies of mammal populations

For Jackie Willis, the most important tools for conducting research may be sharp eyes and a good pair of shoes. Every January, Dr. Willis and her husband Gregory Willis walk hundreds of kilometers on BCI, counting mammals. Their goal is to determine how many mammals of each species live on BCI and why the populations change from year to year.

Because Jackie and Greg can't count every mammal that lives on BCI, they use a technique called sampling to estimate mammal populations. In sampling, a scientist studies a portion (or sample) of a population in order to learn about the characteristics of the whole population. (See the Scientist's Toolbox for more information about populations.)

One sampling method used on BCI is called a "strip census." When conducting a strip census, Jackie and Greg walk BCI's trails and make lists of every mammal they see. They walk a different trail every day for an entire month. Then they total up how many mammals they've seen and what percentage of the island's area they've covered. Using these figures, they can estimate total mammal populations on BCI.

Every year, Jackie and Greg do several census walks after dark. They use binoculars and a powerful spotlight to pick out nocturnal mammals such as opossums, porcupines, and silky anteaters, high in the trees. Some species have eyes that reflect the light back to an observer; their "eyeshines" make them visible from a distance.

For the most elusive species—such as ocelots and other cats—Jackie and Greg set up "trip" cameras that automatically photograph any animal that passes. (The cameras go off when they detect heat from the animals.) By analyzing pictures from the cameras, Jackie and Greg have determined that there are about 25 ocelots on BCI. Each ocelot has a unique pattern of spots, which the researchers use as a kind of "fingerprint" to tell the cats apart. Jackie and Greg have also verified the presence on BCI of jaguarundis and margays and even the much-larger pumas.

Jackie Willis

Dr. Jackie Willis uses an infrared "trip" camera to photograph and count elusive mammals, such as this ocelot. Each ocelot has a unique pattern of spots, which helps the researchers tell the cats apart.

Tracking the interactions between mammals

Jackie and Greg's research has shown that there are almost two ocelots for every square kilometer of land on BCI (25 ocelots living on 15 square kilometers). That's a lot of ocelots, living in a small area. Another scientist, JASON host researcher Dr. Roland Kays, is studying how ocelots share the space on the island. He is trying to learn how ocelots interact with one another and with the animals that they **prey** upon—agoutis, in particular.

Dr. Kays can't simply follow the ocelots around on BCI to monitor their behavior. So he uses **radio telemetry.** Radio telemetry involves using radio transmitters and receivers to track the movements of animals that can't be easily observed. It works like this: First, Dr. Kays traps an ocelot and fits it with a collar that carries a radio transmitter. Then he releases the cat into its native habitat. As the ocelot moves about, the transmitter sends out radio signals. Using a radio receiver attached to an antenna, Dr. Kays can pinpoint the direction in which the ocelot is located.

By tracking changes in the ocelot's location, Dr. Kays can map out the cat's movements around the island. This allows him to answer several important questions: What habitat does the ocelot prefer? How far does the cat travel each day in pursuit of prey? And how large is the ocelot's home range? By mapping out the ranges of several ocelots, Dr. Kays analyzes how the cats share the space on the island. He can also see where interactions might occur—particularly in areas where two cats' ranges overlap.

Radio telemetry has several limitations. Dr. Kays can generally track only one animal at a time. Also, tropical rainforests are not the best place for using telemetry, because the dense vegetation reduces the distance that radio signals can travel.

To overcome these limitations, Dr. Kays is part of an effort to build an automated telemetry system on BCI. The system will consist of seven towers, scattered around the island. The towers are tall enough to extend above the forest canopy, and a group of antennae are mounted atop each tower. These antennae pick up radio signals from transmitters on tagged animals. Then computers will analyze the signals to automatically track the animals' movements, 24 hours a day. Researchers will be able to track hundreds of animals at the same time: ocelots, agoutis, sloths, even smaller animals such as birds and bats. By tracking both predators and their prey, Dr. Kays hopes to gain new insights into the interactions between species.

Research *article*

Studying bats as an example of biodiversity

Among tropical mammals, it's not the big predators such as ocelots and pumas that rule the night. It's the bats, those little mammals with wings. With over 70 species living on BCI, bats are by far the most diverse and abundant mammals. And when night falls, bats are everywhere: zipping through the forest understory, flitting through the canopy and flapping high above it, swooping low over the streams and lake.

With so many bats around, you'd think that life would be pretty easy for JASON host researcher Dr. Elisabeth Kalko, who has studied bats on BCI for 12 years. But the truth is, without all kinds of special equipment, Dr. Kalko would have no way of knowing how many bats live on the island, or what kinds.

Dr. Kalko is studying how so many bat species can live together on BCI. She has found that bats have a remarkable method of sharing space and food. Instead of competing for a single food source, different bat species feed on different foods: fish, frogs, birds, insects, fruit, nectar, pollen, leaves, even blood. Each kind of bat has become a specialist, focusing on one or two food sources found in a specific part of the forest ecosystem.

To study the behavior of individual bat species, Dr. Kalko uses several innovative tools. These include night vision scopes and infrared video cameras that allow her to catch glimpses of the bats as they fly about in the dark. Another tool, called a "bat detector," allows Dr. Kalko to hear the **echolocation** calls made by bats in flight. Humans usually can't hear bats' high-pitched calls, but the bat detector changes the calls so they sound lower and slower. By hooking a tape recorder to the bat detector, Dr. Kalko can record the echolocation calls for later analysis in the lab. She has learned to use echolocation recordings to identify the kind of bat that is flying in the dark and to estimate the bat's activity (or behavior). Through years of research and hard work, she has slowly begun to understand the language of bats.

Elisabeth Kalko

Dr. Elisabeth Kalko used a multiflash camera system to photograph a single greater bulldog bat as it approaches the water, catches prey with its claws, and takes off again. Dr. Kalko's strobe light, which flashes every 50 or 100 milliseconds, catches different moments in the bat's flight.

How does the research on BCI's mammals help scientists to better understand rainforests?

Scientists have a long way to go before they can claim to understand how rainforest ecosystems work. But researchers such as Drs. Willis, Kays, and Kalko feel a special urgency about their work. In Central America, 3,300 square kilometers of rainforest are lost each year through logging and other human activities. Hunting and poaching have removed most of the larger predators from many forests. Worldwide, thousands of species are driven to extinction every year.

The mammal research on BCI is helping us understand how mammals fit into a system that includes thousands of species of other animals and plants. Scientists are examining the relationships between different species, asking very specific questions: What role do ocelots play in controlling agouti populations? What roles do bats play in dispersing the seeds of plants? As scientists answer these questions, they are putting together the pieces of a large and complex puzzle. And they are developing tools and technologies that researchers throughout the world can use in the same pursuit.

As we learn more about the relationships between species, we gain a better understanding of the impacts that humans can have on natural systems. This understanding has direct applications as we try to make wise decisions in conserving and restoring the world's remaining rainforests.

Bringing Back the Harpy Eagle

On BCI, scientists are working with an organization called the Peregrine Fund to consider a plan for reintroducing a large bird of prey called the harpy eagle. Harpies once lived throughout Central America. Today, due to pressure from poaching and habitat loss, the eagles have been driven from much of their range. The Peregrine Fund has begun breeding harpy eagles in captivity for release into the wild. BCI is being considered as a possible release site. But before scientists commit to such a plan, they want to study how it might affect other species. What, for example, would happen to populations of sloths and howler monkeys, which are a main food source for harpies? These arboreal mammals have thrived on BCI in recent decades, possibly because no eagles are around to prey on them. Would their numbers drop if the eagles were reintroduced? Consider that an average harpy eats one 3.5 kilogram animal every 4 days. How many kilograms does each harpy eat per year? For more information on the harpy eagle, visit the Peregrine Fund's Web site at **www.peregrinefund.org/conserv_harpyegl.html.**

Brian Moore, ERG

Research *article*

Journal Question

How do scientists study rainforest mammals and why? View the JASON XV Expedition Field Notes Video, where you'll meet guest researcher Katie Milton and others, and add to your online journal!

Fact or *Fallacy?*

Just as every human has unique fingerprints, every ocelot has a unique pattern of spots.

Fact: Scientists who study ocelots use the cats' spot patterns as a kind of "fingerprint" to tell them apart.

Vocabulary

Arboreal *adj.* Living and foraging in trees.

Biodiversity *n.* A measure of the number and variety of species within a region.

Crepuscular *adj.* Active at dusk and dawn.

Echolocation *n.* A method some bats use to navigate in the dark. The bats make high-pitched calls and interpret their echoes to determine the locations of objects.

Habitat *n.* The environment in which an organism normally lives or occurs.

Home range *n.* The area used by an animal in the course of its typical daily activities.

Mammal *n.* A warm-blooded animal that gives birth to live young and produces milk to feed them.

Nocturnal *adj.* Active at night.

Population *n.* All of the individuals of a single species that make up a specific group or occur in a specific habitat.

Predator *n.* An animal that consumes other animals.

Prey *n., v.* An animal hunted or caught for food. Also, to hunt, catch, or eat prey.

Radio telemetry *n.* The use of radio transmitters and receivers to track the movements of animals.