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SCIENTISTS SPY ON TREEFROGS USING PLASTIC PIPES IN TREES

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YOUNG REVIEWERS:

FLYNN
AGE: 9

RENEE
AGE: 8

Have you ever spied on a treefrog? These nocturnal creatures can be hard to observe, cloaking their lives in mystery. They hatch as legless swimmers but quickly transform into adults with camouflaged skin for daytime hiding and sticky toepads for hunting in tree branches by night. Yet even the most secretive, high-climbing treefrog cannot escape from pollution, new enemies, and habitat loss. Scientists want to know how treefrogs are coping with these threats, so we spy on them in a clever way: we hang small plastic pipes from trees, which mimic the dark cavities where treefrogs love to rest. Since 2011, we have counted treefrogs inside thousands of pipes, yet with so many mysteries, our work will continue for years. One pipe at a time, treefrogs are sharing their secrets about which threats harm them most, helping us better protect and manage the beautiful trees and waters they call home.

WHAT ARE TREEFROGS?

Treefrogs are small, shy amphibians that dwell in our forests and nearby wetland areas. While often difficult to see, their cheerful trills, chatters, and croaks remind us of their presence, sometimes even within our own neighborhoods. A curious and patient observer may find one of these small frogs clinging tightly to a tree branch, its color matching the bark so closely that, when motionless, it almost disappears. In fact, most treefrog species can change their body colors to match their surroundings. With the ability to flatten themselves closely to woody surfaces and hold tight with sticky toepads, treefrog are not only well-hidden from predators, but are skillful and successful hunters of gnats, mites, beetles, and other invertebrates. Within the forested ecosystems that they call home, including within the region's national parks and preserves, these small, tree-climbing amphibians benefit greatly when ecosystems are kept in balance. Understanding the threats and dangers faced by treefrogs helps the National Park Service manage their lands in ways that protect not only treefrogs, but the places where they thrive. How do scientists set up monitoring projects to do this difficult job?

TREEFROG MONITORING PROJECTS

Determining how animal population numbers change over time helps researchers evaluate the health of habitats and their inhabitants. This knowledge is extremely valuable for making good management decisions about the lands that the National Park Service manages and protects. Setting up a project to collect population information takes careful planning, and treefrogs, with their sensitive skin and water-dependency, are good subjects for population studies. In this project, the bottomland hardwood forests of the Barataria Preserve (part of the Jean Lafitte National Historical Park and Preserve south of New Orleans, Louisiana) served as the focus for the amphibian monitoring program [1]. Data collection in the preserve began in 2011 and is still ongoing.

Scientists must sometimes get very creative to "catch" the animals they want to study, and the simplest setups can often be the most effective. To observe treefrogs, the researchers came up with a very clever plan. They used small plastic pipes, which they hung in trees at roughly chest-level. Such pipes were ideal because they resemble other natural cavities, such as holes or crevices in trees. Treefrogs seeking shelter could enter and leave the pipes without harm (Figures 1A,B) and, as the pipes were very durable, they could be used year after year [2, 3].

The research team started by hanging 52 pipes within one small area, which they checked every month to count the treefrogs inside (Figure 1C). Researchers also identified each species and recorded the air

Figure 1

Plastic pipes were hung from trees at the Barataria Preserve, and scientists checked them for the presence of treefrogs. **(A)** A green treefrog peeking out of a short plastic pipe 5 cm in diameter. **(B)** A small squirrel treefrog within the same-sized plastic pipe. This frog has plenty of room to enter and leave the pipe. **(C)** A scientist checking a plastic pipe for treefrogs.

temperature and air moisture level, so a picture could be painted of the site's environmental conditions. This information could then be combined with data on recent weather events, like rainfall amounts, heat waves, cold snaps and windstorms, to help scientists better understand changes in treefrog populations over time.

TREEFROGS AND THEIR HABITS

Four different treefrogs are commonly found in the plastic pipes in the Barataria Preserve (Figures 2A–D): Cope's gray treefrog, bird-voiced treefrog, squirrel treefrog, and green treefrog. As well as sharing the woodland habitats, these treefrogs have many traits in common [4, 5]. Being nocturnal, they are all active at night, hunting for their insect prey sometimes high in trees, sometimes closer to the ground. During the spring and summer, the treefrogs move to nearby wetlands, bayous, and ponds to find mates and lay eggs, attaching the eggs to underwater vegetation. The eggs hatch into tadpoles that feed on algae and other similar aquatic plant matter until, after a number of weeks, these swimmers morph into small frogs that continue their life cycles on land like their parents.

WHAT THE SCIENTISTS DISCOVERED

There were two main objectives that the scientists wanted to explore. The first was to determine roughly how many treefrogs of each species

Figure 2

Treefrog species at the Barataria Preserve. **(A)** Cope's gray treefrog; **(B)** bird-voiced treefrog; **(C)** squirrel treefrog; and **(D)** green treefrog.

Figure 2

lived or visited the bottomland hardwood forests, using the numbers of treefrogs they counted in the pipes as a representation of the frogs' abundance at the site. The second objective was to see how treefrog detections changed across the seasons and from 1 year to the next. Combining these numbers with the environmental data allowed the researchers to paint a picture of the cycles of treefrog presence over several years.

The earliest phase of the study emphasized treefrog identification and how much they used the pipes across seasons. The original 52 pipes were checked monthly between 2011 and 2017, to produce an average number of treefrogs per check for each species recorded (Figure 3A). Two interesting findings emerged. First, some species were found more often than others: squirrel treefrogs were the most often encountered species in those early years, and Cope's gray treefrogs were so scarce that they were not seen even once. Second, treefrogs used pipes less often during the summer than the winter. During one summer season, there were 2 months when not even one frog was counted! This contrasts with the single winter visit, with 80 treefrogs seen in less than 4 h, including 3 pipes with 5 treefrogs each!

In early 2018, the scientists examined their methods for opportunities to improve and decided on three main changes. First, they doubled the number of pipes by adding a second, similar site nearby. Second, they reduced how often they checked to just once every other month, checking both sites in the morning over 2 days. Third, they focused their search primarily on the winter season (November, January, and March), when treefrogs were seen most often. Figure 3B shows the data so far, in terms of total treefrog counts from both sites over the past three winters. The results show that, so far, some years have more treefrogs than other years, and the dominant species changes as well. For example, during the first two winters, squirrel treefrogs

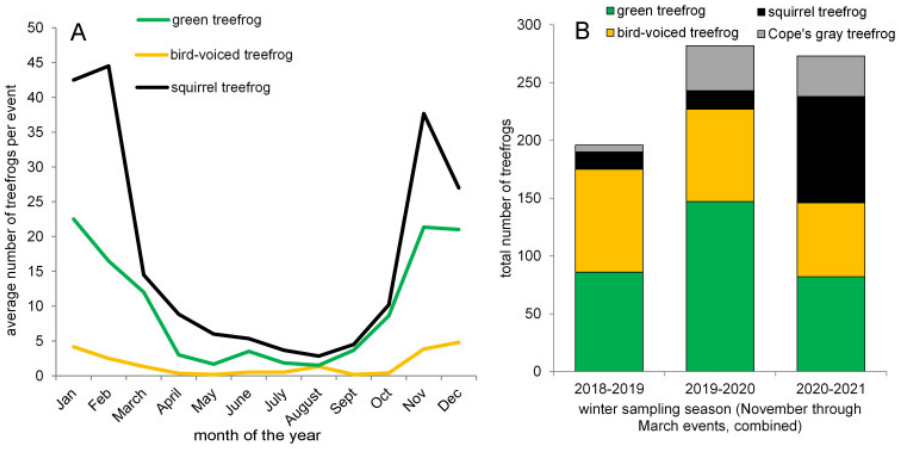

Figure 3

(A) The average number of treefrogs found during a single morning per month at one site with 52 pipes at Barataria Preserve, from 2011 to 2017. Averages were taken for each species, and one of the target species, Cope's gray treefrog, was not recorded before 2018. **(B)** The total number of treefrogs recorded over three winter events for 3 years in a row, beginning in November 2018. The three events were in November, January, and March, and consisted of checking 116–128 pipes, divided between the study's original site and a new, similar site nearby.

were relatively scarce, but during the third winter, they were the most common species.

LEARNING FROM TREEFROG STUDIES

Checking pipes thousands of times provided invaluable information for documenting changes in treefrog populations within and across years. Once the researchers realized that treefrogs did not use pipes evenly throughout the year, they focused their efforts on the winter, allowing them to use their scientific resources more efficiently. Not only were the scientists happy to find ways to improve, but they also considered the seasonal differences an interesting discovery. They think the most likely explanation is that treefrogs, like other amphibians, rely on external temperatures to maintain their own ideal internal temperatures, and to do so, their surrounding environment should remain relatively warm. Thus, as temperatures cool, they take shelter in natural or artificial cavities, which retain accumulated heat. In warmer weather, they more often rest on exposed branches or leaves where the cooler air aids temperature regulation, and it is reasonably safe for them to do so, thanks to their camouflage.

In addition to the discovery of seasonality in cavity use, many other unexpected insights emerged as researchers examined their findings. The scientists became aware of many things that surprised them and raised new questions. For example, precisely how cold did it need to get for treefrogs to seek out cavities for protection, and how likely was each species to share space? Also, what were the consequences of unseasonably cold, hot, or dry spells? To better understand these situations, the researchers now record the temperature inside each pipe as well as the outside air temperature, and they have installed sensors that continuously record the water depth in a nearby waterbody. This extra information is helping to clarify how treefrog pipe use is related to temperature and moisture cues

from the environment. Scientists are also discussing how to increase the frequency of winter sampling.

New and bigger treefrog-related questions are being considered by the National Park Service ecologists. What happens when hurricanes or other storms sweep over the preserve, knocking down trees and causing salt water to seep in? What new enemies may threaten the treefrogs? The biggest threat may be us: land use by humans is increasing. However, humans can also help, by studying treefrogs and adding to the bank of knowledge being collected by scientists all over the world. Collectively, this information can lead to better decisions about how we can all survive together, treefrogs and humans alike. Even treefrogs of different species will share a plastic tube cavity for rest, safety, and shelter. Can we also learn to share the Earth with the treefrogs?

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CONFLICT OF INTEREST: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

YOUNG REVIEWERS

FLYNN, AGE: 9

Hi, I am Flynn! I love football and the Kansas City Chiefs, and Patrick Mahomes is my favorite quarterback! I also love video games. In the summer I like fishing and camping. In the winter, I like to ski with my dad and brother.

RENEE, AGE: 8

I like insects and I am very interested in plants. I have a lot of cactuses and like to catch crickets in the springtime. I also like to cuddle with my kitty, Lisa.

AUTHORS

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Carolyn Carlson is a retired 4th grade teacher living in rural upstate New York, where she tends gardens, bees, and plants trees. Before retirement, she specialized in environmental and science education and was also a Star Lab Planetarium presenter and a volunteer naturalist. Carolyn likes to work with her husband Doug on their 20 acres of wildflowers, wetlands and fields or head out to hike the nearby trails of the Tug Hill, eastern Adirondacks, and Lake Ontario region.

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Jane Carlson is an ecologist for the National Park Service, working in 8 national parks from Texas to Florida. As part of the Gulf Coast Inventory and Monitoring Network, she carries out long-term studies in parks so that managers can learn when their plants or animals need special help. In past jobs, Jane studied plants and animals in far-away places, such as the Costa Rican rainforest and the Cape Region of South Africa. In her spare time, she loves to travel, hike, take photos, draw, and spend time outdoors with her favorite people, like her daughter who is in this picture with her. *jane_carlson@nps.gov