Western Alumni Magazine

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Alarm Call What the birds are telling us about climate change

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What the birds are telling us about climate change

Story by Kurt Kleiner
Illustrations by Melinda Josie

Students and faculty walking near University Hospital in London, Ont. in December 2023 were treated to an unusual sight—five out-of-season baby geese and their parents. Apparently confused by unseasonably warm weather, the adult geese had nested and bred months before the onset of spring.

It was a cute story, but with a bittersweet end. Three of the goslings quickly disappeared, apparently eaten by predators. The other two were taken into care by an animal sanctuary when it seemed likely they wouldn't survive the winter. The story of the winter goslings is just one small example of the effects climate change is having on birds around the world. Even as they suffer from habitat destruction, pollution and other threats, they face increasing danger from changes caused by the climate crisis.

At Western University, researchers are tackling questions vital to the survival of birds. Their work ranges from understanding the basics of bird physiology to creating global radio networks to track birds as they migrate around the world. "You have to understand the fundamental biology, the physiology, the mechanisms. And then you can figure out when the environment changes, why the bird responds the way it does," says Christopher Guglielmo, biology professor at Western and director of Western's Centre for Animals on the Move. "We're interested in the fundamentals. But we're doing this because we care about birds," he says.

WINGED WONDERS

Birds are some of the most successful animals on Earth. They evolved from small, meat-eating dinosaurs that existed more than 150 million years ago, gradually sprouting feathers, growing wings from forelegs, and developing a number of other adaptations that helped them to thrive as flying animals. Today there are 10,000 species of birds, ranging from the tiny two-gram bee hummingbird to the 140-kilogram ostrich.

Birds have exquisitely tuned physiologies—from feathers to hollow bones, from powerful hearts to extra-efficient lungs—that they need to let them perform the implausible trick of heavier-than-air flight. Even today's flightless birds are descended from birds that once flew.

Birds range from seed-eating vegetarians to meat-eating predators; from forest dwellers who live in the same small range their entire lives to birds that fly between continents. The Arctic Tern, for instance, travels 90,000 kilometres every year as it chases summer from the Antarctic to the Arctic and back. The tiny black-capped chickadee, on the other hand, stays put through the Alaskan winter, putting on fat every day and burning it to stay alive during the frigid 18-hour nights.

But despite their success, today one in eight bird species is threatened with extinction, and most others are seeing their populations decline, according to the international conservation organization BirdLife. In North America alone, the total number of individual birds has declined by almost three billion since 1970, a 30 per cent drop.

WINDS OF CHANGE

Amidst these alarming statistics, Western stands as a beacon of hope and innovation in bird research, thanks in part to the Advanced Facility for Avian Research (AFAR). Opened in 2009, the facility houses labs, environmental chambers where light and temperature can be controlled, and sophisticated equipment such as a wind tunnel that researchers use to study birds in flight.

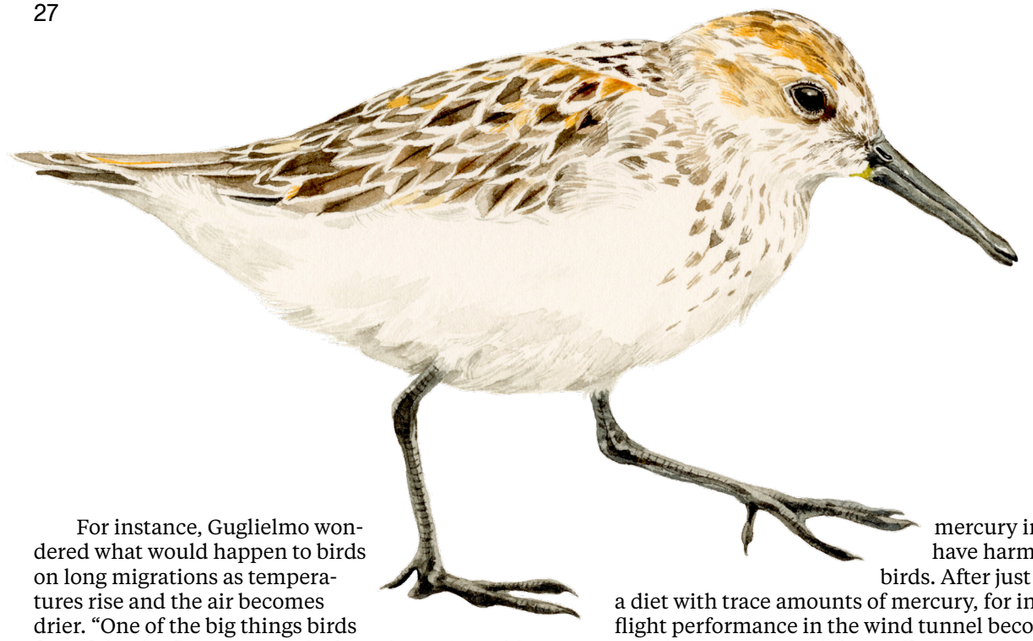
The facility helps attract researchers and students to Western, and also helps keep them there. "It's like, once you have a facility like this, where else are you going to go?" Guglielmo asks.

For instance, the wind tunnel is one of few in the world that lets researchers control not only wind speed, but temperature, humidity and air pressure. It is a massive piece of machinery that takes up a good chunk of the building, can generate winds of up to 65 kilometres per hour and simulate air pressure of up to seven kilometres altitude.

The working section is a small chamber about two metres long and a metre tall. Once the wind gets going, researchers release the birds, who will happily fly in place against the wind for hours at a time, like a swimmer in a stationary pool.

The chamber is equipped with windows, cameras and measurement devices that allow researchers to study the mechanics of bird flight.

The wind tunnel also lets them study the effects of flight on the bird's body, and the impact of different foods and environmental conditions.



For instance, Guglielmo wondered what would happen to birds on long migrations as temperatures rise and the air becomes drier. "One of the big things birds face if they're flying overnight for 12 hours is, unlike a marathon runner, they don't stop to drink. So they generate all of their water internally from their metabolism."

They do that by using the water that is produced as they burn fat, organs and muscle for energy. Even under normal conditions, birds' internal organs will shrink dramatically as they are burned for energy and water; the heart can shrink by 25 per cent, livers and intestines by half. Even flight muscles get smaller.

When the humidity goes down, the researchers found the birds burn even more organs and muscles than they would otherwise. It turns out that burning these non-fat body components generates five times more water than burning fat does.

It's a useful adaptation, and better than dying of thirst. But as the world becomes hotter and drier, it could mean migrating birds show up at their destination even weaker and more exhausted than they normally would, making them less likely to survive and reproduce.

EXTERNAL RISK FACTORS

Other research at Western has shown the effects even small levels of pollutants can have on birds. After the 2010 Deepwater Horizon oil spill in the Gulf of Mexico, the U.S. Department of Justice sued the oil company BP, and wanted to establish how much damage might have been done. As part of that effort, they approached Guglielmo.

He found even small traces of oil on the feathers could harm birds, increasing the energy it took to fly by an extra 25 to 40 per cent. "So it's like flying around with a ball and chain. If you increase their flight cost by 25 or 40 per cent, they're probably not going to make it to the breeding ground that year," Guglielmo says.

Similarly, Guglielmo and Scott MacDougall-Shackleton, psychologist and co-director of AFAR, have both done studies that show even small amounts of mercury in the diet have harmful effects on birds. After just two weeks on a diet with trace amounts of mercury, for instance, their flight performance in the wind tunnel becomes unsteady and their manoeuvrability suffers.

MacDougall-Shackleton is especially interested in the dramatic changes birds go through during different seasons. "Birds essentially go through puberty over and over. They respond to longer days and other cues in the spring so they can activate their reproductive system and breed. In late summer or fall they totally shut down their reproductive system so they can prepare to migrate or, in the case of non-migratory birds, prepare for winter. Testes shrink in males; ovaries shrink in females. They're a totally different animal than in the breeding season."

MacDougall-Shackleton points out these seasonal changes extend beyond breeding hormones. Some species like goldfinches look very different in winter and summer, changing the colour of their feathers. Other species change their social system. Chickadees live in flocks in the winter, but mated pairs will aggressively defend their breeding territory from other chickadees in the spring.

One of the changes that could make the most difference to birds is the shifting timing of the seasons, with winter starting later and spring coming earlier.

It turns out that different birds detect the seasons in different ways, MacDougall-Shackleton says.

"Some species are really locked into daylight, and they ignore everything else, like temperature and food availability. It's only the long days that trigger them. Whereas other species, they respond to daylight, but in a much more flexible way."

This matters because birds often time their egg-laying so the chicks hatch when food will be most available. If the weather warms earlier, but they don't change the time of their egg-laying, there will be less food and fewer chicks will survive. "Some species are really at risk, because they're really specialized in a particular food, in a particular place, at a particular time. Those are the ones that are in the most trouble," MacDougall-Shackleton says.

Birds are the most visible indicators of biodiversity and environmental quality

He conducted other research that showed how another likely effect of climate change—severe weather—can cause yet another problem for birds. He and PhD student Andrea Boyer put white-throated sparrows in the wind tunnel's barometric chamber and lowered the air pressure in a way that mimicked what happens when a storm is coming. They found the sparrows could sense the pressure change. They responded by eating more and putting on fat, apparently preparing to sit out a storm that could prevent them from finding food.

As long as the "storm" came no more than once a week, the birds were able to put on fat and use it when they needed it. But if storms hit twice a week, their metabolisms couldn't keep up—they would eat more, but they couldn't store the fat they needed. It's an example of how climate change is likely to affect birds in all sorts of ways we haven't yet predicted.

"Climate change is not just an overall warming," Guglielmo warns. "It's also more variability in weather."

It has also meant more forest fires in some parts of the world, including North America. In recent years forest fires have raged across Canada and the United States during times birds are raising young and migrating. Smoke causes breathing and other health problems for humans, but could it impact bird populations?

"What I want to do is look at how forest fire smoke affects birds," Guglielmo says. He and postdoctoral fellow Catherine Ivy, who specializes in bird respiration and high-altitude flight, are preparing to investigate it.

MONITORING MIGRATION

On the roof of the Western Interdisciplinary Research Building, a huge, motorized satellite dish antenna peers up into the sky. By the end of next year it should begin to receive signals from Western Skylark, a small satellite Western students are currently building under the supervision of engineering professor Jayshri Sabarinathan.

When the satellite starts operating, it will collect information on bird movements from an existing network of ground-based radio towers and relay the information to researchers at the Western Institute for Earth & Space Exploration. "It's going to help us get access to the data more quickly than we can from remote areas that are difficult to access," says Yolanda Morbey, Western biology professor and co-investigator on the project.

The existing network is called the Motus Wildlife Tracking System. The network (which includes Western) consists of more than 2,000 towers in 34 countries around the world. They receive signals from tiny radio transmitters that have been attached to thousands of birds, as well as bats and insects.

"If we can understand bird behaviour, and physiology, and their responses to the environment, we'll be better able to predict what might happen under climate change or other habitat change, and identify places where some mitigation is required," Morbey says.

When a tagged bird nears a tower within 15 kilometres, the antenna records its signal, which is then uploaded to the network through internet or cell phone connection. However, in remote areas without such connectivity, someone has to go to those towers and download the information manually.

"When you're talking about visiting a station that might be way, way up north or on an island somewhere, that can be quite a logistical challenge," says Andrew Beauchamp, a PhD student working on the project.

Western Skylark will help solve that problem. Some of the remote towers will be fitted with transmitters that can send data up to the satellite, which will relay it to the satellite dish at Western. The satellite is being built as part of the CUBICS program funded by the Canadian Space Agency, intended to give students hands-on experience in space systems engineering while supporting science missions.

At the moment, the satellite, known as a CubeSat, is a modest 30-centimetre-long rectangular frame with a 10x10-centimetre base that students will need to pack with radio transmitters and receivers, solar cells and other components that will let it perform its mission. "If you want something to survive in space, you have to make sure you build it so it can stand up to vacuum, to temperature changes, and to the radiation environment," says Sabarinathan.

Back at the Advanced Facility for Avian Research, scientists will continue to study birds not only for the sake of birds, but for the sake of the climate as well.

"Birds are the most visible indicators of biodiversity and environmental quality. The timing and patterns of their movements are changing along with the climate," says Guglielmo. "We need to understand how changing temperature, humidity and wind conditions in the atmosphere, and habitat shifts on the ground, are going to affect their migrations so we can plan for how to maintain healthy ecosystems in the future." ●

BIRDS

Opposite: Black-capped chickadee (top); Cedar waxwing (bottom)

Right: Barn swallow

Page 25: Black-burnian warbler

Page 27: Western sandpiper

Saving birds, one window at a time

Brendon Samuels sees through the eyes of a bird in flight

Story by Kurt Kleiner
Illustration by Melinda Josie

Navigating Western's campus, biology PhD candidate Brendon Samuels looks beyond the buildings, walkways and greenery; he sees it through the eyes of a bird in flight.

Take windows, for example. To a human, the International and Graduate Affairs Building is easy to see—an attention-getting modernistic box made mostly of reflective glass. For birds flying between the Thames River and nearby woods, it might as well be invisible.

A few years ago, Samuels routinely collected birds that had died there after hitting windows they couldn't see. He estimated at the time that the building killed 150 birds a year. "They just don't understand what glass is. They never really encountered a reflection before in nature. Often their first encounter is a lethal one," Samuels says.

In fact, collisions with windows are estimated to kill more than a billion birds every year in North America and are one of the most common human-made causes of bird deaths.

For his PhD, Samuels studies pre-collision behaviour and tested how birds perceive windows, and how to create the most effective window treatments to make windows visible to them.

It turns out the bird-shaped stickers many people place on windows to make them visible don't really do much. "What we find is that if you put one or two stickers up on your window, a bird is just going to fly around the stickers and hit the glass," he says.

On the other hand, patterns with spaces of no more than five centimetres will signal to even the smallest bird that there is no space to fit through.

Over the past few years, Samuels has worked with the university to identify problem buildings and treat the windows with coatings the birds can see and avoid.

He says this has drastically reduced bird strikes, and the university has committed to making all new buildings bird-safe and is working towards retrofitting existing windows with the protective film.

It may be surprising that the grids of pencil-sized white dots make a difference. From a distance, it's difficult for human eyes to detect them, and even up close they don't stand out. But for birds the dots make all the difference.

Working with the City of London, Samuels is advocating for development planning bylaws to require bird-safe building design. And he has been working with the non-profit organization FLAP (Fatal Light Awareness Program) Canada to advocate for Bill 145, a policy that would incorporate bird-safe building design into the Ontario Building Code.

"Like a lot of issues in conservation, I actually think we have enough knowledge. We know what the solutions are. At least enough so we can take decisive action through policy and systems change to achieve the goals of conservation," Samuels says. ●

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Cover: Western sandpiper illustration by Melinda Josie

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Christopher Guglielmo, Biology professor and Director of Western's Centre for Animals on the Move

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