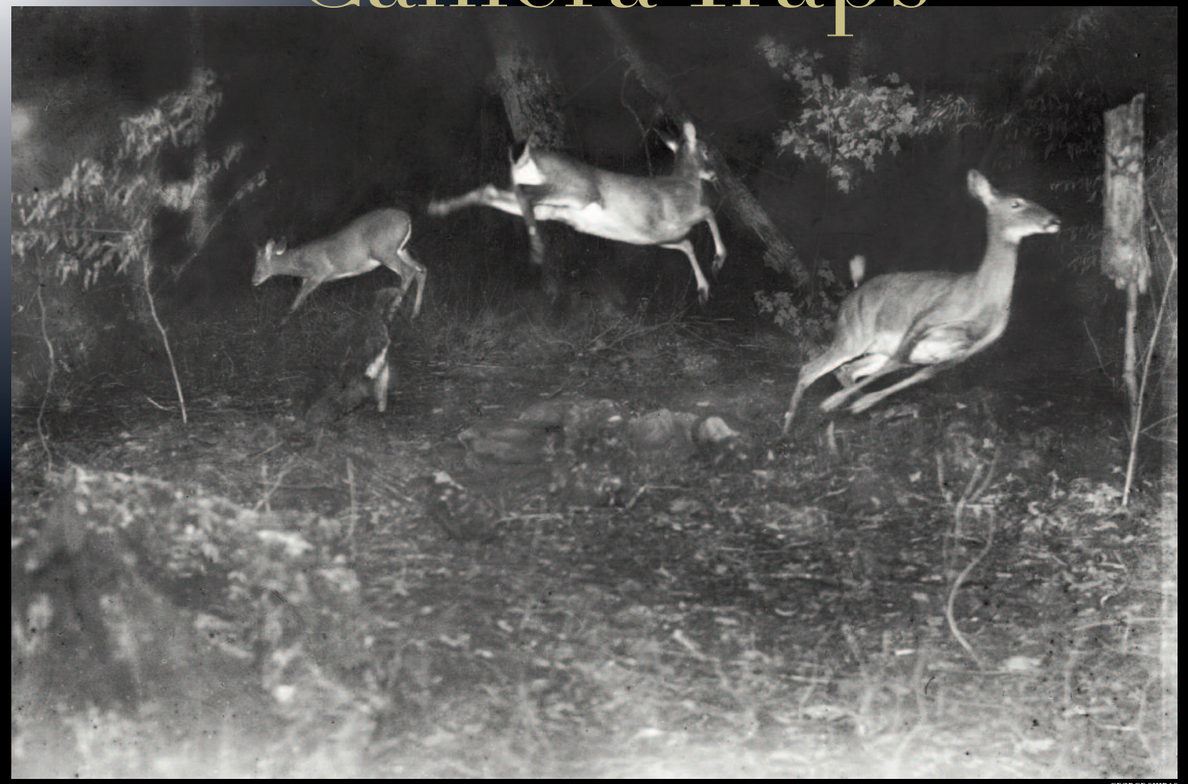
The Evolution of Camera Traps



GEORGE SHIRAS

A new statewide camera trap survey offers beautiful pictures for citizens, data for scientists

Written by Roland Kays

White-tailed deer leap into motion when spooked by the flash apparatus in this first-ever nighttime trail camera photo taken in Michigan.

A typical walk in the woods doesn't turn up much wildlife. Most animals hear people coming and run away or hide before anyone can see them, and some species don't even come out until after dark. This was the topic of discussion as Fred Johnson and his friend hiked through South Mountains Game Lands to pick up a camera trap (also known as a game camera) he set three weeks earlier as part of a citizen science wildlife project. This was Johnson's first time running a camera trap, and given that they hadn't seen even a squirrel on their hike, he was starting to worry he was wasting his time. To his surprise, the memory card was loaded with animal pictures, including one of a smiling coyote.

Camera traps revealed to Johnson a forest alive with animals that are very good at hide and seek, but apparently are not camera shy. This powerful perspective on nature not only captures arresting animal pictures, but is a useful tool for studying animal populations. The thrill of checking a camera trap to see what new pictures it has taken has been popular for over a century. However, new technology has helped turn what was once a highly technical and expensive exercise into a broadly popular hobby that gets people outdoors interacting with wildlife while collecting valuable data for wildlife management.

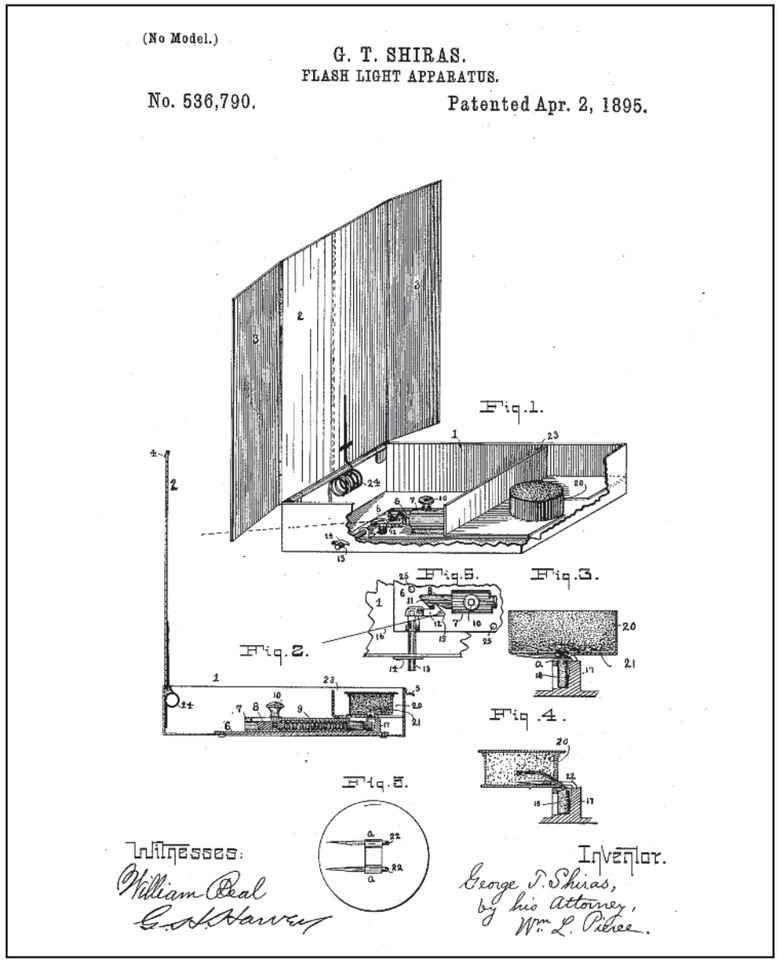
eMAMMAL

A coyote appears to strike a smiling pose while looking at the trail camera in this photograph taken at South Mountains Game Land.

In their 125-year history, camera traps have constantly improved by incorporating the latest technology of the day. However, the jump to digital cameras in the last decade created a new problem—too many pictures. New technology to manage these digital images offers the next big advance in the field, but scientists need your help to make it happen. And you can do just that by participating in North Carolina's Candid Critters program, a three-year statewide citizen science camera trapping survey that seeks the help of residents to figure out what animals are living where. The project, initiated by the Wildlife Resources Commission and in partnership with N.C. State University and the N.C. Museum of Natural Sciences, gives residents the opportunity to set up a camera trap on public land or their own property, and monitor and share the results. These discoveries will help North Carolinians of all ages become more aware of the natural world around them and will help scientists learn about deer reproduction and the movement of mammal species across the state in a variety of habitats.

"Before we can answer all these questions about mammals, we need to collect massive amounts of data, in this case camera trap images, from across all 100 counties in North Carolina," says project coordinator Arielle Parsons, a researcher with the Museum of Natural Sciences. "We really need the public's help to accomplish this. The more people that participate, the more we can learn about North Carolina's critters."

Camera traps have come a long way since George Shiras filed a patent application for a "Flash Light apparatus" in 1895 that opened the door to photographing animals at night. Below: Shiras (front) and his assistant John Hammer photograph animals from a canoe in 1893. The glow from the flash in Shiras' hand would attract an animal's attention long enough to snap its picture.



(No Model.)

G. T. SHIRAS.

FLASH LIGHT APPARATUS.

No. 536,790. Patented Apr. 2, 1895.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Witnesses:
William Beal
E. C. Hazard

Inventor.
George T. Shiras,
by his Attorney,
Wm. L. Pierce.

GEORGE SHIRAS

A History of Innovation

Camera traps were invented in the 1890s when U.S. Representative and amateur photographer George Shiras rigged a trip wire to his camera and left it in the woods, capturing the first close-up pictures of wild animals like raccoons, deer and beavers. Technology improved slowly in those days. Frank Chapman pioneered the use of camera traps for scientific purposes in the 1920s and complained that the magnesium cakes he used as a flash were so loud that they sounded like a small cannon, frightening wildlife for miles around. These camera rigs produced unique close-up pictures of surprised animals, but they required a lot of work for each picture and remained a scientific novelty.

Things picked up in the 1980s and '90s when the combination of auto-winding cameras, electronic flashes, passive infrared motion sensors that detect moving heat, and 35mm film rolls allowed camera traps to be left out in the woods for a few weeks at a time to capture two to three dozen pictures. Even more importantly, these units became less expensive, and wildlife biologists started running dozens of them at a time. Stopping at the photo shop to pick up the latest batch of pictures and see what animals they got on film this time was the highlight of the day. Every wildlife photograph was useful to the scientists because it offered verifiable evidence of what species used a particular place at a specific time. As scientists accumulated more and more pictures, they inevitably got some beautiful pictures, unique in their candid view of otherwise shy species.

Even more important than the cool pictures for scientists was the increased sample size this technology allowed; for the first time they were able to use camera traps to document the animals that used dozens or hundreds of sites across large study areas. This was a bonanza for studying charismatic but hard-to-see species. Suddenly tigers could be counted across nature preserves in India, lynx and fisher could be surveyed in remote mountain habitats, and even elusive wolverines could be studied just by leaving a bunch of cameras out in potential habitat.

The modern digital camera set the stage for citizen science wildlife research enlisting volunteers to run camera traps and share their pictures with scientists.

Hunters began to discover camera traps around this time as well. Less interested in analyzing data about the occurrences of rare species, this group of camera trappers wanted to know where the game was, especially trophy bucks. Hunters often run multiple cameras on their land to try and predict the movement patterns of their quarry, and decide where to focus their effort during the hunting season. Hunters soon outnumbered scientists as users of camera traps, and have created a big market for the devices that has driven companies to continue to improve their technology.

The switch from film to digital cameras was the next advance in the history of camera traps. Not only could this remove the limits on the number of pictures that could fit on a roll of film, but it also allowed engineers to incorporate an infrared flash that didn't disturb the animals at night as much as a bright white flash. Given these clear advantages, most camera trappers were still slow to convert to digital. The biggest problem was that early digital cameras were slow, so that an animal would move out of the frame between triggering the motion sensor and firing the camera. Furthermore, early camera electronics were fragile and very vulnerable to damage from moisture. My own experimentation with early digital camera traps were a frustrating combination of broken electronics, and pictures showing only the tail of an animal as it left the field of view of a slow-triggering camera.

Somewhere between 2008 and 2010, digital technology finally caught up to the needs of the camera trapper, and the results were worth the wait. Camera traps can now reliably trigger on most any mammal larger than a chipmunk that passes by. Battery and memory capacity improve annually, allowing a single camera trap to record many thousands of photographs, or even video. They are very easy to use, becoming more and more popular with hunters and other nature enthusiasts.

Crowd Sourcing

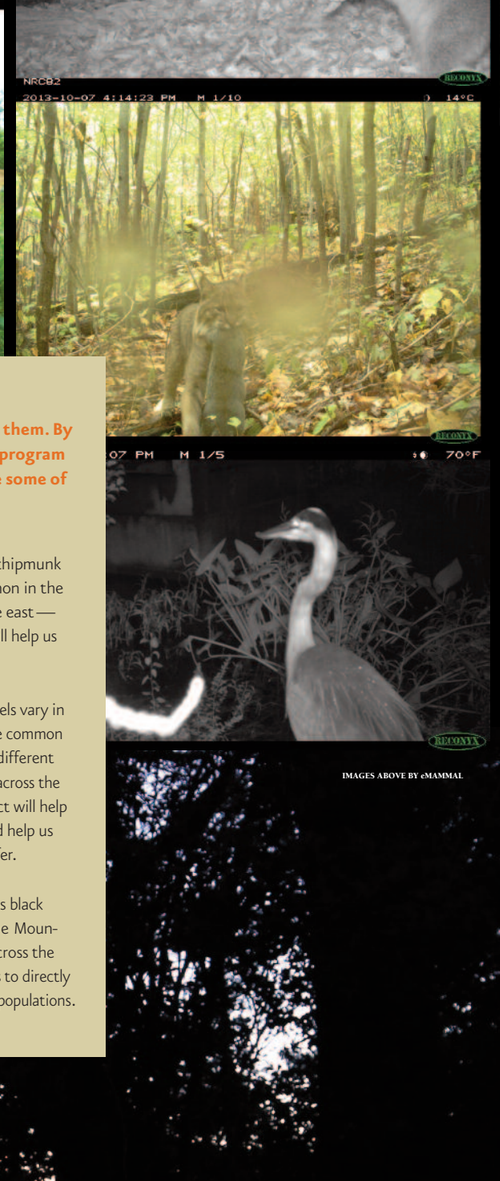
The modern digital camera set the stage for citizen science wildlife research enlisting volunteers to run camera traps and share their pictures with scientists. The devices were easy to use, the quality of the data could be verified by examining the pictures and the appeal of checking a camera trap to see what pictures you get next never gets old. This approach seemed to have the potential to revolutionize the study of wildlife by surveying larger areas with more camera traps than any single team of biologists could accomplish. One problem remained: How to manage so many photographs?

To scientists, the joy of flipping through thousands of cool animal pictures can get killed by the pain of entering data for each one. Addressing scientific questions and testing hypotheses requires statistical analysis of numbers, meaning researchers need to turn the pictures of bears, coyotes and deer into numbers describing which species is found where and when. A typical camera trap left out for a month might take 2,000 pictures;

MATT ZEHER

MATT ZEHER

Modern trail cameras offer high-resolution pictures without lighting that spooks animals. Some will even transmit photos or videos to your home computer or smartphone. The Candid Critters program creates an opportunity to make camera trapping an activity the whole family can share.



IMAGES ABOVE BY eMAMMAL

WILDLIFE RESEARCH QUESTIONS

Camera traps collect data on all medium and large birds and mammals that walk past them. By collecting data in all 100 counties across the state, North Carolina's Candid Critters program will document the wildlife of North Carolina with more detail than before. Below are some of the specific questions we are most excited about.

White-tailed Deer: How do deer populations vary across the state? We will be focusing on fawns in our early fall survey as an indicator of population growth of the herd.

Coyotes: Are coyotes increasing? Where do they live? Coyotes spread across the state in the 1990s but no one knows if their numbers are still growing or how their presence affect prey such as deer, or competitors like foxes and bobcats.

Elk: North Carolina's small elk herd in the mountains is moving and spreading, but where? What habitats do the elk use?

Feral Swine: Where do feral swine range? This invasive animal threatens ecosystems with their aggressive rooting, and domestic pigs with their diseases. Mapping where they persist will help control efforts.

Eastern Chipmunks: What determines chipmunk distribution? This familiar rodent is common in the west of the state but rare or absent in the east—counting these little critters on cameras will help us understand why.

Eastern Fox Squirrels: How do fox squirrels vary in color across the state? Larger than the more common gray squirrel, this species has dramatically different color morphs living in separate populations across the state. Camera trap pictures from our project will help show where these colorful squirrels live and help us understand what types of forests they prefer.

American Black Bears: North Carolina has black bear populations along the Coast and in the Mountains, with a big gap in their distribution across the Piedmont Region. Camera traps will allow us to directly compare the size and reproduction of these populations.

A custom-built camera trap captures a gray fox prowling a suburban backyard on a moonlit night near the coast.

TODD PUSSER

multiply this by the dozens or hundreds of sites most research projects monitor and you can appreciate the problem faced by eager camera trapping scientists. Crowd sourcing the camera work has the potential to collect even more data, which is great for the science, but requires an efficient solution for managing the pictures.

The creation of photo management systems for handling massive amounts of data has been the most important innovation in the camera-trapping field in recent years. My own work with N.C. State and the Museum of Natural Sciences has focused on building the eMammal system, in collaboration with the Smithsonian Institution, which is designed to be used by citizen science projects with hundreds or thousands of volunteers contributing pictures. Experts oversee the projects to make sure the cameras are set up correctly and the species are identified accurately.

As a first test of this citizen science approach, we worked with over 400 citizen scientists to run camera traps in 2,000 sites across 32 protected areas. We collected over 2.6 million pictures, all carefully labeled and archived in the Smithsonian digital repository. Without the help of citizen scientists, we would not have been able to visit all of these sites to set cameras, and without the eMammal system we would have quickly drowned in the tidal wave of digital pictures. Instead, we were able to analyze the results to evaluate the effect of hiking and hunting on wildlife across these parks, finding out that habitat quality was more important to most species. Hunted areas did have somewhat fewer deer, raccoons and squirrels, but more coyote activity. The volume of hikers had no effect on most wildlife. Feral cats were extremely rare across these protected areas, probably because of coyotes. Dogs were common, but almost all were walking on trails and accompanied by owners. The project was also a success from the volunteer's standpoint. Citizen scientists reported very favorably on the experience, and often signed up for additional opportunities.

Emboldened by the success of our citizen science camera-trapping project in selected parks, the Commission approached us with an interesting initiative. Could we survey an entire state?

Camera Trapping a State

Our new project, called North Carolina's Candid Critters, will work with citizen scientists to run camera traps across all 100 counties in North Carolina. Our goal is to work with thousands of volunteers to run cameras in 20,000–30,000 locations, making this the largest camera trap project ever. This isn't just to get cool animal pictures, there are a lot of important questions we can ask about our state's wildlife with data collected at this scale.

Camera trap records provide a gold mine of data on any warm-blooded animal the size of a chipmunk or larger. The motion sensors typically won't trigger on cold-blooded animals like snakes or lizards, but are fabulous at detecting mammals and larger birds like turkeys. Our first step in analyzing this data is simply to plot the sites on a map to document which cameras detected a given species, and which did not (technically referred to as "occupancy"). This can also be done in a way that shows the number of pictures recorded for a given species, helping to differentiate highly preferred habitat (for example, visited every day by a species) from marginal habitat (perhaps visited once per month). By working with citizen scientists, we will be able to plot the distribution of ani-

NEIL JERNIGAN

Photographer Neil Jernigan has taken trail cams several steps further by creating one out of a digital camera. He gets high-resolution photos and employs multiple flash units for better lighting that helps create more artistic images than a normal trail cam would produce. Jernigan was attempting to capture a bobcat photo here, but instead got a shot of a great blue heron that had walked down the stream hunting for fish. Look closely, and a deer can be spotted in the background.

mals not only within each county, but also across the entire state, mapping out wildlife at a scale and resolution never seen before.

After describing the pattern of wildlife occurrence, the next step is to explain why animals live where they do: Do they have certain habitat preferences? Are they limited by cold winters or hot summers? These questions can be addressed by combining the camera trap data with environmental factors in statistical models that help put numbers behind what we see on the map, allowing rigorous testing of hypotheses about what is important to each species. Interactions between species can also be tested, especially predator (like coyotes) and prey (like deer and foxes) relationships.

Whether you discover a secret wildlife hotspot or get only a few animal pictures, you'll help us document which animals live where, and why.

How Can You Help?

We need your help collecting data by running camera traps, looking through pictures to identify animals, and sharing them all with us so we can add your locations to our statewide comparisons. You can use your own camera traps or borrow one of ours after you sign up and take our training course at NCCandidCritters.org. You can run your camera trap on your own property or "adopt" one of the sites on public land that we have selected across the state, using this opportunity to take a hike in your nearby state park, game land or national forest.

Going out into the woods to set a camera trap is a good excuse to get some exercise, but the return trip to pick up the memory card three weeks later is when the fun really starts—this is when you get to see what critters you've captured. We have customized software you can use to flip through the pictures and tag the animals you see. We are partnering with local libraries so you can use their computer and Internet connection for this step. We will also be working with schools across the state to involve kids in this wildlife science project.

As the pictures start rolling in from across the state, we'll be going through them to double-check the identifications, map the results and generate summary statistics. These results and favorite pictures will be shared online, so you can compare your results with others from across the state to see who captures the most elusive, funny or beautiful animal photo.

I can't guarantee you'll get a coyote picture as charismatic as the one Fred Johnson captured, but I am certain that the data you collect will be useful. Whether you discover a secret wildlife hotspot or get only a few animal pictures, you'll help us document which animals live where, and why. Johnson's data helped us evaluate the impact of hunting and hiking on wildlife, finding that most species didn't avoid hiking trails, and that the presence of hunting was relatively unimportant compared to habitat factors.

"Candid Critters is a unique project that will enable the Commission to join with the people of North Carolina to engage in science and explore our beautiful state," said Gordon Myers, the Commission's executive director. "From our backyards to North Carolina's wildest places, the images collected by schoolchildren and adult volunteers will increase everyone's understanding and enjoyment of the natural world, while at the same time informing future wildlife management decisions." ◆

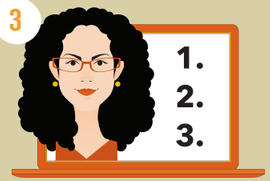
Roland Kays is the head of the biodiversity research lab at the N.C. Museum of Natural Sciences and director of the Candid Critters program.

NORTH CAROLINA'S
CANDID CRITTERS

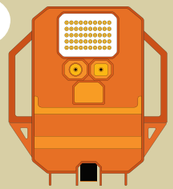
HOW IT WORKS

1 Sign up at NCCandidCritters.org to reserve a space.

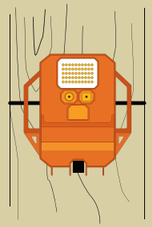
2 Receive an official invitation to participate.



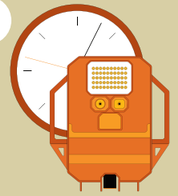
3 Complete an online training course.



4 Borrow a camera trap (or buy one of your own – limited to certain brands).

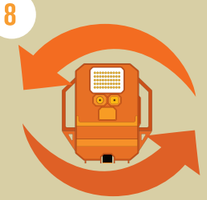


5 Pick a site on public land or your own property and strap your camera to a tree at knee height.



6 In three weeks, retrieve the camera.

7 Identify the animals in your photos and upload the images to us. (Don't worry, we'll give you software and confirm your identifications).



8 Repeat as many times as you would like and return the borrowed camera when you are finished.

ILLUSTRATION BY JAVAN SUTTON