



NRC134

THE POWER OF PUBLIC SCIENCE

By Brent Winter



NC State biologist Rob Dunn recalls the watershed moment several years ago when he realized that his lab's scientific research — studying ecology and evolutionary biology — was missing something vital.

"It dawned on us that, as we did research in the lab, people were earnestly asking how our work mattered in their daily lives," Dunn says. "For the most part, we couldn't answer those questions — at least not to the public's satisfaction."

Dunn started thinking about ways to help members of the public see his research as relevant to their own concerns. The ideal approach not only would inform the public about the results and implications of research; it also would find a way to involve them in the actual research itself, engaging them as "citizen scientists."

Dunn's first citizen science project, called School of Ants, sought to learn more about the ants living in backyards, schoolyards and neighborhoods by asking members of the public to collect ants and send them to the lab for analysis. The response was overwhelming: In the first two weeks alone, 20,000 people signed up to participate.

"That turned into the recognition that we could do bigger things," Dunn says. "There was a whole initiative there that was larger than anything we had thought about."

That initiative eventually became Your Wild Life, a public science and outreach program involving ordinary citizens in research on a variety of topics, including tallying species of camel crickets in the United States, and identifying microscopic organisms living on our bodies.

Your Wild Life has become one of the premier public science programs in the nation, and Dunn has become one of public science's chief advocates. "When people ask me what 'public science' is, I tell them it's science that involves the public in the creation of new scientific knowledge," Dunn says.

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— ROB DUNN

• **LEFT:** NC State's eMammal project uses volunteer-run "camera traps" to monitor wildlife populations and track the effects of hunting and hiking on mammals, such as these coyotes.

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WISDOM OF CROWDS

Dunn sees tremendous value in the ability of public science to solve problems that researchers can't tackle without the help of ordinary citizens.

One example is FoldIt, a crowdsourced method for predicting the structure of a protein molecule based on the amino acids that compose it.

Scientists at the University of Washington adapted FoldIt as part of a multiplayer online game in which people compete and collaborate to predict how a protein will fold into a three-dimensional structure based on its amino acid sequence. Since 2008, more than 100,000 people have played FoldIt — most of whom have no background in biochemistry. Already the game's players have successfully characterized the structures of a number of proteins. In 2011, FoldIt players attempted to determine the structure of a retrovirus that causes AIDS in monkeys. Scientists had been laboring at this task unsuccessfully for 15 years. FoldIt players solved the problem in 10 days.

Closer to home, NC State's Cooperative Institute for Climate and Satellites - North Carolina enlists the public in analyzing images of cyclones to help scientists determine the intensity of each storm. Volunteers can go to CycloneCenter.org to help the institute whittle away at their backlog of 200,000 satellite images of cyclones awaiting analysis. The scientists want each image to be classified by 10 different volunteers, to reduce the chance of error. So far volunteers have racked up about 350,000 image classifications.

Dunn applauds his colleagues' projects. "Most of the key knowledge we need to deal with climate change, manage crops and otherwise survive the next hundred years comes from work being done with the public," he notes.

Citizen science has become such a hot topic that an association has been formed to promote it. The Citizen Science Association was launched to help create a community of citizen science practitioners who can share insights, questions and innovations with each other. NC State researchers are leaders in the organization. Ecologist Caren Cooper, an adjunct professor at NC State and an assistant lab director at the North Carolina Museum of Natural Sciences in Raleigh, is co-editor of the association's peer-reviewed journal, *Citizen Science: Theory and Practice*.



"Citizen science has become a valued research approach in more and more disciplines," Cooper says. "And now there are many fields improving our ability to do citizen science well, such as informal science education, human-computer interactions, informatics, environmental psychology, geography, social sciences and science communication."

TALE OF THE CAT

The association's inaugural conference was held in February 2015 in San Jose, California, and members of NC State's Your Wild Life program were there, presenting the results of an innovative project called Cat Tracker.

"Cat Tracker involves people tracking the movements of their own cats with GPS devices and sharing that data with us so we can determine the effect that cats are having on the wildlife around them," says NC State zoologist Roland Kays, who is also a lab director at the Museum of Natural Sciences in Raleigh.

It's a well-known fact that household cats that are allowed to leave the house will kill lots of birds and mammals while they're outside. Pet cats are estimated to kill 5 billion birds and 20 billion mammals each year in North America alone. Zoologists like Kays are interested in the ecological

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let your cat outdoors, we want you to let us track it.”

Cat owners who want to participate in Cat Tracker can obtain an inexpensive GPS harness that they put on their cat for five days. At the end of that time, the owner sends the data to Your Wild Life, where it’s added to an ever-growing database of tracked cat movements. The project, which aims to track 1,000 cats from all over the world, has more than 100.

• **TOP:** *Cat Tracker uses GPS tools to track the movements of outdoor cats to learn how cats affect the wildlife around them.* • **BOTTOM:** *NC State scientists Rob Dunn and Holly Menninger rely on members of the public to help them conduct research on a much broader scale than they could encompass on their own.* • **OPPOSITE PAGE:** *As coordinator of Cat Tracker, NC State senior Troi Perkins attaches harnesses to study participants.*

damage cats might be doing with all that slaughter. “If they’re just killing field mice in the back yard, that may not be a big problem; but what about protected species in state parks or conservation areas?” he asks. “That’s why it’s helpful to know the cats’ movements.”

Kays is quick to point out that people shouldn’t let their cats roam outside. “Cats are best left indoors, for their own sake and the sake of wildlife,” he says. “But if you do

Cat Tracker is run completely by undergraduates, some of whom are analyzing and interpreting the data for their own research projects. Cat Tracker coordinator Troi Perkins, a senior majoring in fisheries and wildlife science as well as zoology, traveled to the Citizen Science Association conference in San Jose with Kays and other Your Wild Life researchers so she could give the group’s Cat Tracker presentation.

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• **ABOVE:** NC State zoologist Roland Kays leads eMammal, which relies on members of the public placing infrared-activated camera traps in parks and other natural areas to obtain photos of wild mammals. • **OPPOSITE PAGE:** The 2,000 eMammal cameras in 32 parks across six states have captured a wealth of striking images. Volunteers identify the species in the photos and upload the pictures to the eMammal system, where trained researchers verify the species IDs.

“Giving the presentation was nerve-racking,” Perkins says. “Even the travel was intimidating. But I’m so glad I went because I got to see this whole new realm of science where you involve the public in your work.”

Perkins also works with Kays in his lab at the Museum of Natural Sciences. The Biodiversity Lab is one of several at the museum with glass walls, allowing visitors to observe the scientists as they work on their research. “My second week at State, I went to the museum and saw into all of the labs. I was like, whoa, look at those scientists doing research. I want to do that,” Perkins recalls.

NAME THAT MAMMAL

Another citizen science project Kays is managing through Your Wild Life is called eMammal, which involves volunteers placing “camera traps” — infrared-activated cameras — in parks and other natural areas to obtain photos of wildlife, specifically mammals. Volunteers identify the species in the photos and upload the pictures to the eMammal system, where trained researchers verify the reports.

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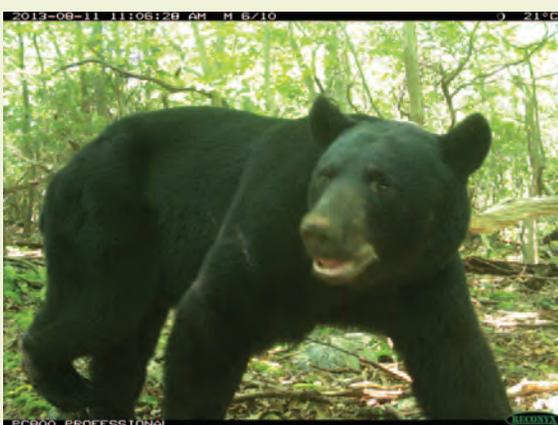
hiking on mammals,” Kays says. “The data we’ve collected over the last two years comes from 2,000 locations in 32 parks across six states. That’s the great thing about citizen science: It’s scalable. It allows you to scale your research up to the level of an ecosystem, which you can’t do with a couple of scientists and some paid field assistants checking a few cameras near your lab.”

One of the unique features of the eMammal project is that middle-school students are running some of its cameras. Students at four Wake County schools — East Cary Middle, North Garner Middle, Carroll Middle and East Wake Middle — have installed camera traps around their schools to see animals that cross the school grounds at night and on weekends, when the campus is deserted.

“These students are collecting real data and doing real research where we don’t know what the answer will be at the end,” Kays says.

Student participation in eMammal is just one part of a larger K-12 science-education project called Students Discover, also being run by Your Wild Life.

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their classrooms,” says entomologist Holly Menninger, a Your Wild Life researcher who is the inaugural director of public science for NC State’s College of Sciences.

“The issue for the teachers was that they needed to connect research questions and activities to curriculums and standards, but we didn’t have a way to do that at first. To remedy that, we brought a high school math teacher onto our team and partnered with educational organizations on campus — particularly the Kenan Fellows program, the Science House and the Friday Institute for Educational Innovation — to apply for a math and science educational partnership grant from the National Science Foundation.”

CLASSROOM CONNECTION

In 2013 the NSF awarded the team a five-year, \$7.2 million grant to fund the work of Students Discover. The project involves middle-school teachers in the Kenan Fellows program partnering with early-career scientists in labs at the Museum of Natural Sciences over the summer to develop a citizen science project and associated

curriculum modules that the teachers take back to their classrooms. After the curriculum modules are piloted and refined in the Kenan Fellows’ classrooms, they’ll be shared online so teachers anywhere in the world can use them.

“It’s an opportunity for teachers and students to be involved in doing authentic research, real science, where the answers are not known ahead of time,” Menninger says. “What students usually see in a science classroom is demonstration science — looking at what is already known. But in this project, students get to help make actual scientific discoveries.”

Each year a new cohort of 12 Kenan Fellows from all over the state enters the program. One of the 2014-2015 fellows, Laura Cochrane, says both she and her students had a great time being involved with Students Discover.

“My experience with Students Discover was a game changer,” says Cochrane, who teaches sixth-grade science at Mills Park Middle School in Cary. “I see real

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potential for engaging students more in the field of science, and it's so smart to use middle schoolers as the jumping-off point. They love feeling like what they're doing in their classroom is making a difference in real-world science."

Cochrane and two other teachers worked with microbial ecologist Julia Stevens in the Genomics and Microbiology Lab at the Museum of Natural Sciences to learn about Stevens' research on the beneficial microbes that dandelions recruit from soil, and how environmental conditions can affect that process.

"In the fall we began implementing the curriculum by asking students to bring in soil samples from their own yards and neighborhoods to use in the experiment," Cochrane says. "Then the students dug up dandelions around the school grounds, and they followed the procedures given by Dr. Stevens to sterilize the roots and replant the dandelions in the soils they brought in from their neighborhoods. The goal was to determine if the dandelion could recruit the microbes it needed from the new soils."

After four weeks, the students pulled the dandelions up, scraped the roots and sent samples to Stevens at the museum, who used polymerase chain reaction to sequence the DNA in the soil to discover which microbes it contained. When the data were ready, Stevens shared it with the class so they could see the results of their research.

"Students got an opportunity to analyze DNA data from the dandelion soil samples they worked with and to actually identify the types of bacteria found in the samples," Cochrane says.

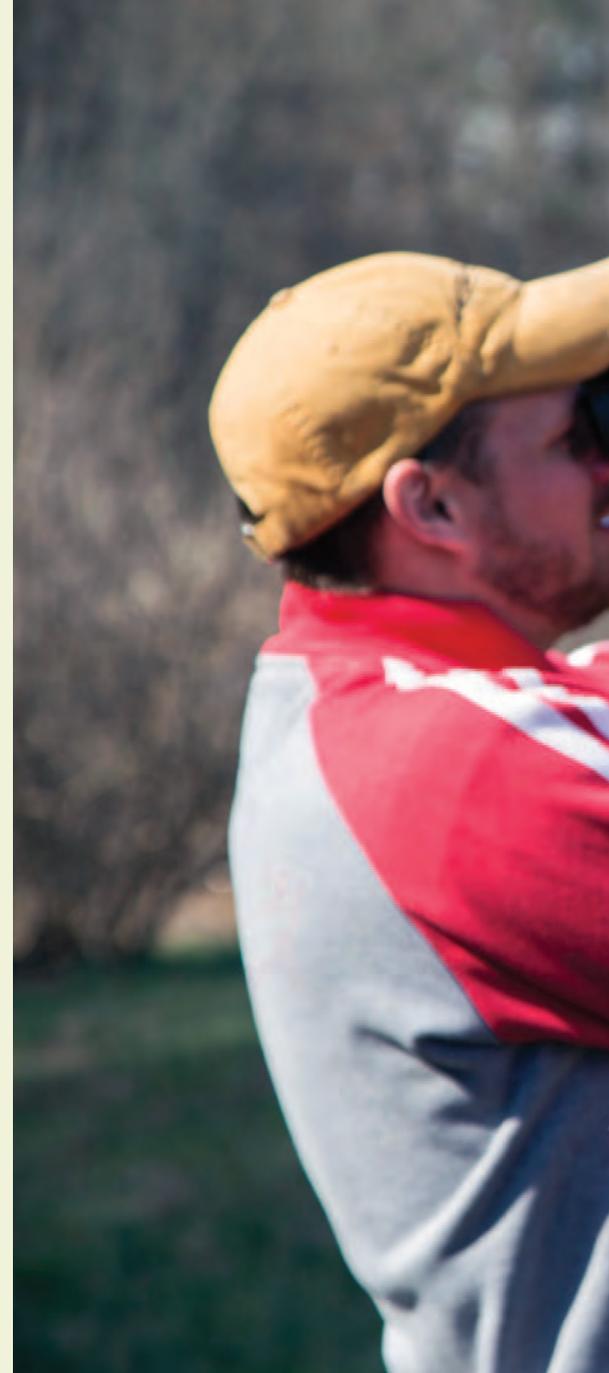
"They were also able to compare the data from their soil samples to those found by the classes taught by my fellow Kenan teachers. This lesson provided much more depth than sixth-graders usually get. They felt ownership of the data, and they were excited to be doing real science and adding to the collective sciences, instead of the data just dying in a lab notebook."

BUILDING MOMENTUM

As extensive as all these citizen science activities are, the movement is still picking up steam. The next cohort of Kenan Fellows is already developing the next set of science curriculums to be used in their classrooms and shared online.

"We have an epicenter of citizen science activity in the Raleigh area. This will be a great place to provide context."

— EMLYN KOSTER



Troi Perkins is adding a new research question to the Cat Tracker project: What do cats eat when they leave the house? Hair samples gathered by cat owners will help to answer that question.

Roland Kays is looking to expand both Cat Tracker and eMammal all over the world; eMammal already has cameras in place in India and Mexico, and Cat Tracker has partnered with researchers in Australia and New Zealand.

Holly Menninger is setting some ambitious goals for her new position as director of public science for the College of Sciences, such as training the next generation of science communicators.

And the Citizen Science Association will hold its next conference in 2017 at the Raleigh Convention Center,



jointly hosted by the Museum of Natural Sciences and NC State. With the conference expected to draw at least 1,000 attendees from around the globe, museum director Emlyn Koster expects to showcase dynamic partnerships at work. “We have an epicenter of citizen science activity in the Raleigh area,” he says. “This will be a great place to provide context.”

In what may be the most exciting development for NC State researchers working in public science, the university recently announced that the Chancellor’s Faculty Excellence Program — an innovative faculty-hiring initiative that recruits world-leading faculty to work in interdisciplinary clusters — will create a cluster in leadership in public science. The cluster will unite faculty across the Colleges of Natural Resources, Sciences, Education, and Humanities and Social

Sciences in efforts to design and conduct scientific research that involves, educates and informs the public in a meaningful way.

Rob Dunn, a co-leader of the new cluster, is looking forward to expanding the possibilities of public engagement with science at NC State and around the world.

“We can be a think tank,” Dunn says. “Not just do public science, but be a place that innovates how to do public science.”

Learn more about Your Wild Life at yourwildlife.org. Follow plans for the 2017 Citizen Science Association meeting in Raleigh at citizenscienceassociation.org.

• **ABOVE:** *NC State University has strong partnerships with the North Carolina Museum of Natural Sciences, which has a range of citizen science projects, including bird counts. The university and museum will co-host the international conference of the Citizen Science Association in February 2017.*