"Everyone likes birds. What wild creature is more accessible to our eyes and ears, as close to us and everyone in the world, as universal as a bird?"

—Sir David Attenborough, English broadcaster and naturalist

At the MIGRATORY CROSSROADS

The University of Oklahoma is the ideal spot to study bird migration and what that phenomenon tells us about our environment.

By Debra Levy Martinelli

Jeff Kelly is a scientist at the intersection of many disciplines: biology, ornithology, physics, geology, meteorology, engineering, cultural geography and anthropology among them.

Kelly, an associate professor of biology at the University of Oklahoma and Heritage Zoologist at the OU-based Oklahoma Biological Survey, studies the ecology and conservation of migrant birds.

"I am fascinated by the way these animals' life histories depend on environments at continental and hemispheric scales," he says. "The unique combination of their relatively small size and long-distance movements also make these migrants fantastic sensors of the environment and potentially very valuable real-time indicators of our impact on the environment at large spatial scales."

The methods Kelly employs to understand bird migration have ranged from the traditional—including the centuries-old practice of outfitting the birds with numbered tracking bands—to the high tech, using such advances as genetic markers, feather chemistry and radio frequency identification.

"In Oklahoma, we think of migrant birds as northern temperate birds," Kelly explains. "They migrate here in the spring and breed, so they have a local population here. That means most of the genetics of that population are shared among a geographically limited pool. If you look across a continent at the DNA of local populations, you can begin to tell an Oklahoma bird versus a California bird or a Nevada bird. Those determinations are based on where the nests are built and the babies are born."

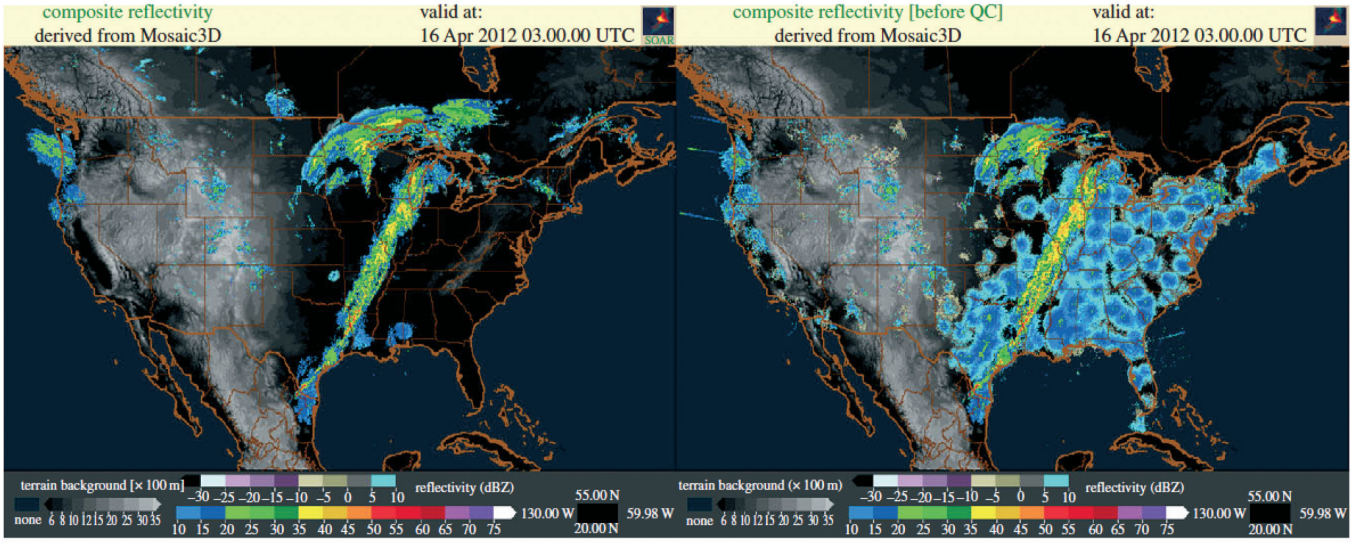
All of those Oklahoma-feathered vertebrates fly to Central or South America when the Oklahoma weather cools. That, Kelly says, can lead to some complicated population genetics.

"When they leave Oklahoma and fly south, the birds can mix with others. One could stop in Mexico and another go to Colombia, but they might be neighbors on the breeding ground," he says. "So we use that same population genetics structure that we've understood from the breeding ground to go to the winter ground and get samples and say, 'Here's an Oklahoma bird in Sinaloa [Mexico] and here's another Oklahoma bird in Costa Rica.' "

The question then is whether Oklahoma birds tend to be mostly in one place or another or, instead, whether they

Jeff Kelly, associate professor of biology, watches the skies for purple martins at the Jimmie Austin OU Golf Course. Kelly hopes to attract martins to the houses so professors and students can study the birds on campus. The nesting birds would also be accessible for attaching tracking devices, called light-level geologgers, enabling scientists to follow their migratory path.

Robert Taylor



The images on the right and left are both based on the same radar data. At left is a typical image of weather, created by processing the data collected by radar, part of which removes everything detected that is not weather. During seasonal bird migrations, the radar data contain information on the distribution and abundance of migratory birds. The image at right includes the weather depicted on the left, but it is dominated by the widespread songbird migration event that occurred that night.

spread out through the wintering grounds. Kelly and his colleagues call those studies migratory connectivity.

"Migratory connectivity is really interesting because it tells us something about how to build conservation plans for birds," Kelly relates. "If we know that all of our Oklahoma birds are in western Mexico, we know that western Mexico is a really important partner for conservation of a particular species. If they are spread throughout Latin America and South America, we have a much more diffused set of conservation partners."

The two connectivity methods—feather genetics and stable isotope chemistry—are crucial to conservation efforts. The genetic information provides good longitudinal data for east to west, while the chemistry data gives reliable data for north to south. With the two different markers, Kelly says, the spatial scales can be refined to understand the migration patterns.

That requires a highly interdisciplinary approach.

"I'm trained as a biologist," Kelly explains. "I work with researchers in meteorology, engineering, anthropology, geology and most of the other science departments on the OU campus because they all have different expertise to offer to our projects. And it's a lot of fun to learn about things you don't know anything about or things you think you understand but really don't after talking to someone who does understand."

He's having quite a bit of fun these days with OU meteorology and engineering colleagues conducting research in what they call radar aeroecology.

Aeroecology is a relatively new discipline that studies how airborne life forms depend on the support of the lower atmosphere. "Aeroecology has changed the way scientists think about the environments in which we study migrations," Kelly states. "Previously, we waited for birds to come down to the ground before we studied them. Now we think about the air as a habitat and are able to study them there, too."

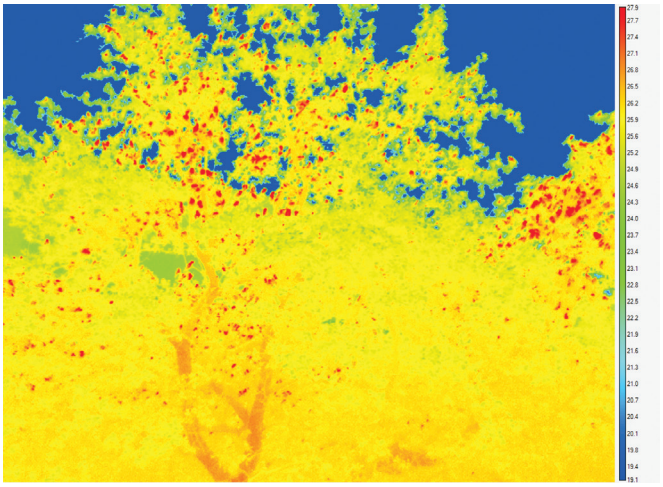
Radar aeroecology refines the new discipline even further by using data collected through the U.S. network of weather surveillance radar known as NEXRAD (Next Generation Radar) to help explain the timing of such seasonal events in nature as bear hibernation, butterfly metamorphosis and, yes, bird migrations between breeding and wintering grounds.

While meteorologists use weather radar to detect water in the air, Kelly's multidisciplinary research group—which includes meteorologists and engineers—uses it to detect birds, bats and bugs, whose bodies contain a large amount of water.

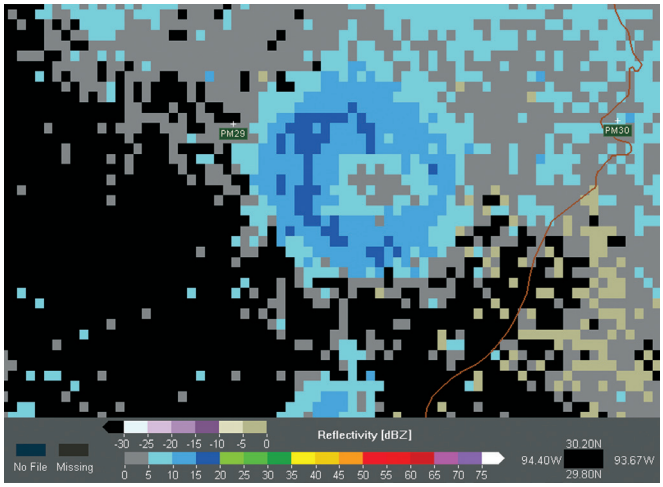
"When you look at a radar map of the weather, the enormous amounts of biological data have been filtered out because meteorologists don't need it," Kelly says. "In fact, the flying animals detected by the radar interfere with the weather data. But that same information is a gold mine for biologists because it shows us continental-scale bird migrations across the United States that helps us better understand the seasonal events in nature—what we call phenology—and how they may be changing."

To that end, he and his colleagues at the OU Animal

Assistant Professor Eli Bridge at the Oklahoma Biological Survey makes tracking devices small enough to be placed on migrant songbirds, such as this purple martin at OU's Biological Station at Lake Texoma. This bird annually migrates from Oklahoma to Brazil and back.



To validate radar measurement by counting birds in images and video at night, scientists can use thermal images. Because birds are warm, they show up against the cold sky, or in this case, a tree at the martin roost near Chesapeake Arena in Oklahoma City.



Purple martins are a common species of migrant songbird, forming large nighttime aggregations in July and August. Because the birds all leave the roost near sunrise and fly high in the air, they show up in weather surveillance radar, typically in the shape of rings like this one.

THE PEOPLE-PLEASING PURPLE MARTIN

The Animal Migration Research Group has six large Purple Martin houses at the OU Biological Station near Madill, Oklahoma. In 2012, the group collaborated with the University's K-20 Center for Educational and Community Renewal to hold a four-day workshop for 12 to 15 teachers from schools across the state to train them in handling Purple Martins, collecting data and building lesson plans around the Martin houses. The teachers then took the houses back to their schools so they could try to attract the Martins for collaborative study between the schools and the Animal Migration Research Group.

The schools still have the houses. At Jenks High School, where some 120 students take an ornithology class, there now are multiple Martin houses and plans for at least one more. Kelly and his team plan to go to Jenks this spring to place bands and geolocational devices on the birds so that the students can start their own migration studies. Then the AMRG can tap into the collected data.

"It's great that the Purple Martin is sort of an urban bird, a bird that is so tied to people that you can work with them as an educational tool," says Kelly, who at OU teaches courses in population ecology and conservation biology. "The students will be able to see on the radar that their Martins were at a particular roost, and they'll be excited about how radar is helping them study the migration. As they start thinking about how the radar works and why these birds and not other birds are showing up, we can start talking to them about related careers in meteorology."

The OU Advanced Radar Research Center's Rapid scan X-band Polarimetric Radar (RAXPOL) has been used to make observations of bird and bat roosts.

Migration Research Group study the migrations of Purple Martins, a large swallow species found in Oklahoma and throughout the eastern half of North America. Particularly in the eastern United States, Martins nest almost exclusively in bird houses provided by humans.

"So you have people raising all of these Martins, and then after the Martins are done nesting, they'll aggregate to large roost sites, many of which they return to year after year," Kelly explains. "There's one at the DoubleTree Hotel in Tulsa and another in Oklahoma City that has moved around a little bit, but this past year was in the parking lot between Devon Energy Tower and Chesapeake Energy Arena. Purple Martins really like people and tend to like cities.

"There are tens of thousands to hundreds of thousands of birds that leave the roosts synchronously just before dawn. Meteorologists call them 'ring angels' because they show up on the radar as a donut shape but aren't storms," he says. "We use the radar to see if the timing of those roosts—when they form and how long they stay—has changed over time and what that has to do with our weather and climate."

One challenge in improving their understanding of bird migrations through radar is that, although the researchers can detect massive migration all over the continent on given nights, they are unable to identify species.

"There are hundreds of species of migrant birds," Kelly reports. "We'd like to be able to say, 'We saw 40 percent thrushes, 20 percent warblers and 10 percent sparrows, and this is what you can expect to see on the ground the next morning.' "

They aren't there yet, but Kelly says OU is the ideal place to be conducting this research because of the University's world-class experts in both biology and meteorology.

"We need biologists who are really good at identifying these birds, but we also need meteorologists with expertise in understanding the radar data and its nontraditional uses. OU has both," Kelly declares. "Other ornithologists around the country don't have the ability to go down the street and ask a whole bunch of people about radar data or how radars works. That's the luxury we have here.

"As a result of this collaborative environment, we're making good progress in our research," he adds. "I think we're going to see some really exciting results in the next couple of years."

That's the beauty of being a scientist at the intersection of many disciplines.

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