The Rectrix

A seasonal newsletter of the Missouri River Bird Observatory Volume 9 No. 2. Summer 2019

rectrix |rek-triks| noun. (pl. -trices) any of the larger feathers in a bird's tail, used for steering in flight.

MISSION
The Missouri River Bird Observatory is a 501(c)3 non-profit entity dedicated to the conservation of Missouri's migratory and resident birds through scientific research, community outreach, K-12 education and conservation policy advocacy.

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This Issues' Photography Credits
Greater Prairie-Chicken, front cover - Donnie Nichols. *The Inspection*, this page - David Seidensticker. *Good Morning Sunshine*, page 3 - Carol Weston. *Loggerhead Shrike*, page 6 - Bill Blackledge. *Grasshopper Sparrow*, page 7 - Linda Williams. *Chillin' Amongst the Calming Purple Berries*, page 19 - Janet Duckett. *Watchful Eye*, back cover - Carol Weston.

In this issue of The Rectrix

Upcoming Events

See more events as they're added at https://mrbo.org

Young Explorers Club at MRBO's Arrow Rock Office
Our outdoor summer camp runs on Mondays, Wednesdays and Fridays during the month of June! Anyone between the ages of 8-11 can join us to explore and learn more about the outdoors!

Runge Nature Center BioBlitz in Jefferson City
Join MRBO for the first ever Runge Nature Center BioBlitz on June 21-22nd. We will be banding early on June 22nd!

Cape Girardeau Nature Center Hummingbird Festival
Join MRBO at this all day event on August 3rd to celebrate Missouri's hummingbirds!

Missouri Young Birders Club Central Region Field Trip
Do you like birds? If you are between the ages of 8-17 yrs old, join us on June 15th at the Arrow Rock State Historic Site to explore what birds are all around us!

Saline County Career Center Class on Birds and Butterflies in Marshall
Join MRBO to get a great introduction to Missouri's Birds and Butterflies! Classes are September 26th and October 3rd. See: https://www.marshallschools.com/o/career-center/page/community-education

Letter from a Partner

By Missouri Department of Conservation Grasslands Coordinator Max Alleger

Prior to European settlement, hundreds of thousands of Greater Prairie-Chickens populated Missouri's tallgrass prairie. The geographic center of the species' range was likely located where Illinois, Iowa and Missouri meet, however scattered flocks could be found on open ridgetops well into the Ozark Highlands.

Populations peaked following the elimination of bison herds and as newly plowed prairie gave way to grain crops that provided a concentrated food source. This peak was soon flattened by market hunting and the unrelenting loss of habitat as even more prairie was plowed for crops. Their decline continued in sync with the loss of prairie habitat, temporarily offset by Soil Bank plantings in the 1960's, then hastened since the 1970's by the widespread planting of tall fescue and encroachment of trees throughout remaining prairie landscapes.

I am among a handful of Missouri Department of Conservation (MDC) biologists who have tracked the relentless decline of the iconic prairie-chicken. This spring, I worked with MDC Media Specialist Bill Graham to develop news releases informing the public that the Greater Prairie-Chicken could soon be extirpated from southwest Missouri's Osage Plains. When the Missouri River Bird Observatory (MRBO) asked me to share thoughts here, I set off, as any detail-oriented biologist might, to recount details of prairie-chicken recovery efforts across the decades. I was intent on sharing numbers and detailing the long-term land use changes that drove ever-constricting range maps for the species. I was several pages in, when I decided to set that aside and tell you, instead, how this makes me feel.

In 2012, Lonesome Chuck (left) was the single surviving male on a lek that once existed northwest of Lockwood, Missouri

Better biologists than me have long foreshadowed the demise of the prairie-chicken in Missouri. Aldo Leopold, widely considered the father of modern wildlife conservation, estimated that Greater Prairie-Chicken numbers peaked in Missouri in 1870, and that declines set in by 1888. As the 1900s sped by, successive voices that included Rudolph Bennitt, Werner Nagle, Charles Schwartz, and Don Christisen questioned the ability of the birds to persist, and called for well-focused land acquisition, private lands assistance programs and the translocation of birds to refill the best remaining habitat.

Research biologist Larry Mechlin updated the species' recovery plan in 1998. He estimated that 1,000 birds remained statewide, occupying a range that had constricted to four percent of its original size; that range was also fragmented into 50-70 distinct segments. Mechlin predicted that the Greater Prairie-Chicken would be extirpated from Missouri by 2009 at the current rate of decline. I picked up that baton in 2006 and had the honor of leading a dedicated team which called for renewed, aggressive recovery objectives.

Each successive generation of conservationists made strides; land was acquired, some neighbors added habitat and ever-improving translocation and monitoring techniques taught us much about the birds' movements and habitat requirements. MDC has invested mightily in prairie-chicken conservation over the years. Sadly, it appears those efforts may prove to be too little, too late for prairie-chickens in the Osage Plains. We have higher hopes for an apparently stable, reintroduced population along the Iowa line in Harrison County.

In a former life I was exceptionally proud of the 15-20 Greater Prairie-Chickens that boomed on my Pettis County farm. Those birds 'blinked out' within two years of the loss of the nearest nesting habitat - 270 acres of Conservation Reserve Program (CRP) on a neighboring farm that went back to crops. That was about the same time I admitted I wasn't a farmer and gratefully entered my current career.

What I could not know at that time was that over the next two decades I would watch one booming ground after another blink out. The pattern would be brought into sharp focus thanks to the tale of Lonesome Chuck, which goes something like this . . .

During the winter of 2011-2012, two wayward, radio-marked hens made their way from Wah-Kon'Tah Prairie to the prairie landscape northwest of Lockwood. One survived the winter, mated with one of two local males and successfully hatched a brood of 14 chicks. Several weeks later she was killed in a fence collision; we didn't know the fate of her brood. The following spring, one lone male occupied the booming ground - but he was not your usual prairie-chicken. Birders quickly found that he would approach closely; some posed for close-up photos. He was soon named Lonesome Chuck. He gained fame on TV news in Springfield and his story ran at the national level; people love heartfelt stories about individual animals.

I tend to think more about populations than individuals, and stories like that of Lonesome Chuck were by then all too familiar. Chuck's curious behavior was driven by the fact he may not have known exactly what he was. The booming ground is the social center of prairie-chicken life and the lessons learned thereon by juvenile birds are likely much more important to future behavior than we understand. It's likely that Chuck wandered the landscape alone, with no opportunity to 'learn the ropes' from older males. Still, he was driven to defend a bit of turf the following spring. . . even if he didn't know how to act.

The author's son, Ben Alleger, with a Greater Prairie-Chicken ready for translocation to Missouri

Word of the cool opportunity to meet Chuck spread quickly. At the time, I likened Chuck's interaction with his human admirers to the death rattle of a local, profoundly isolated sub-population. This sobering reality has played out many times across Missouri's prairie landscapes over the past hundred years. It almost always ends the same way – the confused male finally gets killed and prairie-chickens in that place become just a memory, a historical account. "Fred" - the last male in Audrain County - was struck by a car while booming in the intersection of C and D highways. The last male at Whiteman Air Force Base was taking on jet planes. Residents in southern Henry County brought in photos of the last local male roosting on a school bus, challenging a tractor, and flogging the landowner's hand while booming in his driveway. I got reports from a construction crew working in rural Bates County of being approached and followed by a lone male. I've heard similar stories from other states as well.

Earlier, I said that I would share how I feel about the possible extirpation of the Greater Prairie-Chicken from the Osage Plains. I have a prized picture of my then eight-year-old son holding a prairie-chicken during a work project I was able to share with him. He knows well the sound of the prairie waking up, as he knows the sights and sounds of the booming ground. Those things make him exceedingly rare among Missouri youngsters. What bothers me most is that I know that unless something changes – some profound economic change that I cannot predict nor now foresee - which favors the return of large native grasslands to our modern landscape – my grandkids won't share my son's experiences in the Osage Plains.

Max Alleger with Boomer, a frequent attraction at prairie events

Aside from the sense of loss that realization brings for all of us who care about conservation, the gnawing worry of which species may come next is worse. Will a successor of mine need to write something like this to recount the story of the Loggerhead Shrike? In two generations will the story be about the Northern Bobwhite? I can't know. But what I do know is that our generation needs to turn things around quickly, while instilling in the next generation a sense of love, respect, and wonder for the wild species that share our countryside.

It might be easy to grow pessimistic, but we can't stop. Grassland conservation work is more important now than ever, and I draw hope from MRBO's work. Dana, Ethan and their crew of young professionals help us understand how our land management decisions impact birds, which helps us prioritize our work to make the most of our remaining grasslands. Along with Paige, they are also reaching the next generation with empowering lessons from our natural world. MRBO is an invaluable partner, helping assure that future biologists can share happier stories than this has been. I am grateful for my association with MRBO and look forward to sharing happier stories in years to come.

Max R. Alleger

Scenes from the Prairie

MRBO documents bird use of Missouri prairies, work that includes extensive breeding season surveys and nest monitoring.

Photos, clockwise from top: the MRBO crew on a prairie in Pettis County, Loggerhead Shrike, a Henslow's Sparrow nest, Paige with a Yellow-billed Cuckoo captured during a Missouri Prairie Foundation event.

MRBO recently had the opportunity to survey birds in the Flint Hills of Kansas, where the tallgrass prairie still exists as a relatively intact, 4 million acre ecosystem.

Photos, clockwise from top: Grasshopper Sparrow, Ethan ready to start a survey, Flint Hills landscape, evening primrose blooming from rocky soil.

Meet the 2019 MRBO Staff!

I'm Joseph Mosley, and have been birding for seven years starting in Georgia then moving back to my home state of Missouri in 2013. Birds have always been a source of inspiration for me since watching my grandparents' feeders when I was little. When I was a teenager it became my dream to be an ornithologist as a career and started pursuing every opportunity I could to learn more about birds. Currently I am completing my studies at Metropolitan Community College – Longview before I will transfer to the University of Kansas to complete a Bachelor's in Ecology and Evolutionary Biology. This is my second year of field work and last year I worked as an avian field technician in the Kisatchie National Forest for Louisiana State University. I want to work with birds to gain more understanding to preserve our natural environments. Both birding and working with birds connect me to nature and so causes me to try and do as much as possible to protect the ecosystems they are a part of. I am enjoying working on the grassland project and seek to learn as much as possible about the birds that call this habitat home.

Matt Sim is returning to the MRBO field crew from 2016. He is studying wildlife biology at West Texas A&M University and will be graduating with a Bachelor's degree in December. Since his last stint with MRBO, Matt has done a variety of work with a number of different species including bull shark, yellow mud turtle, and burrowing owl. After graduating, Matt is interested in becoming a conservation biologist.

My name is Zoë Ward, and I graduated from the Gatton Academy in Kentucky this past May. I have always had an interest in animals; however, I was not sure how I could apply this interest to a career. I traveled to Utqiaġvik, Alaska during the summer of 2018 to participate in a sleep study conducted on arctic songbirds, which sparked my interest in wildlife biology. I will be attending Western Kentucky University next fall to complete a double major in biology and Spanish with a minor in photojournalism. I plan to get a doctorate in biology, and I hope to continue conducting wildlife research throughout my career.

Matt Longabaugh's love of birding started in early 2016 with a nesting pair of Bald Eagles and the rest was history. Since then, while working as a pet shop manager in Kansas and nature center tour guide in Costa Rica, he's traveled as much as possible to see new birds and picked up photography somewhere along the way. Long-term, his dream is to pair his love of traveling and birding into a career in ecotourism.

My name is Matt Spinnenweber. I am currently entering my senior year at Westminster College. I am majoring in Environmental Science and minoring in Biology. Working for MRBO is my first field research job. I joined the MRBO team because I'm interested in helping in any way to conserve the Missouri wildlife we still have today. I'm planning on attending graduate school once I complete my four years next spring. I intend to use the knowledge I learn this summer to better my practice and to give me insight on what I may want to study during grad school.

Grasslands Crew

Wetlands Crew

Field Project Leader

I'm Erik Ost. I grew up in Ashburn, VA and later attended Christopher Newport University in southeastern Virginia. All throughout adolescence I was drawn to the outdoors and so it was no surprise I graduated with a degree in organismal biology. After undergrad, I worked for AmeriCorp in Asheville, NC and then waited tables before finding an opportunity with MRBO in 2016. I have been working for MRBO seasonally ever since and as of last year became more of a full-time employee. Between field seasons I have spent time studying Blue-throated Macaws in Bolivia, snowboarding in Vail, traveling around the U.S., and all the while birding! Along with my time spent with MRBO, I am taking graduate classes with Northwest Missouri State University (Go Bearcats!) and plan on graduating with a master's in Geographic Information Science in a year or so. I hope to better serve the field of wildlife conservation with this degree.

Education Department

My name is Emily Koch, I am currently a junior at the University of Missouri studying agricultural education. I am from a small town not easily found on a map. Hidden between the lines of St. Louis and Kansas City sits the cozy town of Belle, Missouri. In this little town I found a passion for agriculture and conservation, one that I will forever be thankful for. My passion has lead me to pursue a career that educates people of all ages about wildlife and agriculture. In fact, my favorite moments are spent teaching students about the benefits wildlife and agriculture can play on their own lives. I hope to one day turn those few moments into a daily routine in my own classroom. I am excited to serve as an intern for the Missouri River Bird Observatory this summer, and look forward to working with students during the Young Explorers Club.

In March of 2017, Paige Witek traveled from her hometown of Green Bay, Wisconsin in search of new adventures with MRBO as a seasonal educator. She returned in 2018 and became MRBO's first Education Coordinator. Paige graduated from the University of Wisconsin- Madison in May of 2016 with a B.S. Degree in Zoology and a Certificate in Environmental Studies. The origin of Paige's passion for conservation, birds and environmental education cannot be pinpointed to any one experience in her lifetime, but developed as a result of a hodgepodge of past experiences, including her work with zoos, wildlife rehabilitation and education centers, wildlife sanctuaries and studying abroad in Queensland, Australia. In 2019, she is working to expand MRBO's Young Explorers Club and the Missouri Young Birders' Club, which she launched in 2017 and 2018, respectively. Paige is truly excited to continue to inform and inspire others.

MRBO Founders

Dana and Ethan Duke founded MRBO in 2010 and continue as the organization's Directors. Dana is originally from northern Illinois but spent six years growing up in Hong Kong. She discovered the wonders of birds at age 19 and received a B.A. in Biology and an M.S. in Wildlife Ecology before working on bird projects in 12 states and Canada. Ethan hails from rural western New York and grew up hunting and fishing. After a tour in the US Air Force, he used the GI Bill to earn a degree in Wildlife Management. Ethan also worked in several states on a variety of bird projects before settling in Missouri. Dana and Ethan are completely devoted to wildlife and habitat conservation, an overarching philosophy that guides MRBO's vision and activities.

Wetland Bird Project Update

13,900 individual birds were documented on 53 private wetlands during spring migration!

71	American Bittern
554	American Coot
81	American Crow
14	American Golden-Plover
88	American Goldfinch
1	American Kestrel
8	American Pipit
3	American Redstart
34	American Robin
120	American White Pelican
2	American Wigeon
3	American Woodcock
49	Bald Eagle
23	Baltimore Oriole
10	Bank Swallow
128	Barn Swallow
28	Barred Owl
16	Belted Kingfisher
9	Black-and-white Warbler
37	Black-capped Chickadee
6	Black-crowned Night-Heron
1	Black-throated Green Warbler
139	Blue Jay
88	Blue-gray Gnatcatcher
2723	Blue-winged Teal
5	Blue-winged Warbler
1	Bobolink
1	Bonaparte's Gull
73	Brown Thrasher
265	Brown-headed Cowbird
2	Bufflehead
417	Canada Goose
21	Carolina Chickadee
61	Carolina Wren
1	Caspian Tern
1	Cattle Egret
14	Chimney Swift
8	Chipping Sparrow
9	Cliff Swallow
2	Common Gallinule
309	Common Grackle
1	Common Merganser
210	Common Yellowthroat
2	Cooper's Hawk
8	Dickcissel
288	Double-crested Cormorant
45	Downy Woodpecker
30	Eastern Bluebird
23	Eastern Kingbird
125	Eastern Meadowlark
24	Eastern Phoebe
33	Eastern Towhee
55	Eastern Tufted Titmouse
62	European Starling
242	Field Sparrow
64	Fish Crow
3	Flycatcher Spp.
2	Forster's Tern
2	Fox Sparrow
18	Franklin's Gull
79	Gadwall
3	Golden-crowned Kinglet
6	Golden-winged Warbler
8	Grasshopper Sparrow
18	Gray Catbird
70	Great Blue Heron
16	Great Crested Flycatcher
80	Great Egret
8	Great Horned Owl
4	Greater White-fronted Goose
234	Greater Yellowlegs
3	Great-tailed Grackle
12	Green Heron
209	Green-winged Teal
5	Hairy Woodpecker
5	Henslow's Sparrow
67	Hooded Merganser
15	Horned Lark
26	House Wren
11	Indigo Bunting
102	Killdeer
2	King Rail
1	Least Bittern
3	Least Flycatcher
19	Least Sandpiper
17	Lesser Scaup
241	Lesser Yellowlegs
8	Lincoln's Sparrow
53	Long-billed Dowitcher
6	Louisiana Waterthrush
113	Mallard
86	Marsh Wren
100	Mourning Dove
2	Nashville Warbler
1	Nelson's Sparrow
34	Northern Bobwhite
261	Northern Cardinal
26	Northern Flicker
21	Northern Harrier
1	Northern Mockingbird
35	Northern Parula
2	Northern Pintail
55	Northern Rough-winged Swallow
540	Northern Shoveler
21	Northern Waterthrush
1	Orange-crowned Warbler
5	Orchard Oriole
2	Ovenbird
449	Pectoral Sandpiper
2	Peregrine Falcon
93	Pied-billed Grebe
18	Pileated Woodpecker
5	Prothonotary Warbler
3	Purple Martin
71	Red-bellied Woodpecker
3	Red-eyed Vireo
37	Red-headed Woodpecker
18	Red-shouldered Hawk
9	Red-tailed Hawk
202	Red-winged Blackbird
8	Ring-billed Gull
35	Ring-necked Duck
10	Rose-breasted Grosbeak
27	Ruby-crowned Kinglet
17	Ruddy Duck
7	Rusty Blackbird
6	Sandhill Crane
71	Savannah Sparrow
1	Scarlet Tanager
1	Scissor-tailed Flycatcher
11	Sedge Wren
1	Sharp-shinned Hawk
1	Slate-colored Junco
7	Snow Goose
47	Solitary Sandpiper
181	Song Sparrow
333	Sora
19	Spotted Sandpiper
1	Summer Tanager
1	Swainson's Thrush
469	Swamp Sparrow
1	Tennessee Warbler
895	Tree Swallow
83	Turkey Vulture
1	Vesper Sparrow
35	Virginia Rail
33	Warbling Vireo
11	Western Palm Warbler
12	White-breasted Nuthatch
8	White-crowned Sparrow
5	White-eyed Vireo
104	White-throated Sparrow
13	Wild Turkey
382	Wilson's Snipe
1	Wilson's Warbler
1	Winter Wren
192	Wood Duck
2	Wood Thrush
2	Yellow Rail
24	Yellow Warbler
4	Yellow-breasted Chat
2	Yellow-crowned Night-Heron
13	Yellow-headed Blackbird
96	Yellow-rumped Warbler
14	Yellow-throated Vireo
1	Yellow-throated Warbler

A Great Blue Heron Innovation?

By MRBO Member and Volunteer Dianne Van Dien

Great blue herons, those gangly, yet graceful, spear-throwers of the bird world, are commonly seen throughout the U.S. standing with Zen-like patience along the shores of lakes, ponds, and rivers as they search for fish, frogs, and crustaceans. Their focused pose is prelude to sudden action. At any moment a heron's head may shoot forward, dart down to the water and reappear with a speared crappie or bass. After repositioning the fish in its bill, it will swallow its prey whole. Seeing the fish make its way down the heron's long skinny neck always makes me wince. But then the heron shudders, raises and settles its feathers, the fish apparently settled comfortably within. The long-legged bird then proceeds forward with careful steps to stalk the next course in its meal. This is how I always envisioned the great blue heron on the hunt—until a few years ago when I saw one land in the middle of a lake in water far too deep to stand in.

The first time I witnessed this behavior I doubted my eyes. It happened so quickly! A heron was flying over the lake, about five or six feet above the surface, when it abruptly went down and floated in the water like a duck. It then craned its head forward, snagged a fish, lifted itself easily back into the air and continued to the opposite shore. This entire sequence took maybe six seconds. Stunned, I turned to my husband. "Did you see that?!" He, of course, had been looking the other way. With his back to the lake, he could provide no verification that I'd actually seen what I'd seen.

But a week later, at the same spot, I again saw a heron pluck a fish from the middle of the lake. So fast! So fluid! And utterly unpredictable. I would never get a photo as proof. Over the next few weeks, I witnessed this same behavior two more times. Then, at another lake two miles away, I spied a heron standing on the shoreline. It jumped four feet forward, splashed into about three feet of water, grabbed a fish, and returned to the shore. Not exactly the same behavior but similar enough to make my previous observations more believable.

I began wondering if the "floating like a duck in deep water" behavior was a local adaptation. Maybe that heron was the first to do this, or maybe its great grandmother had been an innovator and figured this out, passing the technique down to later generations. Before getting too carried away, however, I decided I'd better check Birds of North America. There I read: "Individuals hunt most often by slowly wading or standing in wait of prey in shallow water…. [They] also dive feet first after prey (Forbes 1987), and hunt while floating (Jensen 1932), or from floating objects (Godin 1977). Kubisz (1989) reported a heron landing on the water to pick up a food item and then taking off from floating."

Although disappointed I hadn't stumbled upon a brand new behavior, it was exciting to have made this discovery on my own rather than merely reading about it in a book or on the web. It certainly reinforced my reasons for making time to be outdoors.

Each outing can bring something new. When I told other birders about my discovery, not one had seen a heron land in the middle of a lake. Even common species—those you think you know well—may surprise you.

I did eventually get a photo of a heron swimming in deep water. It never tried to grab a fish, however. Rather it swam slowly for about 15 seconds and then flew to the shore. A minute later it was back in the water, floating like a duck, moving first in one direction and then the other. Perhaps the fish were too deep that day. The heron rose up, squawking, and left the area.

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All Things With Wings: using iNaturalist

By MRBO Co-Director Ethan Duke

iNaturalist: A great, free resource for ID help and documenting all the stuff we love.

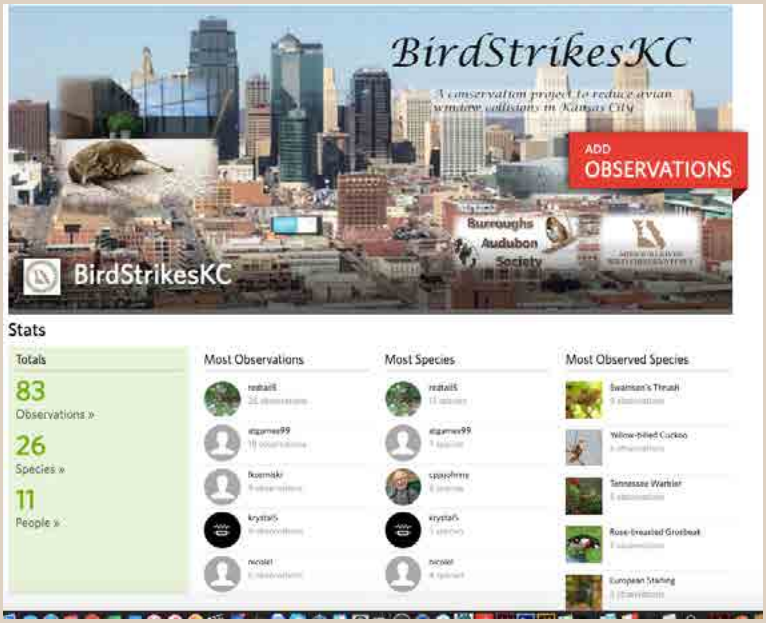
We have a confession to make. We love all critters, not just birds. In fact, Dana and I have a small hobby that we use as a work break, when we are working late on the porch at night… learning about our moths. In addition to our moth field guides (which we clumsily flip through like beginning birders with a Sibley's), we've found the iNaturalist program to be a great resource worth sharing.

This versatile platform can be used on the web and/or via an app. It's a simple process. Find a critter, plant, or fungi. Take the best photo you can and add it as an observation. The superb algorithms in iNaturalist then provide ID suggestions. It was developed by a few graduate students from Berkeley and has taken the world by storm. Here's how the team behind the scenes of the program describe it:
"iNaturalist provides a place to record and organize nature findings, meet other nature enthusiasts, and learn about the natural world. It encourages the participation of a wide variety of nature enthusiasts, including, but not exclusive to, hikers, hunters, birders, beach combers, mushroom foragers, park rangers, ecologists, and fishermen. Through connecting these different perceptions and expertise of the natural world, iNaturalist hopes to create extensive community awareness of local biodiversity and promote further exploration of local environments."

Sound good? Let's take a look…

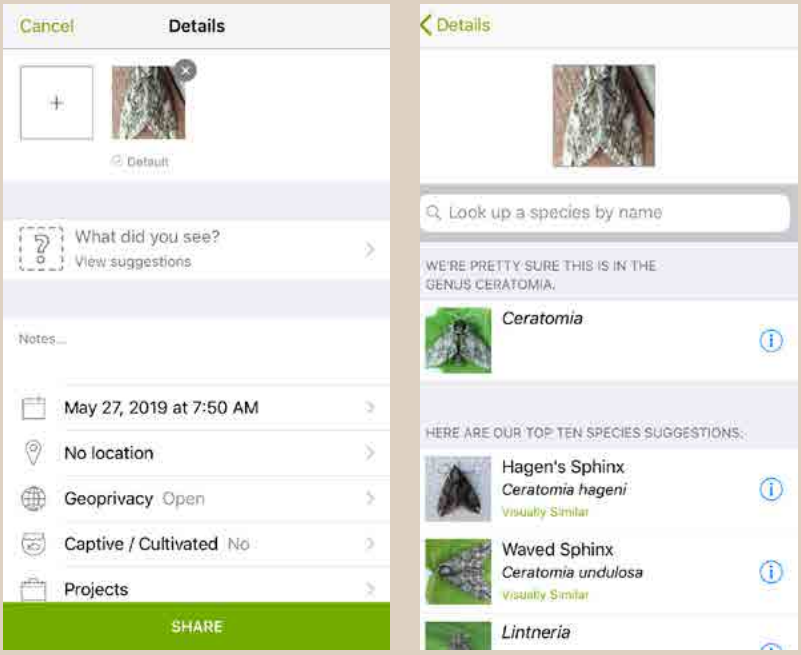
We spotted a little gem on our porch one morning and decided to snap a couple pictures. Later, we opened iNaturalist and added the observation (screenshots to the right), learning quickly that it was a Hagan's Sphinx.

You can see a sample of the other beauties that we have been able to ID, largely thanks to iNaturalist and the support of other users. A great feature of the platform is that other users can help suggest ID and you can help others.

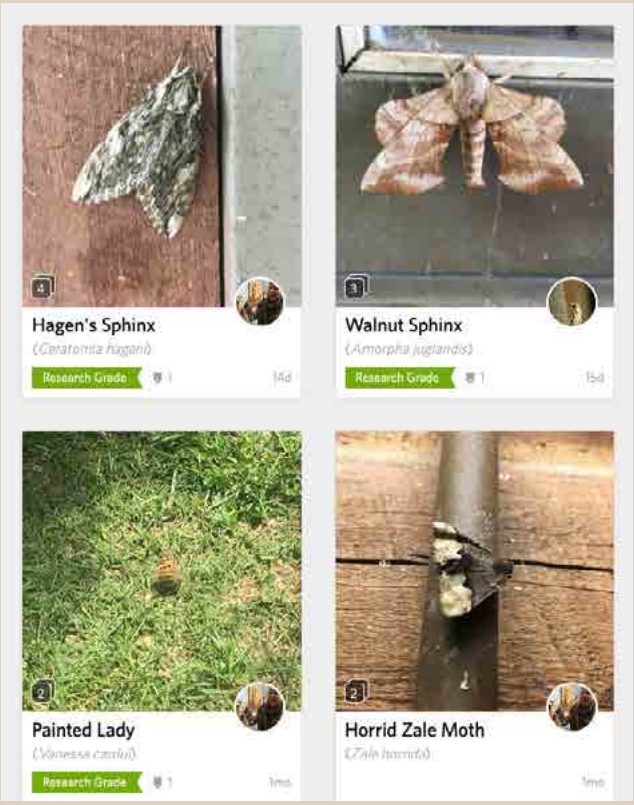


Further, the platform can be customized for specific projects, such as MRBO's #BirdStikesKC project where volunteers are piloting bird window collision project in the Kansas City region (below left). Other uses include Bioblitz events, Atlas projects, and more.

To begin using this great tool and to learn more about all of its amazing functionality visit iNaturalist.org.



Above: Screenshots of the iNaturalist app at work. We added a photo (left), tapped view suggestions and boom! There's a couple suggestions of what that critter is.
Below: A sample of the moths we've been able to ID, thanks to iNaturalist.



Peer Reviewed Article

Light Pollution and Immunosuppression: Determining the Role of Artificial Lighting on the Coccidiosis Infection in Non-Migratory Birds

By Jake Theonen, Camdenton High School student

ABSTRACT

Light pollution is a result of artificial light at night (ALAN), which inhibits many natural cycles of living organisms. Birds and other animals, including humans, are affected through hormonal discrepancies and circadian disruption. However, the effects of light pollution on an animal's immune response to pathogens has not been adequately investigated.

For this study non-migratory birds were chosen to display the impact of light pollution within a certain area--urban, suburban, and rural. Fecal samples were taken from non-migratory bird species in each of the classified areas that were based on sky quality meter readings measured in magnitude/arc second^2. All fecal samples were analyzed for the presence of coccidia, a parasite usually found in avian species. A correlation was then made between the number of coccidiosis-infected individuals and the nocturnal light intensity at each location.

Results demonstrated that non-migratory birds were significantly (p-value < 0.05) more susceptible to contracting coccidiosis when exposed to a greater intensity of light pollution. This may provide a basis for supporting the concept that light pollution causes negative ecological and economic impacts by disrupting natural cycles and instigating immunosuppression. Thus potentially resulting in less product yield and an increase in the need for pharmaceuticals for farmers because the ALAN used at farms throughout the duration of the night may cause infection and inhibition of natural cycles of poultry and other agricultural species. This study may also provide a basis to investigate how humans and other species are immunocompromised by light pollution.

Extent of artificial light at night in the U.S.

INTRODUCTION

Light Pollution

Many people dismiss light as a Pollutant, however, it is very prevalent within the environment. It is instigated by artificial light at night (ALAN), which is mostly found in urban areas. And with an increase in urbanization, light pollution is growing at a rate of 4%-6% annually, according to the International Dark Sky Association. This poses numerous negative ecological impacts ranging from hindered communication, a decrease in reproductive and fertility rates, and ultimately a decrease in the fitness of species as a whole. Light pollution also has numerous negative human health impacts as well. Rods and cones transports information regarding a significant increase in light to retinal neurons, which goes through the suprachiasmatic nucleus to signal the pineal gland to secrete less melatonin. This decrease in melatonin levels disrupts the circadian rhythm, or biological clock, and decreases the amount of cytokines, antibodies, and the immune response of leukocytes which weakens the immune system as a whole. Light pollution is also linked to some diseases and disorders. Doctors Min and Min (2018) observed a correlation between high levels of light pollution and depressive and suicidal behaviors of adults. Spivey (2010) also observed a correlation between ALAN and degenerative diseases that require hormone growth. Although there are numerous studies pertaining to light pollution, Kernbach et al. (2018) stated that there are few studies that investigate the effects of light pollution on the immune system.


Coccidia oocyst as seen under a microscope

Coccidiosis

Coccidia is a single-celled protozoan parasite found within various domesticated and wild animals species including a wide variety of birds resulting in the diagnosis of coccidiosis. Coccidia is ubiquitous in the environment and only presents itself when the immune system of an animal is previously compromised. There are a variety of symptoms including weakness, acute weight loss, dehydration, diarrhea, and even death. The prevention of coccidia is preferred to treatment due to its cost and potential detrimental animal welfare implications. Prevention options include minimizing stress, optimizing nutrition, sanitation of feeding and watering equipment, minimal amounts of overcrowding, and the reduction of feeding on the ground. Keeping coccidia populations in check is of utmost

Ethan Duke recording data on a Northern Cardinal during sampling

importance. Although the disease is widespread, it only impacts immunocompromised individuals making it a perfect candidate for studying immunosuppression. The purpose of this study is to investigate the effects that light pollution has on the immune system of non-migratory birds, discover the effects that photoperiod programs may have on poultry production, and provide a base to investigate how light may induce immunosuppression in humans.

METHODOLOGY

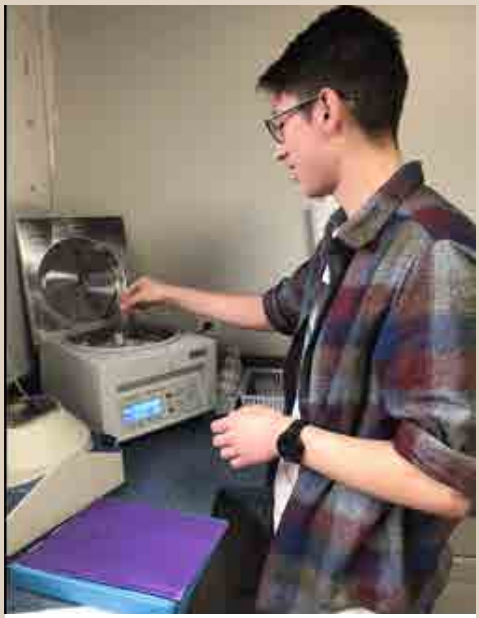
Data Collection and Techniques

The sample species chosen were wild non-migratory bird species due to their innate behavior to remain in one central location, around a ½ mile to a 1-mile radius. This allows for a consistent exposure to light pollution every night, making wild non-migratory bird species a perfect candidate to study how light pollution specifically causes immunosuppression.

Due to the numerous restrictions regarding the handling and capturing of native bird species, licensed bird banders from the Missouri River Bird Observatory were contacted to aid in fecal sample collection. Birds were not specifically netted for this study, but samples were collected during already scheduled mist-nettings by the MRBO. Sampled birds were handled by professional banders, therefore significantly reducing the likelihood of injuring a bird. The birds sampled were captured using a mist net. A mist net consists of fine thread to reduce the risk of harming a bird when caught and has pockets that entrap a bird until it can be removed by a bander. Each individual was then placed into a bag to be transported to a banding station. Each bag was only used once at every banding site, then sterilized after all data was taken to ensure that there was no cross contamination.

Once a bird defecated in a banding bag, a sterile swab was used to swab the feces for 15 seconds and then placed into a micro test tube containing sterile deionized water, as recommended to me by Dr. David Westenburg from the University of Missouri Science and Technology to maintain the coccidia populations within each test tube. All fecal samples were transported to the Lake Ozark Animal Hospital in Linn Creek, MO to be diagnosed for coccidiosis with the supervision of a licensed veterinarian. There were two methods used to determine if a sample had coccidiosis. The first being the direct method in which a portion of a fecal sample was placed directly onto a slide and examined under a microscope for coccidia oocysts. The second method is the float method in which the other part of a fecal sample was placed into a larger test tube filled with a sterile sugar solution then placed into a centrifuge at 1300 rpm for 10 minutes. After a sample was centrifuged, a slide was prepared then examined under the microscope for coccidia oocysts.

Dana Ripper and the author taking a fecal sample from a transport bag.



The author inserting test tubes containing fecal samples into a centrifuge at Lake Ozark Animal Hospital

Sky quality meter (SQM) readings, which quantify the amount of light pollution at each location, were collected using a global information system (GIS) satellite map. Each banding site was pinpointed using latitude and longitude and the subsequent SQM reading was recorded. Based on the SQM readings collected, and for the purpose of this study, the following classifications were given to generalize the representation of the SQM level at each banding site. Urban was considered to be 19 magnitude/arc second^2 and under, suburban was considered to be 19.01 magnitude/arc second^2 to 21 magnitude/arc second^2, and rural was considered to be 21.01 magnitude/arc second^2 and above.

Research Protocol

It should also be noted that there were other extraneous variables that could not be controlled, that could have played a role in the frequency of coccidia. These factors include various types of pollution, muscle scarring, age, access to food, amount of fat, ecto-parasites, quality of habitat, nutrition, stress levels, as well as others. However, there was a significant attempt at controlling these factors. Similar seed and feeders were used at each banding site to address nutrition and food availability. A noise pollution map, created by the U.S. Department of Transportation (USDOT), displayed the amount of noise pollution, in decibels, caused by transportation (includes aviation, railways, highways, roads, interstates,

etc.). Decibel levels were compared using map data and subsequently recorded within a data table. A correlation analysis was conducted between decibel levels and coccidiosis diagnoses and was determined to be insignificant (p-value > 0.05).

With these results, noise pollution could be eliminated from the extraneous factors and was not considered to have an effect on the results. Further, results of fat analysis by MRBO scientists indicated no difference between all three study groups. The lack of fat levels is an expected result given non-migratory birds lack of movement and need to store long-term energy stores. Food sources for non-migratory birds are generally available year round, reducing their need to travel vast distances. Although it is impossible to control all extraneous variables in field studies, a concerted effort was made during this study to exclude as many of these variables as possible.

Statistical Analysis

An alpha level of 0.05 was predetermined to determine significance, then data were analyzed through a point-biserial correlation. Point-biserial correlations differ from other correlation analyses because it analyzes a categorical variable (in this case coccidiosis diagnoses) with a continuous variable (SQM readings) A point-biserial correlation between the light intensity (SQM) and presences of coccidiosis was made to indicate immunosuppression. Additionally, an ANOVA single factor analysis was conducted to determine if there was a difference between coccidiosis diagnoses between groups (urban, suburban, and rural). Values of light pollution recorded as follows: 17.85 magnitude/arc second^2, 18.91 magnitude/arc second^2, 19.4 magnitude/arc second^2, 19.48 magnitude/arc second^2, and 21.74 magnitude/arc second^2.

RESULTS

A total of 45 non-migratory birds were sampled, 5 being diagnosed with coccidiosis. The results demonstrated a significance (p-value < 0.05) with a p-value of -0.0135. The data were then graphically represented through a bar graph with a trend line.

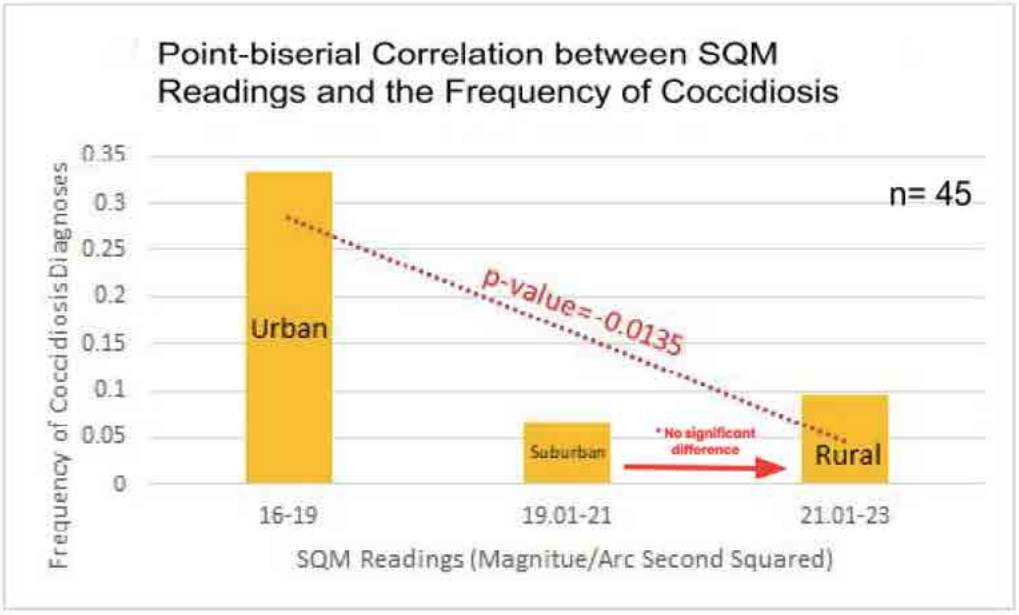
Table 1 | Point-Biserial Correlation between Light Pollution and Coccidiosis Rates

n= 45 p= -0.0135

	SQM Reading	Coccidiosis
SQM Reading	1	
Coccidiosis	-0.0135	1

Point-Biserial Correlation between SQM Readings and the Frequency of Coccidiosis Diagnoses

n= 45 p= -0.0135



CONCLUSION

Analysis of the data indicates that there was a significant (p-value < 0.05) negative correlation between coccidiosis diagnoses and light pollution levels. The correlation supports that when light pollution levels increase, there is a greater chance that a non-migratory bird will be infected with coccidia. Coccidia was chosen because of its ubiquitous nature in multiple species, both wild and domestic. Despite the focus on one pathogen for avian species, it is conceivable that other illnesses may respond to the stress caused by light pollution as well. Is it also possible that this light-induced immunosuppression also affects humans further increasing the need to understand this phenomenon.

Applications of Research

With the continued growth of urbanization it is becoming increasingly difficult for humans to prevent the presence of ALAN. Although humans can reduce or avoid the levels of artificial light, the prevalence of light pollution cannot be completely blocked out. This poses the question: If greater light pollution levels increase the potential of non-migratory birds contracting an infection, could it have the same effect on humans?

Coccidiosis is not the only disease that is prevalent within the agricultural industry; by providing evidence supporting that more individuals become infected with coccidia when there is a greater intensity of light pollution, then other species exposed to ALAN may have the same effect as well. Many animal science industries keep artificial lights on throughout the night. This increased nocturnal light potentially inhibits the circadian rhythm found within each individual, and as evidence supports, adversely affects the immune response of animals, which may result in the reduction of the farmers yield of viable food, and ultimately profit. This suggests that light pollution can cause a significant economic loss. Because of this, it is imperative that those working within the agricultural industry recognize the numerous negative impacts that light pollution, and attempt to limit the amount of ALAN.

Future Studies

Light pollution has been observed to cause numerous negative ecological effects, however, investigating how light pollution affects the immune response of animals, including humans, is understudied. This study aimed at furthering the knowledge of how animal immune systems are potentially compromised by light pollution, as well as encouraging others to research its effects on immune systems. The ultimate goal is to determine what role light pollution plays in compromising the immune response of both wild and domesticated animals as well as humans.

Although the data that were collected was satisfactory, elements of the research could have been changed to provide more efficient results. More samples could have been taken; however, time constraints as well as weather hindered the ability to collect additional data. After investigating the effects of light pollution on the immune response of non-migratory birds, analyzing the effects of ALAN on migratory birds may be of interest. Although migratory birds live in varying amounts of light pollution when migrating, with the increase of light pollution from urbanization there may be a correlation as well. Non-migratory bird immunosuppression through light pollution could be further investigated by conducting research in a laboratory setting, allowing control over factors considered to be extraneous in the natural environment. By researching in a laboratory setting, the results would be considered a cause rather than a correlation, as well as providing even more insight in light pollution immunosuppression. This could result in further testing among other species.

Although there was no significant difference (p-value > 0.05) between coccidiosis infection frequency and nocturnal light intensity, it was observed throughout the duration of this study that species sampled in the rural classification had more individuals infected with coccidia than species sampled within the suburban classification, despite lower light pollution levels. This may indicate that practices common within the agricultural industry, for example the use of pesticides, could have an effect on avian species infection rates. If this is true, this could demonstrate how agricultural practices have negative ecological effects and may provide a basis to address these effects. Furthermore, by showing the potentially significant effects of agriculture on avian species, this could prompt investigation of agricultural practices on humans. Additional research should be conducted to determine the significance of agriculture on animal species.

Poultry farm at night, exhibiting how farms use excessive amounts of artificial light at night (ALAN)

Other groups of animals, specifically agricultural species, could also become immunocompromised by ALAN. Some farms use excessive amount of artificial light throughout the entire night, resulting in an increase in disease infection rates, causing a loss in product yield, an increase for the need of pharmaceuticals to treat pathogens, and ultimately a loss of profit. The economic implications of light pollution would not only affect yield but could cause an increase in prices among agricultural goods, affecting the agricultural industry as a whole as well as consumers. Research on ALAN-related immunosuppression may suggest practical economic applications in addition to the wildlife conservation applications noted here.

The Birds & the Bees

by MRBO Education Coordinator Paige Witek

A long-term goal of MRBO has been to organize a festival that highlighted Missouri's native pollinators, plants, birds and other wildlife, and we believe we accomplished just that with the first annual Birds and Bees Festival. Our first ever festival was a smash! The event took place on May 11th in conjunction with Arrow Rock's Garden Market and Vintage Bazaar and included the entire Main Street of Arrow Rock. The morning started off rainy (while everyone was trying to set up their booths, of course!) but the day began to warm up (slightly) and the sun started to show. Despite the cold and wet weather an estimated 750 people were attended!

There was something for everyone at the Birds and Bees Fest, including vendors, activities, games, guided hikes, seminars and tasty, bird-friendly food from Patchwork Family Farms and The Root Cellar. Other tasty food and drink options included the Fresh On the Go Concessions at the Garden Show, and Badgers Hideaway and J. Houston Tavern located in Arrow Rock. We had so many terrific vendors including Birds-I-View, Ned's Nesting Boxes, Natural Soaps and More, Sow Wild Natives, Sunrise Gardens, Claire's Garden, Prairie Bird Pastures, Jim Rathert Photography, and Birds and Beans Coffee.

There were also many fun and informational games, activities and demonstrations. The Missouri River Bird Observatory staff and Burr Oak Woods Nature Center volunteers demonstrated songbird banding. Veronica Mecko, MRBO's past Project Coordinator, demonstrated hummingbird banding. Raptor Rehabilitation Project from Mizzou brought along two live raptors and many festival-goers got to meet Minnie Pearl, a Great Horned Owl, and Grimm, a Turkey Vulture. This booth worked perfectly next to Dianne Van Dien's booth all about Vultures and how they are our uncelebrated heroes. We also had kids explore what it is like to be a migrating bird with The Great Migration Challenge. Kids were also able to make their own owl masks with Hi-Lonesome Missouri Master Naturalists. The Hi-Lonesome Master Naturalists Booth also featured the wildlife photography of one of their members, Gerald Schlomer. The U.S. Fish and Wildlife Service brought native critters with them including turtles, crawdads and more. There were also a tremendous number of booths that featured education and land conservation information including: Audubon Conservation Ranching, Stream Teams United, Missouri Prairie Foundation and Grow Native!, Missouri Coalition for the Environment, Missouri Department of Conservation, US Fish and Wildlife Service Private Lands, Missouri Young Birders Club, Missouri Bluebird Society, World Migratory Bird Day, Native Bees and Their Homes with Boonslick Master Naturalists, the Hawthorn Chapter of Missouri Native Plant Society, Ozark Prairie Master Gardeners and Local Beekeepers Carter Fawkes and Monte Holder!

Believe it or not, there was even more! We also had Sherry Leonardo and Joseph Mosely of Burroughs Audubon Society and Missouri River Bird Observatory lead a bird-watching hike during which participants got great views of some of Missouri's most beautiful and interesting birds. Chris Edmonson of Knob Noster State Park led a pollinator catch, ID and release at noon and later in the afternoon Nadia Navarette-Tindal of Native Plants and More led a 'Nature of Arrow Rock' tour. Seminars included Landscaping with Natives taught by Paula Diaz with GardeNerd Consultations, Native Edible Plants in Missouri taught by Nadia Navarette-Tindall with Native Plants and More and Attracting Birds to Your Backyard presented by Steve Garr with Birds-I-View.

All of these fantastic people and organizations came together to create an event filled with smiling faces. We would like to thank all of our vendors, guided hike and seminar leaders, organizational booths and volunteers. We would also like to extend a huge thanks to Experience Arrow Rock and Dan Auman whose knowledge helped make things go as smoothly as possible. Friends of Arrow Rock, we would like to thank you for all your support in numerous forms. We would also like to extend our thanks to the Arrow Rock residents who loaned us various items and came out to support the event. We cannot give enough thanks to all of the people that made this event possible. If you weren't able to attend the event this year, keep a look out for next year! Life is better when it includes the birds and the bees.

Photos, clockwise from top left: Ethan shows Jake and Chelsea Davis of Prairie Bird Pastures a White-breasted Nuthatch, Chris Wilson at the Audubon Conservation Ranching booth, Stream Teams United with the Paddle MO exhibit, a young man learning about vulture digestion with Dianne Van Dien, Emma the Great Horned Owl, festival-goers viewing Missouri critters at the USFWS booth, Raptor Rehab Project volunteer Ivan Vining and Grimm the Turkey Vulture, Missouri Coalition for the Environment booth (there is a little girl in a bird costume in that nest!)

Our Thanks to New & Renewing MRBO Supporters

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