



***The ordinary***

# EXTRA- ORDINARY JUNCO

*Singing the praises of a research rock star*

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From the elusive ivory-billed woodpecker to the well-traveled arctic tern, there are a lot of fantastic birds in the world. Dazzlingly iridescent indigo buntings. American redstarts that very nearly glow. Birds with, at least at first glance, a lot more cachet than an ordinary junco.

After all, juncos are ubiquitous. They range from as far north as Alaska to as far south as Costa Rica. Sometimes called “snow-birds” in Indiana, they arrive in autumn, stay through winter, and will be migrating away soon. (Look closely and you just might spot some of the little gray birds outside your window right now.) But, when it comes to research value, the unassuming junco is a veritable rock star.

“There are many, many categories of science that have been advanced through studies of the junco — everything from evolutionary diversification to neuroscience to disease ecology to migration to social behavior,” says Jonathan Atwell, PhD’11, a post-doctoral researcher at IU.

Thanks to IU, the junco is now a film star, too. Officially released last May, *Ordinary Extraordinary Junco: Remarkable Biology from a Backyard Bird* is on par with big-budget documentaries shown on PBS or National





A slate-colored junco swoops down to look for food in the snow in British Columbia, Canada.



Geographic TV. But, without the benefit of major commercial distribution, the film's creators have had to distribute the film on a shoestring, so far relying solely on their existing contacts in science and education, the birding community, the Audubon Society, and social media. (They're still looking for underwriters to help defray the cost of broader distribution to PBS television, as well as online outlets like Netflix and iTunes.)

To date, there have been more than 30 screenings in theaters, 70-plus requests for additional public screenings, more than 21,000 plays of the film modules online through Vimeo, and more than 11,000 unique visitors to the film's website.

The film follows the research team, led by IU experts, on its search for myriad types of both dark- and yellow-eyed juncos. The search takes them across the U.S. to the far reaches of remote Guadalupe Island, a protected ecological preserve 150 miles west of Mexico's Baja California coast, and up Guatemala's Cuchumatanes mountains some 12,000 feet above sea level. Riding along, viewers of the film are treated to gorgeous cinematography, a compelling script, and plenty of surprising findings about juncos and, by extension, humankind as well.

## A BIRD IN HAND

Mid-flight, a junco is captured in sheer netting that's virtually invisible. The researchers have lured him in with seed bait and recordings of his own territorial song. Just as quickly as he was trapped, the junco is deftly extracted from the net, unharmed. With bird in hand, a researcher on camera measures wing, tail, and bill length. Next, the bird's body mass is recorded. He is screened for parasites like mites and lice. Some photos are snapped, and a tiny blood sample is taken from a vein in his wing. And, then, just like that, he's off in a flash of white tail feathers.

The documentary features Ellen Ketterson, BA'66, MA'68, PhD'74, distinguished professor in the College of Arts and Sciences' Department of Biology; Atwell, who works in the Ketterson Lab (a research group devoted to the study of the biology of the junco); and many other field experts.

The film is dedicated in memory of Val Nolan, BA'41, JD'49, an IU professor in both the Maurer School of Law and the Department of Biology. He is Ketterson's late husband, and

they began studying juncos together in the early 1970s.

The biologists will learn a lot from the brief encounter, from the bird's nutritional state and immune function to hormone levels, genetics, and more.

"At its heart, the

film is intended to be an educational science documentary that conveys how people learn about wildlife—the questions they ask, the methods they use, the places they go, and even the friendships they form along the way," Ketterson says.

*Ordinary Extraordinary Junco* was produced with help from the IU Bloomington Office of the Vice Provost for Research, the College of Arts and Sciences' Themester program, the

Department of Biology, the Department of Telecommunications, and the Center for Integrative Study of Animal Behavior.

"We have no profit agenda. We just want to share the film and the bird and the science-education dimensions as widely as possible," Atwell notes. To that end, the 88-minute documentary is available online for free and is broken into eight interconnected modules suitable for classroom use.

## WHY JUNCOS?

Juncos have been studied for the last 100 years. Ketterson has spent 40 years on the junco. But why? Juncos, it turns out, are particularly amenable to study. Because they forage and nest on the ground, they are easy to find and observe. And juncos are docile and can tolerate living in controlled environments.

"They thrive in captivity, so you can provide them with seeds or put them in different social configurations, and they're content. They actually reveal their biology to you," Ketterson explains onscreen.

With marked variation in eye color, social badging (for instance, the color of tail feathers and patches of feathers on their upper backs) and even beak size and shape, juncos are a very diverse bunch. In fact, before advances in genetic sequencing, scientists thought that today's dark-eyed junco groups were actually as many as six or more species, but now they know better. As it happens, all of those variations are recently evolved, having diversified from Mexico's yellow-eyed junco as recently as 10,000 to 20,000 years ago—that's just an eye blink, in evolutionary terms—as they recolonized North America after the last ice age.

## SHAPED BY THEIR ENVIRONMENT

Some juncos have been shown to adapt even more rapidly. One of the most interesting segments in the *Ordinary Extraordinary Junco* series offers a glimpse at evolution in near real-time. In less than 30 years, an urban group of dark-eyed juncos adapted to bustling college life at the University of California campus in San Diego. Instead of migrating back to the nearby mountains for the breeding season, some birds remained on campus year-round.

These days, there are about 80 breeding pairs living comfortably among some 30,000 students—not to mention pets, traffic, constant noise, and lots of artificial lighting. The IU researchers have spent considerable time on the San Diego campus and periodically return to keep tabs on the local population.

Compared to juncos breeding on nearby Mount Laguna, the San Diego juncos have become much bolder and tamer. They allow people to come into closer proximity, and they explore new objects and situations more readily—probably the result of sidling up to so many lawn sprinklers and fountains to drink or hopping over to forage students' leftovers. And, presumably to be heard over area noise, the male juncos on campus now sing at a higher pitch.

Campus life also means a milder climate and longer breeding season, so males are less aggressive with one another. What's more, the appearance of the social badges used to display aggression is even starting to change—now the San Diego hangers-on have less white in their tails and less black on their heads.

So far, the researchers have just scratched the surface. In



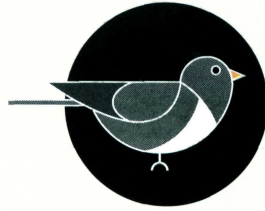
### WATCH THE FILM

See *Ordinary Extraordinary Junco: Remarkable Biology from a Backyard Bird* at [juncoproject.org](http://juncoproject.org). You'll also find links to relevant scientific literature, downloadable teaching guides, study questions, and other open-source educational materials.



# FIND YOUR JUNCO

How about some birding? If you live in North America, you're close to at least one of the many varieties of junco, the small songbird playing a big role for IU researchers. Pair the information here with a pair of binoculars—and, for more direction, The Sibley Guide to Birds—to make your own junco sighting.

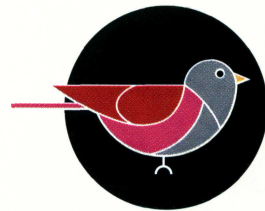


## SLATE COLORED JUNCO

**GEOGRAPHIC RANGE:** Most of U.S. and Canada

**BODY & WING COLOR:** Pale brown to dark gray body, white belly

**EYE COLOR:** Dark

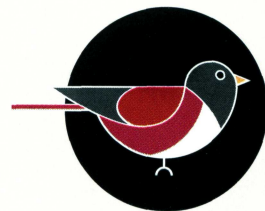


## PINK-SIDED JUNCO

**GEOGRAPHIC RANGE:** Rockies and Western Plains

**BODY & WING COLOR:** Light gray head and breast, brown back and wings, pinkish flanks

**EYE COLOR:** Dark

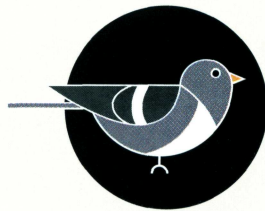


## OREGON JUNCO

**GEOGRAPHIC RANGE:** Western U.S. and Canada

**BODY & WING COLOR:** Dark hood, rusty back, pinkish brown flanks

**EYE COLOR:** Dark

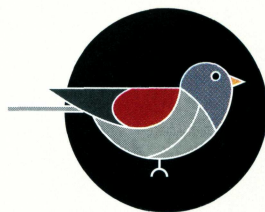


## WHITE WINGED JUNCO

**GEOGRAPHIC RANGE:** Black Hills to New Mexico

**BODY & WING COLOR:** Medium-gray head, pale throat, white wing bars

**EYE COLOR:** Dark

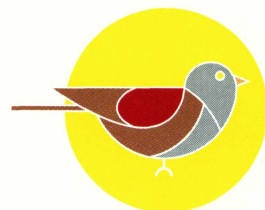


## GRAY HEADED JUNCO

**GEOGRAPHIC RANGE:** Southern Rockies to New Mexico

**BODY & WING COLOR:** Light gray on top, rusty back

**EYE COLOR:** Dark



## YELLOW-EYED JUNCO

**GEOGRAPHIC RANGE:** Mountains of Southeast Arizona, Southwest New Mexico, northern Mexico

**BODY & WING COLOR:** Gray head, red back

**EYE COLOR:** Yellow



## VOLCANO JUNCO

**GEOGRAPHIC RANGE:** Mountains of Costa Rica and western Panama

**BODY & WING COLOR:** Brown upper parts with dark streaking, pink bill

**EYE COLOR:** Yellow

oming years, they will continue to study these and other juncos are adapting to climate change and urbanization—and what they could apply to the hundreds of animals that make up a given ecosystem.

It's likely that the way juncos' behaviors change may be similar to changes in other birds, mammals, and the hormonal or neurological immunological changes that underlie changes in the junco are similar across a range of organisms," Atwell says.

But what does that mean for us? As species struggle to adapt to life in urban settings or in response to climate change, some will thrive where others fail. This can produce cascading impacts throughout an ecosystem and has the potential to cause humans real trouble.

Animals can be beautiful inspirations or obstacles, depending on their population sizes or behaviors," Atwell continues. "Animals can devastate crops or decimate crops. They can provide valuable ecosystem services like nutrient cycling or pest control, but they can also carry zoonotic diseases.... Understanding how animals change in urban habitats or in response to climate change has huge potential to impact human well-being."

## NATURE AND NURTURE

For the pragmatist, Mother Nature likes to hedge her bets when the survival of a species is at play. Encourage some males to roam, impregnating as many different sexual partners as they can find. Let other males remain monogamous and take pains to be responsible parents to a much more limited number of offspring. One way or another, offspring will be created and the species will endure.

IU researchers posit that, over time, natural selection shapes key strategies for maximizing both survival and reproductive success. Faced with limited resources to allocate to key life tasks like seeking mates, raising young, and surviving to breed again, different individuals or groups of animals can balance these conflicting demands differently. Understanding how such tradeoffs are regulated and how they change and evolve among populations and among species is part of "life-history theory," which can also provide many insights into human biology. One classic life-history tradeoff that has interested scientists for decades is why some animals remain monogamous while others seek multiple mates, with some animals investing more in parental care than others.

Turns out variations in male physiology can either elegantly regulate such competing evolutionary strategies. For more than a decade, Letterson and Nolan and their colleagues conducted an elaborate field experiment—another





Two Oregon juncos “flutter up” during a possible territorial dispute or mating ritual in British Columbia, Canada.







# ***Ever the pragmatist, Mother Nature likes to hedge her bets when the survival of a species is in play.***

starring role for juncos — to better understand the role testosterone plays in the mating and parental behaviors.

Over numerous breeding seasons, the researchers caught juncos in the wild and augmented their testosterone levels by implanting a tiny capsule underneath the skin of each male bird. Capsules in the experimental group secreted testosterone, while capsules in a control group did not. The researchers also attached radio transmitters to their subjects' backs to monitor movement and map the size of the territory each bird would defend.

The biologists wondered whether and how an increase in testosterone levels might change the birds' social behavior, physical characteristics, reproductive success, and overall long-term survival rates.

Despite some straying from time to time, juncos are, for the most part, monogamous; a male and female pair will defend its territory and its nest together. But, while all of the males in Ketterson's and Nolan's study *appeared* to behave monogamously, paternity tests revealed that the testosterone-boosted males also mated with their female neighbors. Meanwhile, male juncos in the control group were more likely to remain monogamous, even if their female partners did not — meaning these cuckolds often ended up caring for nestlings that weren't even theirs.

On average, the males with augmented testosterone levels defended larger territories, sang more often, mated with more females, and sired more offspring than did their unadulterated counterparts. But quantity isn't everything. In *Ordinary Extraordinary Junco* Ketterson explains, "The quality of the offspring matters, and it also matters whether the male survives to reproduce again in each subsequent season."

To determine the quality of offspring, the researchers weighed the nestlings and closely observed the amount of parental care they received, right down to tracking the number of feeding trips made to the nestlings per hour. What they found? Those testosterone-boosted juncos were pretty lackluster dads.

Males in Ketterson's control group fed their nestlings nearly twice as often as did the males in the testosterone-boosted group. As a result, the control group's nestlings thrived and were more likely to survive to adulthood.

"So, if it's how many mates you acquire or how many offspring you produce, then a male benefits from having higher levels of testosterone. But if it's the quality of the

offspring he produces or how long he lives, then it's more beneficial for a male to have lower testosterone," she notes.

## **WHAT'S NEXT?**

Since the release of *Ordinary Extraordinary Junco*, funded from the National Science Foundation with additional support from many IU entities, Atwell and others from the Ketterson Lab have turned their attention to junco migration.

"We are testing some new tools that will allow us, for the first time in history, to gain detailed information about the specific locations, distances, seasonal timing, and speed of travel for individual juncos on their annual journeys from breeding to wintering grounds and back again," Atwell says.

Until recently, researchers have had only vague ideas about the distances migrating birds traveled and the specific routes they took, but that's changing. Radio- and GPS-tracking tags have been useful in other types of biological research, but those are still too large to attach to the small junco.

The good news? There is an alternative — tiny, photo-sensitive data-loggers that will record daylight levels every few minutes for an entire year.

"New miniaturization technologies allow for a data-logger that is less than half a gram, so that a junco can wear it as a backpack with no ill effects on flight or behavior or survival," Atwell explains.

If researchers can outfit a junco with a miniaturized data-logger and are able to recapture the bird later, they'll have access to data they can use to determine the timing, distance, rate, and geography of migration.

Provided testing goes well, data-loggers will be placed on juncos across their breeding and wintering ranges, and Atwell and his colleagues will know more than ever about the migratory journeys of different junco types.

They should be able to connect specific junco populations to their corresponding breeding and wintering areas — thereby establishing some parameters that could help make land management and habitat conservation efforts for these wide-ranging birds more effective. Case in point: "For things like wind energy development, information about timing and routes could help offset serious conservation and legal issues surrounding the killing of birds," Atwell says.

Eventually, Atwell adds, they also hope to better understand the relationship between junco migration and disease ecology, genetics, survival, and more: "There really is no end in sight to what we can learn about science and nature by studying juncos." ■

*Read about Susan Brackney's writing on environmental affairs in the Contributors section, page 3.*