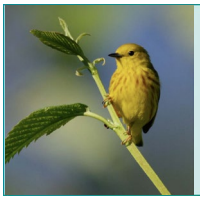

MARINA RODRIGUEZ: I fell in love with birds my freshman year after taking ornithology. Before that, I couldn't tell you the difference between a crow and a yellow warbler. It seems obvious now.

[Marina Rodriguez, Researcher, Colorado State University]

GENARO RODÍGUEZ OTERO*[speaking Spanish]*: Not all who study birds are birders. I am a birder. I am always listening and paying attention to what flies by.

[Genaro Rodíguez Otero, Researcher, Universidad Nacional Autónoma de México]

NARRATOR: Many birds, like these colorful warblers, are migratory - they spend their summers and winters in different places.

KRISTEN RUEGG: Migratory birds are definitely in trouble, and we've known this for decades. Just in my lifetime, it's estimated that there's been a loss of three billion birds from North America.

[Kristen Ruegg, Associate Professor, Colorado State University]

NARRATOR: But it's not always clear why, partly because scientists don't know where some birds go when they migrate. So they don't know what threats they encounter throughout the year. So how can scientists discover where these birds migrate?

[Mapping Migrations: The Bird Genoscape Project]

NARRATOR: Migratory birds breed and raise their young in one area, which is part of their breeding grounds, and then migrate, sometimes vast distances, to spend their winters in warmer places, called their wintering grounds.

[Animation of birds in a tree overlaid on a map labeled breeding grounds, then flying birds landing in another map location labeled wintering grounds.]

KRISTEN: Humans have been fascinated by migration for centuries. One of the reasons why it was always a mystery is because we didn't really have the technology to understand where birds go.

NARRATOR: For most migratory bird species, we already know where they breed and where they winter. But there's a lot we still don't know. For example, in a species that breeds across North America, do the birds breeding in the Northeast spend their winters in the same places that birds breeding in the West do?

Understanding these migratory connections is critical for bird conservation. To track animal movements, many researchers use transmitters that emit a radio or GPS signal, but bulky transmitters aren't a good option for tiny birds that migrate great distances.

KRISTEN: So instead of putting an external device on a bird, like a tracking device, you can actually use DNA, which is found in every tissue in a bird.

NARRATOR: The researchers of the Bird Genoscape Project are doing exactly that. They're using DNA to map the connections between birds' breeding and wintering grounds. They call these maps "genoscapes."

[Animation of a map entitled genoscapes with labeled breeding and wintering grounds and arrows going back and forth between the locations.]

KRISTEN: There's, I'd say, three main steps to building a genoscape. The first is we have to gather the DNA samples from all over the breeding grounds and the wintering grounds of the migratory bird that we're focusing on.

NARRATOR: Here in the Western US, researchers from the US and Mexico are collaborating to study two species that migrate between the two countries: yellow warblers and Wilson's warblers.

MARINA: Yellow warblers, I think, are the prettiest birds. They're bright yellow. The males have these really pretty orange streaks on their chests. You can see them from a distance for sure.

GENARO *[speaking Spanish]*: The Wilson's warbler is a very energetic bird. It is on the move all the time, because it is in search of food almost all the time. I have only ever seen it in Mexico.

MARINA: Once we know that there's birds in the area that we want to catch, then we can set up the net. We put the speaker under the net, and we play the male breeding songs. And that attracts other males, thinking that there's a male in the territory to come out. It also attracts females who are interested in the male that's singing to come out and then hopefully we get birds to fly into the net.

[Yellow warbler chirping]

MARINA: After you have a bird in the net, you reach down, grab the bird. I grab them by the legs. Untangle the legs first, then the shoulders, the head, put them into these little cloth bags. It helps them not to stress out too much. And we take them back to the table.

LUZ *[speaking Spanish]*: This morning, we put nets where we saw them yesterday. We caught two species, the yellow warbler and Wilson's warbler, in order to band them.

[Luz Estela Zamudio, Researcher, Universidad Nacional Autónoma de México]

NARRATOR: Every bird captured first gets an aluminum leg band with a unique ID number.

MARINA: We take some different measurements. Then we will take a feather sample from the tailfeathers.

GENARO *[speaking Spanish]*: Seeing a Wilson's warbler here in the United States was exciting. It's like seeing an old friend.

NARRATOR: When the team has collected enough feather samples, it's back to the lab to extract the birds' DNA.

LUZ *[speaking Spanish]*: The genetic information we can get from a simple feather is very valuable.

MARINA: So once we have the feather back in the lab, we then cut off the very tip of that feather, which holds the DNA that we're looking for. We then isolate the DNA from the rest of that tip of the feather, which we call DNA extraction.

NARRATOR: In the second step of the Bird Genoscape Project, researchers analyze the birds' DNA to identify positions where the DNA sequences vary among individuals. They use this information to map populations in the breeding grounds.

KRISTEN: The vast majority of the A's, C's, T's, and G's, which are the nucleotides that make up DNA, will be the same, but there will be some that differ between individuals. So, in one individual, it may be an A; in another individual, it may be a T, and those would be referred to as "single nucleotide polymorphisms."

[Animation of a DNA chain populating with the nucleotide labels of A, C, G, and T. Two chains appear with birds next to each one, labeled bird 1 and bird 2. The difference in the chains is highlighted and labeled single nucleotide polymorphisms.]

NARRATOR: Over many generations, the DNA of birds breeding in the same area becomes more similar. As a result, individuals that breed close to one another tend to share more of the same nucleotides at these single nucleotide polymorphisms, or "SNPs," than individuals living far apart. This shared genetic variation is like a fingerprint, showing that those birds are part of the same "population." There can be several genetically distinct populations within a species.

[Animation of a map with birds and their associated DNA chains appear labeled population 1 and population 2. A label Single Nucleotide Polymorphisms with acronym SNP appears on the map. The bird illustrations disappear and are replaced with the color-coded geographic locations.]

NARRATOR: In the third and final step of the process, the researchers analyze feather samples collected on the wintering grounds, matching the SNPs with populations across the breeding grounds to find out where each population goes.

[Animation of dots colored to correspond to the geographic areas in a southern portion of the map appear with arrows showing the migration from the color-coded geographic locations and dots. A label for the map called yellow warbler genoscape appears.]

NARRATOR: This complete map is the genoscape, and the migratory connections it reveals can help us understand what threats might impact each population. For example, if yellow warblers have declined on their wintering grounds in central Mexico, researchers could look for the potential causes of the decline either there, or on the corresponding breeding grounds of that population…causes like habitat loss, pesticides, and climate change.

MARINA: Yellow warblers are a really awesome species to study because they have a lot of different adaptations to their climate and to their habitats depending on where they are. So what we know about yellow warblers right now is that they're highly adapted to certain levels of precipitation. Any changes in precipitation could be bad for them in the future.

NARRATOR: Coupled with the yellow warbler genoscape, this work will help pinpoint populations at risk, as well as the breeding and wintering grounds that they rely on. In a fast-changing world, understanding birds' migratory patterns can help us predict and respond to their population declines more effectively. And for these scientists, that helps ensure that the birds they love can thrive — and be appreciated — for many years to come.

MARINA: I'm totally in love with birds. Understanding how to save these animals that I love is really important.

LUZ *[speaking Spanish]*: These types of collaborations help us learn about new techniques, new ways of working, and meet researchers doing studies that really have an impact.

GENARO *[speaking Spanish]*: Birds will always be better when shared. As they say, “Happiness is only real when it’s shared.”