

**The 135<sup>th</sup> Meeting of American Ornithology**

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## **Abstract Book**

**The Inaugural Meeting of the American Ornithological Society  
&  
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*Conference Program Cover & Logo – Kirtland's Warbler perched on a Jack Pine Branch - Michigan's iconic bird species and one of North America's conservation success stories.*

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# Oral Presentations



## Meeting abstracts

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Presenting author is the first author listed unless indicated by a diamond ♦.

### **Egg mimicry of one brood parasite host facilitates exploitation of new hosts with similar egg types**

Virginia Abernathy, Australian National University; Jolyon Troschianko, University of Exeter, UK.; Naomi E. Langmore, Australian National University

When brood parasites exploit multiple host species, egg rejection by hosts may select for the evolution of host-specific races, where each race mimics a particular host's egg type. However, some brood parasites that exploit multiple hosts with the ability to reject foreign eggs appear to have only a single egg type. In these cases, it is unclear how the parasite egg escapes detection by its hosts. Three possible explanations are: (i) host-specific races are present, but differences in egg morphology are difficult for the human eye to detect; (ii) the brood parasite evolves a single egg type that is intermediate in appearance between the eggs of its hosts; (iii) or the parasite evolves mimicry of one of its hosts, which subsequently allows it to exploit other species with similar egg morphology. Here we test these possibilities by quantifying parameters of egg appearance of the brood-parasitic Pacific Koel (*Eudynamys orientalis*) and seven of its hosts. Koel eggs laid in the nests of different hosts did not show significant differences in color or pattern, suggesting that koels have not evolved host-specific races. Koel eggs were similar in color, luminance and pattern to the majority of hosts, but were significantly more similar in color and luminance to one of the major hosts than to two other major hosts, supporting hypothesis (iii). Our findings suggest that mimicry of one host can allow a brood parasite to exploit new hosts with similar egg morphologies, which could inhibit the evolution of host defenses in naïve hosts.

### **Securing the future: How to conserve populations of critically endangered endemic passerines in Kaua'i**

Elizabeth Abraham, Kaua'i Forest Bird Recovery Project; Lisa Crampton, Kaua'i Forest Bird Recovery Project; Justin Hite, Kaua'i Forest Bird Recovery Project; Bryce Masuda, San Diego Zoo Institute for Conservation Research; Michelle Clark, U.S Fish and Wildlife; John Vetter, DLNR-DOFAW

Hawaii is one of the extinction capitals of the world, having lost at least half of its native avifauna since colonization by humans, and with all but a few extant species listed as critically endangered. Alarming population trends of two endangered endemic honeycreepers on Kaua'i, 'Akikiki (*Oreomystis bairdi*) and 'Akeke'e (*Loxops caeruleirostris*), have necessitated immediate action. Largely restricted to the forests of the high elevation Alakai Plateau (>1000 m) these species face numerous threats: hurricanes; non-native, invasive plants and animals, and deadly introduced diseases. Bird density surveys carried in 2012 found only 468 'Akikiki (95% CI: 231-916) and 945 Akeke'e (95%CI: 460-1,547) individuals, down 71% and 48% respectively since 1981, with steeper declines and range contractions since 2000. In 2013, experts deemed the creation of conservation breeding populations, along with in situ threat management, necessary to safeguard against the imminent extinction of these species. In 2015, egg collections began and collections continued in 2016 and 2017 with a goal of 60 founders per species. To date, we have collected 45 'Akikiki eggs from 29 nests and 10 'Akeke'e eggs from four nests. In addition, 150 GoodNature

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rat traps were deployed in 2015, with an additional 150 traps added in 2016 in order to extend our rat control along streams and ridges that are crucial nesting habitat for native birds. We have also recently partnered with the Kaua'i Watershed Alliance to document the effects of removing non-native feral pigs on native birds within a newly fenced area of the Alaka'i.

## **Nonbreeding abundance of Great Lakes waterbirds: integrating aerial survey data across multiple protocols**

Evan Adams, Biodiversity Research Institute; Beth Gardner, University of Washington; Kevin Kenow, United States Geological Survey; David Luukkonen, Michigan Department of Natural Resources; Michael Monfils, Michigan State University; Bill Mueller, Western Great Lakes Bird and Bat Observatory; Kathryn Williams, Biodiversity Research Institute

The Great Lakes comprise the largest surface freshwater system in the world with habitats supporting a diversity of nearshore and pelagic birds. Making large-scale inference about bird distribution and abundance over large regions like the Great Lakes often requires integration of data from multiple sources and addressing biases associated with these sources (e.g., survey type, observation conditions, etc.). Here, we integrate data collected during aerial surveys by 5 different organizations from 2012-14 to estimate the abundance of 8 species of nonbreeding waterbirds in 4 of the Great Lakes. Most, but not all, surveys employed distance sampling techniques to estimate detection probabilities, and each distance protocol collected data differently. To integrate these different data sources, we developed a flexible hierarchical distance sampling model that allowed each survey to have different detection models and estimate detection probability for surveys without distance data. We modeled the abundance of waterbirds in relation to static features like bathymetry and lake sediment while accounting for variation in latitude and ice coverage across the lakes. We found that both latitude and ice coverage were important predictors of the probability of a species being present in a location, and bathymetry and lake sediment type were important determinants of waterbird abundance. We tested model fit for each species and found good fit overall, but a few protocols occasionally saw poor performance. This study describes a formal method for integrating multiple data sources to improve estimation of abundance and make large-scale inferences about nonbreeding waterbirds across the Great Lakes.

## **Using pedigrees and genomics to understand the consequences of limited dispersal**

Stephanie Aguillon, Cornell University; John W. Fitzpatrick, Cornell Lab of Ornithology; Reed Bowman, Archbold Biological Station; Stephan J. Schoech, University of Memphis; Andrew G. Clark, Cornell University; Graham Coop, University of California, Davis; Nancy Chen, University of California, Davis

There is strong theoretical support for the expectation that geographically limited dispersal will result in a correlation between genetic and geographic distance, commonly called isolation-by-distance. Despite its prevalence, to date no study has empirically demonstrated the processes generating isolation-by-distance within a pedigreed and genotyped population. Intensive, long-term demographic studies and exhaustive genomic surveys in the Florida Scrub-Jay (*Aphelocoma coerulescens*) provide an excellent opportunity to investigate the influence of dispersal on genetic structure. Here, we used a panel of genome-wide SNPs and extensive pedigree information to explore the role of limited dispersal in shaping patterns of isolation-by-distance. We found fine-scale isolation-by-distance (within ~10 km) in both sexes using genetic and pedigree-based measures of relatedness. Isolation-by-distance patterns were stronger in males than in females, consistent with known differences in dispersal

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propensity between the sexes. Using a simulation of dispersal events across the pedigree, we estimated the expected geographic distances between breeding individuals of different pedigree relationship classes. We found that most simulations did not differ from the observed distribution of geographic distances between breeding individuals of different pedigree relationship classes. Furthermore, we can reconstruct observed isolation-by-distance patterns in autosomal and Z-linked SNPs using simulations parameterized by the observed dispersal curve and immigration rate. Overall, even within a continuous breeding population, the sedentary nature of the Florida Scrub-Jay produces genetic structure at an extremely small spatial scale that can be reconstructed with just natal dispersal distances and pedigree information.

## **Evaluating biodiversity of sagebrush-dependent species within sage-grouse habitat: an example from the Wyoming Basins**

Cameron Aldridge, Colorado State University and USGS; Joanne Saher, Natural Resource Ecology Laboratory and US Geological Survey; Steven Hanser, U.S. Geological Survey; Julie Heinrichs, Natural Resource Ecology Laboratory and U.S. Geological Survey; Adrian Monroe, Natural Resource Ecology Laboratory and U.S. Geological Survey; Matthias Leu, College of William and Mary

Sagebrush (*Artemisia* spp.) steppe ecosystems have experienced drastic changes resulting in loss, fragmentation, and degradation of remaining habitat. As a result, sagebrush-dependent fauna have experienced population declines. Threats to list the Greater Sage-grouse (*Centrocercus urophasianus*) under the Endangered Species Act have resulted in west-wide conservation efforts to protect sage-grouse habitats, actions presumed to also benefit other sagebrush fauna. To evaluate the effectiveness of using Sage-grouse to conserve biodiversity of sagebrush-dependent species, we first developed and compared data-driven spatial occupancy and abundance models for seven sagebrush obligate/associated species across the greater Wyoming Basins Ecoregional Assessment (WBEA) area (345,300 km<sup>2</sup>). Our models predicted 63,784 km<sup>2</sup> of optimal Sage-grouse habitat. Protection of these areas for conservation may provide added benefits for some species, such as Sage-Thrashers (*Oreoscoptes montanus*), where 73% of predicted breeding habitat was captured across the range of Sage-grouse in the WBEA. However, Brewer's Sparrows (*Spizella breweri*) may not be as well protected by the Sage-grouse umbrella, with only 39% of predicted breeding habitat captured across the range of Sage-grouse within the WBEA. Mapping biodiversity hotspots using models of four songbirds (Brewer's Sparrow, Sage Thrasher, Sagebrush Sparrow (*Artemisiospiza nevadensis*), Green-tailed Towhee (*Pipilo chlorurus*)), pronghorn (*Antilocarpa Americana*), and greater short-horned lizard (*Phrynosoma hernandesi*), Sage-grouse habitat will capture an estimated 40-60% of biodiverse areas containing  $\geq 4$  (of 6) species of conservation concern. If Sage-grouse are to be an effective umbrella for sagebrush ecosystems, biodiversity of other sagebrush species should be considered in conservation efforts.

## **How does recreational disturbance affect activity budgets of staging terns in Cape Cod, Massachusetts?**

Melissa Althouse, SUNY College of Environmental Science and Forestry; Jonathan B. Cohen, SUNY College of Environmental Science and Forestry; Sarah M. Karpanty, Virginia Tech; Jeffrey A. Spendelow, USGS Patuxent Wildlife Research Center; Kayla L. Davis, Virginia Tech, Katharine C. Parsons, Massachusetts Audubon; Cristin F. Luttazi, Massachusetts Audubon

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Anthropogenic disturbance can disrupt the normal behavior of wildlife, potentially leading to fitness consequences. The staging period is an important portion of the annual cycle where migratory birds must accumulate energy resources for migration. We quantified time-activity budgets of staging Roseate and Common Terns among sites with varying levels of human disturbance. We performed a hierarchical clustering analysis in order to group sites by the average number of minutes pedestrians spent within a study area, with a second clustering analysis to group sites by the proportion of time flocks spent flying. We compared the degree of agreement between the two methods with a Pearson Chi-squared test for independence. We then analyzed activity budgets by disturbance level (as designated by our clustering analyses), time of the staging season (before and after Labor Day), and for an interaction between these two factors, with 0,1 inflated beta regression. Staging flocks spent most of their time in low-energy states. Median proportion of the flock in flight during 2-hr observations was lowest for the four site × time period combinations where human activity was low. Proportion of the flock in flight was higher after the peak tourist season than before, possibly due to pre-migratory restlessness. We found that mixed-species staging tern flocks apportion behaviors differentially among sites, and that there is a potential link with even relatively low rates of anthropogenic disturbance. Our method suggests that disturbance rates leading to a shift in activity budgets can be identified and thus targeted for management.

## **Nonnative grasses decouple habitat selection from fitness in grassland birds**

Erik Andersen, University of Arizona; Robert J. Steidl, University of Arizona

Nonnative plants that are structurally similar to native species may present misleading cues to animals indicating the availability of resources that are no longer abundant in invaded areas. Migratory birds that breed in arid grasslands may be especially susceptible to this disassociation between evolutionarily-honed cues and future resources because they establish breeding sites in spring, but delay nesting until summer when monsoon rains trigger increases in abundance of the insect prey that they need to provision nestlings. We established 140 plots across a gradient of invasion by nonnative grasses in southeastern Arizona, where we studied density and nesting success of grassland birds along the invasion gradient. For the two most common bird species, density and nest success were not associated positively. Specifically, as dominance of nonnative grasses increased, density of Grasshopper Sparrows (*Ammodramus savannarum*) decreased by 75% and daily nest survival increased by 19% across the invasion gradient. This suggests that individuals avoid invaded areas that enhance reproductive success. Conversely, as dominance of nonnative grasses increased, density of Botteri's Sparrows (*Peucaea botterii*) increased by 33% and daily nest survival decreased by 4% across the invasion gradient. This suggests that invaded areas might function as ecological traps attracting individuals from areas of high-quality habitat into areas where reproductive success is lower. By decoupling settlement cues from the resources associated with those cues over evolutionary time, nonnative plants can alter substantially the distribution and demography of grassland birds.

## **Lack of seasonal variation in habitat may have facilitated the loss of a song in the boreal chickadee**

Chad Apol, Calvin College; Christopher B. Sturdy, University of Alberta; Darren S. Proppe, Calvin College

Many songbird species have evolved multiple vocalizations, or repertoires, that function to communicate various biological signals. More diverse repertoires may have evolved to accommodate the effects of seasonal variation in habitat structure on signal transmission. Such changes in habitat necessarily occur for migrating species, but they also occur for resident species that occupy deciduous forests. The North American chickadees (Genus *Poecile*) provide an excellent opportunity to test the effects of seasonal changes on vocal repertoire because all species

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possess some form of the chick-a-dee call, but only a subset also possess a distinct breeding song. Consistent with the habitat variability hypothesis, species with songs primarily occupy deciduous forests, whereas those without occur more often in coniferous forests. We explored the mechanistic basis of this hypothesis by recording audio playbacks of two species in two habitat types and two seasons. Specifically, we played both songs and calls of the Black-capped Chickadee (*P. atricapillus*) and calls of the songless Boreal Chickadee (*P. borealis*) in deciduous and coniferous habitats, prior to and after leaf out. We measured attenuation and degradation in re-recorded vocalizations. For Black-capped Chickadees, the song maintained higher integrity and transmission than the call in the post-leaf, deciduous forest. The Boreal Chickadee call generally attenuated more quickly, but maintained its acoustic structure better than both Black-capped Chickadee vocalizations. Our results provide support for the hypothesis that habitat consistency among seasons may have facilitated song loss in some chickadee species and may contribute more generally to inter-specific variation in avian repertoires.

## **Individual variation in reproduction and the fast-slow life history continuum in a short-lived bird**

Peter Arcese, University of British Columbia; Corey E. Tarwater, University of Wyoming

Theory predicts that reproductive tactics will change as individuals near the end of their lives by increasing (terminal allocation hypothesis) or decreasing reproductive allocation (senescence hypothesis). But in populations comprised of individuals expressing both fast (short-lived) and slow (long-lived) phenotypes, we might expect age and years to death to interact. We use a 37-year study of Song Sparrows (*Melospiza melodia*) to show both senescence and terminal allocation, and an interaction between age and years to death. Allocation declined in older birds (senescence), but only among birds with the same number of years to death. We also observed terminal allocation, but only in young females. Reproductive tactics varied greatly in young females; many exerted high effort but lived  $\leq 2$  years whereas others exerting low effort annually lived much longer. These patterns suggest that both short- and long-lived reproductive phenotypes occur in some Song Sparrow populations.

## **Influence of early social complexity on sibling networks and later cognitive development in a wild parrot population.**

Caleb Arellano, University of Texas-Rio Grande Valley; Astolfo Mata-Betancourt, Instituto Venezolano de Investigaciones Científicas; Karl Berg, University of Texas-Rio Grande Valley

Social complexity often correlates with increased brain size and cognition. The Social Intelligence Hypothesis (SIH) proposes that navigation of complex social networks increases demand for neural processing in order to monitor shifting alliances, thereby making increases in brain size selectively advantageous. SIH traditionally focused on an evolutionary explanation of brain size variation in adults. Developmental frameworks fostering increased sociality are less known, despite the ubiquity of social play networks in juveniles. We studied the ontogeny of early sibling interactions in a marked population of wild Green-rumped Parrotlets (*Forpus passerinus*) in Venezuela. Parrotlets offer a unique opportunity to test for sibling influences on early social development because they exhibit large variation in brood size, engage in elaborate social interactions and complex social learning during nestling development. Between 2011-2016, over 5000 hours of hi-definition audio-video recordings were made in 55 randomly-selected successful breeding attempts. To test if nests of varying brood sizes exhibit differences in social complexity, we quantified the number and strength of sibling play partnerships, as a proxy for social bonds, and

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constructed social networks in broods of 4, 6, and 8 nestlings. Preliminary results show that indices of social connectedness increase with sibling age hierarchies but not brood size. In a small number of nests, we manipulated brood sizes by adding or subtracting eggs prior to hatching, to provide a causal explanation for the above patterns. Brood size manipulations will examine effects of social complexity on variation in the onset of a milestone in early cognitive development.

## **Modeling avian vitellogenesis: Linking sublethal effects of $17\beta$ -trenbolone to adverse reproductive outcomes in Japanese quail**

Brandon Armstrong, Michigan State University; Krittika Mittal, McGill University; Niladri Basu, McGill University; Paula F.P. Henry, U.S. Geological Survey; Natalie K. Karouna-Renier, U.S. Geological Survey; Jessica Head, McGill University; Kelsey Born, Michigan State University; Cheryl A. Murphy, Michigan State University

There have been recent initiatives to model the physiological processes involved with egg production and growth in numerous taxa, but to date, there are no such avian models. These models have great utility for determining how perturbations to physiological systems could enhance or inhibit reproduction or growth. Environmental contaminants can cause adverse reproductive effects in vertebrates through the disruption of the hypothalamic-pituitary-gonadal-liver (HPGL) axis including vitellogenin production, a precursor egg yolk protein. Trenbolone-acetate is a synthetic anabolic steroid used as a livestock growth promoter and its metabolite,  $17\beta$ -trenbolone, has been shown to disrupt key physiological processes related to the endocrine system and reduce egg production in birds. In order to parameterize a computational avian vitellogenesis model, we investigated the effects of an eleven-week exposure to  $17\beta$ -Trenbolone on adult female Japanese quail (*Coturnix japonica*). Egg production was measured daily and hormones along the HPGL axis were quantified following exposure. Additionally, we experimented with a double-dye technique to quantify daily egg yolk production using fat soluble dyes which are ingested maternally and transported to the developing egg. Early results indicate that exposure to  $17\beta$ -trenbolone reduced vitellogenin, yolk and egg production. This work aims to establish the first avian vitellogenesis model which will provide researchers a tool to estimate the number of eggs produced by an individual bird and help estimate the adverse effects of contaminant exposure on avian reproduction.

## **Striking convergent phenotype evolution in an African Canary (Oriole Finch) and a Caribbean Siskin (Antillean Siskin)**

Antonio Arnaiz-Villena, University Complutense; Ester Muñiz; Jose Palacio-Gruber; Cristina Campos; Beatriz Tejedor; Manuel Martin-Villa; Valentin Ruiz-del-Valle, University Complutense

Canaries (genus *Serinus*) and goldfinches/siskins (genus *Carduelis*) are genera which include several evolutive radiations, as tested by Bayesian and Maximum Likelihood phylogenetic analyses of the respective species molecules. The oldest radiations started about 9 million years ago in these genera during the Miocene Epoch. Both *Linurgus olivaceus* (Oriole Finch, Equatorial Africa) and *Carduelis dominicensis* (Antillean Siskin, Hispaniola Island mountains) show a striking plumage and color distribution similarity. Even in close photographs males are difficult to distinguish from each other; *C. dominicensis* shows a slight lighter body built than *L. olivaceus*. Both are thriving in a tropical habitat and it was difficult to believe that they had not relatedness. South American tectonic plate was an island between about 60 and 3 million years ago coming from Africa. The existence of a common ancestor for both birds was thus unlikely; however, as species time of divergence calculations are not universally accepted, we studied both finch evolutive radiations at molecular level in order to accept or discard genetic relatedness. mtDNA



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was used to study the African Canaries radiation (including *Linurgus*) and the *Carduelis pinus* North American radiation, which includes Antillean Siskin. Bayesian Inference and Maximum Likelihood dendrograms showed no genetic relationship between these American and African finch species. Oriole Finch is an ancient canary and Antillean Siskin is a more recent bird which has become isolated in La Hispaniola Island mountains. The observed changes to a black head and darker plumage in both finches compared with their respective extant parental species are discussed. Bacterial resistance of darker plumage in humid climates is a crucial environmental common evolutive pressure; dark head advantage against predators in dense woods is also important as a defense. Finally, analogies and shared ancestral homologies are discussed and defined in these two species.

## **Proactive siting of a planned wind turbine installation in response to an eagle occurrence spatial model**

Eric C. Atkinson, Marmot's Edge Conservation & Northwest College; Patrick D. O'Meara, Wind Quarry, LLC; John O'Meara, Wind Quarry, LLC

As wind power installations are deployed in North America, concerns are often raised regarding impacts to both Golden Eagles (*Aquila chrysaetos*) and Bald Eagles (*Haliaeetus leucocephalus*). During the preconstruction phase of a potential wind power development in western South Dakota, we developed a 'heat map' showing potential collision risk to eagles. To guide initial placement of turbines, we modeled eagle occurrence by incorporating inputs into a spatially explicit model: 1) documented eagle (both Bald Eagle and Golden Eagle) nest locations, 2) eagle abundance estimates from 153 60-min raptor point counts (yearround over 4 years), 3) eagle distribution and abundance from incidental and transect observations, and 4) black-tailed prairie dog (*Cynomys ludovicianus*) colonies, an important eagle prey. We buffered each eagle nest by 6440 m (4 miles), capturing all but one of 20 inter-nest distances (mean = 2603.9 + 455.9 m). An eagle suitability index was modeled as: Suitability to eagles = black-tailed prairie dog colony + 6440 m (4 miles) within eagle nests + IDW (inverse distance weighted smoothing on 12 nearest neighbors) of eagle abundances generated from raptor point counts + IDW smoothing on all eagle observations gathered from 2011-2014. An inverse of this model produced areas most suitable for wind turbine placement with respect to avoiding areas used by eagles. Following this model, wind power facility developers voluntarily and proactively moved planned locations of turbines, as well as the project footprint, to reduce impacts to these species.

## **Estimating avian abundance with eBird and exploring cross-scale full annual cycles with BirdVis**

Tom Auer, Cornell Lab of Ornithology; Daniel Fink, Cornell Lab of Ornithology; Wesley M. Hochachka, Cornell Lab of Ornithology; Steve Kelling, Cornell Lab of Ornithology

Understanding how to protect and conserve broadly distributed bird species requires analysis and communication of information about species' occurrences, abundances, and habitat use across their ranges and throughout the year. Citizen science projects are beginning to collect data across sufficiently broad extents and with the necessary resolution to inform full life cycle analyses; however, there are challenges to using these data. Because of the heterogeneity in how participants search for birds, it is important to control for sources of bias and uncertainty, such as variation in detection rates or sampling coverage of available habitats, during data analysis. In this presentation, we will describe the analysis of data from the citizen science project eBird, to provide full annual cycle information at regional scales across species' ranges. A multi-scaled approach based on an ensemble of

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spatially and temporally local adaptive regression models is used to discover and quantify spatiotemporal patterns while controlling for important sources of bias. Using BirdVis, a new interactive visualization tool, we will demonstrate how the results of this ensemble model can be explored and used to study patterns of relative abundance and land cover associations across spatial scales and throughout the full annual cycle. This novel method for interactive exploration of modeled information will be especially useful for enabling better understanding of the patterns of species' movements and habitat use throughout the year, and to plan and coordinate regional-scale conservation actions across continental extents.

## **Using robots to conduct behavioral research: a case study of species recognition in prairie-chickens**

Jacqueline Augustine, The Ohio State University at Lima

Behavioral research is often conducted by observing natural behaviors in the field. However, numerous confounding factors may influence quality of the data obtained, such as the previous interactions between the research subjects or interruptions by non-focal individuals. To control some of these variables, ornithologists have used vocal playback and model presentation experiments with great success. Technological advances are giving behavioral researchers another tool: remotely-controlled robots. The benefits of remotely-controlled robots is that the model has the ability to respond to the focal bird and may elicit more realistic behaviors. I used robotic female Greater and Lesser Prairie-Chickens (*Tympanuchus cupido* and *T. pallidicinctus*, respectively) to study mate choice recognition in a hybrid zone. If male display behavior is costly, and males are able to correctly differentiate between conspecific and heterospecific females, then males should display more intensely to conspecific females. Robotic females of each species were presented to males using the same path, and stayed on each focal male's territory for 5 min. The presentation of the robotic females was video-taped using a Sony HDR-CX160 video camera with 30x optical zoom. Proximity to the robot, time spent displaying and fighting, and intensity of display and aggression were recorded. Results suggest that male Greater Prairie-Chickens display more intensely to models than Lesser Prairie-Chickens irrespective of the species identity of the female. This study demonstrates the value of robotic models in conducting behavioral research, but I will also outline the challenges to constructing and properly using robots.

## **Using radio frequency identification (RFID) technology to investigate gap crossing decisions in Black-Capped Chickadees**

Jacob Bailey, University of Northern British Columbia; Dr. Ken Otter, University of Northern BC; Dr. Matthew Reudink, Thompson Rivers University; Dr. Mark Paetkau, Thompson Rivers University; Dr. Steffi LaZerte, Thompson Rivers University

Increasing development and deforestation are causing habitat fragmentation worldwide. The result is a matrix of forest patches separated by deforested gaps that must be navigated by forest songbirds. Our work used a novel approach (radio-frequency identification - RFID) to assess the permeability of habitat gaps, and to investigate the factors influencing avian gap crossing decisions. Using bird feeders outfitted with RFID readers, we tracked the movement patterns of 137 wintering black-capped chickadees banded with passive integrated transponder (PIT) tags. Over the past two winters we placed RFID feeders in square grids centered on habitat gaps (two feeders on each side of the gap) at fifteen sites in central BC, Canada. While all four feeders in a grid were equidistant from one another, movement between feeders within the same forest patch did not require gap crossing, while movement between feeders on opposite sides of the gap did require gap crossing. We collated feeder visits using an R package

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(feedr) specifically developed for analyzing animal movement data to determine how habitat gaps influence bird movement patterns. Bird movements between feeders on opposite sides of gaps were significantly reduced compared to feeders on the same sides of gaps despite distances between feeders being equivalent. Additionally, larger gaps caused a greater impediment to movement than did smaller gaps. Gaining a better understanding of the behavioral decisions made by songbirds and what factors influence their gap-crossing decisions will allow for better management that minimizes the negative effects of habitat fragmentation.

## **Behavioral and genetic consequences of domestication in the Zebra Finch**

Chris Balakrishnan, East Carolina University; Allison Lansverk, East Carolina University; David Clayton, Queen Mary University of London; Sarah London, University of Chicago; Simon Griffith, Macquarie University

Zebra Finches have been the subject of extensive neurobiological and behavioral research. The majority of research conducted on these birds relies on domesticated populations but little is known about patterns of behavioral or genomic divergence between domesticated and wild populations. Domestication is known to influence aspects of social behavior, so an understanding of both behavioral and genomic variation in Zebra Finch populations is critical to the advancement of the Zebra Finch as a model system for studying gene-behavior relationships. In order to derive a complete picture of genetic variation, we resequenced full genomes at medium coverage ( $\sim 8x$ ) in a sample of 20 domesticated and 19 wild Zebra Finches. We detected over 11 million polymorphisms and find that populations show an overall low level of overall genetic differentiation ( $F_{st} = 0.04$ ). Site-specific  $F_{st}$ , however, ranged up to 0.92, indicating regions of high differentiation potentially influenced by selective breeding. As might be expected, the two populations differ significantly in diversity (theta: wild = 14.9, theta domesticated = 10.4,  $p < 0.01$ ). Average Tajima's  $D$  also differed significantly between populations (domesticated = -0.75, wild = -1.51) and indicates a loss of rare alleles in domesticated birds. In addition to genetic differences, we also find population differences in vocal behavior. In this case, however, songs from domesticated birds are more variable than wild-derived birds perhaps indicating the consequences of genetic drift acting on sensory or motor components of song learning behavior.

## **Do parents listen to their children? Begging does not go unanswered in European Starlings (*Sturnus vulgaris*)**

Colleen A. Barber, Saint Mary's University; Hannah B. Corney, Saint Mary's University

Begging by nestling passerines is an important way to communicate their state of hunger to parents. We examined whether experimentally increased nestling begging can quickly alter parental provisioning rates in European Starlings (*Sturnus vulgaris*). We predicted that an increase in begging heard by parents during the experimental treatment would result in a significantly higher number of provisioning visits compared to the control of natural begging levels (matched pairs design). Total number of parental provisioning visits during control and experimental periods were compared for 20 broods. Begging calls of each brood were recorded when nestlings were 13 days old, and the loudest calls from each brood were made into a three-minute loop. On day 14, the total number of parental provisioning trips was first determined over a one-hour control watch, and then over a one-hour experimental watch when the begging audio loop playback was continuously projected. As predicted, parents provisioned at a significantly higher rate during the experimental treatment than the control. This finding shows

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that European starlings are very sensitive to begging calls made by their offspring, and respond quickly to any changes in their begging.

## **Personality types in the polymorphic White-throated Sparrow (*Zonotrichia albicollis*)**

Margarida Barcelo, Serra Indiana State University; Rusty A. Gonser, Indiana State University; Elaina M. Tuttle, Indiana State University

White-throated Sparrows (*Zonotrichia albicollis*) are a polymorphic species exhibiting two morphologies (tan and white) that differ in plumage coloration, behavior, physiology and genetics. Morph is determined by the presence of alternate supergene alleles located on a rearrangement of chromosome two. Tan birds are homozygous for the ZAL2 supergene allele (i.e. ZAL2/ZAL2), whereas white birds are heterozygous for both supergene alleles (i.e. ZAL2m/ZAL2). During the breeding season, white birds are found to be more aggressive and sing at higher rates than tan birds. Our research during the winter has demonstrated differences between morphs in response towards a novel object, with white birds being more neophobic (less bold) than tan birds. These findings do not follow the lines of animal personality; less bold individuals should also be less aggressive across seasons. In this study, we used a breeding population of White-throated Sparrows to examine personality differences between morphs. We assessed aggression towards conspecifics, boldness towards a novel object, and boldness towards a predator. We did not find differences between morphs in aggression, boldness, or response to novel objects during the breeding season. Our results indicate that the behavioral polymorphism between morphs needs to be further examined taking into consideration the effect of the social environment and habitat type. Examining behavioral differences between and within genetic morphs of the white-throated sparrow across seasons can expand our understanding of the roles of environment and genetics on shaping animal behavior.

## **If you build it, who will come? Assessing use of created snags by cavity-nesting birds across 25 years.**

Amy Barry, Oregon State University; James Rivers, Oregon State University; Joan Hagar, United States Geological Survey

Snags provide critical habitat for wildlife worldwide, yet snag availability has declined in many areas due to forest management practices. Resource managers often mitigate snag loss by intentional snag creation, but long-term data (>20 years) regarding wildlife use of created snags is scarce. In this study, we measured characteristics and avian use of created Douglas-fir (*Pseudotsuga menziesii*) snags across a 25-y period, and assessed whether these measurements were influenced by harvest treatment (i.e., group selection, two-story, and clearcut) and snag configuration (i.e., scattered and clustered). Our preliminary results indicated that 91% of created snags remained standing, 65% remained unbroken, and snag characteristics differed among harvest treatments when measured during our study (2016). Despite extensive observations across two years (>750 h), we found that only 11% of snags were used for nesting by 4 species of cavity-nesting birds (n=36 nests). Similarly, use of created snags for foraging was limited, with only 1 foraging detection for every 20 h of observation. Concurrent surveys revealed additional cavity-nesting bird species were common in our study area, suggesting that created snags provide limited nesting and foraging substrates after 25 years of decay. This hypothesis was supported by our finding that use of snags has decreased notably relative to past surveys conducted on the same snags. Our results suggest that although older created snags are important structures that contribute to many ecosystem services, they provided limited nesting and foraging opportunities for most species of cavity-nesting birds after 25 y.

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## **Bird collisions at glass bus shelters in an urban landscape: magnitude and correlates**

Christine Barton, Oklahoma State University; Corey Riding, Oklahoma State University; Scott Loss, Oklahoma State University

Wildlife residing in urban landscapes face many human-related threats to their survival. For birds, collision with glass on manmade structures has been identified as a major hazard, causing hundreds of millions of avian fatalities in North America every year. Although factors associated with bird-glass collision mortality have been investigated at buildings, no prior studies have focused on bird fatalities at glass-walled bus shelters. Our objectives were to assess the magnitude of bird-bus shelter collisions and evaluate potential predictors of collision risk, including characteristics of shelters (glass area) and surrounding land cover characteristics (e.g., vegetative features). We surveyed for bird carcasses and indirect collision evidence at 18 bus shelters in Stillwater, Oklahoma over a five-month period. Linear regression and model selection results revealed that the amount of glass on shelters and the area of lawn within 50 m of shelters were both positively related to fatal bird collisions; glass area was also positively associated with observations of collision evidence on glass surfaces. After accounting for scavenger removal of carcasses, we estimate that 34.3 birds are killed between May and September by collision with the 36 bus shelters in the city of Stillwater. Our results suggest that total North American bird mortality from collisions with bus shelters is likely substantial. Designing new bus shelters to include less glass and retrofitting existing shelters to increase visibility of glass to birds will likely reduce fatal bird collisions and thus reduce the cumulative magnitude of anthropogenic impacts to birds in cities.

## **The underdogs are winning: drivers of elevational distribution in Himalayan titmice**

Sahas Barve, Old Dominion University; Rekha Warriar, Colorado State University; André A. Dhondt, Cornell University.

Elevational species replacement is a widely documented pattern in montane species. Although interspecific competition has been shown to be important in setting species elevational limits in tropical habitats, its influence on species of temperate regions is poorly studied. We tested the role of interspecific competition in driving the distribution of a pair of resident of Himalayan titmice taxa. We found that high elevation Green-backed Tits (*Parus monticolus*) are behaviorally dominant over low elevation Cinereous Tits (*Parus cinereus*) in both song playback (competition over space) and feeder trials (competition over food). We then conducted an occupancy survey and conditional occupancy analyses to test if spatial distribution of the two species is predicted by the known dominance relationships between them. Despite being subordinate, at their elevational upper limit, Cinereous Tits occur in sympatry with Green-backed Tits in, but are restricted to human modified habitats. The dominant Green-backed Tits on the other hand prefer to breed away from human-modified habitats. Our study thus suggests that the loss of natural habitats in the sympatric zone, not interspecific competition, might be limiting the distribution of the high-elevation Green-backed Tits and facilitating an upward range shift through human association in Cinereous Tits.

## **Uncovering the effects of climate change on U.S. bird species with Audubon's Climate Watch program**

Brooke Bateman, National Audubon Society; Nicole Michel, National Audubon Society; Kathy Dale, National Audubon Society; Zach Slavin, National Audubon Society; Geoff LeBaron, National Audubon Society; John Rowden,

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National Audubon Society; Chad Wilsey, National Audubon Society; Lotem Taylor, National Audubon Society; Gary Langham, National Audubon Society

Species are facing an unprecedented rate of climate change, with over half of North American bird species at risk to lose 50% or more of their current climatic range by the end of the century. In an uncertain future, we must be able to both forecast and monitor how species are responding to climate change. To track climate effects throughout species' ranges requires a landscape-scale coordinated and structured effort. Audubon's Climate Watch program integrates climate projections with community scientists' local knowledge to track how birds are responding to climate change. Skilled volunteers from across the U.S. collaborate with Audubon scientists by testing the predictions of target species' mid-2020s climate model projections through on-the-ground monitoring of bluebirds and nuthatches. Structured surveys, conducted both in winter and summer, are designed to measure both presence and detectability. We analyzed the relationship between climate suitability and the occupancy probability of each bluebird and nuthatch species. By monitoring bird responses to climate change as it is happening, we can directly test hypotheses about bird climate change responses. With two years of data collected, occupancy models suggest that bluebirds and nuthatches are already responding to contemporary climate change. In some species, there is a positive relationship with change in climate suitability, indicating that these species are tracking climate change range shifts. However, other species, like the Eastern Bluebird, appear to be occurring in areas where climate suitability is declining indicating that they are lagging behind changes in climate.

## **Habitat associations of breeding birds in a lowland conifer dominated landscape, Minnesota, USA**

Josh Bednar, University of Minnesota-Duluth; Edmund Zlonis, University of Minnesota-Duluth, Minnesota Department of Natural Resources; Maya Hamady, Minnesota Department of Natural Resources; Gerald Niemi, University of Minnesota-Duluth, Natural Resources Research Institute

Breeding bird habitat use and community metrics were compared among ten lowland conifer cover types in northern Minnesota. Breeding birds were sampled at 130 points distributed throughout black spruce, tamarack and white cedar forests within the Agassiz Lowland Subsection (ALS), Minnesota. Birds were sampled three times in the spring and summer of 2013 and twice during the spring and summer of 2014. Ten lowland conifer cover types were identified using hierarchical clustering, along with distinctive breeding bird species through species indicator analyses-percent perfect indication (PPI). Connecticut Warbler (*Oporornis agilis*) was most distinctive in semi-productive black spruce-tamarack bog cover types (PPI=40,  $P<0.01$ ). Boreal Chickadee (*Poecile hudsonicus*) was most distinctive in productive black-spruce-tamarack bog cover types (PPI=8,  $p<0.01$ ). Species such as the Nashville Warbler (*Leiothlypis ruficapilla*), Yellow-rumped Warbler (*Setophaga coronata*) and White-throated Sparrow (*Zonotrichia albicollis*) were ubiquitous across many lowland conifer cover types. Results from the Canonical Correspondence Analysis (CCA) showed significant relationships between breeding birds and vegetation variables ( $p<0.01$ ). The results from the CCA ordination support the ten cover types identified from the hierarchical cluster analysis. These findings can inform forest and wildlife management decisions that will benefit the conservation and management of breeding birds in lowland conifer forests of the ALS. Disturbances such as logging, insect outbreaks, fire and climate change have the capacity to significantly alter bird communities within these lowland coniferous forests. Data presented here can improve predictions of how the ALS avifauna will change given future changes to lowland conifer forests in the ALS.

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## **How many are there and where do you find Cassia Crossbills (*Loxia sinesciurus*)?**

Nathaniel Behl, University of Wyoming; Craig Benkman, University of Wyoming

The recently discovered Cassia Crossbill (*Loxia sinesciurus*) occurs only in two small, isolated mountain ranges in southern Idaho, the South Hills and Albion Mountains. This small finch relies entirely on the seeds of Rocky Mountain lodgepole pine (*Pinus contorta latifolia*) occurring in areas where red squirrels (*Tamiasciurus hudsonicus*) are absent, and is highly imperiled by two main effects of climate change. First, increased numbers of hot summer days (>32 °C), which have resulted in seasonal food shortages, led to an 80% decline in crossbill densities from 2003-2011. Second, climate change is predicted to cause the extirpation of lodgepole pine from the South Hills and Albion Mountains by 2080. Although the Cassia Crossbill has rebounded in recent years, we lack defendable estimates of total population size and knowledge of how variation in habitat features influences crossbill densities. We predicted the Cassia Crossbill's range using random-forest modelling, and conducted point-count surveys to estimate crossbill density at 137 locations randomly selected from that range. We then used conditional modeling to evaluate the influence of 16 habitat metrics on crossbill density. Our results indicate Cassia Crossbills have a small total population (7668 individuals [95% CL: 5709-15458]) restricted to 70 km<sup>2</sup>, and would have decreased to around 1500 individuals in 2011. They were also more abundant in stands of older, larger lodgepole pine on north-facing slopes. These results, current trends, and the threats posed to Cassia Crossbills by climate change, represent a significant conservation challenge for this range-restricted species.

## **Temporal variation in nesting propensity suggests tradeoffs between adult survival and current reproductive effort in Greater Sage-grouse**

Tessa Behnke, University of Nevada, Reno; Phillip A. Street, University of Nevada, Reno; James S. Sedinger, University of Nevada, Reno

Breeding propensity is an important contribution to population dynamics. Greater Sage-grouse (*Centrocercus urophasianus*) have an intermediate life-span, which creates the opportunity for trade-offs between survival and current and/or future reproduction. A female sage-grouse can attempt a second nest if her first attempt fails. However, the resources required to renest and raise chicks are finite and temporally limited within each season. In this study, we looked at temporal variation within and among years in nesting and renesting rates. We followed 520 females from 2013- 2016 in Nevada and Oregon. We used multi-state models with states for pre-nesting, nesting, failure of nest, and brood rearing. Using the transition probabilities between states, we calculated rates of nesting and renesting. Overall breeding propensity was high, but fewer birds chose to renest. There was considerable variation in first nesting for adults (0.659 - 0.892) and renesting for juveniles (0.069 - 0.463). The last year, 2016, showed the greatest age effect on first and second nesting attempts. Adult hens were more likely to attempt a first nest (mean=0.892, SE=0.018) than juveniles (mean=0.634, SE=0.062). However, juveniles were more likely to renest (mean=0.463, SE=0.145), compared to adults (mean=0.061, SE=0.024). Our results suggest that the proportion of females that breed each year can vary, and this may have serious consequences for recruitment of new individuals. These results suggest that in sage-grouse, in years where reproduction is costly, life history theory has selected for individuals who invest more in survival and future reproductive opportunities than individuals who invest in current reproduction.

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## **Evaluation of land restoration practices on Northern Bobwhite survival and land used in North-Central Texas**

Danielle Belleny, Tarleton State University; Heather Mathewson, Tarleton State University; Jeff Breeden, Tarleton State University; John Tomeček, Texas A&M AgriLife Extension; T. Wayne Schwertner, Tarleton State University; Jim Giocomo, Oaks and Prairies Joint Venture and American Bird Conservancy

Land-use change is attributed as a predominate threat influencing widespread declines in grassland species throughout the last century. Land restoration practices offer opportunities to mitigate these declines, however direct linkages with survival are not well documented. Due to their economic importance and reliance on healthy grasslands, attention focused towards land management for Northern Bobwhite (*Colinus virginianus*) also benefits other grassland species. This study addressed the effectiveness of land restoration practices that attempt to alleviate the impacts of land-use change on northern bobwhite. We radio-marked and located Northern Bobwhite to gather diurnal movement and survival information. From April – August 2016 we monitored 31 radio-marked individuals' movements across restored and non-restored landscapes then compared their survival. Utilization distributions of northern bobwhite in restored landscapes averaged 0.65 ha compared to 1.19 ha to those in non-restored landscapes. Survival analyses determined adult Northern Bobwhite have an 81% weekly survival and 34% survival over the 16-week period. Our sample size restricted survival comparisons between landscapes. After location of radio-marked birds, we measured vegetation characteristics including visual obstruction and herbaceous ground cover. We compared the means of vegetation measurements at locations between landscapes and found no significant differences ( $P > 0.05$ ). We are currently monitoring the survival and movements of 80 radio-marked individuals. Furthermore, we are conducting additional landscape measurements on horizontal heterogeneity to determine if restoration practices change vegetation structure. Further assessments of adult survival between restored and non-restored landscapes will provide a better understanding on the effects of restoration practices.

## **Female-dominated nonbreeding sites are low quality for male but not female Golden-winged Warblers**

Ruth Bennett, Cornell University; Amanda Rodewald, Cornell Lab of Ornithology; Kenneth V. Rosenberg, Cornell Lab of Ornithology

Successful conservation of Nearctic-Neotropical migratory birds requires a thorough knowledge of non-breeding habitat selection and quality. For the Golden-winged Warbler (*Vermivora chrysoptera*), a sharply declining Neotropical migrant, nonbreeding season conservation efforts are complicated by sexual segregation that relegates females to drier and more fragmented habitats than males. Despite compelling evidence of sexual segregation across the nonbreeding landscape, no work has yet examined the mechanisms or consequences of this phenomenon. We sought to determine if male-dominated habitat was preferentially selected and of higher quality to both males and females by examining the timing and order of arrival and the body condition of birds in both habitats. We conducted 1,700 point count surveys during October 2015 and 2016 in both male and female-dominated sites in Honduras. Across all sites, males and females arrived in the same proportions in which they ultimately established non-breeding territories, though males arrived later than females to female-dominated areas. Of 102 overwintering Golden-winged Warblers captured between 2012 and 2017, males had a significantly lower body condition in female-dominated than in male-dominated areas, while females showed no difference in body condition between sites. Our results suggest that male-dominated sites are both preferentially selected and of higher quality to males. However, our results provide no evidence that female-dominated sites are avoided or of lower habitat quality to females. As a significant proportion of the female population likely overwinters in female-



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dominated sites, we recommend these sites be prioritized for conservation in addition to areas of high male occupancy.

## **Exploratory behavior as a component of personality in Carolina, Black-capped, and hybrid chickadees**

Breanna Bennett, Villanova University; Sarah E. Polekoff, Villanova University; Robert L. Curry, Villanova University

Personality involves behavior that is consistent within individuals but variable among conspecifics. One component is exploratory behavior, or willingness to investigate novel environments; this behavior may have fitness consequences, including correlates with foraging success or mate selection. We investigated whether exploratory behavior varies among parental and hybrid chickadees. We used a portable observation chamber in 2016 to quantify exploratory behavior in the hybrid zone at Hawk Mountain (5 Carolina Chickadees, CACH; 5 Black-capped Chickadees, BCCH; and 20 hybrids, HYCH) plus 41 CACH and 24 BCCH from sites to the south and north respectively. From principal components analysis, PC1 scores reflecting 'activity' (number of actions, flight time, number of pegs visited, etc.) explained > 60% of overall variation. In a subset of 22 chickadees, first test and second test scores correlated strongly ( $r_s > 0.50$ ), suggesting personality-type consistency within individuals. However, mean PC1 did not vary among CACH, HYCH, and BCCH (ANOVA). Further study of behavior in the hybrid zone could help to determine whether personality is an important trait for mate choice in chickadees, and thus an influence on hybridization.

## **Effects of oil contaminant exposure on pre-migratory fuelling in two shorebird species**

Kristin Bianchini, University of Saskatchewan; David Newstead, Coastal Bend Bays & Estuaries Program; Christy A. Morrissey, University of Saskatchewan

Many shorebirds are failing to sufficiently fuel prior to departure for migration, which may be contributing to population declines in these birds. Pre-migratory fuelling is important because it increases a bird's probability of surviving migration and it determines migration speeds, which are correlated with reproductive performance. The polycyclic aromatic hydrocarbons (PAHs) found in oil pollution have the potential to interfere with pre-migratory fuelling physiology. However, a link between PAH exposure and impaired pre-migratory fuelling has yet to be established. Our objective was to determine if PAH contamination affects pre-migratory fuelling in two shorebird species. We captured over 35 Red Knots (*Calidris canutus*) and over 375 Sanderling (*Calidris alba*) from Chaplin Lake, SK, a relatively uncontaminated site, and from the Gulf of Mexico, which is subject to recurring oil spills. We measured each bird's body condition, fuelling rate and status, and plasma PAH levels. Motus radio telemetry array technology and blood isotopic signatures were used to determine the arrival and departure timing and stopover duration of over 20 Red Knots and over 75 Sanderling. We found that mean stopover durations in the Gulf of Mexico were longer than in Chaplin Lake (27 versus 15 days), and that stopover duration was associated with body condition and fuelling status at capture. We also measured higher plasma PAH concentrations in birds at certain Gulf sites, suggesting that PAH exposure is associated with lower pre-migratory fuelling rates. This work will inform shorebird conservation by providing valuable insight into a potential cause of migratory shorebird declines.

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## **Introgression across a towhee hybrid zone from the Great Plains characterized with historical DNA**

Shawn Billerman, Cornell Lab of Ornithology; Irby Lovette, Cornell University

Hybrid zones—locations where two previously isolated populations come into secondary contact and interbreed—are often regarded as natural laboratories that can provide powerful insights into the differences that contribute most importantly to reproductive isolation between taxa. In part owing to their past prominence in classical studies of hybridization dynamics, the avian hybrid zones of the Great Plains represent a particularly powerful system in which to explore mechanisms important for the maintenance of biodiversity on a large geographic scale. While there is an extensive and valuable history of research on most of these hybrid zones, the hybrid zone between Eastern (*Pipilo erythrophthalmus*) and Spotted Towhees (*P. maculatus*) has not been studied since the 1950s. We take advantage of a valuable series of specimens collected over 60 years ago, combined with new genomics tools, to investigate patterns of genetic and phenotypic introgression between towhees across the Great Plains. This first in-depth analysis of genetic introgression between Eastern and Spotted Towhees will help us to understand hybridization and speciation in the context of other well-studied systems across the Great Plains. Analyses of phenotypes from the towhee hybrid zone suggest extensive introgression, with high proportions of intermediate phenotypes relative to parentals, differing from other hybrid zones of the Great Plains, where intermediate phenotypes represent a relatively small proportion of individuals. These differences suggest different selection pressures between these systems, and may help us better understand how and why these hybrid zones are maintained across the Great Plains.

## **Recent advances in the use of drones to count seabirds and track songbirds**

David Bird, McGill University; Emile Brisson-Curadeau, McGill University; Kyle Elliott, McGill University; Junior Tremblay, Environment and Climate Change Canada; Andre Desrochers, Laval University; Paul Pace, Carleton University; Yves Aubry, Environment and Climate Change Canada

As a rapidly emerging technology, Unmanned Aerial Vehicles (UAVs AKA drones) demonstrate great potential for ornithology and bird conservation. We report on two separate studies done in 2016 which allowed us to 1) safely count seabirds in remote, rugged areas and 2) track songbirds in dense forest habitat. First, we compared the use of a rotary UAV with ground photography to census Arctic cliff-nesting seabirds. Most nesting gulls flew off in response to the UAV, but returned within five minutes. Counts of gull nests and adults were similar between UAV and ground photography, but the UAV detected up to 54.4% more chicks otherwise camouflaged and invisible to ground observers. An average of 8.5% of Thick-billed Murres (*Uria lomvia*) flew off in response to the UAV but with a small loss of eggs because >99% of them were non-breeders. We found little evidence for habituation by Thick-billed Murres to the UAV. Second, we outfitted a small rotary UAV with a receiver and antenna to pick up signals from radio-transmitters worn by small forest birds (*Catharus bickenilli* and *C. ustulatus*). We compared radio-monitoring using an UAV and a ground-based vehicle. We detected over 50% of the tagged birds with 50 m altitude flights with a signal strength significantly greater and more constant than ground-based signals. The signal receptor experienced no significant interference from the UAV electronics, thus enabling a “clean” set of detections. Based on these two studies, we conclude that using UAVs confer important benefits for both censusing seabirds and radio-tracking songbirds.

## **Paternity and reproductive success in a polyandrous shorebird (*Actitis macularius*)**

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Misha Blizard, University of Chicago; Stephen Pruett-Jones, University of Chicago

Polyandry typically involves substantial male investment in parental care and female investment in acquiring mates. Accordingly, certainty of paternity by males is expected to be high in polyandrous systems, and females are expected to display sexually selected ornaments to attract mates. We investigated genetic parentage in Spotted Sandpipers (*Actitis macularius*), a polyandrous shorebird species, to establish rates of extra-pair paternity and polyandry and to examine correlates of female reproductive success. Using microsatellite markers, for every offspring in a clutch, we determined that the social father was the most probable genetic father. On two occasions, males abandoned clutches to have a second clutch with a different female. Based on genetic (hatched clutches) and observational data (nest attempts), 13.6% to 27.8% of females were polyandrous each season. Females that laid eggs had greater spotted plumage cover than those that did not lay eggs or left the study site, while males exhibited no relationship between reproductive success and plumage pattern. This study suggests that although females may pair with multiple males, adults were reproductively monogamous with their current mate and extra-pair young are rare in this polyandrous system. Additionally, female reproductive success can correlate with a sexually dimorphic plumage pattern.

## **History of the Kirtland's Warbler: Successful conservation leads to anticipated delisting**

Carol Bocetti, California University of Pennsylvania

The Kirtland's Warbler's (*Setophaga kirtlandii*) rarity contributed to the long delay between its original discovery on migration in Ohio in 1851 to the identification of its wintering grounds in The Bahamas in 1879 and its nesting grounds in Michigan in 1903. Throughout the 1900s, the population declined due to breeding habitat limitation and nest parasitism by Brown-headed Cowbirds (*Molothrus ater*), dropping as low as 167 pairs by 1974. The species is a habitat specialist on its breeding grounds, where it requires large stands of patchy, high density, young Jack Pine (*Pinus banksiana*) and shrubby ground vegetation on well-drained, sandy outwash plains. It is more of a generalist on the wintering grounds where it uses patchy, dense, low coppice with adequate fruit production and foliage volume to support arthropod populations. Recovery efforts included removal of cowbirds from nesting habitats since 1972, establishment of the first Recovery Team appointed under the 1973 Endangered Species Act (ESA), and habitat creation that replicated the natural, wildfire-regenerated conditions. The Recovery Team facilitated interagency collaboration and fostered the research-management connection for key recovery strategies: habitat regeneration, cowbird control, monitoring, and outreach. The Kirtland's Warbler population responded and reached the goal of 1000 breeding pairs in 2001. However, its conservation-reliance presents a challenge to removal from the protection of ESA. With future de-listing in mind, a new public/private partnership now oversees the long-term sustainability of the species, and current research focuses on narrowing full life cycle data gaps and on improving the efficiency of sustainable management strategies.

## **Effects of individual condition and habitat urbanization on Mountain Chickadee reproductive behaviour**

Erica S. Bonderud, University of Northern British Columbia; Kristen L.D. Marini, Thompson Rivers University; Theresa M. Burg, University of Lethbridge; Matthew W. Reudink, Thompson Rivers University; Ken A. Otter, University of Northern British Columbia

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Chickadee social structure revolves around dominance hierarchies; dominant individuals gain increased resource access and are sought as both social and extra-pair partners. Males signal their dominance through condition-dependent traits, like song output during dawn singing, which may be used by females to assess quality. Extra-pair paternity in chickadees is often explained by the good genes hypothesis: females seek extra-pair copulations with high-quality males to obtain good genes for their offspring. Male condition may also influence brood sex ratios. Sex allocation theory suggests the production of sons may be advantageous when a female is paired to a high-quality male. Urbanization can affect population densities, intraspecific interactions, and individual condition, and thus, may influence reproductive behaviour. Recent work in our study population found evidence that male mountain chickadees in urban habitats may be in better condition than those in neighbouring rural areas, suggesting urban habitat may promote extra-pair copulations and male biased broods. Here, we ask whether mate condition or habitat urbanization influence brood sex ratios or a female's propensity to seek extra-pair copulations. Over three breeding seasons, we monitored 48 Mountain Chickadee nests in rural (coniferous forest) and urban habitat, recording male dawn singing and collecting genetic samples for sex ratio and parentage analyses. We found a moderate proportion of nests (30%) contain extra-pair young, ranging from a single nestling to entire broods being extra-pair. Males in urban areas did have higher song output during dawn chorusing, and we will contrast whether these differences result in differential reproductive success among habitats.

## **Investigating the role of ecology and evolution in bill shape variation among Malagasy Vangas using 3D geometric morphometrics**

Matt Bonfitto, Loyola University Chicago, Field Museum; Sushma Reddy, Loyola University Chicago, Field Museum

The Malagasy Vangas display very disparate bill forms and body sizes, taking up more morphospace than other classic examples of adaptive radiation such as the Hawaiian Honeycreepers and the Galapagos Finches. Their impressive phenotypic diversity as a result of niche filling on Madagascar makes the Vangas a fascinating group to study the relationship between lifestyle, evolutionary history, and form. Our aim is to use a 3D morphometric approach to understand the phenotypic aspects of the vangid evolution, in context with published phylogenies and data on foraging behavior. With 3D photogrammetry, we built models of bird bills and used landmarks to study fine-scale nuances of vanga bill shapes. We assessed how this method compares to other morphometric methods such as linear measurements and 2D shape analysis. We used shape data to examine the correlations between bill shape and feeding ecology, as well the difference between island and mainland groups with regards to phenotypic diversification through time. Preliminary findings show clear morphological differentiation correlated with foraging behavior and colonization of Madagascar. This study will help to more thoroughly understand the relationship between bill shapes and lifestyle in vangas and give better insight into island radiation.

## **Relationship between wingbeat frequency and altitude change in migrating Swainson's Thrushes (*Catharus ustulatus*)**

Melissa Bowlin, University of Michigan-Dearborn; David A. Enstrom, Illinois Natural History Survey; Brian Murphy, University of Michigan-Dearborn; Hassan Al-Fanharawi, University of Michigan-Dearborn; Aleksa Fortuna, University of Michigan-Dearborn; Nicholas Wesner, University of Michigan-Dearborn; James Cochran, JDJC Corp.

Our lab uses radio-transmitters to monitor the flight altitude of migrating Swainson's Thrushes (*Catharus ustulatus*). The transmitters we use can also provide us with wingbeat frequency if we have a good signal. Here, we present wingbeat and altitude data from 8+ hours of flight from two Swainson's Thrushes (*Catharus ustulatus*).

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Data from the transmitters consists of 13s of wingbeat data followed by a 2s 'data burst' that allowed us to measure temperature and pressure (and therefore altitude). For each 13s interval where the signal was clear, we counted wingbeats, pauses, and pause lengths. We then calculated actual wingbeat frequency (number of wingbeats divided by 13s) and effective wingbeat frequency (number of wingbeats divided by time, not including pause length). Our preliminary data strongly suggest wingbeat frequency is the proximate mechanism by which birds ascend and descend in the atmosphere. Increases in wingbeat frequency are followed almost immediately by ascent (the higher the wingbeat frequency, the steeper the ascent), whereas birds start to slow their wingbeat frequency and increase the number of pauses approximately 8 min prior to descent. Actual and effective wingbeat frequency are generally tightly correlated, but diverge when the birds engage in numerous pauses toward the end of steep descents. These data can provide insight into ascent and descent behavior during flights for which we have no altitude data, but still possess a record of wingbeat frequency.

## **Can we effectively estimate ancestral effective populations sizes? A case study in Galliformes**

Edward L. Braun, University of Florida; Rebecca T. Kimball, University of Florida

Methods for the large-scale collection of genomic markers, along with new analytical approaches, have the potential to provide accurate estimates of coalescent branch lengths. Ancestral population sizes can be estimated by combining those coalescent branch lengths with information about the number of generations between speciation events. Information about ancestral population sizes is useful for addressing many hypotheses. For example, founder-effect speciation models predict small population sizes at the time of divergence, whereas allopatric and sympatric speciation allow for larger population sizes. Likewise, information about ancestral population sizes could provide a "reality check" for studies focused on the identification of genes subject to positive selection. Overall, ancestral population size data allows researchers to gain rich information about ancient speciation events, moving beyond examinations of when organisms diverged. However, it is far from clear whether it is possible to obtain those estimates of ancestral population sizes using data that can be collected using available methods. Our previous data suggests that loci with limited variation can yield misleading estimates of the species tree in multispecies coalescent analyses, suggesting that low-variation loci will also yield biased estimates of coalescent branch lengths. Here we use sequence data from 90 introns representing 40 loci along with data from thousands of ultra-conserved elements (UCEs) collected from 16 phasianids to examine whether using regions that have relatively few informative sites (short introns, many ultra-conserved elements) yield different estimates than using regions with higher variation (longer or multiple introns per locus).

## **Habitat selection of captive-reared Barn Owls**

Eric Brossman, Governors State University; John Yunger, Governors State University; Jon Mendelson, Governors State University; Erik Neidy, Forest Preserve District of DuPage County; Dan Thompson, Forest Preserve District of DuPage County; Steve Capps, Forest Preserve District of DuPage County

Determining how threatened and endangered species interact within their environment is important for drafting recovery plans. These interactions are of interest where habitat loss from anthropogenic disturbance has contributed to low species abundance. Species are also less abundant at the periphery of their range compared to the central region of their distribution. The Barn Owl (*Tyto alba*) is listed as endangered in Illinois. Northern

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Illinois is the northern most distribution of its range and Northeastern Illinois is also one of the most urbanized in the United States. Between 2004 and 2010, fledgling Barn Owls were released from hack sites (n=7) in Northeastern Illinois attached with both satellite (n=14) and radio transmitters (n=16). Geographic information systems (GIS) identified habitat categories (n=8) that were available. Habitat selection comparisons between satellite and radio-tracked owls were done using MANOVA. There was a significant difference in mean dispersal distances for satellite-tracked (1077 km) compared to radio-tracked Barn Owls (26 km) due to the tracking capabilities of the two methods. Satellite-tagged Barn Owls selected habitats south of their hack sites and more towards the central region of their range with a preference for agricultural areas. Variations in habitat selection between satellite and radio-tracked Barn Owls may be due to the longer spatial and temporal monitoring capabilities of the satellite transmitters compared to the radio transmitters. However, some radio-tracked Barn Owls showed a preference towards agricultural areas near their hack sites.

## **Site occupancy and behavior of migratory shorebirds in agriculture fields in the Rainwater Basin, NE**

Lindsay Brown, University of Nebraska-Omaha; John P. McCarty, University of Nebraska-Omaha; L. LaReesa Wolfenbarger, University of Nebraska-Omaha

Some upland shorebird species are undergoing population declines. During northward migration, these species stopover in agricultural landscapes. These landscapes are typically lower in resources, which could compromise energy demands during migration, and may carry risks associated with agricultural practices. We lack information on what landscape features influence where species stop and on how species use agricultural habitats. To close the gap, I compared landscape features between species-present and species-absent sites and developed models to predict migratory stopping sites. I focused on three upland species: American Golden-Plover (*Pluvialis dominica*), Buff-breasted Sandpiper (*Calidris subruficollis*), and Upland Sandpiper (*Bartramia longicauda*). To understand how these species use sites, we recorded flock and individual behavior. Each species responded to different landscape features and displayed different behaviors. American Golden-Plovers occupied sites with greater variation in slope and spent most of their time resting in these fields. Buff-breasted Sandpipers occupied sites that were higher in elevation and flatter and spent most of their time feeding. Compared to the other two species, Buff-breasted Sandpiper flocks were engaged in more social activities. Upland Sandpipers occupied sites with higher elevations. They often spent their time walking in the fields. Compared to the other two species they significantly spend more time displaying territorial behaviors and courting. While all three species use upland sites, how they used these sites and what features attracted them differed among species.

## **Seasonal changes in rainfall influence habitat utilization and diet in wintering Swainson's Warblers**

Alicia Brunner, The Ohio State University; Christopher Tonra, The Ohio State University; Peter Marra, Smithsonian Migratory Bird Center

Non-breeding migratory birds that overwinter in the Caribbean are experiencing fluctuations in food abundance caused by shifting rainfall regimes and an overall drying trend. Migratory passerines already endure reductions in arthropod abundance during the seasonal dry period in late winter, and climate change associated drying could worsen these drought conditions. But, birds may be able to adapt by tracking changes in the spatial distribution of their food. By shifting their home ranges to areas with particular habitat characteristics that promote higher food availability birds may be able to offset the effects of drought-induced declines in arthropod abundances. Swainson's Warblers *Limnothlypis swainsonii* may be particularly sensitive to drying since their ground foraging

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strategy requires an abundance of leaf litter arthropods that rely on moist soil environments. Using Swainson's as a focal species, we hypothesize that their habitat utilization differs between wet and dry periods, and that certain habitat characteristics may facilitate this change. To test this hypothesis, we tracked Swainson's Warblers movements and habitat use from January-April, 2016 and 2017, utilizing the long-term study site at Font Hill, Jamaica. Habitat measurements and leaf litter samples were taken in each individual bird's home range during dry and wet periods to determine variance in habitat and arthropod composition/abundance during times of differing wetness. By identifying if wintering birds can track prey abundance on a seasonal scale, we can understand if they can use this flexibility in habitat use and tracking ability to adapt to long-term environmental change.

## **House sparrows exhibit less nest defense than both eastern bluebirds and tree swallows**

Michael W. Butler, Lafayette College; Marissa L. Rossi, Lafayette College

The degree to which birds allocate parental care, such as nest defense, may vary based on life history characteristics and/or parental investment. Here, we evaluated nest defense in three cavity-nesting species within two frameworks: 1) intraspecific variation due to other forms of parental investment (e.g., number of eggs or nestlings), and 2) interspecific variation associated with life history traits (i.e., number of potential future breeding opportunities). To investigate these frameworks, we placed either a neutral object (toy football) or a nest competitor (taxidermied European Starling) both on and near nest boxes during both the egg and nestling stages for three cavity-nesting species (Tree Swallows, Eastern Bluebirds, and House Sparrows). We then quantified both nest defense behaviors and other parameters of investment (i.e., number and mass of eggs and nestlings) in 13 bluebird, 16 sparrow, and 14 swallow nests. We found that nest defense was poorly correlated with other metrics of investment, with only one behavior (returning to the nest site quickly after a disturbance) associated with heavier, but not more, eggs. However, there were multiple interspecific differences in nest defense behavior. Overall, Tree Swallows were the most aggressive using several behavioral metrics, bluebirds were intermediately aggressive, and House Sparrows were the least aggressive. In Pennsylvania, these species are likely to breed approximately, once, twice, or up to three times per summer, respectively. Therefore, we suggest that degree of nest defense may be driven less by factors associated with a current clutch, and more by number of potential future breeding attempts.

## **Interactions between mosquitoes and birds: role of volatile components of preen gland secretions**

Max Butler, Oberlin College; Rebecca Whelan, Oberlin College; Mary Garvin, Oberlin College

The transmission of the mosquito-borne West Nile virus (WNV) among birds is dependent on the ability of the mosquito vector to locate and feed upon the avian host. A number of birds acquire WNV infections and serve as natural reservoirs of the virus, however American Robins are believed to be the most important reservoir. Chemical analysis of the volatile components of the preen gland secretions of American Robins and two other common WNV reservoir hosts, House Sparrows and European Starlings, reveal species-specific volatile profiles. We hypothesized that the *Cx. pipiens* mosquito WNV vector is preferentially attracted to American Robins over the other two species and that this attraction is based on the volatile components of preen gland secretions. We conducted mosquito choice trials using an olfactometer to test the predictions that 1) *Cx. pipiens* is preferentially attracted to American Robins over House Sparrows and European Starlings and 2) *Cx. pipiens* is preferentially

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attracted to preen gland secretions of American Robins over those of the other two species. We found that *Cx. pipiens* is more often attracted to live robins over sparrows; however, we found no preference for robin preen gland volatiles over those of sparrows. Surprisingly, we also found that *Cx. pipiens* is more often attracted to starlings over robins and to the volatile components of starling preen gland secretions over those of robins.

## **Are flight altitudes of nocturnally migrating birds influenced by light pollution?**

Sergio A. Cabrera-Cruz, University of Delaware; Jaclyn A. Smolinsky, University of Delaware; Jeffrey J. Buler, University of Delaware

Several species of nocturnally-migrating birds are attracted to point sources of artificial lights at a small scale and sky glow from cities, presumably at a large scale. Therefore, at a landscape scale, we hypothesized that flight altitudes of nocturnal migrants may differ over intensely-light polluted areas compared to areas without intense light pollution. Weather radars are a valuable tool for studying nocturnal bird migration over large extents and can produce vertical profiles of radar reflectivity (VPRs), a measure of bird density in the air, from which to quantify flight heights of birds. We used data from three weather radars in the eastern US to estimate VPRs over “dark” and “bright” (light polluted) areas during the peak time of migration (~3 hours after sunset) during bird-dominated nights in three consecutive fall migratory seasons (2010-2012). When all data was pooled together, we found a large overlap in the vertical distribution of nocturnal migrants between “dark” and “bright” areas, but also that median flight altitudes were significantly higher over “bright” areas. However, when data from each radar was considered independently, we found no difference for two of the radars (AKQ in Wakefield, VA, and DOX in Dover, DE), and hence the difference was driven mainly by the vertical distribution of birds as detected by the DIX radar (in Mt. Holly, NJ). These results suggest a potential influence of light pollution on flight altitudes of nocturnal migrants in a landscape scale, but further analyses are still needed in order to fully assess this.

## **Understanding the evolution of a polymorphic supergene by genomic comparison to a related species**

Jennifer Callaway, Indiana State University; Yongsheng Bai, Indiana State University; Gary W. Stuart, Indiana State University; Elaina M. Tuttle, Indiana State University; Rusty A. Gonsler, Indiana State University

New bioinformatics tools have made it possible to identify structural variants, but little has been done to explore these genomic changes within an avian supergene. A color polymorphic supergene exists on the second chromosome of the white-throated sparrow (*Zonotrichia albicollis*), but much less is known about the newly sequenced genome of the rufous-collared sparrow (*Zonotrichia capensis*). *Z. capensis* is hypothesized to have diverged before the *Zonotrichia* ancestor with the alternative supergene version and is geographically isolated from other *Zonotrichia* species. We compared the genomes of *Z. albicollis* and *Z. capensis* to generate a list of structural variants in *Z. capensis* and to compare two detection programs. We used Pindel and BreakDancer to identify structural variations within the *Z. capensis* genome based upon the *Z. albicollis* reference. We searched for structural variants in *Z. capensis* within 806 genes located in a large inversion involved in the supergene of *Z. albicollis*. Pindel identified 68,721 structural variants, with the majority shorter than 100 nucleotides. BreakDancer identified 277 inversions and deletions, all greater than 185 nucleotides, including an inversion nearly 300,000 bases long. Close inspection of ten genes revealed differences in the protein coding sequences of seven genes between the two species, suggesting possible mechanisms of phenotypic differences. These structural variants may have contributed to the divergence between *Zonotrichia* species or resulted from geographic reproductive



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isolation. Increased knowledge on genomic variants can allow for a better understanding of speciation mechanisms, functional consequences of variants, and the evolution of the genome, including supergenes.

## **Repeated divergent selection on pigmentation genes in a rapid finch radiation**

Leonardo Campagna, Cornell Lab of Ornithology; Márcio Repenning, Laboratório de Ornitologia, Museu de Ciências; Luis Fabio Silveira, Universidade de São Paulo (MZUSP); Carla Suertegaray Fontana, Laboratório de Ornitologia, Museu de Ciências e Tecnologia; Pablo L Tubaro, Museo Argentino de Ciencias Naturales; Irby J Lovette, Cornell University.

Instances of recent and rapid speciation are suitable for associating phenotypes with their causal genotypes, especially if gene flow homogenizes areas of the genome that are not under divergent selection. We study a rapid radiation of nine sympatric bird species known as Capuchino Seedeaters, which are differentiated in sexually selected characters of male plumage and song. We sequenced the genomes of a phenotypically diverse set of species to search for differentiated genomic regions. Capuchinos show differences in a small proportion of their genomes, yet selection has acted independently on the same targets in different members of this radiation. Many divergent regions contain genes involved in the melanogenesis pathway, with the strongest signal originating from putative regulatory regions. Selection has acted on these same genomic regions in different lineages, likely shaping the evolution of cis-regulatory elements, which control how more conserved genes are expressed and thereby generate diversity in classically sexually selected traits.

## **Kingfisher feather lice exhibit differing degrees of cospeciation with their hosts**

Therese Catanach, Drexel University; Kevin P. Johnson, Illinois Natural History Survey, University of Illinois at Urbana-Champaign; Ben D. Marks, Field Museum of Natural History; Robert G. Moyle, University of Kansas; Jason D. Weckstein, Drexel University

In many bird species, individual hosts are parasitized by multiple louse genera. However, kingfishers are typically only infected with a single louse genus. These louse genera, partition hosts by subfamily with *Alcedoecus* parasitizing *Daceloninae* and *Alcedoffula* parasitizing both *Alcedininae* and *Cerylinae*. We used two molecular markers, the nuclear gene EF-1a and mitochondrial gene COI to infer species level phylogenies for both *Alcedoffula* and *Alcedoecus*. These phylogenies included 47 kingfisher lice sampled from 11 of the 19 currently recognized genera of kingfishers. In several cases, our louse phylogeny also reflects recently proposed host splits. Thus, the genetic divergence in the lice is mirroring divergence in the host kingfishers. We compared louse phylogenies to a host phylogeny to reconstruct their cophylogenetic history. We determined that there are two distinct clades within *Alcedoffula* one that parasitizes *Alcedininae* and a second that infests *Cerylinae* and that *Alcedoecus* only occurs on *Daceloninae*. Cophylogenetic analysis of these reciprocally monophyletic genera of kingfisher lice and their hosts indicates only the lineage of *Alcedoffula* occurring on *Cerylinae* showed strong evidence of cospeciation. Lastly, we reconstructed biogeographic patterns of the lice using BioGeoBEARS. Australian lice from both genera are placed within clades of lice from Africa mirroring patterns suggested in informal assessments of host biogeographic patterns. Conversely, in lice from cerylinine kingfishers, we inferred a single South American origin followed by an invasion of Africa which contrasts with published assessments pointing to multiple invasions of the New World from the Old World.

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## **The Greater Sage-Grouse as a conservation surrogate: Where are the holes in the umbrella?**

Anna Chalfoun, U.S. Geological Survey and University of Wyoming; Jason Carlisle, University of Wyoming; Douglas Keinath, U.S. Fish and Wildlife Service; Kurt Smith, University of Wyoming; Jeffrey Beck, University of Wyoming; Melanie Murphy, University of Wyoming; Shannon Albeke, University of Wyoming

Conservation practitioners have been hopeful that the Greater Sage-Grouse (*Centrocercus urophasianus*) serves as an effective conservation surrogate for other species of concern in the sagebrush biome. While appealing in theory, rigorous tests of the surrogacy concept have been rare. Consequently, the types of species that may most benefit under the sage-grouse umbrella, and at which spatial scale(s), remains unclear. Using a multi-faceted approach (broad-scale spatial modeling, empirical studies, and field experiment) in Wyoming, USA, we addressed the following questions: How much habitat protection does a reserve established for sage-grouse offer 52 other species of concern? Do finer-scale measures of sage-grouse abundance, habitat preference, and habitat quality mirror those of other sagebrush birds? How do habitat treatments meant to enhance sage-grouse brood-rearing habitat affect non-target birds? The reserve protected an average of 21% of focal species' habitat; however, protection varied substantially across species. Species most likely to receive more habitat protection were other birds, and those with wider geographic distributions and strong associations with sagebrush. The local abundance of sagebrush-associated songbirds was largely unrelated to that of sage-grouse. Moreover, the nesting habitat that was preferred and that conferred higher nest survival varied for sage-grouse and songbirds. Habitat treatments implemented for sage-grouse had mixed effects on other birds, but resulted in the loss of nesting habitat for shrub-nesting passerines. In sum, our results suggest that broad-scale habitat protections implemented for the Greater Sage-Grouse benefit many, but not all co-occurring species of concern. The sage-grouse "umbrella," however, collapses at smaller spatial scales.

## **Natural gas fields as ecological traps for nesting birds**

Anna Chalfoun, U.S. Geological Survey and University of Wyoming; Matthew Hethcoat, University of Wyoming; Lindsey Sanders, University of Wyoming

Ecological traps can arise when contemporary, human-induced habitat change decouples habitat preferences with historic fitness outcomes. The specific contexts in which traps are likely to occur, trap severity, the mechanisms underlying traps, and the potential for habitat features to modulate traps, however, remain unclear. We investigated whether natural gas fields in Wyoming, USA were functioning as ecological traps for nesting sagebrush songbirds. Across seven years of study at twelve sites, the probability of nest survival for all three species of sagebrush-obligates (Brewer's Sparrow, *Spizella breweri*; Sagebrush Sparrow, *Artemisiospiza nevadensis*; Sage Thrasher, *Oreoscoptes montanus*) decreased with surrounding habitat loss due to energy development. Yet, birds did not settle safe sites any earlier than risky sites. The main cause of nest failures was nest predation by rodents, and most species of rodents increased in abundance with increasing energy development. Brewer's sparrows consistently preferred nest sites surrounded by greater densities of potentially-suitable nest shrubs, which lessened the effect of increased predation near energy development. Collectively, our results suggest that energy development can lead to equal-preference or severe traps for breeding birds by concentrating nest predators in areas still utilized for nesting. Moreover, at least some species of birds may be able to modulate the severity of traps in altered landscapes via the selection of optimal microhabitats.

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## **Do cross-scale interactions between climate and socioeconomic factors affect the persistence of avian species?**

Anand Chaudhary, Baylor University; Kevin J. Gutzwiller, Baylor University

Knowledge of how social and ecological variables interact to affect avian populations is crucial for species' conservation in the Anthropocene. Yet, scientists know very little about the effects of cross-scale interactions (CSIs) on birds. We explored how persistence of eight species of forest birds in the eastern United States was affected by CSIs involving regional-scale climate (mean maximum temperature of the breeding season) and landscape-scale socioeconomic factors (median age, median income, proportion of the population  $\geq 25$  years old with  $\geq 4$  years of college, and proportion of the population that was female and  $\geq 30$  years old). Multiple linear regression indicated that synergistic CSIs involving regional climate and landscape-scale socioeconomic variables (median income and median age) affected the persistence of White-breasted Nuthatch (*Sitta carolinensis*) and Yellow-breasted Chat (*Icteria virens*). However, CSI influences on these species' persistence were less important than were influences from habitat and weather variables. We did not find evidence of differences in the effects of CSIs between Neotropical- and Nearctic-wintering species, or between forest-interior and forest-edge species. Our results indicate that CSIs may be important for some species. Without information about CSIs, conservationists may make inappropriate planning or management decisions. Given the range of variables that are known to affect avian persistence at different spatial scales, ecologists should routinely check for CSIs involving socio-ecological conditions to ensure that the best available science is supporting avian conservation decisions in human-dominated environments.

## **Communal nocturnal roosting behaviour of Pied Wagtails (*Motacilla alba yarrelli*) may serve no function**

Glen Chilton, James Cook University; Lisa Chilton, James Cook University

Communal, nocturnal roosting at traditional sites is uncommon among songbird species, limited to members of just five families. Among the *Motacillidae*, communal roosting is most prevalent in White wagtails, and particularly the Pied Wagtail. In the British Isles, Pied Wagtails travel long distances from diurnal foraging sites to gather at traditional roosts occupied by hundreds or thousands of individuals, almost all in urban settings. We documented seasonal changes in roosting behavior in Stirling, Scotland. More than 23,000 arrivals and departures were recorded in fortnightly observations over thirteen months. Unlike other reported sites, the Stirling roost was used throughout the year by approximately 460 individuals, with numbers swelling fourfold during migration, and falling by half during the breeding season. Arrivals to and departures from the roost tracked seasonal changes in sunset and sunrise, but birds in winter arrived 40 minutes later and departed 75 minutes earlier in winter. Numbers of individuals occupying the roost, and the timing of arrivals and departures did not differ on successive days with very different weather. Although a dramatic behavior, of the estimated 1.4 million Pied Wagtails in Great Britain and Ireland, it appears that less than one percent participate in communal nocturnal roosting at traditional sites. None of the proposed functions of nocturnal roosts (predator avoidance; information sharing; favorable microclimate) are supported by our observations. Communal roosting in Pied Wagtails may be an epiphenomenon, resulting from responses to aspects of the urban environment.

## **Song as a driver of reproductive isolation in western Spotted Towhees (*Pipilo maculatus*)**

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Carla Cicero, Museum of Vertebrate Zoology, University of California, Berkeley; Colin Jenkins, Museum of Vertebrate Zoology, University of California, Berkeley

Song is an important reproductive isolating mechanism in birds. In particular, song combined with genetic, phenotypic, and ecological data can provide important insight into population divergence, species limits, and hybridization. Spotted Towhees (*Pipilo maculatus*) are common birds in North America, where they hybridize with Collared Towhees (*P. ocai*) in Mexico and with Eastern Towhees (*P. erythrophthalmus*) in the central Great Plains. Within Spotted Towhees, 21 subspecies have been named on the basis of size and color differences, with 8 subspecies occurring in the western United States from the Pacific coast (including the California Channel Islands) to the Rocky Mountains. In addition to phenotypic differences, these populations differ ecologically and vocally. We quantified variation in 57,903 songs recorded from 1,206 individuals to assess patterns of song divergence in Spotted Towhees, with an emphasis on populations from the Pacific coast and Sierra Nevada (“Pacific slope”) through the Great Basin and Intermountain (“interior”) regions. We analyzed 17 characters from 2,108 distinct songs and found strong differences between Pacific slope and interior populations in song complexity and trill rate. In addition, we identified areas of contact between different song types. These data are discussed in the context of what is known about genetic and phenotypic variation among populations of Spotted Towhee in the western United States. Our analysis of song variation will provide a framework for future study that integrates genetic, phenotypic, and ecological niche data to assess whether populations in the different regions are reproductively isolated.

## **Community structure and animal behavior are shaped by anthropogenic noise in a grassland bird community**

Jonathan Clark, George Mason University; David Luther, George Mason University; Terry Chesser, USGS

Species that live in grassland ecosystems are declining globally at a rate faster than species in any other ecosystem. To determine how these species might be impacted by human-made sound from major roadways, we measured the territory sizes of two grassland bird species and conducted point-count surveys. We found that males of both Eastern Meadowlarks (*Sturnella magna*) and Grasshopper Sparrows (*Ammodramus savannarum*) have smaller territories in areas of high ambient sound level. We also found that both grassland bird species richness and abundance decreased as the amplitude from traffic noise increased. More specifically, we found that a particular species which is in decline across the region, the Grasshopper Sparrow (*Ammodramus savannarum*), decreased significantly with an increase in traffic noise. Results indicate that noise is affecting species on both the community level and the level of individual behavior. Our approach found significant shifts in response to traffic noise at both an individual and community level, affirming the powerful influence anthropogenic noise has on animal behavior and a variety of ecosystems.

## **Changes in stopover site function from fall to spring for migrating landbirds along the Gulf of Mexico**

Hannah Clipp, University of Delaware; Tim Schreckengost, University of Delaware; Jaclyn A. Smolinsky, University of Delaware; Frank R. Moore, University of Southern Mississippi; Jeffrey J. Buler, University of Delaware

The broad variability in quality and use of stopover sites by migrating landbirds reflects a spectrum of functions, from transient resting to extensive refueling. Transient rest stops have reduced food resources and support birds for short stopovers, while extensive refueling occurs at sites with rich food resources. Seasonal changes in these

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stopover site functions have not been well documented. Therefore, we investigated whether the general function of stopover sites for migrants changes from fall to spring. For two fall and two spring seasons, we conducted distance-sampling bird surveys along 500-m transects at 16 sites in southern Mississippi and Louisiana. We calculated an index of stopover duration (i.e., days per bird) by dividing mean daily nocturnal migrant density at each transect (i.e., bird-use days) by mean nightly density of birds emigrating from sites based on weather surveillance radar data (i.e., number of birds). We then performed a cluster analysis using insect density, distance to the coast, forest cover within 5 km, and stopover duration to classify the function of each stopover site. At inland sites with high amounts of surrounding forest cover, insect abundance was greater during fall. At these same sites, stopover duration was relatively short in the fall (indicating quick refueling) and relatively long in the spring (indicating slow refueling). In both seasons, sites near the coastline consistently had low insect abundances and short stopover durations, functioning as transient rest stops. These results improve our understanding of landbird stopover ecology and inform how we prioritize important stopover habitat.

## **Heterospecific extra-pair fertilizations as a mechanism for hybridization between two species of wood warblers**

Benjamin Cloud, University of Kentucky; Patricia Hartman, Auburn University; John Confer, Ithaca College; David Westneat, University of Kentucky

When reinforcement against hybridization fails, the extinction of an incipient species is plausible. This form of outbreeding appears to be the case in the Golden-winged (*Vermivora chrysoptera*, GWWA) and Blue-winged (*V. cyanoptera*, BWWA) Warbler system where a mosaic and mobile hybrid zone across the eastern United States is advancing on the GWWA range. Because hybrid phenotypes are maintained despite heterospecific pairings being rare, we hypothesize that heterospecific extra-pair paternity is the main mechanism of hybridization. DNA samples were collected from family groups in 33 pure GWWA nests, 21 pure BWWA nests, and 10 hybrid nests between 2006-2010 in 2 regions within the hybrid zone. All individuals were genotyped using 4 microsatellite markers and paternity was assigned to all nestlings as either within-pair or extra-pair using a likelihood-based method. Identities of extra-pair nestlings were confirmed via RFLP assays for 3 loci linked to distinctive plumage characteristics. Results were similar between the two regions. Of the 133 nestlings sampled in GWWA nests, 10 were assigned BWWA sires and 3 were assigned hybrid sires. Of the 83 nestlings sampled in BWWA nests, only 3 were assigned a GWWA sire. Interestingly, hybrid nests contained a higher proportion of extra-pair nestlings assigned heterospecific parents (9/10). The results indicate that heterospecific extra-pair paternity is leading to introgression and that hybridization may be asymmetrical, affecting GWWA females disproportionately. These data call for a better understanding of the behavioral and ecological factors causing heterospecific extra-pair fertilizations and possible asymmetrical hybridization in this system.

## **Hierarchical population monitoring to inform adaptive management: an example from the sagebrush ecosystem**

Peter Coates, U.S. Geological Survey; Brian G. Prochazka, U.S. Geological Survey; Mark A. Ricca, U.S. Geological Survey; Cameron L. Aldridge, Colorado State University and U.S. Geological Survey; Michael S. O'Donnell, U.S. Geological Survey; Steven E. Hanser, U.S. Geological Survey; Kevin E. Doherty, U.S. Fish and Wildlife Service

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Population ecologists have recognized the importance of ecological scale in understanding processes that guide observed demographic patterns for wildlife species. However, directly incorporating spatial scale into monitoring strategies that detect whether trajectories are driven by local or regional factors is challenging and rarely implemented. Identifying appropriate scale is critical to the development of management actions that are likely to reverse population declines. We describe a novel example of a monitoring framework for estimating annual rates of population change for Greater Sage-Grouse (*Centrocercus urophasianus*) within a hierarchical spatial structure. This framework allows partitioning of biotic and abiotic effects across spatial scales that are likely to adversely influence populations, and further identifies the appropriate scale to target actions aimed at reversing such effects. We demonstrate how declines governed by local disturbances are disentangled from those operating at larger scales (e.g., broad-scale wildfire and region-wide drought). We conducted Bayesian analyses on a 17-year lek count dataset in the Great Basin to estimate annual changes and compare trends across nested scales. We identified populations at specific spatial scales that are in immediate need of management based on two criteria: declining trend and decoupling trend from larger spatial scales. We offer a range of values for these criteria derived from modeled simulations. Overall, this adaptive management framework can facilitate responsive and effective actions of an indicator species for sagebrush ecosystems on an annual basis. Similar hierarchical approaches might be beneficial for other species occupying landscapes with heterogeneous disturbance and climatic regimes.

## **Reproductive ecology of Reddish Egrets nesting on a natural marsh island in southwest Louisiana**

Samantha Collins, Louisiana Department of Wildlife and Fisheries; Will Selman, Millsaps College, Louisiana Department of Wildlife and Fisheries; William Strong, Louisiana Department of Wildlife and Fisheries

Rabbit Island is an 85-hectare marsh island located within Calcasieu Lake in southwestern Louisiana. The island supports ~30 breeding pairs of Reddish Egrets (*Egretta rufescens*) along with thousands of other breeding wading, marsh, and seabirds. Because of the low island elevation (0.3 – 0.57 m asl), nests may be lost due to overwash events during high spring tides or wind-driven tides. The purpose of this study was to determine nest site selection and nest success of breeding Reddish Egrets on Rabbit Island, while also identifying causes of nest loss. We conducted nest searches and monitored active nests during the 2016 and 2017 breeding seasons (April-August). Nest initiation occurred on 5 April and 26 March in 2016 and 2017, respectively. We found no evidence of mammalian-induced predation. Overwash was the primary cause of nest loss across both years but occurred infrequently during the breeding seasons. In 2016, breeding pairs initially selected nesting areas in *Spartina alterniflora* on the south side of the island but the majority of pairs renested in *Juncus roemerianus* on the north side of the island following an extreme overwash event and complete nest failure. In the absence of extreme overwash events, we observed high nest success (67% of nests survived to hatch after the overwash event in 2016). This is suggestive of an ecological tradeoff whereby Reddish Egrets selected the predator-free island and cope with occasional nest failure because of high water. This scenario makes Rabbit Island one of the most important coastal breeding bird sites in Louisiana.

## **Genomics of the Painted Bunting: adaptive genetic variation across populations**

Andrea Contina, Oklahoma Biological Survey, University of Oklahoma; Kristen Ruegg, University of California Santa Cruz and University of California Los Angeles; Rachael Bay, University of California Los Angeles; Jeffrey Kelly, Oklahoma Biological Survey, University of Oklahoma; Eli Bridge, Oklahoma Biological Survey, University of Oklahoma

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The Painted Bunting (*Passerina ciris*) is a North American migratory songbird and a focal species of the Bird Genoscape Project, a cutting-edge genomic effort by the Center for Tropical Research (UCLA) to study migratory connectivity of North American songbirds. Painted Buntings breed in allopatric populations with divergent molt and migration strategies. These traits make the Painted Bunting an ideal species in which to study adaptive genetic variation across distant breeding sites. We used RAD-Seq to examine 174,152 single nucleotide polymorphisms (SNPs) across the Painted Bunting genome. Using these SNPs, we analyzed the species' population structure across its breeding range and searched for SNPs within annotated genes to detect signatures of selection. We present a novel list of candidate loci under diversifying selection based on a single-locus population differentiation approach. Our results move forward our understanding of the evolution of migration in allopatric Painted Bunting populations and potentially in other species of songbirds through the identification of novel candidate loci under differential selective forces.

## **Structure of ecological specialization: Implications for conservation in a rapidly changing environment**

Meaghan Conway, University of Maine; Adrienne I. Kovach, University of New Hampshire; Brian J. Olsen, University of Maine

The degree of an organism's specialization can influence its distribution across space. Ecological specialization is synonymous with narrow niche breadth, resulting from trade-offs between the ability of a species to exploit a range of resources and their capacity to compete effectively. This competitive advantage can accompany a reduced ability to adapt to changing conditions. However, a species' niche can vary across spatial scales. A species-level definition treats individuals as equivalent, ignoring variation among individuals and populations that occur over a range of ecological conditions. Differences in population niche width can reflect a balance between the diversifying force of intraspecific competition and the constraining effect of interspecific competitors. The Niche Variation Hypothesis proposed two mechanisms for niche expansion following release from interspecific competition. Every individual in the population could expand its niche, or there could be greater among individual variation. Increased niche diversity may also arise due to divergent ecological selection among populations. We test predictions of these three mechanisms by comparing patterns of variation in functional traits across spatial scales in three species of Emberizid sparrows that colonized northeastern tidal marshes at different time scales (and thus show variation in species-level niche width). We focus on bill morphology, which has documented functional value associated with diet and thermoregulation. We further explore the effect of inter- and intraspecific competition and salinity and tidal regimes along an upriver gradient on patterns of variation. Populations with greater functional diversity are more likely to persist under changing ecological conditions, which has important conservation implications.

## **Effects of cattle grazing on Greater Sage-grouse and other sagebrush steppe birds**

Courtney Conway, U.S. Geological Survey; David Musil, Idaho Department of Fish and Game; Paul Makela, Bureau of Land Management; Shane Roberts, Idaho Department of Fish and Game; Karen Launchbaugh, University of Idaho; Andrew Meyers, University of Idaho

Livestock grazing policies on public land in the western U.S. are influenced by the perceived effect of grazing on Greater Sage-Grouse (*Centrocercus urophasianus*). However, few studies have examined the effects of different

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grazing regimes on sage-grouse or other sagebrush steppe birds. Since 2014, we have been conducting a collaborative experimental study to quantify the relationship between cattle grazing and sage-grouse demographic traits. We have also been examining the effects of the different grazing treatments on all sagebrush steppe birds via point-count surveys. The study includes a landscape-scale BACI experimental design to compare the effects of 4 grazing treatments (including a no-grazing treatment) on sage-grouse vital rates and songbird abundance. We also have examined the effects grazing intensity on sage-grouse vital rates and songbird abundance based on correlative analyses. We will show the association between grazing intensity and: 1) abundance of >10 species of songbirds, and 2) sage-grouse demographic traits based on data collected over the past 3 years from 5 study sites in southern Idaho.

## **Explaining population declines in cool-adapted species in the southern Appalachians: more questions than answers.**

Robert Cooper, University of Georgia; Richard Chandler, University of Georgia; Ryan Chitwood, University of Georgia; Mason Cline, New Mexico Department of Game and Fish; Joanna Hatt, New Mexico Department of Game and Fish; William Lewis, University of Georgia; Samuel Merker, University of Georgia; Kirk Stodola, University of Illinois

Many cool-adapted species, including migratory birds, which have a trailing edge of their range in the southern Appalachian Mountains are showing declines in those trailing-edge populations; our objective is to find out why. Our approach was to use a combination of broad-scale surveys, intensive demographic research, and experimentation, with an emphasis on potential effects of climate change as the main ecological driver of interest. Since 2002, we have studied populations of Black-throated Blue Warblers (*Setophaga caerulescens*) to estimate their vital rates on study plots at three different elevations. By 2008, the low elevation population declined to virtual extirpation. Fecundity and adult survival rates did not differ over this period among locations, but the low elevation plot failed to attract many second-year birds. Caterpillar abundance was lowest on the low elevation plot, and peaked earlier in the season compared with the other plots. Adult provisioning at nests and nestling weights were lowest on the low elevation plot as well. Habitat models of most cool-adapted species showed that occupancy was most strongly predicted by temperature and precipitation gradients rather than habitat structure and biotic interactions. Taken together, the results suggest an influence of climate factors on cool-adapted species in this region, with the most likely mechanism being lower food abundance. However, there are still numerous other potential drivers, which will be discussed.

## **Phylogeographic insights into the subspecific diversity of *Cinnyris reichenowi***

Jacob Cooper, The University of Chicago Committee on Evolutionary Biology

*Cinnyris reichenowi* is one of several species of sunbird (*Nectariniidae*) of sub-Saharan Africa referred to as the 'double-collared sunbirds'. These sunbirds are infamous for having similar phenotypes and confusing species limits. One of the more widespread taxa in this group, *C. reichenowi*, possesses two subspecies: nominate *reichenowi* of the East African highlands and *preussi* of the Cameroon Mountains. While taxonomic treatments of these populations have varied through time, these morphologically unique subspecies are now widely accepted. Surprisingly, recent collections-based research has shown that there exists a population of *Cinnyris* in Cameroon that is morphologically distinct from parapatric *preussi*, indicating the presence of a currently unrecognized taxon. Using genomic sequencing, collections, and historical accounts, I seek to resolve the phylogeographic relationships



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of one of Africa's most confusing bird lineages and determine exactly how many distinct types of double-collared *Cinnyris* exist in Cameroon and what they should be called.

## **Wintering distribution, migration routes, and migratory connectivity in the Kirtland's Warbler**

Nathan Cooper, Smithsonian Migratory Bird Center; Michael Hallworth, Smithsonian Migratory Bird Center; Peter Marra, Smithsonian Migratory Bird Center

The importance of understanding the geographic distribution of the full annual cycle of migratory birds has been increasingly highlighted over the past several decades. However, the difficulty of tracking small birds between breeding and wintering areas has hindered progress in this area. To learn more about Kirtland's Warbler (*Setophaga kirtlandii*) movement patterns throughout the annual cycle, we deployed archival light-level geolocators across the breeding range in Michigan. We recovered devices from 27 males and analyzed light-level data within a Bayesian framework. We found that most males wintered in the central Bahamas and exhibited a loop migration pattern. In both fall and spring, departure date was the strongest predictor of arrival date, but in spring, stopover duration and migration distance were also important. Though stopover strategies varied, males spent the majority of their spring migration at stopover sites, several of which were located just before or after large ecological barriers. The migratory periods remain the least understood periods for all birds, but by describing Kirtland's Warbler migration routes and timing, and identifying locations of stopover sites, we have begun the process of better understanding the dynamics of their full annual cycle. We will also present results from our most recent tracking effort, in which we attached 63 coded radio-tags to males and females in The Bahamas and used a network of automated telemetry towers to detect birds on the breeding grounds in Michigan.

## **Evaluating the cowbird control program to reduce conservation-reliance of the Kirtland's Warbler**

Nathan Cooper, Smithsonian Migratory Bird Center; Peter Marra, Smithsonian Migratory Bird Center

Brood parasitism is a fascinating breeding strategy in which one individual deceives another unrelated individual into hatching and raising its young. The Brown-headed Cowbird (*Molothrus ater*) is North America's most common avian brood parasite and is known to have laid eggs in the nests of 247 different "host" species. Due to presumed increases in cowbird population size and range, extremely high parasitism rates in some areas, and negative impacts on reproductive success, parasitism by cowbirds was implicated as one of the major drivers of the widespread decline of songbirds. However, more recent research suggests that cowbirds may only be a serious threat to avian populations when combined with other factors such as small population size, limited breeding habitat, and habitat fragmentation. Nonetheless, cowbird control programs are commonplace in some areas of the country, even though their effectiveness and necessity has rarely been assessed. In this talk we will use the Kirtland's Warbler cowbird control program as a case study to examine the possibility of reducing cowbird trapping while maintaining a sustainable, but less conservation-reliant Kirtland's Warbler breeding population.

## **Migratory stopover biology is not related to circulating testosterone levels**

Kristen Covino, Canisius College; Frank R. Moore, University of Southern Mississippi

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For migratory birds, a successful journey is dependent upon performance during migratory stopover as well as during migratory flight. During spring, migrating songbirds begin the development of breeding physiology, which may include increases in testosterone levels, as they approach the breeding grounds. Testosterone is an influential hormone mediating effects throughout the breeding season but its role during spring migration is understudied. We investigated the relationship between testosterone and stopover likelihood, stopover length, foraging behaviors, fuel deposition rate, and intensity of competition from other migrants in Black-and-white Warblers (*Mniotilta varia*) at a spring stopover site. Testosterone was unrelated to all measures of stopover biology. We also investigated variation in testosterone during the stopover period and found that testosterone was lower in birds after they had been at a stopover site for 2-14 days. To fully investigate the potential relationship between testosterone and stopover biology, future studies should experimentally manipulate hormone levels in free-living migrants.

## **Quantifying migratory behaviour using the Motus automated radio-telemetry array: opportunities and challenges.**

Tara Crewe, Bird Studies Canada; Jessica Deakin, Western University; Yolanda Morbey, Western University; Philip Taylor, Acadia University

The Motus Wildlife Tracking System (Motus) is increasingly being used to track the movements and stopover behaviour of migratory animals. Expansion of the network has been driven largely by 1) the small size of coded nanotags, which allows small animals including songbirds, bats, and insects to be tracked, and 2) the high temporal precision of data, which has allowed important and novel information on stopover and movement parameters to be estimated. However, challenges do exist. Detection places an individual within the detection range of a receiving station, yet little work has been done to test the performance of the system, including quantifying the detection range and detection probability of receiving stations, and how detection range and probability vary among sites and with bird behaviour (e.g., stopover vs. active migration). We used known positions of birds on stopover and actively migrating, collected using manual telemetry and GPS, respectively, to assess detection range of Motus towers, and how detection varied among sites and with habitat structure, distance from the receiver, and angle relative to the receiving antenna. We discuss results of these experiments, and how results might be used to 1) determine the ideal placement of receiving stations to meet research goals, and 2) contribute to the detection component of animal movement models. We also discuss current efforts to use signal strength data to derive a more precise position estimate for individuals detected by Motus, and how this might be used to further refine movement models.

## **Survival, Site Fidelity, and Territory Size of American Kestrels Wintering in South Texas**

Carter Crouch, Texas A&M University-Kingsville; Leonard A. Brennan, Texas A&M University-Kingsville; Robert H. Benson, Texas A&M University-Corpus Christi; Eric D. Grahmann, Texas A&M University-Kingsville; Fidel Hernández, Texas A&M University-Kingsville; Jeffrey F. Kelly, Oklahoma Biological Survey, University of Oklahoma

American Kestrels (*Falco sparverius*) are North America's most abundant falcon, but they are declining throughout much of their range. While nest success studies are prevalent, far less is known about kestrels during migration and on the wintering grounds. We conducted this study along county roadways in South Texas. We trapped and color marked 65 kestrels during October–December in 2014 and 2015 and searched for kestrels once per week using a spotting scope, until birds started departing winter grounds. We also searched for returning kestrels from

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September-March, 2015-2016 and 2016-2017. For individuals with  $\geq 10$  locations, we took the maximum linear distance between locations to estimate territory size. We estimated both raw site fidelity and site fidelity adjusted for winter mortality and dispersal. We used the Cormack-Jolly-Seber data type in Program MARK to estimate apparent survival. The average territory size ranged from  $531.4 \pm 32.3$  m in 2016-2017 to  $744.52 \pm 73.5$  m in 2014-2015. Our estimates of raw site fidelity ranged from 38.2% to 54.5% and adjusted site fidelity estimates ranged from 56.5% to 64.9%. Weekly winter survival estimates ranged from  $98.097 \pm 0.673\%$  for hatch year (HY) females to  $98.776 \pm 0.296\%$  for after hatch year (AHY) females that had returned to a winter territory. Our winter territory sizes (pooled over three years) were less than half the size of those previously reported, and our estimates of site fidelity are 10-19% higher than previously reported. This study will help scientists and management agencies better understand the wintering ecology of American Kestrels and kestrel demographics.

## **The return of Bald Eagles: Spatiotemporal dynamics of a recovering apex predator and beneficial management impacts**

Jennyffer Cruz Bernal, University of Wisconsin-Madison; Steven Windels, Voyageurs National Park; Wayne Thogmartin, U.S. Geological Survey, Upper Midwest Environmental Sciences Center; Shawn Crimmins, University of Wisconsin-Stevens Point; Lee Grim, Voyageurs National Park; Benjamin Zuckerberg, University of Wisconsin-Madison

Bald eagles have been rewilding North America following legal protection and the ban of DDTs. In recent decades, buffer areas around “at-risk” nests have been closed to human access in some National Parks to minimize disturbance on nesting bald eagles, but the ongoing benefits of this strategy remain unknown. We aimed firstly to quantify the long-term dynamics of bald eagle recovery in Voyageurs National Park (VNP), Minnesota. We used data from repeated aerial surveys of nest occupancy and productivity during 1973-2016, which we combined into an Integrated Population Model (IPM) to provide robust demographic estimates including: nest-level measures of occupancy, success, and high productivity, as well as population-level measures of abundance, growth rate, nest success rate, nest productivity and brood size. Secondly, we aimed to evaluate potential changes in the effectiveness of management at different stages of eagle recovery during 1991-2016. The breeding population of bald eagles remained small ( $< 10$  pairs) during the 70s and early 80s, increasing steadily in the late 80s, 90s and 2000s up to  $\sim 50$  breeding pairs. At a nest-level, management significantly improved the mean probabilities that a nest was occupied and successful, but not that it was highly productive. As avian predators recover throughout their former ranges, rigorous strategies are needed to monitor the dynamics of their recovery. Our study is a clear demonstration of the benefits of using IPMs to produce robust estimates of recovery dynamics based on multiple data sources and assess the potential impacts of management strategies on recovering avian populations.

## **Evolution of response to nest predators in passerines**

George Cummins, Northern Arizona University; Eben Paxton, Pacific Island Ecosystems Research Center-USGS; Tad Theimer, Northern Arizona University

The ability of birds to respond appropriately to nest predators may be compromised when birds have been free from predation for long periods or when novel predators are initially introduced. We experimentally tested the multipredator hypothesis, that as long as birds are exposed to one predator, they should retain antipredator

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responses to similar predator types even if those predators are absent, by quantifying reactions of five endemic and two introduced songbird species on the island of Hawaii to models of four different predators. We used a rat, an introduced predator to Hawaii, and a snake, a predator absent from Hawaii, while using a box and a branch as controls. We predicted that endemic Hawaiian birds will display antipredator responses to the rat, but would not respond to the snake. We also predicted that introduced bird species would respond to both the rat and snake according to the multipredator hypothesis. Consistent with our predictions, we found that 1) all birds reacted most strongly to the rat model, and 2) none of the endemic birds reacted to the snake model, while one introduced bird, the Red-billed Leiothrix (*Leiothrix lutea*), reacted as strongly to the snake as to the rat. Our results suggest that predator recognition has both learned and innate aspects, and provide partial support to the multipredator hypothesis. This is a hopeful message for conservation efforts trying to maintain endemic birds in the face of introduced predators and for reintroduction of naïve individuals to the wild.

## Testing prediction accuracy of spatially explicit models for grassland birds

Claire Curry, Oklahoma Biological Survey; Jeremy D. Ross, Oklahoma Biological Survey; Andrea J. Contina, Oklahoma Biological Survey; Eli S. Bridge, Oklahoma Biological Survey

Species distribution models are a useful predictive tool to help understand both where species may occur (and hence what areas should be protected) and what factors influence and constrain species' ranges. Because the processes underlying species distribution may vary by region, species distribution models can be made more accurate by use of new "Spatiotemporal Exploratory Models" (STEMs), a type of spatially explicit ensemble model developed at the continental scale. STEMs use regional models and average the predictions to create more accurate predictions of species distributions. This model framework was developed at a continental scale, so we tested its efficacy at a smaller, state-level scale. STEMs are computationally expensive, so we examined how much computational effort it takes to get increases in accuracy that come from using such a model. We develop a technique for mapping variable importance in these spatially explicit models using a mosaic of random forest variable rankings for variables of interest. Finally, we ask how estimates of distributional changes from climate change may be altered by use of different spatial scales. We used a combination of survey and citizen science data to test spatially explicit ensemble models at regional scales using random forest classification trees for 11 grassland species in Oklahoma, many of which are declining according to Breeding Bird Survey estimates. We present recommendations for use of spatially explicit models by managers based on increases in accuracy relative to the increase in computational time required.

## Efficacy of adjusted songs for communication in noise varies with infrastructure type and hormone levels

Claire Curry, Oklahoma Biological Survey; Paulson G. Des Brisay, University of Manitoba; Patricia Rosa, University of Manitoba; Nicola Koper, University of Manitoba

Birds' acoustic signals can be altered to make signals audible in noisy environments but these alterations can change the original information content, and thus communication efficacy might be compromised. Relatively little is known about whether signal adjustments actually improve communication or whether the adjustments help near infrastructure with differing frequency spectra. Response to signals is also physiologically mediated and the presence of infrastructure may stress individuals, altering their hormone levels. We studied territorial male Savannah Sparrows (*Passerculus sandwichensis*) at two types of oil-extraction infrastructure and at control sites, playing them songs sang originally in noisy environments and songs from quiet environments and measuring

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adrenocortical responsiveness (in corticosterone) of males at banding. We found that (1) males responded appropriately to noise-adjusted songs in the presence of some types of oil-extraction infrastructure but not others, (2) did not respond appropriately to songs that were produced in different acoustic environments, and (3) that adrenocortical responsiveness can alter the appropriateness of the bird's response to songs from a matching acoustic environment. Our results demonstrate that songs must be altered to receive appropriate responses in noisy sites, but that variation in physiological responses to different types of infrastructure result in varying effectiveness of signal alterations. Therefore, humans could reduce our ecological footprint by using less impactful infrastructure both to reduce masking and reduce the physiological changes resulting in communication disruption.

## **Effect of chronic anthropogenic noise on extra-pair paternity rate and mate choice of a threatened prairie obligate**

Marie-Eve Cyr, University of Manitoba, Natural Resources Institute; Nicola Koper, University of Manitoba, Natural Resources Institute

Prairies are among the most threatened ecosystems in North America due to habitat loss and alterations from human activities, such as oil and gas extraction. As the oil and gas industry continues to expand, this may present a growing threat to biodiversity reliant on prairies. Grassland birds have suffered significant declines in population size over the last half of the century. Our focal species, the Chestnut-collared Longspur (*Calcarius ornatus*) is a threatened prairie obligate. Oil infrastructure fragments the landscape and produces chronic low-amplitude noise, consequently altering the soundscape. Since acoustic signals play major roles in avian communication, birds are susceptible to such changes in the soundscape. Anthropogenic noise has the potential to alter perception and reception of acoustic signals that regulate mating systems leading to changes in preferences for social and extra-pair mates and, therefore, extra-pair paternity rates. This study isolated effects of noise from associated infrastructures by broadcasting high-fidelity playback oil-well noise in mixed-grass prairies of Southern Alberta from May to August 2016. During this period, 119 adults and 253 nestlings Chestnut-collared Longspurs were captured, and a total of 82 nests were sampled. We collected blood samples for genetic analyses and a series of morphometric measurements. Adults and nestlings were genotyped at 8 microsatellite loci to assess parentage. Using body condition indices, we evaluated differences in quality between socially paired individuals. The use of both genetic and physiological measures allowed us to assess impacts of oil infrastructure and isolated effects of noise on extra-pair behaviours and social-pair mate choice.

## **Fitness consequences of alternative migratory strategies in Western Bluebirds**

Catherine Dale, Queen's University; Joseph J. Nocera, University of New Brunswick; Drew Sauve, Queen's University; Kurt Kyser, Queen's University; Vicki L. Friesen, Queen's University; Laurene M. Ratcliffe, Queen's University

Partial migration occurs when only some individuals in a breeding population migrate. Two theories exist regarding the maintenance of partial migration over evolutionary time. The first suggests that migration and residency result in equal fitness returns, while the second proposes that one strategy (usually migration) is always inferior. Previous studies have found that migrants frequently have lower fitness than residents, implying that

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migrants may be 'making the best of a bad job'. In this study, we asked whether survival, body condition, and reproductive success differed between migrant and resident western bluebirds (*Sialia mexicana*) breeding in British Columbia, Canada. We used stable hydrogen isotope analysis to determine individual migratory strategies, monitored nests to determine the timing and fate of nesting attempts, used genetic analysis to assess parentage, and conducted site searches to resight banded birds in successive years. Approximately 40% of bluebirds were resighted the year after they were banded, but residents were not more likely to be resighted than migrants. Body condition, breeding phenology, total number of fledglings, and rates of extra-pair paternity did not differ between migrant and resident bluebirds. Average nestling mass was not related to migratory strategy in males; however, among females breeding for the first time, residents produced significantly heavier nestlings than migrants. Our results suggest that migration and residency result in equal fitness returns for males and older females, but that young females may incur a cost of migration for which they are unable to compensate.

## **Behavior and demography of HY Roseate Terns at a major tourist destination during the pre-migratory staging period**

Kayla Davis, Virginia Tech; Sarah M. Karpanty, Virginia Tech; Jeffrey A. Spindel, U.S. Geological Survey, Patuxent Wildlife Research Center; Jonathan B. Cohen, State University of New York; Melissa A. Althouse, State University of New York; Katharine C. Parsons, Massachusetts Audubon; Cristin F. Luttaza, Massachusetts Audubon

Prior to migration, many long-distance migratory birds congregate at forage-rich pre-migratory staging grounds, leaving birds vulnerable to the same threats at these areas. Roseate Terns (*Sterna dougallii*; ROST) are an ideal focal species for studying the effects of potential disturbance and environmental variables on staging bird behavior and demography because a large proportion of the northwest Atlantic population stages at or around Cape Cod, Massachusetts before post-breeding migration. We studied hatch-year (HY) ROST during two post-breeding staging seasons at Cape Cod National Seashore (CCNS) to determine the effects of possible disturbance (human and non-human activities) and environmental factors (year, time of day, and day of staging season) on HY ROST behavior. We also quantified HY ROST weekly residency to investigate potential limitations to HY ROST apparent survival during the staging period. In a mixed-effects logistic regression we found that probability of HY ROST locomotion increased with day of staging season, human activity (minutes humans were present during survey), and non-human activity (minutes any non-human entity was present during survey). Hatch-year ROST residency throughout the staging period at CCNS during the 2014 and 2015 seasons was nearly 1; thus, the human and non-human activities that increased HY ROST locomotion behavior did not limit HY ROST residency during the staging period at CCNS. Our results demonstrate that human and non-human disturbance sources alter HY behavior of this focal species, but human and non-human activities did not have a measurable effect on HY ROST residency during the staging periods we studied.

## **Song sparrows: as temperature decreases body size increases, always?**

Kyle Davis Ohio Wesleyan University; Dustin Reichard, Ohio Wesleyan University

Bergmann's Rule predicts that individuals within a species have larger body sizes in colder habitats. There are 24 subspecies of song sparrows (*Melospiza melodia*) in North America with three endemic to the eastern half of the continent and the remaining subspecies are located in the west. Agreement with Bergmann's Rule is well documented in the western song sparrow subspecies, but the eastern subspecies have not been tested. We sampled one metric of body size in three western subspecies: *M. m. fallax* (south), *M. m. morphna* (middle), and *M.*

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*m. kenaiensis* (north) and three eastern subspecies: *M. m. melodia* in Georgia (south), New England (middle), and northeastern Canada (north) by measuring the tarsometatarsus of 123 sparrows with digital calipers. In the west, *M. m. kenaiensis* (24.8 mm) was the largest, *M. m. morphna* (22.6) intermediate, and *M. m. fallax* (21.8), the most southern, was smallest. The differences among subspecies in the east were less extreme, but still consistent with Bergmann's Rule: northeastern Canada (22.2), New England (21.8), and Georgia (21.4). However, when compared statistically, only the western subspecies exhibited any significant differences among subspecies, as *M. m. kenaiensis* was significantly larger than all other subspecies, none of which differed significantly from each other. Thus, we found some support for Bergmann's Rule in western subspecies, but only if the northernmost subspecies is included in the analysis. The eastern subspecies exhibit a latitudinal cline in tarsus length predicted by Bergmann's Rule, but the differences between subspecies and latitudes are not statistically significant.

## **Correlated trait evolution among abiotic and biotic factors in a continental radiation (*Thraupidae*)**

Amelia-Juliette Demery, San Diego State University; Kevin J. Burns, San Diego State University; Nicholas A. Mason, Cornell University

Studying macroevolutionary patterns across large spatial and phylogenetic scales is crucial to understanding how biodiversity is generated. Here, we examine morphological variation in Tanagers, the largest family of songbirds, in combination with diet, song, and abiotic conditions to discover selective pressures associated with morphological evolution. We fit 20 morphological traits to evolutionary models and found support for either a lambda or kappa model of trait evolution reflecting deviation from Brownian motion. We found that diet significantly predicted beak shape. Overall size, beak, wing, and tail were significantly predicted by song, each suggesting a decrease in peak frequency and/or note rate with increasing trait size. Three quarters of traits best fit to a kappa model of evolution were significantly predicted by song variation, suggesting that relatively rapid morphological disparity across the clade could have occurred in response to relaxed ecological constraints and intensified sexual selection. In summary, we have shown that the evolution of bill morphology is associated with both diet and song. Our study highlights the utility of multidimensional comparative data to identify selective factors underpinning patterns of phenotypic evolution in large continental radiations.

## **The vocal behavior of a tropical resident songbird, the Rufous-capped Warbler**

Alana Demko, University of Windsor; Daniel Mennill, University of Windsor

Many songbirds use different song types in different contexts. In the family Parulidae, males in some temperate species use structurally-distinct song types or patterns of song delivery. Male vocal behavior in most tropical wood-warbler species remains undescribed, however, and female song is reported but poorly-documented. We provide the first quantitative description of vocal behavior in the tropical resident Rufous-capped Warbler (*Basileuterus rufifrons*) based on recordings of dawn and daytime song bouts from 50 color-banded males over three years in Costa Rica. We describe repertoire size, song organization, and repertoire sharing among males, and we examine seasonal and temporal variation in repertoire use. We show that males lack discrete song types; instead, they have repertoires of  $178 \pm 158$  song variants (unique syllable sequences) built from a pool of  $42 \pm 9$  syllable types with little within-song syllable repetition. Males share many syllables with neighboring males, such that males form neighborhoods of birds with similar syllable repertoires. Males have longer and more rapid song

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bouts at dawn than during the day, although they sing with immediate variety during both time periods. We also provide the first detailed analysis of song structure in females ( $n = 4$ ). Female songs have similar syllable types and organization to male songs, but they are shorter with less clearly formed syllables. Our research provides the first detailed vocal analysis in *Basileuterus* warblers, and will enhance our understanding of the evolution of repertoire specialization and female song among the Parulidae.

## Effects of northern hardwoods silviculture on forest bird community dynamics

Andrew Dennhardt, Michigan State University; Gary Roloff, Michigan State University; Doug Pearsall, The Nature Conservancy; Patrick Doran, The Nature Conservancy; Christine Hall, The Nature Conservancy.

The Two Hearted River Forest System (THFS; Luce County, MI) is a northern hardwood ecosystem recently managed by The Nature Conservancy (TNC) toward restoring forest diversity previously diminished by historic sugar maple production. For TNC, forest management is not only aimed at regenerating desirable tree species, but also focused on restoring more diverse forest structure and associated plant and animal community assemblages. TNC has been monitoring bird communities during varied harvest treatments on 5 sites (3 treatment areas, 1 no harvest control, and 1 reference old-growth site) in the THFS during 2010 – 2012. To understand how bird communities responded to silviculture in the area over time, we used multivariate statistical analyses to characterize local community structure. In addition to fine-scale field data on species' relative abundances and secondary variables observed at point-count locations, we also compiled data on broad-scale environmental correlates for use in regression. Results showed that stand-level species richness scores are a poor indicator of forest bird diversity status; whereas, stand-level species evenness scores provide more meaningful comparisons between and among sites. Broad-scale geophysical variables and fine-scale detection factors best explained bird community composition and individual species' abundances over time, and communities more closely resembled the reference old-growth site in areas treated with 60-ft canopy gap harvest prescriptions. Overall, our findings highlight potential issues with using broad diversity metrics to quantify community-level responses to harvests and multivariate analyses of species' abundance may provide more meaningful interpretations of ecological community responses to modern silviculture in the Anthropocene.

## Cultural, genetic, and behavioral divergence coincide in an avian hybrid zone

Elizabeth Derryberry, University of Tennessee Knoxville; Sara Lipshutz, University of Tennessee Knoxville; Isaac Overcast, City College of New York; Mike Hickerson, City College of New York; Robb Brumfield, Louisiana State University

Divergence in sexual signals may drive reproductive isolation between lineages, but behavioural barriers can weaken in contact zones. Here, we investigate the role of song as a behavioural and genetic barrier in a contact zone between two subspecies of White-crowned Sparrows (*Zonotrichia leucophrys*). We employed a reduced genomic data set to assess population structure and infer the history underlying divergence, gene flow and hybridization. We also measured divergence in song and tested behavioural responses to song using playback experiments within and outside the contact zone. We found that the subspecies form distinct genetic clusters, and demographic inference supported a model of secondary contact. Song phenotype, particularly length of the first note (a whistle), was a significant predictor of genetic subspecies identity and genetic distance along the hybrid zone, suggesting a close link between song and genetic divergence in this system. Individuals from both parental and admixed localities responded significantly more strongly to their own song than to the other subspecies song,



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supporting song as a behavioural barrier. Putative parental and admixed individuals were not significantly different in their strength of discrimination between own and other songs; however, individuals from admixed localities tended to discriminate less strongly, and this difference in discrimination strength was explained by song dissimilarity as well as genetic distance. Therefore, we find that song acts as a reproductive isolating mechanism that is potentially weakening in a contact zone between the subspecies. Our findings also support the hypothesis that intraspecific song variation can reduce gene flow between populations.

## **Corticosterone is not a consistent predictor of response to disturbance in three grassland songbirds**

Paulson Des Brisay, University of Manitoba; Marty Leonard, Dalhousie University; Nicola Koper, University of Manitoba

The non-lethal effects of human disturbance on wildlife may be contributing factors to population declines, particularly in sensitive or at-risk species. However, the presence and magnitude of these effects can be hard to demonstrate. Corticosterone (the primary glucocorticoid in birds) may provide an opportunity to examine the presence of non-lethal impacts from human development by indicating if individuals are exhibiting physiological coping mechanisms. The mixed-grass prairie region of Canada has recently undergone rapid oil development, fragmenting grassland habitat and introducing novel physical and acoustic features onto the landscape, and may be contributing to the drastic declines seen in grassland bird populations. We examined how oil wells and the associated linear disturbances impact circulating levels of corticosterone in one stable (Savannah Sparrow), and two declining (Baird's Sparrow and Chestnut-collared Longspur) species of grassland songbirds. We assessed whether higher or lower levels of corticosterone were consistent with impacts on settlement patterns, physical condition, and reproductive success across species. We found that changes in corticosterone levels were not consistent in direction or magnitude between species in response to disturbance. However, we found that density of and proximity to roads had a greater impact on corticosterone, suggesting roads may be more impactful than the oil wells themselves. Reducing the number of roads constructed during oil development by clustering wells may help reduce the impact of these disturbances on grassland bird communities.

## **Mining biological data from weather radar: where great potential meets great challenges**

Robb Diehl, US Geological Survey; Sidney A. Gauthreaux, Jr. University of Illinois

The biological potential of weather radar remains largely unrealized, and the implications are far reaching. Flying animals directly influence a wide range of areas (e.g., species management and conservation, flight safety, alternative energy development, disease tracking, ecosystem services) that have serious implications for the well-being of animal populations as well as human health and economic security. Central to addressing these challenges is developing the capacity to reliably mine taxon-specific biological data from real-time and archived weather radar data streams. Using data from the US next generation radar system (NEXRAD), seven different radar echo types were identified for classification, six biological and one meteorological. A concerted effort was made to train classification algorithms using only radar types uncontaminated by other sources of radar echo. Results from a general purpose ensemble learning algorithm shows how classification accuracy varies with taxon, degree of biological aggregation, polar dependence, behavior, and parameter set. This pilot effort suggest classification of specific radar biological types is tractable and shows promise. The most accurate classifications will likely mix

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features from radar and natural history while adopting a strategic approach to classification that includes favoring more specific over more general classification models.

## **Mountain Plover (*Charadrius montanus*) nest spacing patterns in Montana**

Stephen Dinsmore, Iowa State University; Zachary J. Ruff, Iowa State University

The spatial distribution of bird nests across a landscape or within a breeding colony may stem from a number of underlying processes, including uneven distribution of suitable nest sites, food or other resources, territoriality and interactions with conspecifics, optimal defense against predators, or other factors. Analyzing patterns in these distributions provides insights into these underlying processes. We investigated the spatial pattern of Mountain Plover (*Charadrius montanus*) nests using location and nest survival data from >1500 nests located on black-tailed prairie dog (*Cynomys ludovicianus*) colonies in Phillips County, Montana. We used the K and G functions to characterize the clustering or dispersion of plover nests at multiple spatial scales using all pairwise inter-nest distances and all nearest-neighbor distances, respectively. Both the K and G functions provided evidence that plover nests are more regularly spaced at small spatial scales (<200 m) than would be expected under random placement. We used information on the distances between each nest and its local neighbors as well as data on the placement of nests within the host colony to explore the effects of spatial clustering on nest survival. There were no significant effects of the placement of nests within the host colony or relative to each other on daily nest survival. This implies that regularity in the spacing of Mountain Plover nests on prairie dog colonies is likely an effect of competition rather than a response to nest predation or other sources of nest mortality.

## **Estimating continent-wide productivity and survival from migratory fluxes detected by weather radar**

Adriaan Dokter, Cornell Lab of Ornithology; Andrew Farnsworth, Cornell Lab of Ornithology; Steve Kelling, Cornell Lab of Ornithology

Global anthropogenic changes pose serious threats to already declining populations of many migratory birds. These changes may not be uniform in space or time, and detecting these changes has been difficult because of the large spatial and temporal scales involved, the broad distributions of many migratory bird species, and the challenges of analyzing such large quantities of data. Yet, a comprehensive long-term and large-scale understanding of the seasonal distribution and population dynamics of migratory birds is needed urgently. Weather surveillance radar networks provide unique opportunities to address these difficulties. Although these sensor networks were designed to study meteorology at local to continental scales, radar can also measure migratory fluxes of birds into and out of geographic areas in a standardized and continuous way. Influx and efflux budgets can potentially reveal information on hotspots and variations in large-scale productivity and mortality. Using the full network of WSR-88D radars in the US, we show how the total number of birds passing radars stations in spring and autumn varied consistently among different radars, and that large differences exist between spring and autumn in the number of migrants in this region. We suggest we can use these sensors to monitor numbers and trends in the total number of migrants moving above a continent. We further outline how we are harnessing the power of cloud computing to analyze the entire US weather radar archive dating to 1991, paving the way to the analysis of multi-decadal changes in the spatiotemporal dynamics of full flyways and of long-term trends in continent-wide multi-species productivity and survival estimates.

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## **Variation in SA-alpha2,3-Gal is linked to variation of avian influenza viral shedding in Mallard ducks**

Amanda Dolinski, Michigan State University; Jennifer Owen, Michigan State University

Mallards (*Anas platyrhynchos*) are an important natural host for low path avian influenza viruses (LPAIV). Within a population there is extreme variation in the amount of virus shed with 20% of the population accounting for 80% of the shed virus. LPAIV replicates in the intestinal tract of these ducks by attaching to alpha-2,3-galactose (SA-alpha2,3-Gal) linked receptors located on the surface of host intestinal epithelial cells. The objective of this study was to determine if variation in abundance of SA-alpha2,3-Gal in sections of the intestines and bursa of Fabricius corresponds to observed variation in viral shedding. Wild mallard eggs (n=70) were collected from uncultivated fields in Northeastern North Dakota, then hatched and raised in captivity. At 2-3 months of age they were orally infected with LPAIV H5N9 (n = 60) or sham-inoculated (n=10). Viral shedding was assessed via cloacal swabs collected at different time points post infection. Ducks (n= 10-15) were sacrificed at 1, 2, 5, 15, and 29 days post infection (DPI). Using Image-J we quantified the concentration of SA-alpha2,3Gal by lectin staining (Maackia amurensis agglutinin I) in the duodenum, jejunum, ileum, cecum, colon, and bursa of Fabricius. Mallards exhibit marked variation in SA-alpha2,3Gal concentration throughout the intestines, while the bursa remained relatively consistent. Further, the concentration of receptors is positively correlated with the total virus shed by individual birds. While we cannot establish cause and effect, a better understanding of the inherent variation in SA-alpha2,3-Gal could be the key to understanding the variation in viral shedding by individuals within a population.

## **Kirtland's Warbler summer and winter habitat changes in response to future climate condition scenarios**

Deahn M. Donner, US Forest Service; Christine A. Ribic, U.S. Geological Survey; Donald J. Brown, West Virginia University; Daniel M. Wolcott, University of Wisconsin-Madison; Carol Bocetti, California University of Pennsylvania; Tim Greco, Michigan Department of Natural Resources; Mark Nelson, Northern Research Station, U.S. Forest Service

Long-term conservation of the endangered Kirtland's Warbler requires assessing impacts of changing environmental conditions on their breeding and wintering grounds. Shifting precipitation and temperature patterns in the Midwest may affect establishment and growth of jack pine, the species primary breeding habitat, while drying conditions and sea-level rise may threaten habitat quality and quantity within their Bahamian wintering grounds. We modeled jack pine occupancy and growth in relation to several environmental variables under current and future climate scenarios to determine if shifts in distribution and growth rate may occur. Our models projected that jack pine distribution across the Upper Midwest could decrease by up to 90% by 2099, and up to 50% of current Kirtland's Warbler Management Areas could become unsuitable for jack pine. We also projected winter precipitation and temperature across the Bahamian archipelago and determined how much winter habitat (open lands) was susceptible to 1- and 2-m sea-level rise. Islands currently used by Kirtland's Warbler are predicted to become warmer and wetter, except during March when the central islands are predicted to go through a drying trend that may influence food supply prior to migration. Greatest loss of open land was predicted for the northern, lower-elevation islands. From a conservation perspective, the central Bahamian islands, which currently contain the majority of the wintering population, will be critical islands on which to focus climate adaptation efforts. In the Great Lakes region, new habitat management areas may be necessary to adapt to the potential loss and redistribution of jack pine habitat.

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## **Seasonal rainfall influences intra- and inter-seasonal variation in territoriality of a wintering migratory songbird.**

Bryant Dossman, Cornell University; Amanda D. Rodewald, Cornell Lab of Ornithology; Peter P. Marra, Smithsonian Migratory Bird Center

The role of territoriality and space use in regulating animal populations is arguably one of the most important concepts in population ecology. For migratory birds, territoriality during the non-breeding season is primarily driven by competition over food. However, despite profound consequences for population dynamics, temporal variation in territorial behavior has yet to be examined. Given the importance of rainfall on insect (food) abundance and redstart ecology, we hypothesize that variation in territorial behavior will be influenced by annual and seasonal variation in rainfall. To test this hypothesis, we utilize the long-term model system of American Redstarts *Setophaga ruticilla* wintering in Southwest Jamaica. Using a dynamic occupancy approach, we directly estimate territory-fidelity (site occupancy) within and between seasons. Rainfall has been previously shown to influence redstart ecology and will be used in this analysis to determine its effect on modifying the strength of territoriality. This study is the first to investigate the extent of intra-seasonal variation in territorial behavior brought upon by variation in seasonal rainfall. With ongoing declines in rainfall predicted to continue throughout the Caribbean, future efforts will seek to build upon the potential implications that variation in territorial behavior will have on population dynamics of migrants wintering in the Caribbean.

## **Characterizing the aerial behavior of three North American hirundines from an individual perspective using a novel altitudinal datalogger**

Andrew Dreelin, Cornell University; J. Ryan Shipley, Cornell University; David W. Winkler, Cornell University

Swallows and martins (Aves: Hirundinidae) are well-studied with respect to their breeding biology, but major aspects of their aerial behavior and ecology are relatively poorly understood. To better understand their aerial behavior, we deployed a novel tag technology, an altitude datalogger, on breeding populations of Purple Martin (*Progne subis*), Tree Swallow (*Tachycineta bicolor*), and Barn Swallow (*Hirundo rustica*) in upstate New York during the summer of 2016, providing accurate, individual-level flight data with a fine temporal resolution. Using linear models, we investigated differences in altitudinal behavior between species and the relationship between atmospheric conditions and flight altitudes in each species. The major findings were 1) that the three study species partition the aerial environment into distinct strata, presumably due to foraging specialization, 2) individuals of each species responded differently to atmospheric conditions depending on the time of day and altitudinal stratum, and 3) species differed from one another in the relationships between their flight altitudes and weather variables, suggesting different adaptive strategies for tracking their environment and/or prey. More research is needed to determine the precise relationships between specific meteorological variables and altitude, and we encourage broader use of this methodology to better understand the behavior and ecology of aerial insectivores globally.

## **Bird specimens track 135 years of atmospheric soot and environmental policy**

Shane DuBay, University of Chicago; Carl Fuldner, University of Chicago

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Natural history collections have become powerful resources for tracking environmental pollutants through time. We analyzed a time series of >1300 bird specimens to reconstruct trends in atmospheric soot (also known as black carbon) within the U.S. Manufacturing Belt between 1880 and 2015. At the start of the twentieth century dense clouds of soot engulfed industrial cities. These sources of atmospheric black carbon are recognized as major contributors to climate change, but estimates of black carbon emissions for the early industrial era have high uncertainty because air-quality sampling was sparse before 1950. Without reliable emissions estimates for this period, it has been difficult to accurately model the historical effects of black carbon on climate forcing. By quantifying the relative “sootiness” of each specimen from photometric reflectance data, we recovered historical black carbon emissions estimates that extend back >70 years before systematic air-monitoring networks were in place. Our results show that black carbon deposition on bird specimens peaked during the first two decades of the twentieth century. The first precipitous drop coincided with a temporary reduction in overall coal consumption during the Great Depression. A second and lasting drop in atmospheric soot began after WWII and continues to present day. Our findings show that the mitigation of atmospheric soot coincided with policies that promoted burning efficiency and fuel transitions rather than regulating emissions directly. We also find that current emissions inventories underestimate past levels of atmospheric black carbon, suggesting that the contribution of black carbon to climate forcing may also be underestimated.

## **Using social media to help drive your own research article’s Altmetric Attention Score**

Steve Dudley, British Ornithologists' Union (BOU)

The Altmetric Attention Score of a research article is a metric for our digital and social media age, as this article-level metric measures the online attention, not scientific quality, of an article. Altmetrics were launched mainstream by most journal publishers in 2014. The BOU was already using social media to promote our journal articles in IBIS, and now we had a means to measure the impact our outreach. Getting research talked about is not only good for science, but also has benefits for authors, journals and publishing societies. But it occurred to us that in order for the ornithology community to get behind this new metric, it required independent, within-sector education to gain traction, which the BOU could provide. Three years on, and working with an increasing number of partners, the ornithology community’s understanding of altmetrics has greatly improved. This has led to an increasing number of researchers taking up social media, including blogging, to help drive the Altmetric Attention Score of their own research articles. From a study of over 6,500 articles from 10 ornithology journals, I will illustrate how authors, institutes and publishing societies can help drive the Altmetric Attention Score of their own research articles. This will include an author who drove the score of his own paper to become the highest scoring altmetric paper in IBIS; and a UK institute who used the Altmetric Attention Scores of their staffs’ research articles as a means to measure, and drive, the outreach of their own research output.

## **Breeding propensity and age-at-1st reproduction of Adélie penguins in a multi-colony meta-population**

Katie M. Dugger, U.S. Geological Survey and Oregon State University ; David G. Ainley, H.T. Harvey and Associates; Grant Ballard, Point Blue Conservation Science; Phil O’B. Lyver, Landcare Research; Kerry Barton, BartonK Solutions

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Adélie penguins (*Pygoscelis adeliae*) exhibit high survival, breeding philopatry and delayed maturation, but, unlike many other seabirds, environmental variation leads to periods of variable survival and relaxed breeding philopatry. The dynamics of juvenile survival, age-at-1st reproduction, and breeding propensity are poorly understood for this and many species but likely play a large role in population dynamics. Using a long-term mark-resight data set (18 years) collected on individuals banded as chicks and multi-state capture-recapture models, we estimated age-at-1st reproduction and breeding propensity for 3 colonies of a 4-colony metapopulation in the Ross Sea, Antarctica in relation to expanding colony size (which span 3 orders of magnitude) and environmental variation. Penguins recruited into the breeding population starting at age 3, and the probability of becoming a breeder increased through age 8, with dramatic declines in recruitment rate estimated for older age classes. We observed no differences in age-related probability of recruitment among the colonies, but average age-at-1st reproduction did vary by colony as a function of colony-dependent, age-related apparent survival rates. Adélie penguins do not breed every year after recruitment and breeding propensity was variable by year and colony, averaging 56-64% across the study. We continue to investigate whether temporal variation observed in annual recruitment rates and breeding propensity can be explained by environmental variation. Identifying the underlying mechanisms that maintain the large degree of size discrepancy among these 3 colonies and the role annual environmental variation plays in maintaining this system is needed to understand the population dynamics of this meta-population.

## **Red-breasted Nuthatch irruptions in eastern North America: insights from citizen science**

Erica Dunn, Environment and Climate Change Canada

Irruptions of Red-breasted Nuthatch (*Sitta canadensis*) in eastern North America from 1961-2012 were described using data from Long Point Bird Observatory (southern Ontario), the Christmas Bird Count, Project FeederWatch, eBird and the Breeding Bird Survey. Fall movements through Long Point were of all magnitudes, from almost none to very large numbers. Recognizable irruptions averaged every two years, but patterns were irregular. Spring return flights were smaller, but similar in proportion to fall numbers regardless of irruption size. Fall movements through Long Point were positively correlated with that summer's Breeding Bird Survey indices in eastern Canada. Birds returning in spring after large irruptions were lighter than in years with little exodus, and Breeding Bird Survey indices following irruptions were also lower. Results illustrate the growing value of citizen science data sets for integrated study of population dynamics.

## **Occupancy of tree cavities as they age: selection for young, mid-aged and older nesting cavities by cavity-nesting vertebrates**

Amanda Edworthy, Washington State University; Kurt Trzcinski, University of British Columbia; Kristina Cockle, Proyecto Selva de Pino Parana; Karen Wiebe, University of Saskatchewan; Kathy Martin, University of British Columbia

Tree cavities are a critical nesting resource for many forest birds and mammals. In temperate systems, cavities can last for more than 25 years and their characteristics change with time, potentially influencing their value as nesting sites. In the context of wildlife and forest management, we investigate the relative value of generating a supply of fresh cavities—which are thought to be of high quality—versus protecting cavities as they age and expand in interior volume. For 20 years (1995-2015), we monitored the formation and occupancy of tree cavities used by more than 30 species of birds and mammals in interior British Columbia, Canada. Cavity occupancy by secondary

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users was highest 1-year post-excavation (66%), then declined to 37% after two years, remained at  $33 \pm 7\%$  between 3 and 16 years of age, and increased to 50% use from 17-19 yr post-excavation. Excavators that reused cavities (woodpeckers, nuthatches) strongly selected for one and two year old cavities, while large-bodied species (ducks, raptors, squirrels) selected mid-aged cavities and Mountain Bluebirds and Tree Swallows selected the oldest cavities. Cavities in living aspen trees, especially those excavated by northern flickers maintained occupancy by secondary users well across cavity age, and provided the bulk of cavities used in this system. Our results emphasize the need for diverse excavator communities to generate a supply of fresh cavities, but also the need to retain the mid-aged and older cavities to provide nest sites for large-bodied species (as cavities increase in volume with age).

## Estimating avian diversity in western Waorani territory using indigenous habitat designations

Rory Eggleston, Duke University; Stuart Pimm, Duke University

With oil exploration and road construction expanding in the Ecuadorian Amazon, new and integrative survey and conservation methods are needed to keep abreast of this development and degradation. Many indigenous communities are also threatened by oil exploration, namely the Waorani of eastern Ecuador, and many community members want to participate in conservation research and application. Working alongside people from the Waorani community of Keweriono, we compiled information on traditional Waorani habitat designations and their species compositions, and recorded bird songs and calls in the most common of these traditional habitat types. Comparing the species compositions of the Waorani habitat types with the more generalized models typically used in ecological research (such as terra firme forest and riparian habitats), we found that there is significant overlap between many of the Waorani-designated habitat types and the more widely accepted habitats. The many similarities between the two types of habitat designation mean that using the Waorani designations in ecological and conservation research in this region could be instrumental to furthering understanding of microhabitats and also integrating community members into research and conservation. Thus, although this study was small in scale, this methodology warrants further research and application, and represents a new and integrative approach to community-based research and conservation, with potential benefits for both community protection and long-term monitoring of biodiversity.

## Broccoli or candy: What should I feed my captive bird?

Kayla Eggleston, Ohio Wesleyan University; Elizabeth M. Schultz, Kenyon College; Dustin G. Reichard, Ohio Wesleyan University

Proper diets for captive birds depend on our knowledge of each species' nutritional requirements, placing captive individuals at higher risk of malnutrition. In the wild, the Budgerigar (*Melopsittacus undulates*) consumes a diet consisting predominantly of native Australian grass seeds. It is generally considered advantageous to model captive diets after wild diets, but species that have been bred for many generations in captivity may no longer follow this rule. The common nutritional recommendations for Budgerigars and other psittaciforms are almost entirely based upon data from poultry (*Galliformes*). Commercially available diets that are fed to captive Budgerigars often either lack essential nutrients (seed diets) or they contain potentially toxic levels of certain vitamins and minerals (formulated pellet diets). In this study, we examined the relationship between diet and

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immune function by separating 36 budgerigars into three diet groups: (1) Roudybush formulated pellet diet, (2) Kaytee Forti-Diet Pro Health seed mix, and (3) a mimic natural seed diet of our own design. We monitored weight, conducted bacterial killing assays with *E. coli* and *C. albicans*, and collected blood smears over a period of 8 weeks. Because malnutrition in Psittaciformes is often linked to the most common clinical appearances of captive animals, we predicted that nutrient deficient diets would cause a negative effect on immune function and body weight. However, we observed no significant effects of diet on bird weight or bacterial killing ability. The roudybush diet did result in smaller fluctuations in *E.coli* killing ability and may provide the most consistent nutrition.

## **Seasonal changes in songbird detection in urban forests: implications for studies of emerald ash borer invasion dynamics**

Mandy Ehnes Nipissing University ; Jennifer Foote, Algoma University; Jeff Dech, Nipissing University; Joe Meating, BioForest Technologies

Forests provide important breeding habitat for many avian species. Emerald ash-borer (EAB) is an invasive beetle that kills North American ash trees creating gaps in the upper canopy of forests and has the potential to change avian community composition in affected woodlots. Forests in Southern Ontario are particularly at risk due to large ash components and close proximity to EAB infested urban centres. Ash species are late to leaf-out compared to other tree species, doing so after most migratory birds have returned. Our study seeks to determine optimal timing for sampling avian communities in mixed-wood stands susceptible to EAB. We used automated recording to sample breeding birds in forest tracts of either moderate (10 – 29%) or major (30%) ash composition, in York Region, Ontario. Thirteen plots were recorded for 2 days in mid-May (before ash flush) and again in mid-June (when most EAB related forestry work is conducted). We found that among early recordings, there are similar trends in community composition across forest tracts varying in ash composition. Overall, significantly more species were detected in May compared to June. Significantly fewer species of migrants, insectivores, omnivores, and upper canopy species were detected in June. However, significantly more bark gleaners were detected in June. Our results demonstrate the importance of early sampling during the breeding season to detect shifts in vulnerable upper canopy species that may be affected by EAB invasions. Additionally, we found an increase in bark foraging birds later in the season when EAB typically emerges.

## **Area sensitivity of birds in mixed-grass prairies: Does the paradigm differ between forests and prairies**

Mike Eichholz CWRL, Center for Ecology, Southern Illinois University Carbondale

Area sensitivity describes relationships between habitat patch size and animal population dynamics. First used to explain why forest fragmentation has negatively influenced breeding populations of forest nesting birds, it has evolved into an accepted paradigm for habitat managers across a range of habitat types including short- and mixed-grass prairies. Evidence supporting this paradigm for grassland nesting birds in short- or mixed-grass prairies is, however, limited. I review the potential mechanisms by which area sensitivity may act and present results of studies conducted in the prairie pothole region of North and South Dakota suggesting area sensitivity and specifically edge effects differ between fragment forests and mixed grass prairies patches ranging in sizes of 60 to 400 ha. Nest success of upland nesting ducks declined with patch size until patch size reached approximately 200 ha, at which point the relationship became positive. Furthermore, we found no evidence distance to edge influenced nest success or parasitism rate of passerine nests and edge type had only a marginal impact with wetland edges providing the higher likelihood of nest parasitism. These results indicate that grassland birds have



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neither adapted the ability to use patch size as a habitat selection characteristic or receive benefit from choosing larger patches. Furthermore, consistent with other studies, I found nest success actually declines with increasing patch size for patches ranging in size most frequently preserved and the habitat conservation organizations in this region may be developing prairie patches of sizes that are the least beneficial to grassland birds.

## **Forage fish abundance in Common Tern diets, and its implications for seabird populations**

Aspen Ellis, University of Michigan; Paula Shannon, Project Puffin

Overfishing and climate change are affecting the abundance and phenology of fish worldwide. There is ample evidence that forage fish availability and seabird colony health and success are correlated, and that climate change is affecting dietary composition. Visual observations of chick provisioning at a Common Tern (*Sterna hirundo*) colony during fieldwork indicated that the abundance of primary forage fish, Atlantic herring (*Clupea harengus*) and hake/four-beard rockling (*Urophycis tenuis/Enchelyopus cimbrius*) had declined, whereas poorer food items like butterfish (*Peprilus triacanthus*) and invertebrates had increased. However, this observation had not been tested quantitatively. In this paper, we used long-term monitoring data from feeding studies and productivity studies to test the abundance of the forage fish in Common Tern diets from 2002-2016 on Jenny Island, Maine, and considered what it means for seabird productivity. We found a significant decline of hake in Common Tern diets over the study period, though no significant change was observed in the abundances of Atlantic herring, butterfish, and invertebrates, nor in the productivity of Common Terns. While the declines of hake and the possible declines of Atlantic herring are in line with our predictions, these results are inconclusive for determining whether the diet quality of Common Terns is declining, or if it is affecting overall colony health. However, the declines that were found could have alarming implications, for the future health and success of the North Atlantic populations of Common Terns and other seabirds.

## **American Woodcock (*Scolopax minor*) movement ecology in Louisiana, USA**

Elisa Elizondo, Louisiana State University; Bret A. Collier

The American Woodcock (*Scolopax minor*) has experienced steady population declines across its range attributed to loss of early successional habitat. Although American Woodcock habitat use has been studied on its breeding grounds, there are fewer data regarding the migratory and wintering ground habitat use. Previous studies also relied on abundance surveys or VHF radio tags, limiting the temporal resolution of spatial data collected. We conducted a study in Louisiana to assess the movement of wintering American Woodcock in the state between November 2015 and February 2017 utilizing newly developed GPS tags as well as VHF and PTT tag technology. GPS tags were deployed utilizing back-style attachment and programmed to record time-specific spatial data during both diurnal and nocturnal periods. We recovered data for 31 woodcock and generated Minimum Convex Polygons to estimate day-specific ranges, which we then sampled to identify and evaluate vegetation structure. We found that American Woodcock regularly utilized mixed-pine and bottomland hardwood habitats within 1.5 km of nightly foraging habitat. The overall area covered by GPS-tagged birds was on average 0.110 ha during the day and 0.239 ha at night. Woodcock moved on average 1.03 km from their diurnal habitat to their nocturnal habitat when moving from a forested area to an open field, a movement attributed to their foraging strategies. Our data set

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allows for the exploration of daily/nightly range sizes as well as foraging patterns of woodcock across the state of Louisiana, thereby providing managers with new insight into managing strategies for this declining species.

## **Degree of female ornamentation is associated with aggression and circulating androgens in a tropical passerine bird**

Erik Enbody, Tulane University; Jordan Boersma, Washington State University; Hubert Schwabl, Washington State University; Jordan Karubian, Tulane University

Elaborate plumage ornaments are used as signals in many passerine birds for conspecific communication. In males, there is widespread support for the function of plumage ornaments in aggressive and mating contexts. These behaviors may also be associated with higher levels of circulating hormones, such as testosterone. Ornaments are common in females, but the function of and underlying mechanism for the production of female ornaments is less clear. We use the White-shouldered Fairywren (*Malurus alboscapulatus*), that varies in female (but not male) ornamentation, to assess the mechanism for and function of female ornaments. The study design was to compare females from two populations: one with ornamented females and the other with unornamented females. We found that females with ornamented plumage have higher levels of androgens, consistent with the idea that ornamentation is associated with an increase in testosterone. We also found that more ornamented females responded more aggressively and used more pair coordination behaviors when presented with experimental mounts, simulating territorial intrusions. Our findings are consistent with the idea that variation in female ornamentation may be associated with increased aggressive behavior and pair territorial defense. We suggest that female ornamentation in this system may signal aggression or dominance, and be achieved via proximate mechanisms similar to those used by males.

## **Assessing the risks of pesticides to bird populations in agroecosystems**

Matthew Etterson, US Environmental Protection Agency; Kristina Garber, US Environmental Protection Agency; Ed Odenkirchen, US Environmental Protection Agency; Nathan Schumaker, US Environmental Protection Agency

Insecticide usage in the United States is ubiquitous in urban, suburban, and rural environments. The United States Environmental Protection Agency (USEPA) assesses risks of insecticides to terrestrial and aquatic organisms, using a taxa-based approach, which includes birds. Current USEPA risk assessments for pesticides generally rely on measurements of egg viability, eggshell thickness, and egg hatchability from laboratory based toxicity studies and do not directly assess population-level endpoints. We present a mechanistic model, comprised of two submodels, TIM and MCnest, which allows risk assessors to estimate the effects of insecticide exposure on the survival and fecundity of birds known to forage in agricultural fields during their breeding season. This model relies on individual-based toxicity data and translates effects into endpoints meaningful at the population level (i.e., magnitude of mortality and reproductive impairment). The model was used to assess the relative risk of 12 insecticides applied via aerial spray to control corn pests on a suite of 31 avian species known to forage in cornfields in agroecosystems of the Midwest, USA. We found extensive differences in risk to birds among insecticides, with chlorpyrifos and malathion (organophosphates) generally posing the greatest risk, and bifenthrin and  $\delta$ -cyhalothrin (pyrethroids) posing the least risk. Comparative sensitivity analysis across the 31 species showed that ecological trait parameters related to the timing of breeding and reproductive output per nest attempt offered the greatest explanatory power for predicting the magnitude of risk. Future work with TIM/MCnest will implement the model in the HexSim spatially explicit modeling environment.

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## **Adult and juvenile Bank Swallows (*Riparia riparia*) show differential post-fledging movements and departure for autumn migration**

Dean Evans, University of Western Ontario; Greg Mitchell, Environment and Climate Change Canada; Myles Falconer, Bird Studies Canada; Douglas Tozer, Bird Studies Canada; Mike Cadman, Canadian Wildlife Service

Due to the difficulty of tracking birds once they leave the nest, the post-fledging period is often the least understood part of the avian life cycle. However, recent advances in automated radio telemetry are allowing for the smallest of birds to be tracked at greater temporal and spatial scales. Bank Swallows (*Riparia riparia*) are a threatened long distance neotropical migrant and little is known about their pre-migratory and migratory movements, especially in North America. We used the Motus Wildlife Tracking System to track the post-fledging movements and autumn migration departure decisions of adult and juvenile Bank Swallows in southern Ontario, Canada. We show that juveniles travel greater distances ( $1,416 \pm 821$  km (mean  $\pm$  SD) versus  $507 \pm 309$  km) and depart later (14.6 days) than adults. This is consistent with the exploration hypothesis whereby post-fledging movements are for exploring to assess habitat and social cues for future breeding as well as to aid in future navigation. We found four prevalent departure routes across Lake Erie with respect to the onset of migration, including direct over water crossings from Long Point or Point Pelee and movements around the eastern and western sides of the lake. Together, these routes suggest birds try to minimize or eliminate large over water flights. This is the first study to examine the post-fledging movements and departure choices of Bank Swallows in North America. We also show the value of automated telemetry in the study of small species for which other tracking methods do not work.

## **Conservation of the Kirtland's Warbler: Future considerations**

David Ewert, The Nature Conservancy; Abigail Ertel, Huron-Pines; Keith Kintigh, Michigan Department of Natural Resources

The Kirtland's Warbler (*Setophaga kirtlandii*) is one of the better studied long-distance migratory species, in part because of its endangered status and its limited breeding and wintering ranges, which have facilitated studies of its full life-cycle. Research results have been successfully applied to habitat and Brown-headed Cowbird (*Molothrus ater*) management on the breeding grounds. Efforts have increasingly focused on the non-breeding portion of the life-cycle to identify factors that may influence conservation of the Kirtland's Warbler. A Kirtland's Warbler Conservation Team, composed of researchers and land managers, has synthesized past work to identify future research and conservation needs required to maintain a population of at least 1,000 pairs of Kirtland's Warbler. Proposed future research and conservation activities identified by this group, organized by breeding season, non-breeding seasons, and outreach, will be presented.

## **A framework for using eBird observer data to model human values for bird conservation**

Harold Eyster, University of British Columbia; Kai M. A. Chan, University of British Columbia

eBird has become a widely successful platform for eliciting bird observations from birders. This platform was developed to elucidate bird distribution patterns, has led to many advances in our understanding of bird

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distributions, trends, movements, and conservation. Yet an entire category of eBird data remains largely untapped. eBird provides data not only on bird occurrences, but also on the human observers themselves. For every bird record, there is a corresponding human record. This aspect of eBird data has barely been touched, but offers much promise: helping us to understand where birds are most highly valued, and where bird conservation may go the furthest towards increasing human well-being. However, this data cannot be used in all conservation contexts. Nevertheless, different types of analyses and metrics can help to broaden the utility eBird human data. Here I present a framework for appropriately using eBird human data to enhance the effectiveness of bird conservation. Together, the human and bird dimensions of eBird can lead to more targeted and value-aware conservation efforts.

## **Sialic acid in avian blood: implication for disease host range**

Jeanne Fair, Los Alamos National Laboratory; Mark Jankowski, Environmental Protection Agency; Scott Glaberman, University of South Alabama

Management and detection of highly pathogenic influenzas in wild and domestic avian populations require a better understanding of the determinants of host range. The major host range determinant for influenza is the binding site for the virus, sialic acid, which varies between mammals and bird cell membranes. Erythrocyte invasion by *Plasmodium* is also dependent on the high affinity recognition of sialic acid on cell surface receptors. We tested the working hypothesis that the characterization of sialic acid of species in the Class Aves can be used as a phylogenetic guide map to host range for influenza or *Plasmodium*. This hypothesis was based on the fact that to gain entrance into cells, human influenza viruses bind preferentially to sialic acid containing N-acetylneuraminic acid  $\alpha$ 2,6-galactose (SA $\alpha$ 2,6Gal) linkages, while avian and equine viruses bind preferentially those containing N-acetylneuraminic acid  $\alpha$ 2,3-galactose (SA $\alpha$ 2,3Gal) linkages. We characterized and compared sialic acid in red blood cells between bird species and investigated correlations for phylogenetic relationships between bird taxon groups. We found that while most taxon groups of birds contained higher amounts of SA $\alpha$ 2,6Gal than SA $\alpha$ 2,3Gal, Anseriformes and Galliformes contained less. However, neither sialic acid quantity nor the glycosidic linkage data showed any phylogenetic signal, meaning there was no relationship between the bird tree and the data for sialic acid in erythrocytes even with differences between species. This finding suggests that phylogeny has little to do with RBC sialic acid variation. Thus, immunity may play a more important role in avian influenza and malaria host range than receptors in blood. However, more research is essential to ascertain the influence of sialic acid in blood to susceptibility to these two agents.

## **Analysis of modern and fossil avian hindlimbs suggests advanced ornithurine birds in the Early Cretaceous**

Amanda Falk, Centre College; James C. Lamsdell, West Virginia University

Principal Component Analysis of avian feet and hindlimbs reveals distinct occupation of morphospace by avian morphotypes largely based on morphology (e.g., palmate) and life habit (e.g., perching, wading, shorebird). When fossil taxa are added into the analysis further clustering occurs, especially within Enantiornithines, which occupy a distinct morphospace that is statistically separate from other birds. Furthermore, fossil ornithurine birds from the Early Cretaceous Jehol Group of northeastern China show a distinct shift towards modern clusters and overlap with many groups of modern birds. This shift in morphospace occupation suggests that the foot and hindlimb of fossil ornithurine birds in the Early Cretaceous had already locked into a modern configuration, in which the femur is fixed to the body wall with muscle and has limited mobility. When data on toe length are combined with hindlimb elements, morphospace occupation shifts to reflect two key patterns. The first critical pattern is the

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length of the hallux. The second critical pattern is the relative importance of the foot morphology as compared to the hindlimb morphology. In some morphotypes (e.g. foot-propelled divers), the relative digit lengths were more impactful than the relative lengths of the hindlimb elements. In others, (e.g. ground birds), hindlimb elements were more impactful. In Early Cretaceous ornithurine birds, the relative lengths of hindlimb elements were more impactful than the relative toe lengths; this may reflect the relatively recent shift to a restrictive hindlimb morphology. The presence of modern-type hindlimb configurations in these birds implies that this shift occurred before the Cretaceous.

## **Decision support tool for pinyon-juniper removal: maximizing benefits to sagebrush and forest obligate songbirds**

Michael Falkowski, Colorado State University; Jason R. Reinhardt, University of Minnesota; David E. Naugle, University of Montana; Kevin E. Doherty, US Fish and Wildlife Service; Brady Allred, University of Montana; Jason D. Tack, US Fish and Wildlife Service

The expansion of coniferous trees (primarily *Juniperus* spp. and *Pinus* spp.) into sagebrush ecosystems is a major driver of habitat loss and fragmentation, resulting in negative impacts to Greater Sage-Grouse, which respond directly to conifer expansion through changes in breeding activity, nesting, and overall survival. Small amounts of conifer expansion can have significant impacts on sage-grouse habitat and populations. As a result, conservation partners have collaborated across private and public lands to reduce the threat of conifer expansion through the removal of conifer trees, which has resulted in positive impacts on sage-grouse as well as sage-brush obligate song birds. Yet a pervasive question remains in how are conifer-reliant species impacted by removal? In this study, we specifically combine information on competing habitat requirements across multiple species within a conservation-optimization framework (MARXAN) to develop a spatial decision-support tool that prioritizes restoration of sagebrush steppe habitats while avoiding impacts to forest birds of conservation concern.

## **Breeding songbird response to forest fragmentation due to Marcellus-Utica shale gas development**

Laura Farwell, West Virginia University; Petra B. Wood, U.S. Geological Survey, WV Cooperative Fish and Wildlife Research Unit, West Virginia University

Development of the Marcellus-Utica shale gas play has increased exponentially in the central Appalachian region. We evaluated effects of shale gas development on forest habitat and breeding songbirds during an intensive, long-term (2008–2015) study at 142-point count locations on a forested site in WV. Construction of shale gas infrastructure (e.g., well pads, pipelines) contributed to an overall 4.5% loss in forest cover at the site, a 12.4% loss in core forest, and a 51.7% increase in forest edge density. We evaluated the relationship between land-cover metrics and species abundance and richness at two spatial extents (point-level and landscape-level), for three avian guilds (forest-interior, early-successional, and synanthropic), and 21 focal species. We observed variability in species-specific responses, but found distinct trends in response among the three guilds. Forest-interior guild richness declined at all points across the site and at points impacted within 100 m by shale gas but did not change at unimpacted points. Early-successional and synanthropic guild richness increased at all points and at impacted points. We also conducted an extensive region-wide study (2014–2015) at 2,583 points on 190 sites (120 impacted, 70 control) in PA, WV, and OH, across gradients of disturbance and forest cover. Preliminary analyses

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suggest patterns of bird response observed regionally are consistent with patterns observed during the long-term study. Our results suggest shale gas development has the potential to fragment regional forests and alter avian communities, and efforts to minimize new development in core forests will reduce negative impacts to forest-dependent species.

## **Habitat selection and movement of fledgling Golden-winged Warblers in managed mixed-oak forests of the Central Appalachian Mountains**

Cameron Fiss, Indiana University of Pennsylvania; Jeffery Larkin, Indiana University of Pennsylvania; Darin McNeil, Cornell University

Recent studies have demonstrated that many songbird species exhibit different habitat use patterns between the nesting and post-fledging periods. The implications of this behavior are such that management for declining birds which focuses solely on nesting habitat may not provide all the habitat elements required during the full reproductive cycle. We studied the influence of multi-scale habitat features on movement and resource selection of fledgling Golden-winged Warblers, a declining species for which considerable conservation funds are being allocated. Specifically, we used discrete choice and linear mixed-effects models to examine patterns of habitat selection and movements of 84 radio-tagged fledglings in managed forests from 2014 to 2016. Analysis of micro-habitat features revealed that fledglings selected for denser vegetation and more vertical cover. In a landscape with the higher availability of diverse forest conditions, fledglings selected successively for early-successional forest, mature forest, and sapling forests as they aged. In landscapes with lower availability of diverse forest conditions, fledglings selected for early-successional forest throughout the dependent post-fledging period. Fledglings moved at faster rates (m/d) when in forests with higher basal area (i.e., mature forest) and at slower rates when in forests with reduced basal area (i.e., early-successional forests). This movement pattern along with habitat selection results suggests fledglings used mature forest (the matrix) for traveling between patches of regenerating forests. These results highlight the importance of managing forested landscapes in a way that optimizes the distribution and diversity of forest structure in areas where Golden-winged Warbler conservation is a goal.

## **Extra-pair mating and the strength of sexual selection: Insights from a polymorphic species**

Lindsay Forrette, Indiana State University; Andrea S. Grunst, University of Antwerp; Melissa L. Grunst, University of Antwerp; Marisa Korody, San Diego Zoo Institute for Conservation Research; Elaina M. Tuttle, Indiana State University; Rusty A. Gonser, Indiana State University

Extra-pair mating could drive sexual selection in socially monogamous species, but support for this hypothesis remains equivocal. We used lifetime fitness data and a unique model species, the dimorphic white-throated sparrow (*Zonotrichia albicollis*), to examine how extra-pair mating affects the potential for sexual selection. The morphs of this species employ distinct reproductive strategies, with white males pursuing extra-pair mating at higher rates than tan counterparts. Social and extra-pair mating is disassortative by morph, with paternity exchange occurring primarily between pairs composed of white males and tan females. We predicted stronger sexual selection as quantified by Bateman gradients and standardized variance in reproductive success in white compared to tan males. Furthermore, because males drive extra-pair mating, we predicted costs of multiple mating and a negative Bateman gradient in tan females. The Bateman gradient for lifetime reproductive success was larger in white than tan males, and extra-pair mating contributed more to the Bateman gradient for white males. However, the Bateman gradient was positive in tan females. White males had higher variance in annual

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reproductive success than tan males or females, but variance in lifetime reproductive success did not differ between the morphs or sexes. Moreover, extra-pair mating did not increase variance in male reproductive success relative to apparent patterns, and within-pair success accounted for much more variance than extra-pair success. Although extra-pair mating in white males increases Bateman gradients, and potential for sexual selection via mate numbers, these latter results call the overall importance of extra-pair mating in driving selection into question.

## **Application of structured decision making to marshbird monitoring in the Gulf of Mexico**

Auriel Fournier, Mississippi State University; Mark S. Woodrey, Mississippi State University, Grand Bay National Estuarine Research Reserve; Jim E. Lyons, US Geological Survey, Patuxent Wildlife Research Center; Bob J. Cooper, University of Georgia; Kristine O. Evans, Mississippi State University

Although many avian monitoring projects have been implemented across the Gulf of Mexico, scientists and conservationists often lack a comprehensive and coordinated approach to monitoring avian resources, including marshbirds. The Gulf of Mexico Avian Monitoring Network (GoMAMN) - a diverse group of conservation partners including state and federal agencies, NGOs, and academic institutions - was formed to coalesce a community of practice and define a vision and process for framing the role of bird monitoring in response to the critical information needs highlighted by the Deepwater Horizon oil spill. We used a Structured Decision Making (SDM) process to develop a set of fundamental objectives along with an explicit objectives hierarchy and value models to qualitatively and quantitatively define stakeholder values and goals related to avian monitoring along the Gulf of Mexico. We used the SDM framework to establish baselines, evaluate restoration activities, and identify critical information gaps related to how ecological process drive marshbird populations as well establish priorities. Marshbirds are an ideal case study since they have high rates of endemism, their population status is poorly known and they are often species of concern. Here, we demonstrate how the SDM framework can be used to guide the development of a Gulf of Mexico-wide, strategic plan for monitoring marshbirds.

## **#MORails #MOScience: Tweeting Live From The Field**

Auriel Fournier, Mississippi State University

The combination of field work and social media, in this case twitter, presents a fantastic opportunity to share your science with the general public as it is happening. I will share my experiences, successes, and failures of three years of tweeting about my doctoral work (#MORails) studying the autumn migration of rails in wetlands across Missouri. Through text, pictures and video I've been able to share my work, and teach people around the world about wetland processes, their importance in the larger ecosystem, and why rails are so incredibly cool. I'll provide tips for how to tweet about your own work, create a hashtag, find an audience, and share your science.

## **Phenotypic plasticity in spring migration behaviour through reverse migration in a trans-hemispheric migratory songbird**

Kevin Fraser, University of Manitoba; Lawrence Lam, University of Manitoba

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Migration enables animals to synchronize their movements with favourable environmental conditions, to enhance survival and reproductive success. Long-distance migratory songbirds are expected to be the least plastic in their migration, as many species must initiate their migration while thousands of kilometres away from their breeding sites. We investigated the behavioural responses and fitness consequences of purple Martins (*Progne subis*) that encountered an aseasonal period of cold weather during their spring migration to breeding sites in Manitoba and Alberta. Remarkably, when Martins encountered temperatures less than 10°C when they reached 40.7 - 42.7°N, more than 80% of reverse-migrated southward to locations >1000 km away, before resuming their northward migration direction ~May 20. Birds that reverse-migrated experienced lower temperatures and higher atmospheric pressure than individuals that migrated through this region earlier or later, suggesting these environmental factors may have cued the behaviour. Reverse migration added 2735 km ( $\pm$  812) and 6 days  $\pm$  1.3 to spring migratory journeys, and birds did not travel faster after northward migration was resumed. Birds that reverse-migrated had shorter intervals between breeding arrival date and first egg date, as compared to earlier migrants. However, we did not detect any short-term fitness consequences of reverse migration; reverse-migrating birds had similar clutch sizes and number of fledged young as birds that had arrived earlier or later at the same breeding sites. These results reveal previously unknown phenotypic plasticity in the migration program of a long-distance migrant in response to weather conditions experienced while en route.

## **Evolutionary distinctiveness and conservation priorities in a large radiation of New World birds (*Emberizoidea*)**

Erik Funk, San Diego State University; Kevin J. Burns, San Diego State University

Degree of phylogenetic relatedness provides a measure of functional diversity, and greater phylogenetic distinctiveness is likely linked to ecosystem stability. Thus, phylogenetic information is an important factor to consider in evaluating species and regions for conservation attention. Emberizoidea, also known as the New World nine-primaried oscines, is a large radiation of songbirds consisting of approximately 830 species, making it the second most diverse New World lineage behind the suboscine radiation. The large distribution of this clade, coupled with its morphological and ecological diversity, makes this clade an important radiation to study from an evolutionary and conservation perspective. This study provides conservation priorities for all species in Emberizoidea using Evolutionary Distinctiveness (ED) and Evolutionarily Distinct and Globally Endangered (EDGE) values from a pseudoposterior distribution of time-calibrate supertrees. We examine patterns in the distribution of threatened species across the complete phylogeny and within all major families. EDGE values range from 0.53 (*Porophila pileata*) to 4.88 (*Conothraupis mesoleuca*) indicating that *Conothraupis mesoleuca*, represents the most evolutionarily distinct and globally endangered species, and should therefore receive the highest priority for species level conservation. Additionally, we found that evolutionary distinctiveness does not differ by threat level. In general, threatened species are slightly clustered across the phylogeny, but are not more likely to be closest relatives. This indicates habitat degradation may be affecting closely related species within localized radiations.

## **Using knowledge of local adaptation to climate to inform reintroduction in the face of climate change**

Maybellene Gamboa, Colorado State University; T. Scott Sillett, Smithsonian Migratory Bird Center; W. Chris Funk, Colorado State University; Scott A. Morrison, The Nature Conservancy; Cameron K. Ghalambor, Colorado State University



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Understanding how populations are adapted to local environments is critical for managing species for future environmental change particularly in the context of reintroductions. Locally-adapted phenotypes may arise as a product of divergent selection across environmental gradients, but this may be mediated by the effects of gene flow. Islands are ideal for studying the interaction of genetic isolation and the environment on phenotypic variation as water is often a barrier to dispersal. Yet, the enhanced dispersal ability of birds compared to many other organisms may increase gene flow across islands thereby potentially constraining the effects of selection. Here, we assess the degree to which Song Sparrows (*Melospiza melodia graminea*) are adapted to climate given varying degrees of isolation and use this to infer the local adaptation. Previous work suggests selection acts on the thermoregulatory ability of birds inhabiting different climates. To investigate this, we measured thermoregulatory traits in birds along a temperature gradient on the California Channel Islands. We coupled this with landscape genomic analyses of 2,767 SNPs to infer population structure and identify candidate loci under selection. Song Sparrows varied predictably in bill size with larger bills on hotter islands thereby facilitating increased heat dissipation. Contrary to our prediction that birds on hotter islands would have reduced basal metabolic rate (BMR), flow-through respirometry reveal no difference suggesting selection may not act BMR. Finally, we found distinct genetic clustering by island despite some gene flow which suggests that both population history and selection may yield locally-adapted phenotypes. By inferring the genetic basis of these locally-adapted phenotypes, we may identify source populations best suited for reintroduction to an island where they have been extirpated.

## **The role of helpers and territory quality in mitigating reproductive senescence in three species of cooperatively breeding birds**

Victoria Garcia, Old Dominion University; Reed Bowman, Archbold Biological Station; John W. Fitzpatrick, Cornell Lab of Ornithology; Walter D. Koenig, Cornell University; Jeffrey R. Walters, Virginia Tech; Eric L. Walters, Old Dominion University

Cooperative breeding is often associated with delayed senescence because cooperatively breeding species share the costs of reproduction, have low mortality, and delay reproduction. Here we use long-term data to test if presence of helpers or territory quality are associated with delayed reproductive senescence. We confirmed that helpers affected fledgling production in each species and sex, but the effects of helpers on reproductive senescence were inconsistent. More helpers were associated with decreased senescence (but not higher reproduction) only in Red-cockaded Woodpecker (*Picoides borealis*) males. Greater numbers of helpers facilitated higher annual reproduction early in life in Acorn Woodpecker (*Melanerpes formicivorus*) females, but this was also associated with a faster rate of senescence later in life. Similarly, Florida Scrub-Jay (*Aphelocoma coerulescens*) males with more helpers produced more fledglings early in life, had earlier onset of senescence, and a steeper decline in reproduction with age. Therefore, helpers had variable effects on reproductive senescence: when more helpers were associated with greater fledgling production in early life for breeders, reproductive senescence was also accelerated, possibly due to early versus late life history trade-offs. If delayed senescence is a widespread pattern in cooperative breeders, the effect is not likely to be due to helpers sharing the costs of reproduction with breeders. Territory quality did not affect reproductive senescence after accounting for other factors in any of the species examined.

## **Can birds provide ecosystem services in North American industrial agriculture?**

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Megan Garfinkel, University of Illinois at Chicago; Christopher Whelan, University of Illinois at Chicago

Birds have been shown to provide effective pest removal services in many agricultural systems, but the majority of those studies have taken place in “wildlife friendly” or tropical agriculture where bird density and/or diversity tends to be high. Most agriculture in the US, however, consists of industrialized monocrop systems, which often do not harbor high bird diversity. Nevertheless, birds do make use of these fields, especially when they are adjacent to source habitat such as grasslands or prairies. Very few studies have examined whether birds may provide services or disservices in these systems. In this presentation, we will discuss the results of a pilot experiment that quantified bird services and disservices in the two most commonly grown crops in the Midwest, corn and soybeans. We used exclosures to examine the indirect effects of birds on crop yield, and a fecal DNA diet analysis to characterize the arthropod prey of birds caught on or near the cropped fields. Birds had a neutral effect on corn, but a negative indirect effect on soybean yield. We will use the diet analysis data to help explain these results. The results of this study suggest that birds may have significant indirect effects even in industrial monocrop systems. Whether those indirect effects become services or disservices may depend on a variety of factors, including which pest species cause the most damage. Because the dominant crop pest species change over time, we suggest a need for further research on bird services and disservices on large-scale industrialized farms.

## **Individual-level variation in Brown Pelican (*Pelecanus occidentalis*) foraging behaviors in the Gulf of Mexico**

Brock Geary, Tulane University; Scott Walter, Tulane University and Texas State University-San Marcos; Paul Leberg, University of Louisiana at Lafayette; Jordan Karubian, Tulane University

Modern developments in seabird tracking technology have enabled unprecedented insights into individual-level behaviors, the proximate drivers of their movements, and the ultimate consequences of movement strategies. These species have maintained consistent popularity as subjects of these studies, as they can accommodate the most current developments in bio-logging devices and often serve as valuable monitors of ecosystem health. In the northern Gulf of Mexico, Brown Pelicans (*Pelecanus occidentalis*) navigate a foraging landscape that is patchy and dynamic at a variety of scales due to both natural and anthropogenic stressors. The species is therefore an ideal subject through which the trophic dynamics of the Gulf, as well as the broader significance of behavioral plasticity in uncertain environments, can be understood. From 2012-present, we have attached GPS transmitters and accelerometers to breeding adult pelicans on Louisiana barrier island colonies and simultaneously monitored nesting success throughout the summers. Consistent variation within and among individuals has been shown across several foraging metrics, including their spatial use of the foraging environment, with possible linkages to prey availability and the presence of the Gulf hypoxic zone. Additional work combines these findings with accelerometer analysis, simulation modeling, and ecotoxicological assays to understand the relative contributions of individual foraging strategies, density-dependent resource distributions, and contaminant exposure to fitness in heavily disturbed systems. Results will also be used to model population-level processes and provide unprecedented insights into the movement ecology and demography of an important Gulf seabird.

## **Topographical influences on migratory orientation along the southwest coast of Lake Erie**

David Gesicki, Bowling Green State University; Verner Bingman, Bowling Green State University

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Identifying migratory pathways is critical for understanding the potential risks affecting migratory birds. Large expanses of open water are a potential challenge during migration as a consequence of increased mortality and the potential energetic cost of flight “detours”. Therefore, migratory birds face trade-offs between the risk assumed by overwater flights and minimizing energy or time. However, it may favor a bird energetically to deviate their flight paths following coastlines, or in many cases, there may exist an optimum detour involving a shortcut across a smaller fraction of the obstacle. We investigated the patterns of nocturnal bird migration in spring at three coastal sites on the southwest coast of Lake Erie, by means of a passive infrared device. The directions of the coastlines differed by 35° at the three observation sites, which were 16km apart. Observations were made from civil sunset through civil sunrise when conditions permitted. Generally, mean track directions of birds observed along the coast differed from the prevailing broad front direction (NNE) suggesting a counterclockwise shift in orientation to reduce the extent of an overwater flight. The mean track direction differed between sites, suggesting some local influence of the underlying topography on orientation behavior. The mean orientation on nights with head winds displayed orientations which more closely followed the direction of the coastline and differed significantly from observations under tail winds. The results suggest birds actively shifting their migratory orientation in an adaptively meaningful way upon arrival to the Lake Erie coast.

## **A Bayesian robust design Jolly-Seber model: Assessing the impacts of Hurricane Matthew on American Oystercatchers**

Daniel Gibson, Virginia Tech; Daniel Gibson, Virginia Tech; Thomas Riecke, University of Nevada; Tim Keyes, Georgia Department of Natural Resources; Chris Depkin, Georgia Department of Natural Resources; Daniel Catlin, Virginia Tech

The popularity of Bayesian inference in demography requires rapid advancements in modelling frameworks to approach the rigor and flexibility of the current suite of maximum likelihood models. For example, the lack of an unbiased Bayesian parameterization of a Robust Design model reduced researchers’ ability to estimate certain demographic processes. Here, we have developed a Robust Design Jolly-Seber superpopulation model in a Bayesian hierarchical multistate framework. We assessed potential biases in model and parameter estimation with a series of data simulations. We applied this model to assess the demographic impacts of a Category 5 hurricane (Hurricane Matthew) on a population of American Oystercatchers (*Haematopus palliatus*) in coastal Georgia. We found that the 1) entry probabilities of new individuals; 2) probabilities of remaining in; and 3) returning to the system were at their lowest immediately prior to, or during Hurricane Matthew. However, in the weeks following Hurricane Matthew, apparent survival probabilities, entry probabilities of new individuals, current individuals remaining in the observable population, and re-immigration probabilities of temporary emigrants rebounded, resulting in a larger population of American Oystercatchers after the hurricane than prior to its landfall. Ultimately, we found that Hurricane Matthew temporarily altered local population dynamics of American Oystercatchers through movements of individuals into and out of the population, but survival was generally unaffected. Here, the use of the Robust Design Jolly-Seber superpopulation model was critical in describing local population dynamics in response to an environmental disturbance due to its ability to simultaneously estimate entry, temporary emigration, and apparent survival probabilities.

## **The ecological disturbance associated with exurban development does not create habitat for most shrubland birds**

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Neil Gilbert, University of Alabama; Paige F. B. Ferguson, University of Alabama

Exurban development covers at least 25% of the contiguous United States and impairs habitat for certain forest songbirds that occupied the landscape prior to development while creating habitat for urban-adapted generalist species. In this study, we investigate the potential for exurban development to create habitat opportunities for shrubland birds. We hypothesized that (1) occupancy probability would be most affected by the amount of development in the landscape, and (2) the disturbance caused by exurban development would benefit at least a subset of shrubland birds. To address these hypotheses, we conducted point counts in Macon County, North Carolina, across a spectrum of land uses and land covers. We used a hierarchical occupancy model to estimate occupancy, true positive detection, and false positive detection probabilities for twelve species of shrubland birds. For each species, we created twenty-four candidate models incorporating local- and landscape-scale covariates that quantified patterns related to exurban development. We then performed model selection using Bayesian Information Criterion. Contagion—a metric of landscape heterogeneity—was the most frequently appearing covariate in the selected models. We conclude that ecological disturbance creates heterogeneous landscapes, and therefore landscape heterogeneity can at least partially predict habitat suitability for shrubland birds. We also conclude that exurban development benefits urban-adapted shrubland species such as Song Sparrow, marginally benefits other species such as Indigo Bunting, and impairs habitat for insectivorous Neotropical migrants such as Prairie Warbler. Exurban development does not create appreciable habitat opportunity for the majority of disturbance-dependent shrubland birds despite exerting considerable disturbance to landscapes.

## **Speciation by loss of migration in the partially migratory Fork-tailed Flycatcher (*Tyrannus savana*)?**

Valentina Gomez, University of Illinois at Chicago and Field Museum of Natural History; Cristina Miyaki, Universidade de São Paulo; Silvia Restrepo, Universidad de los Andes; Alex E. Jahn, Universidade Estadual Paulista; C. Daniel Cadena, Universidad de los Andes

Migratory behavior is widespread among birds and has fascinated scientist and natural historians for decades. Despite a large body of work that has been devoted to understanding migratory behavior, few studies have focused on the role that it can play in the speciation process. Partial migration occurs when a population (or subspecies) is migratory and the other is sedentary, often breeding in allopatry but coexisting during the non-breeding season. It is common among birds and it has been suggested to be an intermediate stage in the speciation process. To test this hypothesis, we studied the Fork-tailed Flycatcher (*Tyrannus savana*), a species composed of a long distance migratory subspecies (*T. s. savana*) that breeds in Southern South America and migrates during the non-breeding season to Northern South America, where it coexists with three other sedentary subspecies (*T. s. monachus*, *T. s. sanctaemartae* and *T. s. circumdatus*). Based on mtDNA sequences and a set of SNPs obtained through genotyping by sequencing, we find evidence for a recent divergence possibly associated to loss of migration. We found low genetic diversity in the sedentary subspecies in comparison to the migratory subspecies and population assignment analyses cluster all three sedentary subspecies as one group apart from the migratory subspecies. Estimations of gene flow are low, suggesting reproductive isolation between them. Overall our results suggest that loss of migration could have promoted reproductive isolation in the Fork-tailed Flycatcher.

## **Fuel loads acquired at a stopover site influence the pace of intercontinental migration in a boreal songbird**

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Camila Gomez, Universidad de Los Andes; Nicholas J. Bayly, SELVA; D. Ryan Norris, University of Guelph; Stuart A. Mackenzie, Bird Studies Canada; Kenneth V. Rosenberg, Cornell Lab of Ornithology; Philip D. Taylor, Acadia University; Keith A. Hobson, University of Western Ontario; Carlos Daniel Cadena, Universidad de los Andes

Long-distance migratory organisms are under strong selection to migrate quickly. Stopovers demand more time than flying and are used by individuals to refuel during migration, but the effect of fuel loads (fat) acquired at stopover sites on the subsequent pace of migration has not been quantified. We studied stopover behaviour of Gray-cheeked Thrush (*Catharus minimus*) at a site in northern Colombia and then subsequently tracked their migration using an intercontinental radio-telemetry array. Tracking confirmed long-distance flights of more than 3000 km, confirming the key importance of a single stopover site to the migration strategy of this species. Our results suggest that these songbirds behave as time-minimizers as predicted by optimal migration theory, and that fuel loads acquired at this South American stopover site, as well as timing of departure from this site, carry-over to influence the pace of migration, contributing to differences in travelling time of up to 30 days in birds subsequently detected in the U. S. and Canada. Such variation in the pace of migration arising from a single stopover site, likely has important fitness consequences and suggests that identifying important fuelling sites will be essential to effectively conserve migratory species.

## **Managing the services and disservices of birds in California farmlands**

David Gonthier, University of California, Berkeley; Amber Sciligo, University of California, Berkeley; Daniel Karp, University of California, Davis; Adrian Lu, University of California, Berkeley; Karina Garcia, University of California, Berkeley; Gila Juarez, University of California, Berkeley; Taiki Chiba, University of California, Berkeley; Claire Kremen, University of California, Berkeley

Bird management in agriculture is highly controversial. While birds are important pests of fruit crops, birds can also improve production through the suppression of insect pests. However, few have simultaneously compared the services and disservices provided by birds. Using a bird exclusion experiment in strawberry farms in California's Central Coast, we show that birds suppress berry damage by insect pests (about 3.8% of berries) in a similar magnitude to the damage birds inflict on strawberries (about 2.4% of berries). We show that local diversification practices on farms, like hedgerows, flower strips or increased crop diversity, increased bird richness and total abundance compared to farms lacking such practices. We show that greater amounts of semi-natural habitat in the landscape surrounding farms is associated with increased bird species richness and the abundance of insectivorous birds. However, pest birds and bird damage declined with semi-natural habitat within homogenous farms, while diversified farms maintained pest birds across the gradient of semi-natural habitat. Finally, practices intended to reduce birds (such as sound cannons) had no impact on the total bird abundance, pest birds or bird damage, suggesting such practices are not effective. Importantly, our data suggest that growers wishing to reduce pest bird abundance and bird damage to strawberries should not remove bird habitat and would instead benefit from maintaining or restoring natural habitat in and around California agricultural areas.

## **Not another drab grouse - mate choice and the role of color in the Lesser Prairie-Chicken**

Geoffrey Gould, The Ohio State University; Jacqueline K. Augustine, The Ohio State University at Lima

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During sexual selection, females evaluate potential mates based on a variety of factors including the color of secondary sexual traits. Color variables relating to aspects of ultraviolet reflectance from plumage and skin ornaments have been shown to predict male mating success in several avian species. The Lesser Prairie-Chicken (*Tympanuchus pallidicinctus*) is an ideal species for studying questions relating to sexual selection as copulation conspicuously occurs at aggregated leks where females simultaneously evaluate multiple males. During their mating displays, male Lesser Prairie-Chickens prominently display fleshy ornaments (air sacs and combs) which reflect ultraviolet wavelengths. Using UV-visible reflectance spectrometry (300–700nm) of these ornaments from wild birds captured in western Kansas, we evaluated whether color variables under sexual selection play a role in the mate choice decisions of female Lesser Prairie-Chickens. Mating success tends to be positively correlated with brightness in the visible and UV portions of the spectrum (N=6 successful and 22 unsuccessful males), in addition to morphological variables including the size of UV reflecting combs. Our results suggest that color is one of several factors female prairie-chickens use to evaluate mates. Further research is needed to determine whether ornament coloration advertises a specific measure of health or genetic makeup.

## **Latitudinal variation and similarity in the range wide timing of the annual cycle of Tree Swallows from 12 breeding populations**

Elizabeth Gow, University of Guelph; Samantha M. Knight, University of Guelph; David W. Bradley, Bird Studies Canada; Robert G. Clark, Environment Canada; Marc Bélisle, Université de Sherbrooke; Lisha Berzins, University of Northern British Columbia; Tricia Blake, Alaska Songbird Institute; Eli S. Bridge, University of Oklahoma; Lauren Burke, Dalhousie University; Russell D. Dawson, University of Northern British Columbia; Peter O. Dunn, University of Wisconsin; Dany Garant, Université de Sherbrooke; Geoff Holroyd, Beaverhill Bird Observatory; Andrew G. Horn, Dalhousie University; David J. T. Hussell, Ontario Ministry of Natural Resources; Olga Lansdorp, Simon Fraser University; Andrew J. Laughlin, UNC Asheville; Marty L. Leonard, Dalhousie University; Fanie Pelletier, Université de Sherbrooke; Dave Shutler, Acadia University; Lynn Siefferman, Appalachian State University; Caz M. Taylor, Tulane University; Helen Trefry, Beaverhill Bird Observatory; Carol M. Vleck, Iowa State University; David Vleck, Iowa State University; David W. Winkler, Cornell University; Linda A. Whittingham, University of Wisconsin; D. Ryan Norris, University of Guelph

While it is well-established there are latitudinal differences in the timing of breeding, whether these differences carry over to influence subsequent events in the annual cycle of migratory birds is not well understood. Using data from 138 light-level geolocators, we examined the timing of annual events in 12 breeding populations of tree swallows (*Tachycineta bicolor*) ranging from 36°N (North Carolina) to 65°N (Alaska). While there were latitudinal differences in the timing of breeding, individuals generally departed the breeding grounds at similar times. This was achieved, in part, because northern breeders tended to depart for migration much sooner after rearing young compared to southern breeders. While this translated to similar arrival times at fall stopover sites, arrival at the first non-breeding site was primarily driven by the number of fall stopovers used and the total distance travelled. At the end of the winter, birds occupying more southern non-breeding sites departed earlier, but their departure was not related to the latitude of their breeding site. Arrival at the breeding grounds was positively related to distance travelled. Overall, with the exception of the most southerly breeding site in North Carolina, the timing of events outside the breeding period was fairly consistent across breeding latitudes. Our results suggest that individuals, particularly at more northern latitudes, are highly effective at making up lost time incurred during the breeding period and that the timing of events in one period of the year may not always carry-over to influence the timing in later periods.

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## **When to change your tune? Unpaired and paired male wrens respond differently to anthropogenic noise**

Erin Grabarczyk, Western Michigan University; Monique Pipkin, Western Michigan University; Maarten Vonhof, Western Michigan University; Sharon Gill, Western Michigan University

When confronted with anthropogenic noise, many bird species adjust song frequency, presumably to optimize song transmission under challenging conditions. However, benefits of such adjustments could vary across different stages of breeding, depending on the locations of potential receivers. Unpaired males should be expected to alter their songs as they sing to attract females that may be widespread, whereas paired males might not if mates and neighbors are primary receivers of their songs. We tested this idea using male House Wren (*Troglodytes aedon*), a species in which males sing to attract mates but once paired alter singing patterns. We monitored color-banded males using nest boxes to determine pairing status, played pink noise at two intensities (65 and 80 dB, plus control) at boxes of paired and unpaired males prior to laying, and recorded their songs. Neither unpaired or paired males changed peak frequency of songs in noise. Paired males sang shorter songs than unpaired males, but noise treatment had no effect on song duration for either group. Paired males however sang fewer songs than unpaired males, but only when they were exposed to high intensity noise. Contrary to expectations, unpaired male house wrens did not alter singing in noise and paired males did. However, under high noise conditions, paired males simply put less effort into singing, giving fewer, shorter songs rather than altering frequency of songs to optimize transmission. These results suggest that singing in noise might be costly and that only unpaired males may be willing to pay the price.

## **Learning on the fly: dispersal influences acoustic variation for both males and females in a tropical songbird**

Brendan Graham, University of Windsor; Daniel D Heath, University of Windsor; Daniel J. Mennill, University of Windsor

Dispersal influences the genetic structure of populations as well as geographic variation in phenotypic traits. Patterns of spatial genetic structure and geographic variation may vary between the sexes whenever males and females exhibit different dispersal behaviours. Here, we examine dispersal, spatial genetic structure, and spatial acoustic structure in Rufous-and-white Wrens (*Thryophilus rufalbus*). Both sexes sing in this species, allowing us to compare acoustic variation between males and females, and examine the relationship between dispersal and song sharing for both sexes. Using a long-term dataset collected over an 11-year period, we used banding data and molecular genetic analyses to quantify natal and breeding dispersal distance in Rufous-and-white Wrens. We quantified song sharing and examined whether sharing varied with dispersal distance, both for males and females. Observational data and molecular genetic analyses indicate that dispersal is female-biased. Females dispersed farther from natal territories and more often between breeding territories than males. Furthermore, females showed no significant spatial genetic structure, whereas males showed significant spatial genetic structure. Song sharing between pairs of same-sex animals decreases with the distance between their territories for both males and females, although males exhibited significantly greater song sharing than females. Lastly, we measured the relationship between natal dispersal distance and song sharing. We found that sons shared fewer songs with their fathers the farther they dispersed from their natal territories, but that song sharing between daughters and

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mothers was not significantly correlated with natal dispersal distance. Our results reveal cultural differences between the sexes that correspond with sex-biased dispersal.

## **Extreme environmental conditions and reproductive behavior in a desert songbird (*Verdins: Remizidae*)**

Emma Greig, Cornell Lab of Ornithology; Eric C. Larsen, University of Chicago

As the environment warms globally it becomes critical to assess how species in different habitats respond. Verdins (*Auriparus flaviceps*), a songbird inhabiting the hottest desert in North America, provide a study system in which to explore the relationships between extreme and variable environmental conditions and reproductive behavior. We investigate how patterns of monsoon and winter rainfall relate to territory density, nest initiation date and mating decisions over a 3-year period. We used precipitation data from the PRISM Climate Group, Verdin nesting data collected at Organ Pipe National Monument, and hundreds of genetic markers derived from a reduced representation genomic approach (ddRAD seq) to assess mating decisions. Following declines in rainfall over the 3-year study period, Verdins showed a nearly 10-fold decline in territory density, nested earlier in drier years, and shifted towards a polygamous mating system in the lowest density (also driest) year. We cannot yet differentiate if the decline in Verdin density was caused by reduced survival or increased dispersal. Nonetheless, the magnitude of the decline demonstrates the importance of precipitation in arid environments; even desert-adapted species need water.

## **Spatio-temporal dynamics of wood warblers**

Alexis Grinde, University of Minnesota Duluth; Gerald J. Niemi, University of Minnesota Duluth

Forest management has altered the spatial and temporal pattern of natural disturbance regimes resulting in a mosaic of relatively small patches in the landscape. The effects of landscape attributes have recently been documented in many studies, yet an understanding on the relative impacts of landscape attributes on long-term population patterns and dynamics of species in managed ecosystems remains limited. We used multi-season occupancy models to characterize long term (20 year) population dynamics and determine the relative influence of patch area, edge, and habitat composition at multiple spatial scales on local extinction and colonization probabilities for 22 warbler species in two national forests of Minnesota. Our results show that long-term dynamics of 22 warbler species at large spatial scales were associated with species' population density and habitat specialization. Landscape effects of mean patch size and total edge, as well as scale, on local extinction and colonization dynamics were species specific. We show that habitat generalist species were more likely to have landscape effects related to colonization and probability of local extinction not related with life history or ecological traits. Identifying mechanisms of species occupancy dynamics at large scales is critical for understanding the ecology of these species, their population trends, and their conservation.

## **Blood parasites in cooperative breeding versus monogamous breeding Woodpeckers**

Tierra Groff, San Francisco State University; Teresa J. Lorenz, Pacific Northwest Research Station US Forest Service; Ravinder N. Sehgal, San Francisco State University



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Avian malaria has been used as a model study system for human malarial disease dynamics since the late 1800s. While there are many well categorized physiological responses to infection in birds, there can also be behavioral responses. This study compares the genetic relationship between haemosporidian parasites in two woodpecker species with different mating strategies. The White-headed Woodpecker (*Picoides albolarvatus*) breeds monogamously and the Acorn Woodpecker (*Melanerpes formicivorus*) exhibits polygynandry. Previous studies have indicated that there may be pseudo-vertical transmission of parasites from parents to adults. Insect vectors that bite infected adults will return and bite offspring. Determining how the genetic relationship of the parasites relates to the genetic relationship of individual birds, within and between family groups, will provide insight as to what effect avian mating systems may have on malaria prevalence. We will examine the prevalence of haemosporidian parasites in White-headed Woodpeckers in the Wenatchee National Forest and Acorn Woodpeckers at Hastings Natural History Reservation. Acorn Woodpeckers should have different parasite assemblages based on their social standing in the group. White-headed Woodpeckers should have similar parasite assemblages given their smaller family groups. Understanding the parasite population structure can help answer larger behavioral questions. Both White-headed Woodpeckers and Acorn Woodpeckers disperse as juveniles from their natal territory. It is possible that birds infected in the nest do not disperse as far and are not as reproductively successful as those who remain uninfected. This project will shed light on the behavioral effect of parasite infection on the breeding behavior in woodpeckers.

## **Snag-nesting Purple Martins in upland forests of the Pacific Northwest**

Joan Hagar, USGS; Lorelle Sherman, Oregon State University

The Western Purple Martin (*Progne subis arboricola*) is a species of conservation concern throughout the Pacific Northwest. As cavity-nesting, aerial foragers, Purple Martins require nesting structures in open habitat. Incidental observations suggest that Purple Martins use snags in early post-disturbance forest, but the population size, distribution, and habitat associations of snag-nesting Purple Martins have not been quantified. We conducted surveys in burned forest and recently logged clear-cuts in western Oregon to 1) document current distribution and habitat associations of western purple martin, and 2) estimate the population size of purple martins nesting in snags. Out of a total of 102 sites surveyed in 2016, we found 34 nesting pairs at 20 sites. Nest cavities were primarily in large-diameter Douglas-fir (*Pseudotsuga menziesii*) snags in advanced stages of decay. Our preliminary results indicate that clear-cut timber harvesting may be compatible with habitat restoration for the Western Purple Martin because it creates early seral habitat, but availability of large-diameter snags in the appropriate stage of decay likely limits nesting opportunities. Planning for retention of nesting structures well in advance of harvest may be one approach to maintaining self-sustaining populations of Purple Martins in the Pacific Northwest. Because snag-nesting Purple Martins represent a suite of species that are limited by the availability of structurally diverse, early seral habitat, management for their nesting habitat is likely to benefit numerous other species.

## **Effects of water quality and depth on macroinvertebrate biomass and shorebird abundance in a managed wetland**

Laurie A. Hall, U.S. Geological Survey; Susan E. W. De La Cruz, U.S. Geological Survey; Lacy M. Smith, U.S. Geological Survey; John Krause, California Department of Fish and Wildlife, Eden Landing Ecological Reserve

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Coastal regions worldwide have suffered extensive loss of intertidal mudflats and wetlands; however, managed wetlands can provide important habitat to support migratory shorebirds and help buffer population declines. In San Francisco Bay, California, part of the Western Hemisphere Shorebird Reserve Network, managers are examining ways to optimize managed wetlands to provide foraging and roosting habitat for wintering and staging shorebirds. We evaluated the effects of water quality and water level on shorebird abundance and macroinvertebrate prey biomass in constructed multi-elevation sediment mounds throughout an experimental managed wetland. Results from generalized linear mixed models indicated that total macroinvertebrate biomass was driven by water level, salinity of the previous month, and temperature of the current month, while small and medium shorebird abundance was most influenced by water level and mound exposure. Shorebirds both foraged and roosted at water levels where macroinvertebrate biomass was greatest. This behavior may allow birds to improve body condition by minimizing the energy expended to travel between foraging and roosting areas. By maintaining optimal water levels and salinities, land managers can provide both foraging and roosting habitats for shorebirds and reduce the potential for population-level impacts of tidal wetland loss.

## **Growing and optimizing ex situ efforts supporting songbird conservation**

Sara Hallager<sup>\*</sup>, Smithsonian's National Zoological Park, Jessica Steiner<sup>\*</sup>, Wildlife Preservation Canada; Katy Palfrey, Conservation Centers for Species Survival (C2S2);

A collaborative, multi-disciplinary, and broad-scale approach is needed to interrupt the steep decline of North American migratory songbird populations. Conservation centers and zoos have the resources and expertise to develop ex situ efforts that can benefit efforts in the field by targeting and helping address critical needs of the wild population. For example, conservation centers and zoos play a key role in breeding, genetically managing populations, and reintroduction of iconic North American bird species such as Whooping Cranes, California Condors, and Attwater's Prairie Chickens. For these reasons, the Conservation Centers for Species Survival (C2S2) is launching a North American songbirds initiative that will leverage the scientific expertise, resources, and networks of some of the world's best ex situ conservation organizations to establish ex situ populations as appropriate for priority species. The initiative takes a One Plan Approach (International Union for the Conservation of Nature's Species Survival Commission (IUCN SSC)) linking across ex situ and in situ activities. Working with in situ efforts, conservation centers and zoos can conduct conservation breeding for essential research to provide models for rare species; generate new knowledge of songbird biology, threats, and life history; and test potential field methods. The network of centers and zoos can also be hubs for landowner outreach, expanded citizen science efforts, and education of visitors about the threats facing migratory bird populations. Partnering across diverse sectors, these collaborations can help to build the scale and scope necessary to grow the long-term sustainability of many threatened songbird species.

## **The cost of reproduction in a greening world**

Michael Hallworth, Smithsonian Migratory Bird Center; T. Scott Sillett, Smithsonian Migratory Bird Center; Sara A. Kaiser, Smithsonian Migratory Bird Center; T. Brandt Ryder, Smithsonian Migratory Bird Center; Michael Webster, Cornell University

Life history theory postulates that individuals balance current reproductive investment with future reproductive potential. Previous work has demonstrated that reproductive investment varies between sexes, age classes and

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along habitat quality gradients. Reproductive strategies likely differ in the amount of effort required, as such their influence on survival may differ. Furthermore, environmental conditions experienced at the start of the breeding season contribute to the investment in reproduction. At Hubbard Brook, the start of the breeding season is closely tied to spring leaf-out. During years with warm springs individuals are more likely to double brood and produce more young. Therefore, reproductive investment is higher in years with warm spring temperatures and early leaf expansion. Here, using long-term demographic data of breeding Black-throated blue warblers we address the following questions 1) is there a cost of reproductive effort on survival? and 2) does the environment mediate the cost of reproduction? We found that female survival was negatively associated with the timing of leaf-out and length of the green period regardless of age but positively associated with the number of eggs laid for experienced females. Male survival was negatively associated with within-pair young and duration of the green period. Our results support previous findings that the cost of reproduction differs between sexes and age classes. In addition, they suggest that environmental change resulting in earlier springs and an extended green period negatively influences survival of Black-throated blue warblers. Further research is needed to determine where within the annual-cycle the cost of reproduction is occurring.

## **Sagebrush birds and the collaborative conservation effort to recover an imperiled ecosystem**

Steven Hanser, U.S. Geological Survey; Cameron L. Aldridge, Colorado State University and U.S. Geological Survey; Peter S. Coates, U.S. Geological Survey

The sagebrush (*Artemisia* spp.) ecosystem is among the largest and most imperiled ecosystems in North America. Only 59% of its historical area persists and over half of the remaining habitat has been altered due to a variety of ecosystem threats and human activity, including invasive species, conifer encroachment, climate change, livestock grazing, and development of a variety of energy resources. These changes have led to the decline of the Greater Sage-Grouse (*Centrocercus urophasianus*) and other sagebrush obligate bird species. These declines have prompted several petitions for listing the greater sage-grouse under the Endangered Species Act (ESA), and concern for other avifauna. Three successive greater sage-grouse ESA status reviews over the past decade have led to unprecedented, multidisciplinary, and interagency collaborations to identify science and conservation needs and prioritize actions aimed at recovery of the sagebrush ecosystem and improving condition for all of the 350 plant and animal species living in the system. We provide an overview of the issues facing the sagebrush bird community and a number of ongoing collaborative conservation efforts, including the development of a science framework for the conservation and restoration of the sagebrush ecosystem that links information on species habitat requirements to the resistance of habitat to invasion by invasive annual grasses and resilience to disturbance. This presentation will introduce the issues that will be discussed in talks that follow for this symposium.

## **Potential misalignment of management practices and Greater Prairie-chicken demography in Wisconsin's grasslands**

Michael Hardy, University of Wisconsin-Madison; Matthew S. Broadway, Indiana Department of Natural Resources; Scott D. Hull, Wisconsin Department of Natural Resources; Jason D. Riddle, University of Wisconsin-Stevens Point; Benjamin Zuckerberg, University of Wisconsin-Madison

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In Wisconsin, Greater Prairie-Chickens (GRPC) have experienced a long-term population decline and a significant range contraction coincident with extensive conversion of grassland habitat to other land uses. Consequently, remaining grassland patches are intensively managed with the goal of boosting GRPC productivity. Until recently, however, the effects of land use change and habitat management on GRPC vital rates in Wisconsin have remained largely unexplored. We used demographic data collected from 2007-2015 to characterize the influence of 12 land cover types and 10 management practices on the survival rates of nests (N=192), broods (N=23), and hens (N=189) at three core sites in central Wisconsin. Nest survival increased with the amount of shrub and tree removal conducted during the previous year but was negatively associated with high-intensity grazing. Hen survival also increased with shrub and tree removal during the previous year but decreased with plow/disk/idle treatments and herbicide spraying. Brood survival was higher in areas with greater amounts of small grain cover and responded positively to prescribed burning during the previous year, conventional grazing, and mowing. Despite these relationships, the frequency of beneficial management actions has generally declined over the past 35 years. Conversely, practices associated with lower GRPC vital rates have remained stable or increased. Concurrent with shifting management practices, GRPC have declined to the lowest numbers observed in the past 65 years. These trends suggest a possible disconnect between GRPC management goals and land management actions with significant consequences for the long-term viability of GRPC populations in Wisconsin.

## **An assessment of population genomic structure in Black Guillemots**

Bronwyn Harkness, Queen's University; Gregory J. Robertson, Environment and Climate Change Canada; Vicki Friesen, Queen's University

Identifying genetically differentiated populations can be important for successful species conservation. If local populations become genetically differentiated then the loss of a population can result in partial loss of a species' genetic diversity, which can affect a species' ability to adapt to stressors. Black Guillemots (*Cephus grylle*) are seabirds that may be highly vulnerable to climate change, but we have little knowledge of their population genetics and demographics. I conducted a genome-wide survey of genetic variation using double-digest restriction-site associated DNA sequencing (ddRADseq) to test the hypothesis that regional populations of Black Guillemots are genetically distinct. Alternatively, Black Guillemots might comprise one large population that mixes genetically and demographically.  $F_{st}$  values were weak but significant, suggesting that gene flow among Black Guillemot populations is restricted. Clear population genetic structure was also visible in a principle components analysis. These results confirm what has been found in previous studies of population genetic structure in Black Guillemots using mtDNA. Possible reasons for this marked genetic structure include strong philopatry, physical barriers to gene flow, tendency to remain close to breeding colonies year-round, and historical isolation in separate refugia during the Pleistocene. Our research indicates that Black Guillemots from different regions differ genetically at neutral markers and should be managed as separate units.

## **Seaside Sparrow (*Ammodramus maritimus*) nest success following the Deepwater Horizon oil spill**

Megan Hart, Austin Peay State University; Philip C Stouffer, Louisiana State University; Sabrina S. Taylor, Louisiana State University; Christine Bergeon Burns, Indiana University Bloomington; Andrea Bonisoli Alquati, California State Polytechnic University; Stefan Woltmann, Austin Peay State University

In 2010, the Deepwater Horizon oil spill released an estimated 4.9 million barrels of oil into the Gulf of Mexico, damaging coastal ecosystems. The Seaside Sparrow (*Ammodramus maritimus*) is a year-round resident of the salt

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marshes of Louisiana, which were heavily impacted by the spill. We monitored Seaside Sparrow nests in Plaquemines Parish, Louisiana from 2012-2016 in initially oiled and unoiled plots within the salt marsh. We found high inter-annual variation in both sparrow abundance and daily survival rate (DSR) that was independent of oiling status, but preliminary analyses suggest that there were more failed nests and lower daily nest survival on oiled vs unoiled sites across all years, with oiled sites in 2012 having the lowest daily survival rate (DSR=0.87, SE=0.02; at least 1.4% lower than any other year). We also found underlying differences in vegetation structure and composition between oiled and unoiled plots, which may influence nest site selection and DSR. Ongoing analyses will improve our understanding of how other variables, such as storm surges and nest predators, influence nest success in this salt marsh specialist bird.

## **Female-specific consistency in the egg morphology of Common Murres**

Mark Hauber, Hunter College/GC CUNY, University of Illinois, Urbana-Champaign; Ketti Barateli, Hunter College; CJ McCarthy, Oregon Coast Aquarium; Phillip Cassey, University of Adelaide; James Dale, Massey University

Individual recognition of progeny is critical in group living organisms that provide prolonged parental care for their young. The eggs of the seabird Common Murre (*Uria aalge*) provide a classic example of strong selection for individual distinctiveness of recognition cues: murres nest in dense colonies and do not build a nest. As such, parental recognition is critical for incubating the correct (own) egg. Indeed, Murre eggs are famous for their variability in color and maculation, and parents are capable of selecting their own egg when given a choice. It remains unknown whether, as seen in most other avian species, eggs of individual female Murres are also consistent in appearance between different breeding attempts. We quantified egg phenotypes of captive Murres laying eggs across multiple years. Despite the small sample sizes, we found that individual female murres' eggs are consistent in both color and patterning across years. Murres may benefit from laying individually consistent eggs across breeding attempts through minimizing the costs of updating the recognition cues of their own eggs.

## **Understanding landscape variables that influence gene flow in a highly vagile species, the Black-capped Vireo (*Vireo atricapilla*)**

Samantha Hauser, University of Louisiana at Lafayette; Paul Leberg, University of Louisiana at Lafayette

The Black-capped Vireo (*Vireo atricapilla*) is an endangered migratory passerine that has experienced a population bottleneck caused by habitat fragmentation, habitat loss and brood parasitism. Demographic studies (namely, Walker et al., 2016) have suggested that there may be source-sink dynamics in central Texas but logistical restraints have prevented gene flow, crucial to population dynamic studies, from being directly studied. We used molecular markers to elucidate the population dynamics of the Black-capped Vireo in central Texas surrounding Fort Hood, which houses the largest and most stable breeding population. We used microsatellite markers to gain insight into gene flow among populations and resistance analysis to elucidate the landscape features that influence gene flow. Data suggest that there may be source-sink dynamics, with Fort Hood generally as a source population. We found no isolation by distance, which is unsurprising at this spatial scale due to the species' highly vagility. Agriculture and scrub habitat play a role in shaping dispersal amongst the metapopulation. As the Black-capped Vireo is widely threatened by fire suppression and habitat fragmentation, rapid development in central Texas may

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be an ever-growing threat to connectivity in this metapopulation. These results have the potential to be applied in conservation and land management for the endangered species.

## **Forest fragmentation effects on survivorship, dispersal and autumn migration on-set in juvenile Wood Thrush**

Sue Hayes, York University; Brendan Boyd, York University; Bridget Stutchbury, York University

Our research is focused on the issue of how forest fragmentation affects survivorship, dispersal and the on-set of fall migration in juvenile Wood Thrush (*Hylocichla mustelina*). We are looking to address the main research question as to whether there are carry-over effects for Wood Thrush originating from small forest fragments that put them at a disadvantage compared to offspring originating from larger fragments. This study is unique as it has only recently been made possible to execute through the innovation of the automated long-distance radio telemetry collaborative Motus Wildlife Tracking System. This system is built on an array of >300 receiver towers that allows researchers to track tagged wildlife movements over larger spatial scales. For our study, we will be able to detect and track tagged juvenile Wood Thrush dispersal movements at a spatial and temporal scale that has never been done before thereby providing knowledge to fill the data gap in our collective understanding for Wood Thrush conservation.

## **Investigating the effects of oil development and noise on corticosterone in an altricial grassland songbird nestling**

Alexandra Heathcote, University of Manitoba; Nicola Koper, University of Manitoba

In recent decades oil and gas development and associated infrastructure has increased in central North America; fragmenting the landscape, reducing habitat suitability for species at risk, and introducing anthropogenic noise to the soundscape. The non-lethal effects of human disturbance may be contributing to the rapid decline of grassland songbirds. Physiological mediators, such as corticosterone, are increasingly being used to measure an organism's ability to respond to and cope with environmental and anthropogenic disturbance. Chronic disturbances on the landscape may impact corticosterone levels in altricial nestlings, potentially influencing growth rate, fledgling success, or adult phenotypes. To determine how anthropogenic disturbance and chronic noise impact the development of the stress response in Chestnut-collared Longspur (*Calcarius ornatus*) nestlings, we measured basal and acute plasma corticosterone levels. We isolated noise from the associated infrastructure by broadcasting screw-pump recordings on the short- and mixed- grass prairies of southeastern Alberta using solar-powered playback units in addition to sampling nestlings at sites with active screw-pump leases. Preliminary results indicate that basal corticosterone is lower in nestlings close to active playback sites, but not real infrastructure, suggesting that noise or the effects of noise may impact the ability of nestlings to respond to an acoustic stressor. Future research that uses corticosterone as an indicator of physiological stress during development should consider how deviations from baseline corticosterone affect fitness. Disentangling the effects of noise from anthropogenic disturbances will aid land managers in the difficult task of mediating human impact on declining species during vulnerable stages of their life history.

## **Assessing the effects of climate-driven shifts in prey on Red Knots using Virginia stopover habitat**

East Lansing, Michigan

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Erin Heller, Virginia Tech; Sarah M. Karpanty, Virginia Tech; James D. Fraser, Virginia Tech; Shannon J. Ritter, Virginia Tech

Every year during spring migration, thousands of migratory Red Knots (*Calidris canutus rufa*) use Virginia's barrier islands as stopover habitat to regain the fat required to continue flights to breeding grounds. Blue Mussels (*Mytilus edulis*) and Coquina Clams (*Donax variabilis*), two important prey resources for Red Knots, are experiencing range shifts. Blue Mussels are retreating northward, and Coquina Clams expanding northward, due to increasing ocean temperatures. These alterations in prey distribution may result in spatial mismatches between Red Knots and their prey. We investigated the variation in prey and Red Knot abundances from 2007-2016 by counting Red Knots and collecting core samples containing prey on Virginia's barrier islands to explore how changes in prey abundances may affect Red Knots. We also conducted carbon ( $^{12}\text{C}$  vs.  $^{13}\text{C}$ ) and oxygen ( $^{16}\text{O}$  vs.  $^{18}\text{O}$ ) stable isotope analyses on 21 Blue Mussel samples to address where larval Blue Mussels originate and how the Blue Mussel's range contraction may impact Red Knots. During peak migration (May 14-28), we estimated that 3600-11900 Red Knots used the islands. Prey distribution was not continuous, but where present, 850-12500 Coquina Clams and 150-56700 Blue Mussels were available/m<sup>2</sup> shoreline. Stable isotope analyses indicated that Blue Mussel umbos (first portion of shell precipitated) contain more positive oxygen-carbon isotopic ratios than shell edges, suggesting that Blue Mussels originate from subtidal populations in cold saline water. Continued ocean temperature increases may further prey range contractions/expansions, potentially making Blue Mussels less available, and Coquina Clams more available, to Red Knots in the future.

## **The effect of diet on avian cecum size and intestinal absorbency rate**

Stephanie Hempfling, The Ohio State University; Jacqueline K. Augustine, The Ohio State University at Lima

The morphology of bird's intestines and cecum critically impact their survival and reproduction because intestinal morphology affects absorption and enzymatic breakdown of nutrients. The purpose of this study is to determine if birds with a herbivorous diet have a well-developed ceca and faster intestinal absorbency rate compared to insectivores or omnivores. The birds were salvaged, frozen, thawed and then weighed before skinning. The mass of the cecum (if present) and intestine was measured and both were expressed as a percent of the body mass. We developed a new 'sausage' method to determine absorbency rate of the intestine by filling a segment of the intestine with cornmeal, sealing the ends of the intestine, placing the 'sausage' in water, and recording the change in mass at regular intervals. Intestinal absorbency was defined as the slope of a regression of time and mass. The diet of the birds was based on gizzard contents and literature. Logistic regression was used for cecum analysis with the independent variable as diet and binary order (Passeriformes or non-Passeriformes), and the presence of a cecum was the dependent variable. Mixed effect model was used to analyze the intestinal absorbency, percent mass of 4-centimeter intestine, and percent intestine + cecum as dependent variables, and the independent variables were diet as a fixed effect and binary order as a random effect. Presence of a cecum related to binary order, but not diet. The intestinal absorbency, percent of 4-centimeter intestine, and percent intestine + cecum likewise did not relate to diet. Hence, our hypothesis was not supported because cecum presence and intestinal absorbency did not relate to diet. Although previous studies have shown diet to have a greater impact on gut morphology, this study suggests that taxonomy had a larger effect on gut morphology than diet. However, this analysis was limited because the sample size was insufficient to make detailed comparisons of the independent contributions of taxonomic order and diet to cecum presence and absorbency rate.

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## **A long-term study of population persistence in Henslow's Sparrows**

Jim Herkert, Illinois Audubon Society

Henslow's Sparrow is a rare grassland bird that breeds primarily in the Midwest and Northeastern United States. In some locations it is well established as a breeder, whereas in other areas it can be irregular and its presence hard to predict. Gaining a better understanding of factors associated with persistent populations is important for conservation of the species. I studied Henslow's Sparrow at three sites in northern Illinois. Annual surveys were conducted at 69 points located in eight fields between 1995 and 2016. Henslow's Sparrow was the fourth most common species in this system. The species was detected at an average of 33 of the 69 points per year, and ranged from a low of 19 points in 1995 to a high of 44 points in 2002 and 2006. Henslow's Sparrow occurrence within these grasslands was more consistent than several other grassland birds, including Dickcissel, Bobolink, Eastern Meadowlark, Grasshopper Sparrow and Sedge Wren. Although grassland management (burning, grazing, mowing) significantly influenced Henslow's Sparrow annual abundance within this system, there was no relationship between the number of years the species was detected at a point and the number of years it was idle. Both vegetation height and litter depth, however, were associated with both annual abundance and the number of years the species was detected at particular points. My study shows that Henslow's Sparrow can be highly persistent in some areas and that factors associated with annual abundance (such as management) may be poor predictors of long-term persistence.

## **The mitonuclear compatibility species concept**

Geoffrey Hill, Auburn University

I propose that a neglected consideration in discussions of avian speciation is the necessity of coadaptation between nuclear (N) and mitochondrial (mt) genes to enable core energy production via oxidative phosphorylation. Because mt genomes are non-recombining and subject to high mutation rates, they evolve rapidly. Consequently, N and mt coadaptation persists only through perpetual coevolution between mt and N genes. Mitonuclear coevolution leads to rapid divergences in coadapted mitonuclear gene sets whenever there is a disruption in gene flow among populations. As a result, once populations diverge in coadapted mitonuclear genotypes, the reduced fitness of offspring due to mitonuclear incompatibilities prohibits exchange of mt and N-mt genes and effectively isolates individuals with shared coadapted N and mt genotypes. Given these considerations, I propose that animal species can be objectively diagnosed by uniquely coadapted mt and N genotypes that are incompatible with the coadapted mt and N genotype of any other population. According to this mitonuclear compatibility species concept, mitochondrial genotype is the best current method for diagnosing species.

## **A fine-scale U.S. population estimate of a montane spruce-fir bird species of conservation concern**

Jason Hill, Vermont Center for Ecostudies; John D. Lloyd, Vermont Center for Ecostudies

Bicknell's Thrush (*Catharus bicknelli*) is one of the most range-restricted bird species in North America, occurring in the U.S. only in the disturbed spruce-fir montane forests in New York, Vermont, New Hampshire and Maine. Despite the increasingly tenuous conservation status of the species, overall population size is uncertain. We used N-mixture models in a hierarchical Bayesian framework to predict population size and to elucidate spatial patterns of Bicknell's Thrush abundance. From 2011 to 2016, as part of Mountain Birdwatch, citizen scientists conducted 14,552 five-minute point counts at 747 sampling locations along hiking trails. Bicknell's Thrush abundance was parsimoniously modeled as a complex function of elevation, forest canopy cover, and latitude. We produced the



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first fine-scale (~1.0 ha resolution) abundance estimate and map of Bicknell's Thrush density across their U.S. range. We predicted the U.S. Bicknell's Thrush population in 2016 as 71,618 (95% CRI: 56,788 – 90,219), and 95% of that population occurred above 805 m. Bicknell's Thrush likely have one of the smallest population sizes of regularly occurring bird species within the contiguous U.S. and Canada. We estimated that 76.6% of Bicknell's Thrush habitat occurred on conserved lands across the U.S., and that this habitat supported 84.6% of the predicted population. The White Mountain National Forest is the largest conservator of Bicknell's Thrush habitat in the U.S., and supports approximately 31% of the predicted U.S. population. Our model provides a testable framework for assessing the success of future conservation and management actions on Bicknell's Thrush populations throughout their U.S. range.

## **Knowns and unknowns in the origin of leapfrog variation in Andean birds**

Anna Hiller, Louisiana State University; Robb T. Brumfield, Louisiana State University; and Brant C. Faircloth, Louisiana State University

Among montane ecosystems, the Andes are some of the most species rich, high-elevation communities in the world, particularly in terms of avian diversity, and within the Andes, high phenotypic turnover occurs among many birds. The purpose of this presentation is to examine the current state of knowledge regarding a particularly intriguing pattern of plumage variation found in at least 33 species of Andean birds: leapfrog variation. Leapfrog variation was first described by Remsen (1984) as “two geographically nonadjacent taxa [that] were more similar in plumage pattern and color to one another than either was to the intervening taxon”. Since the original identification of this phenomenon new species of birds have been documented to show this phenotypic repetition. However, the underlying genetics behind leapfrog variation have only been examined a handful of times. While these studies have advanced our understanding of how the traits involved in leapfrog variation are distributed across a single taxon, we still lack an understanding of how this pattern has arisen across multiple groups. In this work we first discuss the suite of hypotheses that have been proposed to explain leapfrog variation. We then evaluate the support provided for each theory based on a compilation of published genetic data sets, comparing across taxa. We conclude with a discussion on what questions remain untested regarding the drivers of leapfrog variation and how high-resolution phylogenomic data can play a role in distinguishing between the different speciation scenarios.

## **Characteristics of Canada Goose flight formations using a stereoscopic imager**

Tim Hills, University of Colorado-Colorado Springs; Jon Pigage, University of Colorado-Colorado Springs; Andrew Ketsdever, University of Colorado-Colorado Springs

This study analyzed Canada geese (*Branta canadensis*) flight formations to describe quantitatively several aspects of their collective behavioral traits and locomotive tactics. To evaluate the characteristics and physical flight configurations, each flock members' three-dimensional location while in flight was numerically analyzed in software and hardware developed for this work. The parameters from which their behavior was categorized included the separation, cohesion and alignment within a formation. The system to acquire the three-dimensional location data of geese in flight consisted of a stereoscopic camera system and an image processing software both of which are artifacts of this project. Using the formerly described system for analysis of volant species provides a

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platform from which such organisms can be studied without disruption of their natural behavior. Developing this process of data acquisition and analysis exists to not only to provide the data that will be shown throughout this work, but will also serve as a method of analyzing flight behavior in Canada geese and other species that fly in formations.

## **Avian influenza and the cloacal microbiome of wild avian hosts**

Sarah Hird, University of Connecticut; Walter Boyce, University of California Davis

Influenza A viruses (IAV) cause significant global disease and mortality in birds and mammals. Waterfowl are the natural reservoir for IAV and exhibit little to no pathology during infection with the virus. Along another axis of health, vertebrates house billions of microorganisms (their microbiome) which are also intimately tied to their development, immune system and behavior. In the current study, we examine the patterns between and within the microbiomes of 5 wild duck species (Northern Pintail, American Wigeon, Northern Shoveler, Green-winged Teal and Mallard). Using several standard alpha and beta diversity metrics and tests, we found significant changes within species based on status of influenza infection but little pattern across species. The sampling locality, date of sampling and viral subtype are all correlated with cloacal microbiome in small, but significant, ways. We also identified OTUs that are significantly associated with influenza infection and uncovered a curious pattern of influenza positive Mallards sharing many significant OTUs with influenza negative Northern Shovelers. Our results imply that different reservoir species may respond to, or protect themselves from, infection in independent ways, although further functional data will greatly increase our understanding of the system.

## **Effects of lead exposure on songbirds breeding in the Southeast Missouri lead mining district**

Kathy Hixson, Southeast Missouri State University; Melissa Roach, University of Missouri; Frank R. Thompson III, University of Missouri; Rebecka Brasso, Southeast Missouri State University

The history of lead mining in Southeast Missouri goes back nearly three centuries. Over this long period of extraction, smelting, and other associated activities, soils have been heavily contaminated with lead. The purpose of this study was to determine the extent of lead exposure in breeding songbirds and the impact that it may have on their reproductive success. We focused on ground-foraging species because of their higher risk of lead ingestion in soil due to their ground foraging behaviors. At three contaminated sites and two uncontaminated reference sites, we monitored reproduction in 10 species of open-cup nesting songbirds as well as in Eastern Bluebirds (*Sialia sialis*) using nest boxes. At each nest, reproductive parameters including clutch size, number of nestlings hatched, number of fledglings, and overall nest success were monitored. Blood samples were taken from the adults and young at each nest to assess lead exposure. So far, blood lead concentrations from 45 songbirds have been analyzed. Blood lead levels are significantly higher in songbirds that breed in the contaminated areas compared to those that breed in areas with only background levels of lead. Songbird reproductive data and more blood samples are currently being analyzed. Although the effects of lead toxicity have been documented in other wildlife or in laboratory settings, few studies have evaluated the sub-lethal effects of lead contamination on reproductive success in free-living songbirds.

## **The migrant turnstile, quantifying 21 years of migration through the Gulf of Mexico**

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Kyle Horton, Oklahoma Biological Survey, University of Oklahoma; Benjamin M. Van Doren, University of Oxford; Frank A. La Sorte, Cornell Lab of Ornithology; Daniel Fink, Cornell Lab of Ornithology; Andrew Farnsworth, Cornell Lab of Ornithology; Jeffrey F. Kelly, Oklahoma Biological Survey, University of Oklahoma

The scale and magnitude of avian movements between the Nearctic and Neotropical ecozones have transfixed naturalists and captivated the attention of generations of ornithologists. The notion of hundreds of millions, if not billions, of migratory birds passing in and out of broad regions is of considerable ecological interest – and of conservation concern. Quantification of these movements at the macrosystem scale is paramount in understanding the influence of recent climate and landscape changes on large-scale ecological processes. Estimating the population size of one species, let alone hundreds, presents tremendous obstacles. We bring together, for the first time, eBird and weather surveillance radar data to quantify the number of migrants passing through one of the most critical regions for migration in the western hemisphere – the northern coast of the Gulf of Mexico. Across all sites, we estimated an average of 0.93 to 1.03 billion birds passed through the region each spring. Half of these individuals passed through the region in just 17 days, between April 20th and May 7th. We observed strong longitudinal patterns of migration intensity across the extent of the Gulf of Mexico ( $R^2=0.70$ ). The three most western sites accounted for 71.1% of the cumulative movements, as contrasted with the three most eastern sites only accounting for 11.0%. The spatial, temporal, and altitudinal mappings of these migratory movements are a critical advance in our ability to quantify large-scale, long-term avian movements. This study marks the first data-based estimate of migrant passage across an entire region in North America.

## **Analysis of insertion/deletion mutations in 48 genomes provides perspectives on avian demographics in deep time.**

Peter Houde, New Mexico State University; Nitish Narula, New Mexico State University; Edward L. Braun, University of Florida; Siavash Mirarabbaygi, University of California, San Diego

We scored >5.3 million insertion/deletion mutations (indels) from the alignment of 48 avian genomes as binary data, and performed analyses based on their distribution on the “total evidence nucleotide tree” of Jarvis et al 2014. Indel phylogenetic informativeness is very strong, and related to indel frequency and length. We used these data to reconstruct hemiplasy on deep branches of avian phylogeny. Hemiplasy, not to be confused with homoplasy, describes alleles with a different true phylogenetic history than that of the population in which they exist. Hemiplasy frequency reflects the rate of fixation of ancestral polymorphisms, which is a rate-dependent function of effective population size ( $N_e$ ). We used parsimony and coalescent estimates of indel hemiplasy in combination with ancestral reconstruction of generation length and internode distances to estimate ancestral  $N_e$  in the early radiation of Neoaves. Using simulated and real datasets, we tested a novel extension of ASTRAL's method of calculating branch length support to binary characters to provide better estimates of coalescent unit branch lengths than those based on gene trees. Density compensation is a transient increase in  $N_e$  hypothesized to be a signature of adaptive radiations associated with ecological release. Thus by temporal coincidence, fluctuations in  $N_e$  may be suggestive of agents that facilitated the neoavian radiation.

## **The curious case of the White-throated Sparrow**

Anne Houtman, Rose-Hulman Institute of Technology

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The White-throated Sparrow (WTSP), *Zonotrichia albicollis*, is a common emberizine passerine that breeds in the northeastern United States and throughout eastern Canada. Wright (1936) accurately described White-throated Sparrows as the most beautiful of all the sparrows. WTSP's are dimorphic, with adults of both sexes either brightly colored (white-striped morph) or more dully colored (tan-striped morph). Historically, the tan-striped birds were believed to be either female or in immature plumage. Lowther (1961) conclusively established that adult birds are always one of two distinct color morphs, with white-striped birds of either sex behaving more aggressively than tan-striped birds. Thornycroft (1966,1975) demonstrated that the color polymorphism correlates with a chromosomal polymorphism resulting from a pericentric inversion of the second chromosome. This finding set the foundation for field studies conducted by Bruce Falls and his students in Canada, and Elaina Tuttle and her students in the United States, which demonstrated that most WTSP's mate with the opposite morph, and that the combined activity of these white-tan pairs (MF or FM) show similar amounts of singing and territory defense, as well as feeding and care of chicks. This "natural experiment" has clearly shown that the white-throated sparrow is a unique study species that effectively behaves as if it has four sexes. Looking into the future as the research of Tuttle and colleagues approaches 30 years, WTSP data can be applied to Bateman's gradients, models of senescence, evolution of sex chromosomes, and studies of animal personality.

## **Cleared for take-off? Shorebird migratory decisions and behavior in flight at a stopover site.**

Jessica Howell, University of Saskatchewan; Christy A. Morrissey, University of Saskatchewan; Ann E. McKellar, Environment and Climate Change Canada, University of Saskatchewan

Shorebirds (order Charadriiformes) undergo some of the longest migrations of any avian taxon. Fueling, time, and weather all factor into a migrating bird's decisions of when to fly and when to rest at stopover sites. Chaplin Lake, in southcentral Saskatchewan, is an important stopover for shorebirds migrating through the Prairie Pothole Region. We examined Sanderling (*Calidris alba*) usage of this area, hypothesizing that the decision to depart and direction of departure are related to environmental conditions and that the timing of peak population abundance is consistent with individuals' arrival and departure dates. Sanderling were monitored during spring migration by conducting point count surveys and by radio-tagging and tracking individual birds. We found that the decision to depart from Chaplin was significantly influenced by date, wind speed, and wind direction. The peak in number of departing tagged birds followed the peak in population abundance based on point counts. These results have implications for shorebird conservation and management of the Chaplin Lake area, particularly in the context of increasing wind energy development in the prairies.

## **Habitat management of the Kirtland's Warbler (*Setophaga kirtlandii*) on the breeding grounds**

Philip Huber, Huron-Manistee National Forests; Keith Kintigh, Michigan Department of Natural Resources; David E. Rothstein, Michigan State University; Dan Kashian, Wayne State University

The US Forest Service, Michigan Department of Natural Resources and US Fish and Wildlife Service cooperatively manage approximately 3,000 acres (1,200 ha) of jack pine each year in the northeast Lower Peninsula and Upper Peninsula of Michigan to provide breeding habitat for the endangered Kirtland's Warbler. Land management agencies have been providing habitat since the late 1950's, and habitat management has evolved substantially since that time. Since the mid-1970's, most Kirtland's Warbler breeding habitat has been developed by harvesting large tracts of mature jack pine followed by planting two-year old jack pine in an opposing wave pattern. This pattern allows jack pine to be planted at a high density, while incorporating a ¼-acre opening in every acre that

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was planted. This planting pattern provides ideal breeding habitat for Kirtland's warblers, but does not mimic the spatial patterns of post-fire regeneration and therefore may limit use of the habitat by other animals and plants native to the jack pine ecosystem. Land manager and researchers are working to develop new approaches to develop Kirtland's Warbler breeding habitat to: 1) buffer the species against habitat shifts arising from climate change, 2) better emulate ecosystem structure associated with a natural disturbance regime, and 3) improve the marketability of forest products when the plantations are eventually harvested.

## **Changes in adult sex ratios of the Brown-headed Cowbird in grasslands in the northern Great Plains.**

Lawrence Igl USGS Northern Prairie Wildlife Research Center; Deborah Buhl, USGS Northern Prairie Wildlife Research Center

Sex ratios of the Brown-headed Cowbird, an obligate brood parasite, are typically reported as male-biased, and the sex ratio of a local population is known to influence the species' mating system. The literature is mostly devoid of information on how cowbird sex ratios vary through time. Surveys of free-ranging adult cowbirds were conducted during the breeding season over a 23-year period (1994-2016) in several hundred grasslands in nine counties in four north-central states. Within each grassland, the number of male and female cowbirds was recorded by group and time. Differences in sex ratios among counties, years, and time of survey were assessed. Of 12,850 groups observed, 65% consisted of single cowbirds, 21% of two cowbirds, and 14% of >3 cowbirds. The most-common groupings were lone males (49.2%) followed by lone females (16.1%) and pairs (15.9%). Average annual sex ratios (males:females) ranged from 1.8:1 in 2012 to 3.8:1 in 1999. A logistic regression model with repeated measures was used to test for differences in the proportion males among counties and years, to examine the relationship of proportion males with time of survey, and to test for differences in this relationship among counties and years. The relationship between time of survey and proportion males varied with county; the relationship was negative for all counties except one. Mean proportion of males differed among counties and years, but the county\*year interaction was not significant. More long-term studies of cowbirds are warranted to increase our understanding of the spatial and temporal variation in sex ratios.

## **Making the transition: Comparing avian biogeographic responses to climate change across biomes**

Kelly Iknayan, University of California, Berkeley; Steven R. Beissinger, University of California, Berkeley

There is substantial evidence that terrestrial species have shifted distributions poleward in response to climate warming. However, responses are heterogeneous: some species show none, while others are shifting in directions opposing expectations. We used a historic resource that spans a temporal scale long enough (over a century) to be able quantify change from original baseline conditions, and also, one broad enough (> 1000 km) to evaluate the spatial dynamics of both community and species-level latitudinal response. Resurveys of 106 historic sites for avian diversity (n = 154 species) were performed across, the Mojave, a warm desert, and the Great Basin, a cold desert. We hypothesized: (1) the lesser degree of warming in the Great Basin will maintain the original structuring of the community into the modern era, and the greater amount of warming in the Mojave will cause its assemblage to lose richness and its species to disperse poleward into the Great Basin; (2) persistent abiotic factors, which comprise the Mojave-Great Basin transition zone, and potential lags in vegetation will act as a barrier to distributional changes causing site-level response to vary as a function of distance from the transition zone. Preliminary results from a multi-species, multi-season occupancy model show that colonization rates are three times higher in the Great Basin than the Mojave. Proximity to the transition zone between the biomes was a

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significant predictor of turnover, with more turnover occurring at sites near the boundary than those distant from it; with 0.003% less turnover per kilometer from the boundary in either direction.

## Carry-over effects from wintering to breeding for Barn and Cliff Swallows

Tara Imlay, Dalhousie University; Gabriela Mastromonaco, Toronto Zoo; Frédéric Angelier, Centre d'Etudes Biologiques de Chizé; Keith Hobson, Western University; Marty Leonard, Dalhousie University

Swallows and other aerial insectivores are experiencing steep population declines in North America. These declines are greater for species that migrate longer distances, suggesting that conditions during wintering or migration may be driving population declines, potentially through carry-over effects from wintering to breeding. On the breeding grounds in New Brunswick, Canada from 2014-2016, we frequently monitored Barn *Hirundo rustica* and Cliff Swallows *Petrochelidon pyrrhonota* nests. We also captured breeding adults to collect feather samples from both species for corticosterone analysis and blood samples from Barn Swallows to determine telomere length; both feather corticosterone levels and telomere dynamics can be indicators of wintering conditions. We determined if corticosterone and telomere length, as indicators of wintering conditions, were related to potential carry-over effects during the subsequent breeding season (e.g., adult mass, breeding phenology and reproductive success). For Barn Swallows, there was no relationship between corticosterone and potential carry-over effects, but greater rates of telomere shortening were related to higher rates of nest failure during the subsequent breeding season. For Cliff Swallows, intermediate levels of corticosterone were associated with larger clutches and higher nestling survival. Also, high levels of corticosterone were associated with higher rates of nest failure and lower adult mass. We found differences in corticosterone levels and changes in telomere length between years with high levels of corticosterone and greater rates of telomere shortening during the winter of 2015-2016. Together, these results suggest stressors on the wintering grounds result in carry-over effects to breeding for both species, but wintering conditions vary between years.

## Avian response to shade layer restoration in coffee plantations in Puerto Rico

Amarilys Irizarry, North Carolina State University; Jaime A. Collazo, U.S. Geological Survey and North Carolina State University; Krishna Pacifici, North Carolina State University; Brian Reich, North Carolina State University

Shaded coffee plantations played a historic role in fostering avian persistence in Puerto Rico partly because they retained many ecological services and structural features of secondary forests. Yet many have been replaced by sun-grown coffee in recent decades. In 2003 the U.S. Fish and Wildlife Service and USDA Natural Resources Conservation Services initiated a shade restoration program to promote conservation, and both agencies wanted to assess the benefits for resident avifauna. We quantified habitat heterogeneity, and estimated avian occupancy and abundance during spring 2015 and 2016 in 65 farms, and 40 survey stations in secondary forest. Farms were classified based on time-since-restoration: recent (2011-2014), intermediate (2007-2010), and old (2003-2006). We hypothesized that occupancy and abundance of frugivores/nectarivores would be higher in farms restored in 2003-2006, commensurate with greater structural heterogeneity. Conversely, insectivores and granivores would exhibit the opposite pattern in recently restored farms. Results matched expectations. For example, forest-dwelling PR Vireos (*Vireo latimeri*) were more abundant in oldest farms, whereas Yellow-faced grassquits (*Tiaris olivaceus*), a granivore, was more abundant in recently restored farms. We also showed that most forest-dependent species exhibited higher occupancy and abundance rather quickly or 6-10 years post-restoration (intermediate). Radio-telemetered PR Bullfinches (*Loxigilla portoricensis*), a forest-dweller, used open (sun) coffee less than

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expected by chance alone as compared to restored shaded coffee (proportionally) or secondary forest (greater than expected). Restoring the shade layer in sun plantations improves habitat suitability for forest-dependent species without completely losing open dwellers (e.g., insectivores) that provide ecological services to farmers.

## **Patterns of diversification in cranial shape in the Hawaiian Honeycreepers and Darwin's Finches**

Helen James, Smithsonian Institution; Masayoshi Tokita, Harvard University; Wataru Yano, Asahi University School of Dentistry, Arhat Abzhanov, Harvard University

The evolutionary phenomenon of adaptive radiation is exemplified by beak diversity in two island radiations of birds, the Hawaiian Honeycreepers and Darwin's Finches. To better understand patterns of morphological diversification in adaptive radiations, we performed 3D geometric morphometric analyses of the cranium in the two radiations. We used microCT scanning to image 353 skulls, densely sampling the two radiations and their closely related outgroups and also including more distantly related outgroup taxa. We then performed a series of comparative morphometric analyses based on generalized Procrustes analysis of landmark coordinate data. We found that both Darwin's Finches and the Hawaiian Honeycreepers occupy a broader morphospace than their close relatives, but the Hawaiian Honeycreepers stand out as occupying morphospace not occupied by any other group in the analysis, having high variance in skull shape, and having relatively low correlation between overall cranial shape and the shape of different cranial modules. We describe the significant role that allometry plays in comparative cranial shape in our study taxa. Plotting the Hawaiian Honeycreepers, Darwin's Finches, and their outgroups in a phylomorphospace reveals areas of morphological overlap and instances of convergent evolution, within and among the two radiations. We discuss our results in the context of extrinsic (ecological) and intrinsic (genetic and developmental) factors that may play a role in adaptive radiation.

## **Methodologies to detect avian-induced ecosystem services**

Julie Jedlicka, Missouri Western State University

Determining the ecosystem function of high-order predators is critical for evaluation of food web interactions. Insectivorous birds are abundant predators in many ecosystems yet because they forage upon such small taxa, it remains largely unknown whether birds are providing ecosystem services in the form of pest control or disservices by preying upon predaceous arthropod species, functioning as intraguild predators. I provide a look into various methods used to quantify the ecosystem services provided by insectivorous birds including exclosures, sentinel pest experiments, and more recent molecular scatology methods. Deep sequencing of adult and nestling Western Bluebird (*Sialia mexicana*) fecal matter revealed a broad diet comprising 66 unique arthropod species from six orders and 28 families. *Aedes* sp. (mosquitoes: Culicidae), a previously unknown prey item to Western Bluebirds, were the most common prey recovered, occurring in over 100 fecal samples. Herbivorous insects, primarily from the orders Hemiptera and Lepidoptera, represented over half (56%) of the prey items in bluebird diets. Ectoparasitic bird blowfly (Protocalliphora) DNA was found in three adult and 18 nestling samples. Because larvae feed at night and retreat deep in nests during the day, it was previously thought that blowflies avoid direct consumption. Intraguild predation (of predator or parasitoid arthropods) represented only 3% of adult and nestling dietary items. As high-throughput Illumina sequencing becomes more accessible, the powerfully

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informative techniques molecular scatology offers can be more widely applied to reveal the ecosystem function and services provided by abundant yet cryptic foragers.

## **Postfledging survival of Wood Thrush and Ovenbirds: incorporating climate and landscape features.**

Julianna Jenkins, USDA Forest Service; Frank Thompson, USDA Forest Service; David King, USDA Forest Service; Tim Dellinger, Florida Fish and Wildlife Conservation Commission; Petra Wood, USGS WV Coop. Fish & Wildlife Research Unit; Henry Streby, University of Toledo; Samuel Hache, Environment and Climate Change Canada

The postfledging period, after fledging and before migration, is a critical life stage for estimating juvenile survival in Neotropical migrant songbirds. While it is established that temperature and landscape variation can influence nest survival rates, their influence on postfledging survival is unknown. We investigated effects of climate and landscape on postfledging survival using the consolidated data from eight studies that followed Ovenbirds, *Seiurus aurocapilla*, or Wood Thrush, *Hylocichla mustelina*, from the nest into the postfledging period using radio telemetry in Massachusetts, Minnesota, Missouri, New Brunswick, New Hampshire, Ohio, and West Virginia between 1997 and 2015. We obtained daily surface weather for each study site and summarized remotely sensed landscape variables of interest around each observation using circular plots with radii of 100m, 500m, 5km, and 10km. We used multinomial logistic exposure regression within an information theoretic approach to evaluate relative support for candidate models that represented 6 hypotheses of factors influencing daily postfledging survival: (H0) Older birds have higher survival; (H1) Heavier fledglings have higher survival (H2) Survival rates vary by geographic location; (H3) Survival rates decline with extreme weather events and during drought; (H4) Survival declines with increased forest fragmentation; (H5) Effect of fragmentation varies with edge type; and (H6) Small scale forest heterogeneity improves survival. We found support for climate, landscape, and edge effects on postfledge survival for both species.

## **Estimates of observer expertise improve species distributions from citizen science data**

Alison Johnston, Cornell Lab of Ornithology; Daniel Fink, Cornell Lab of Ornithology; Wesley Hochachka, Cornell Lab of Ornithology; Steve Kelling, Cornell Lab of Ornithology

Citizen science data are growing in scope and increasingly being used in a broad range of ecological applications. However, many citizen science surveys are designed to encourage wide participation, and therefore participants have a range of natural history expertise, leading to variation and potentially bias in the data. We describe an estimate of observer expertise, calculated based on the average number of species recorded on checklists by eBird observers. Experts were defined by recording high numbers of species, controlling for survey duration, habitat, time of day, and time of year. We show that this expertise score, based on species richness, also describes variation in the reporting rates of individual species. As expected, experts reported rare and cryptic species at much higher rates than novice observers. However, experts also reported common and easily detectable at higher rates than novice observers. To test if accounting for variation in expertise improves the quality of species distribution models, we included expertise scores in occupancy models as a detection covariate. When modelling breeding season distributions, accounting for expertise led to slightly higher estimates of species occupancy and altered spatial patterns of species occupancy. When modelling distributions throughout the year, we found that the effect of expertise exhibited strong seasonal variation. These results highlight the importance of accounting for variation in observer expertise when analysing data from citizen science schemes with wide participation.



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## **Heart Rot Hotel 2: the next generation of tree cavities and fungi**

Michelle A. Jusino, USFS; Teresa J. Lorenz, USFS; Eric L. Walters, Old Dominion University; Amy Wynia, University of North Texas; Mark T. Banik, USFS; Jonathan M. Palmer, USFS; Walter D. Koenig, Cornell University; Natasha D.G. Hagemeyer, Old Dominion University; Jessica Stitt, University of Idaho; Philip C. Fischer, Retired Civil Engineer, Washington; Kerri T. Vierling, University of Idaho; Jaime Jiménez, University of North Texas, Universidad de Magallanes; Jeffrey R. Walters, Virginia Tech; Daniel L. Lindner, USFS

Fungi are intricately involved in tree cavity formation and excavation. Historically, studies of the relationships between cavity-nesting birds and fungi relied upon visual observation of fungal fruiting bodies, tree decay class categorization, and culturing work. While these methods were informative, they provided limited information and required extensive expertise, time, and money. Consequently, there are still many fundamental questions about cavity nesters and fungi that remain unanswered. Powerful molecular-based techniques provide far more time-efficient and cost-effective characterization of the fungi associated with tree cavities and their inhabitants. Here, we utilize amplicon-based next generation sequencing (NGS) to address questions about fungi associated with cavity nesters distributed across North and South America. We survey the fungal associates of cavity nesters that cover a range of ecologies and management needs, including both endangered and non-endangered birds, cooperative and non-cooperative breeders, species that prefer living vs. non-living trees, and species spanning two continents. These data address specific questions about the fungal communities associated with excavation, nesting, and foraging sites, and serve as a first step to answering larger-scale questions about global associations between cavity nesters and fungi. Moreover, we discuss the potential pitfalls and limitations of NGS techniques and provide an overview of potential solutions. Constantly advancing molecular techniques provide the tools to answer fundamental questions, and uncover new questions about previously unimagined relationships across multiple biological phyla.

## **Does duetting behaviour predict parental investment? A test of the signalling commitment hypothesis**

Zach Kahn, University of Windsor; Sarah Tremain-Douglas, University of Windsor; Kristin Kovach, University of Windsor

In many socially monogamous animals, breeding partners combine their vocalizations to create acoustic duets. Although duets have been shown to function in territory defense, acoustic mate guarding, and maintaining contact, few studies have investigated their importance in post-pairing mate assessment or signalling partnership commitment. In this study, we tested the hypothesis that duets signal willingness to invest in future reproductive activities (i.e. the Signalling Commitment Hypothesis), by investigating the relationship between pre-breeding singing behavior and subsequent parental investment during the nest-building and nestling-provisioning breeding stages. We recorded singing behavior and breeding activities from 57 pairs of birds in a color-marked population of Rufous-and-white Wren (*Thryophilus rufalbus*) in Costa Rica. In contrast to predictions of the Signaling Commitment Hypothesis, we found no relationship between duetting behavior and either nest-building or nestling-provisioning effort. We did find, however, that males with higher solo song rates provided less parental care during the provisioning stage, suggesting that there are potential trade-offs between singing behavior and parental care in males. This study is the first to directly assess the relationship between singing behavior and

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parental investment in a duetting species, and suggests that duets do not function as displays involved in post-pairing mate assessment or signaling parental effort in Rufous-and-white Wrens.

## **Space use and foraging patterns of the White-headed Woodpecker in western Idaho**

Adam Kehoe, Montana State University & US Forest Service; Victoria A. Saab, USDA Forest Service; Quresh Latif, USDA Forest Service; Jonathan G. Dudley, USDA Forest Service

The White-headed Woodpecker (*Picoides albolarvatus*) is a species of conservation concern that is strongly associated with ponderosa pine (*Pinus ponderosa*)-dominated forests in the Inland Northwest. More information on home range size and habitat selection patterns is needed to inform conservation of the White-headed Woodpecker, a focal management species for dry-forest restoration treatments. We examined whether home range size was associated with food resources and if fine-scale habitat characteristics influenced selection of foraging sites. During the post-fledging periods of 2014 and 2015, we radio-tracked 11 White-headed Woodpeckers in west-central Idaho. We hypothesized that ponderosa pine cones would be a highly-valued food resource providing seeds and arthropods. We expected smaller home ranges to be associated with a greater availability of cones for foraging and that cone foraging would be concentrated in core use areas. We used foraging behavior to test this hypothesis, specifically, the proportion of foraging time on cones as an index of cone availability. Consistent with our hypothesis, individuals with relatively small home ranges spent a greater proportion of foraging time on cones and concentrated cone foraging in core use areas. We also expected foraging woodpeckers to favor larger diameter pines in sites with moderate to high canopy closure. To test this hypothesis, we analyzed foraging-site selection by comparing habitat characteristics between foraging and available trees, which provided support for our foraging-site prediction. We recommend restoration treatments that retain high-density patches of large diameter pines while promoting mosaics of open and closed canopies at larger spatial scales.

## **Habitat degradation and landscape heterogeneity on wintering migrants in lowland Belize rainforest**

Gregory Keller, Gordon College

Habitat degradation is a significant and ongoing threat to Nearctic-Neotropical migratory songbirds, requiring efforts to connect breeding and wintering seasons through full life-cycle conservation in different habitats at multiple scales. In central Belize, primary fragmentation occurs from high-intensity clearing for orange groves and low-intensity clearing for residential land use. Natural heterogeneity occurs in the form of wetland openings and hurricane damage; in November 2010, Hurricane Richard left a mix of high-impact (50-100 midstory and overstory remnant trees/ha) and low-impact (>200 trees/ha) hurricane habitats. I selected 35 sites in five habitats in remnant patches of secondary lowland rainforest in heterogeneous and degraded sites: riparian habitat, high-impact hurricane, low-impact hurricane, orange grove edges, and residential habitat. At each site, I surveyed migratory songbirds during January-February 2012, 2013, and 2017, calculated Partners-in-Flight importance scores, and calculated landscape metrics at broader scales. Riparian followed by residential sites had greater richness, abundance, and PIF total assessment scores (2x-4x greater) than other habitats. Of 18 species I analyzed, six species were most abundant at residential sites (e.g., Hooded Warbler and Northern Waterthrush), five at riparian sites (e.g., American Redstart, Baltimore Oriole), three at orchard sites (e.g., Wilson's Warbler), and one at low-hurricane sites (Kentucky Warbler). Models from landscape measures illustrate that migratory songbirds respond to multiple scales with a variety of fragmentation variables. These results illustrate that both regional

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hurricane damage and widespread habitat degradation may significantly reduce habitat use by at-risk species of migratory songbirds in the tropics and require further analysis at multiple scales.

## **Estimating migrating populations of scoter and loon species through the Bay of Fundy**

James Kelley, University of New Brunswick; Heather L. Major, University of New Brunswick; James G. Wilson, Point Lepreau Bird Observatory Committee, Saint John Naturalists' Club

Hundreds of thousands of Atlantic-wintering waterfowl travel through the Bay of Fundy (BOF) every spring on their annual migration to summer breeding grounds in Northern Canada. The Saint John Naturalists' Club has documented this migration at the Point Lepreau Bird Observatory (PLBO) in New Brunswick since 1996 but a lack of afternoon migration monitoring (post 1000h AST) has limited how this database is used in current Atlantic waterfowl population estimates, which remain critical data gaps. In spring 2016, we began afternoon migration observations at PLBO to supplement standard morning data collection and more completely monitor daily migration rates over the course of the migration season as part of a multi-year initiative. Using GLMMs, we model relationships between daily mean afternoon and morning migration rates of scoter and loon species over 134 days with continuous all day monitoring (0600-1400h AST) between 2001-2016. We use these models to estimate species' afternoon migration rates for days without afternoon data collection and use them with collected morning data to generate annual migrating population estimates (MPEs) for these species for the past 16 years. We use GLMMs, AICc scores and weights to compare these MPEs to others derived from morning only data extrapolated over diurnal hours. We predict a statistically important difference between MPEs among calculation methods and predict the proposed technique will generate lower and more defensible estimates. Information from our research will give industry and wildlife managers the ability to effectively monitor changes and manage migrating populations of waterfowl moving through the BOF.

## **The need for exploratory and confirmatory analyses of bird populations**

Steve Kelling, Cornell Lab of Ornithology; Daniel Fink, Cornell Lab of Ornithology

The process of science comes from new ideas made exploring and visualizing patterns of data, and seldom come from preconceived ideas about how systems function (John Tukey, *The American Statistician*, 1980). Periodically, technological advances allow scientists to observe the world in novel ways. With few preconceived ideas for guidance, scientific inquiry begins with exploratory analyses to describe novel observed patterns, which leads to new hypotheses and subsequent confirmatory analyses with the goal of explaining the underlying processes that give rise to observed patterns. Over the past decade numerous bird-monitoring projects (i.e., eBird) have harnessed technological advances to gather observations across larger spatial and temporal extents. With hundreds of millions of observations collected year-round from across the globe, these data are providing new insights to bird populations, filling key knowledge gaps necessary for a holistic, full annual cycle perspective. However, data analysis must address the inherent biases of this method of data collection: 1) uneven sampling effort over space and time 2) uneven observation skill across participants, and 3) uneven detectability of organisms. This talk examines methods of exploratory and confirmatory analyses from these data from the perspective of its contribution to ecological science. We discuss how bias can be controlled by data filtering, through the use of ancillary information collected along with species observations, and through the choice of

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proper statistical techniques. Being able to estimate the relative abundance and trends of species across their entire range could provide tremendous value in the conservation of species and the landscapes they require.

## **Phenology of the annual cycle of an avian synanthrope.**

Jeff Kelly, Oklahoma Biological Survey, University of Oklahoma; Kyle G. Horton, Oklahoma Biological Survey, University of Oklahoma; Sandra M. Pletschet, Oklahoma Biological Survey, University of Oklahoma

Phenology of avian annual cycle is responding to climate change. To understand mechanisms that underlie this response, we need data that capture the spatial and temporal variation in phenology of key annual events. Population-level phenology data collected at high temporal frequency over broad spatial extents are rare. Consequently, questions about the spatial and temporal patterning of phenological change are difficult to address. We explore these questions by focusing on the Purple Martin (*Progne subis*). The Purple Martin is an abundant synanthropic migrant that travels from wintering locations in Brazil to breeding locations in the eastern USA every year. We combine data from the eBird citizen science network with those from the US weather surveillance radar network to document spatial and temporal variation in first-of-season arrival date, post-breeding roost formation date, end of roost date, and last-of season departure date over a 7 year period. We test the hypothesis that phenological delays within a season carry-over to subsequent seasonal events. Data suggest that compensation, rather than carry-over, for phenological delays (or advances) is common within the annual cycle. Finally, we examine the variation in these phenologies relative to annual environmental conditions.

## **Conspecific and heterospecific responses to perceived density for breeding habitat selection**

Janice Kelly, University of Illinois at Urbana-Champaign; Michael Ward, University of Illinois at Urbana-Champaign

Theoretical models of habitat selection often incorporate negative density dependence. Despite strong negative density-dependent effects on habitat selection, more recent studies indicate that animals settle near members of their own (conspecific) and other species (heterospecific) when selecting habitat with social cues. Social cue use for habitat selection is particularly common among songbirds, but few studies have investigated if songbirds use social cues to assess conspecific or heterospecific density (as opposed to just presence/absence) when making settlement decisions. We conducted a playback experiment to evaluate if Yellow Warblers (*Setophaga petechia*) and Willow Flycatchers (*Empidonax traillii*), two potential competitors for breeding habitat, use social cues to assess density of their competition when selecting breeding locations at two different spatial scales. We manipulated apparent warbler density to be high or low at multiple treatment plots, and evaluated settlement decisions by comparing warbler and flycatcher abundances across plots (broad scale habitat selection) as well as individual space use within plots (fine scale territory establishment). Apparent Warbler density did not affect habitat selection by warblers at the broad scale, but caused individuals to cluster territories where playbacks simulated high apparent conspecific density. In contrast, flycatchers were most abundant at plots with high apparent warbler density, but did not influence territory locations based on apparent warbler density. The results indicate that perceived density from social cues can have species-specific effects at different scales in the habitat selection process.

## **Why do the color patterns of bird species differ when they live together?**

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Haley Kenyon, Queen's University; Paul R. Martin, Queen's University

The divergence of signals, such as color patterns and songs, is thought to be important in species formation because divergence can promote reproductive and ecological isolation, allowing new species to live together. Indeed, closely related species often show divergent signals, but the relative importance of selective pressures favoring divergence remains mysterious. For example, selection against both hybridization and interspecific aggression can produce signal divergence, but the relative contributions of these processes are unknown. Here we examine the roles of these alternative processes in explaining color pattern divergence among closely related species of birds that live in sympatry. We used field experiments to test for selection against hybridization and interspecific aggression as causes of color pattern divergence in two clades (chickadees, cardinals) that show divergent color patterns in sympatry based on a broader comparative analysis. To test among these alternatives, we created 3D scanned and printed models with spectrometer-matched color patterns of equally closely related sympatric and allopatric congeners. In both breeding and wintering contexts, we tested whether birds are more aggressive towards models of sympatric or allopatric males. During the breeding season, we also tested whether females are more receptive to models of sympatric or allopatric males. We focused on male color pattern evolution by conducting all experiments outside of regions of overlap where neither learning, nor the evolution of female choice is expected. Experiments are ongoing, but results thus far do not support aggression as a driver of sympatric color pattern divergence in one of our two focal clades.

## **Year-round competition in a migratory songbird: Dietary opportunism, overlap, and private resources**

Cody Kent, Tulane University; Thomas W. Sherry, Tulane University

Interspecific competition for limiting resources has been implicated in many processes central to ecology and evolution. However, most studies of competition, especially in birds, are limited to a single site in a particular season, and rarely quantify resources consumed. Migrant birds potentially compete with different species at different times during the annual cycle. Additionally, competitive interactions can vary from diffuse competition involving multiple species scrambling for resources without contests to preemptive social dominance hierarchies. In this study, we examined the potential competitive interactions for arthropod prey between the migratory American Redstart (*Setophaga ruticilla*) and potential competitors in multiple seasons. We quantified niche breadth, overlap, and private resources based on stomach contents. In addition, we compare these results to inferences based on diet proxies, such as microhabitat and foraging behavior. Overall, we found that redstarts have high dietary overlaps with potential competitors in multiple seasons. Despite this high level of dietary overlap, we found some level of specialization between species that is consistent with what is known about their foraging behavior and morphology. We conclude that high dietary overlap, coupled with previous documentation of intraspecific competition for limited food resources, indicate a strong potential for interspecific competition to affect population processes throughout much of, if not the entire annual cycle.

## **Elaina M. Tuttle: the sparrow whisperer**

Ellen Ketterson, Indiana University

Elaina Tuttle had a way with birds and people. From her first experiences with Cranberry Lake Biological Station and White-throated Sparrows, she committed to understanding what was up with their morphs and their chromosomal inversion. Field biologists who study birds have to possess the best attributes of those who make their living outdoors by turning adversity into opportunity. Whether it's an early spring, a late spring, a drought, a

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hailstorm, or an outbreak of chipmunks or botflies, each field season provides an opportunity to learn how birds cope with variability and uncertainty in nature. This talk will describe how great field biologists display their determination and resilience to conduct long-term studies on single species of birds in their natural environments. In addition to resilience and insight, Elaina brought rigorous methodology from animal behavior, physiology, ecology, and genomics to make ground-breaking discoveries about the causes, consequences, and maintenance of variation in a representative north temperate songbird, the white-throated sparrow. She personified the best of the committed ornithologists who conduct their research in the wild by being monomaniacal about single species of birds whose secrets they uncover. It is an honor to introduce her and this symposium.

## **How super are supermatrices?**

Rebecca T Kimball, University of Florida; Peter A. Hosner, University of Florida; Edward L. Braun, University of Florida

Comparative methods are important to address a wide range of questions, including those in behavior, ecology and evolution. However, such studies require phylogenies that include most or all of the species in the focal group. Although data collection methods have improved, the existing data are heterogeneous for most groups of birds, with different loci sampled for different studies. Supermatrices combine these heterogeneous data to develop species-rich phylogenies. However, concerns have been raised that missing data, which is a key feature of supermatrices, may affect branch length estimates in the resulting phylogeny. Since branch lengths are used in comparative analyses, biased branch lengths may lead to biased or misleading results in comparative studies. What has not been addressed in this context is the role for different types of markers to also affect branch lengths. Most supermatrices in birds have mitochondrial data for all or most species and nuclear data for only a subset of the species. This means that some species are represented only by more rapidly evolving mitochondrial sequences while others have large amounts of more slowly evolving nuclear data. We assembled a supermatrix of galliform birds that represents nearly 90% of the order. We incorporated complete mitochondria, sequences from nuclear introns and coding regions, as well as ultra-conserved element sequences. We use this data to explore the impact of data type on branch lengths, and explore approaches that may minimize branch length biases in other studies.

## **Bird conservation and cattle production: Improving the matrix through silvopasture**

Lillie Kline, University of Michigan; John Andreoni, University of Michigan; Alex Truelove, University of Michigan; Astrid Santiago, University of Michigan; Wyatt Klipa, University of Michigan; Kimberly Williams-Guillén, Paso Pácfico

Agriculture shapes landscapes with important ecological and social implications. Much of conservation research focuses on forest fragments, while our study aims to understand how a high-quality matrix can benefit both resident birds and farmer livelihoods through connectivity and provision of ecosystem services. In the current study, we assess how silvopasture can enhance the conservation value of disturbed tropical dry forest habitat while also benefiting local ranchers. We collected data during summer 2016 throughout 17 cattle ranches in Nicaragua's Rivas Isthmus where ranching is the dominant land use. We studied how isolated pasture trees influence bird use, pasture quality, and cattle health, as well as rancher perceptions. We documented 130 trees of various species and sizes, six main behaviors of 29 bird species using these trees, and the temperature and weight of 116 cattle. Trees with wide canopies, mature fruits, and lower leaf densities experienced significantly higher bird visitation rates. Birds most frequently used these trees for perching, a behavior associated with hunting,

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communicating, and maintenance. Our findings suggest that isolated trees likely provide very different resources to birds than do forest trees. Furthermore, isolated trees did not have a negative effect on pasture quality or cattle health. This study supports the argument that improved tree cover in pastoral systems can enhance their conservation value for biodiversity without detriment to agricultural productivity. Today's agricultural practices will likely predict the future of tropical biodiversity. Sustainable land management techniques are therefore crucial to maintaining rich biodiversity, as well as thriving local populations.

## **Effects of oil and gas infrastructure on abundance, productivity and behavior of grassland songbirds**

Nicola Koper, Natural Resources Institute, University of Manitoba; Jacy Bernath-Plaisted, University of Manitoba; Heather Nenninger, University of Manitoba; Christoph Ng, University of Manitoba; Miyako Warrington, St. George's University

New oil wells are continually being developed across the Northern Great Plains, but their effects on grassland songbirds, including species at risk, are poorly understood. We compared effects of different types of oil wells to evaluate which might have lower ecological footprints, compared these with even louder natural gas compressor stations, and evaluated whether effects of wells were driven by the presence of infrastructure, or noise, traffic, and human activity by comparing effects of active wells with wells that were turned off. We assessed effects of oil and gas infrastructure on abundance, nesting success, brood parasitism, parental behaviour, and song structure. Abundance of Baird's sparrows and Sprague's pipits was significantly and substantially lower in sites with oil wells, and nesting success was significantly lower in sites with screw pumps. These impacts were the same regardless of whether infrastructure was active or inactive, and thus were not caused by noise. Brood parasitism rates were four times higher in sites with oil wells or compressor stations. Nest attentiveness was lower near energy infrastructure and roads, and in noisy compared with quiet sites. Compressor stations, but not quieter oil wells, influenced parental responses to alarm calls at nests. Conversely, song structure was most strongly altered at screw pump sites, which produce greater amplitudes of high-frequency noises than the other types of infrastructure. Our results demonstrate that effects of noise vary among different types of infrastructure, and this can impact behavior of individuals, but that population-level impacts are driven more strongly by well and compressor station structures and associated linear developments than noise. Mitigation strategies should focus on reducing the extent of above-ground infrastructure, including perch sites and roads, supplemented by selective use of commercially available infrastructure that can help reduce the ecological footprint of individual wells.

## **Will it ever end? Cowbird management and a conservation reliant species**

Richard Kostecke, The Nature Conservancy; Chad Wilsey, National Audubon Society; David A. Cimprich, Department of the Army, Environmental Division, Natural Resources Management Branch; Scott G. Summers, Department of the Army, Environmental Division, Natural Resources Management Branch

Arguably, Fort Hood's Black-capped Vireo (*Vireo atricapilla*) population has increased to the point that per-capita risk of cowbird (*Molothrus ater*) parasitism has decreased, and may be low enough for the population to sustain itself in the absence of cowbird management. To assess this assumption, we used modeling and experimental approaches. First, we used a nonspatial stochastic population projection matrix simulation and a spatially explicit population model to estimate the effects of parasitism on the vireo population. Dependent on the population growth rate scenario, vireos tolerated low to moderate (12-49%) levels of sustained parasitism. Sustained parasitism above 45-85%, depending on the scenario, would likely result in the vireo population dropping below

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its recovery goal in the next 25 years. Second, we initiated a 5-yr experimental cessation of cowbird management on half of Fort Hood while continuing to manage cowbirds on the other half. In the 5-yrs prior to the experiment, parasitism frequency was similar between the managed (3.9%) and unmanaged (4.0%) sides. After initiation of the experiment, parasitism frequency increased on the unmanaged side and was always greater (7.9–33.9%) than on the managed side (0.0–4.4%). Prior to the experiment, mean nest survival was similar between managed (0.329) and unmanaged (0.303) sides. After initiation of the experiment, overall nest survival was always lower on the unmanaged side (0.246–0.289) than on the managed side (0.300–0.394). These results suggest that vireos, although tolerant of parasitism to a degree, are a conservation-reliant species dependent on cowbird management.

## **Range-wide migration patterns and distribution of *Vermivora* warblers during the nonbreeding period**

Gunnar Kramer, University of Toledo; David E. Andersen, U.S. Geological Survey; David A. Buehler, University of Tennessee; Petra B. Wood, U.S. Geological Survey; Sean M. Peterson, University of Minnesota; Justin A. Lehman, University of Tennessee; Kyle R. Aldinger, West Virginia University; Lesley P. Bulluck, Virginia Commonwealth University; Brandon Gray, Ohio University; Sergio Harding, Virginia Department of Game and Inland Fisheries; John A. Jones, Tulane University; David I. King, U.S. Forest Service, University of Massachusetts; Jeffery L. Larkin, Indiana University of Pennsylvania; John P. Loegering, University of Minnesota; Darin J. McNeil, Indiana University of Pennsylvania; Donald B. Miles, Ohio University; Curtis Smalling, Audubon North Carolina; Rachel Vallender, Canadian Wildlife Service, Environment Canada; Henry M. Streby, University of Toledo

Golden- and Blue-winged Warblers (*Vermivora chrysoptera* and *V. cyanoptera*, respectively) are closely related Neotropical-Nearctic migrant songbirds exhibiting varied and complex regional population trends within and between species. Intensive landscape management focused on increasing cover types associated with both species has not resulted in observable responses in breeding population trends suggesting that nonbreeding factors may be limiting breeding populations of these species. To investigate the potential for nonbreeding factors to differentially influence breeding population trends of these species we used light-level geolocators to track the annual movements of 43 Golden-winged Warblers, 24 Blue-winged Warblers, and 4 phenotypic hybrids from 21 sites across both species' breeding distributions. We determined nonbreeding locations and migratory routes to investigate the potential for population- and/or species-specific nonbreeding and migration patterns to explain breeding population trends. Blue-winged Warblers demonstrated weak connectivity with individuals across the breeding distribution occurring throughout Central America during the nonbreeding period. Conversely, Golden-winged Warblers exhibited strong connectivity with eastern, declining populations occurring exclusively in northern South America during the nonbreeding period, and western populations occurring throughout Central America. Our results suggest that nonbreeding-site factors may explain differences in population trends observed in Golden-winged Warbler breeding populations, but not trends in Blue-winged Warbler populations. Blue-winged Warblers showed weaker connectivity and occurred in similar areas as stationary or increasing, western-breeding Golden-winged Warbler populations (i.e., Central America). We discuss the conservation and management implications of species- and population-specific nonbreeding distributions and investigate potential nonbreeding-site drivers of population declines.

## **Predator induced maternal effects**

Nicole Krauss, Washington State University; Mike Webster, Cornell University; Scott Sillett, Smithsonian Migratory Bird Center; Hubert Schwabl, Washington State University



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Predation risk is a powerful selective pressure with potential to impose behavioral and physiological changes on prey. During the breeding season, the presence of predators may change parental reproductive strategies. Long-lived species are predicted to decrease reproductive effort when predation risk is high, while short-lived species are predicted to reallocate investment into fewer high quality offspring rather than spreading their efforts across many low-quality offspring. Changes in parental, particularly maternal, reproductive strategies can result in altered offspring phenotype. We aim to evaluate the response in reproductive effort of Black-throated Blue Warbler (*Setophaga caerulescens*) females to predator abundance during reproduction, and consequences for offspring. We used a 20-year data set collected at Hubbard Brook Experimental Forest in New Hampshire in which breeding pairs were intensely monitored and censuses of predators were conducted biweekly within fifteen meters of active nests. Female investment was measured in two ways: clutch size and female feeding rates towards the end of the nestling phase, when female effort is at a maximum. Nestling morphometrics and age at fledge were used as metrics of offspring phenotype. Linear mixed models were used to evaluate the effect of predator abundance on both female investment and offspring phenotype. Preliminary results indicate that clutch size, nestling mass and tarsus are not influenced by predator abundance. However, there was a negative trend in nestling tarsi standard deviation within a nest in relation to predator abundance. This suggests that females alter their investment within a nest in response to increased predation risk.

## **Molecular data suggests admixture between species of the African mainland Paradise Flycatchers**

Sarah Kurtis, University of Florida; Rebecca Kimball, University of Florida; John Bates, Field Museum of Natural History

Species delimitation has always been a subject of much contention across evolutionary biologists. One of the principle factors contributing to this issue is interspecific hybridization, which clouds evolutionary lineages with incongruence across morphological and molecular characters. A prime example of ambiguity in species boundaries is in the Paradise Flycatchers (genus *Terpsiphone*) inhabiting mainland Africa. However, teasing out hybridization from retention of ancestral characteristics, particularly in highly polytypic species, is particularly challenging. American ornithologist James Chapin regarded “Any attempt to sort out the African species and races of Paradise Flycatchers (genus *Terpsiphone*) into neat compartments is doomed to failure, because of their perplexing variability in so many districts” (1963). Chapin attributed this perplexity based on field observations to hybridization across species. To determine if this is indeed the case, we used twelve microsatellites and sequenced twelve nuclear and three mitochondrial markers in the African paradise flycatcher (*T. viridis*) and the Red-bellied Paradise Flycatcher (*T. rufiventer*), two potentially hybridizing species, plus outgroups. Compared to prior genus- and family-level phylogenetic approaches, our study includes the largest species-level sampling and highest genetic coverage. Initial phylogenetic and population genetic analyses indicate a lack of monophyly and little genetic structure. This suggests admixture between *T. viridis* and *T. rufiventer*, consistent with hybridization. Analyses of our different data types will clarify species and subspecies delimitation of this historically confounding lineage and address whether hybridization or another process such as cryptic speciation or incomplete lineage sorting is responsible for our observed patterns.

## **When less is more: alternative protocols for reducing parasitism of the Least Bell’s Vireo**

Barbara Kus, USGS Western Ecological Research Center; Suellen Lynn, USGS Western Ecological Research Center

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Brown-headed Cowbird parasitism is a leading cause of decline of the endangered Least Bell's Vireo in California, and management to trap and remove cowbirds from riparian breeding areas has been accompanied by a 15-fold increase in vireo numbers statewide during the past 30 years. As traditionally implemented, cowbird control entails annual deployment of modified Australian Crow traps between 1 April and 15 July, coinciding with the vireo nesting season. We conducted a 5-year experiment to test alternatives to the temporal components of the traditional trapping protocol with the goal of optimizing cost- and biological effectiveness. In particular, we assessed the effectiveness of a shortened trapping period (April-May) and biennial trapping in reducing parasitism. We monitored vireo nests in Treatment and Reference plots along a 5-km reach of the San Diego River in San Diego County, CA, and compared the proportion of nests parasitized each year. We used AIC to evaluate support for logistic regression models quantifying the effects of treatment type (no, full-season or short-season trapping regimes) on the likelihood that a nest would be parasitized. Both full- and short-season trapping significantly reduced the likelihood of parasitism relative to no trapping, and short-season trapping was at least as effective as full-season trapping. However, we did not find evidence of carryover effects of trapping in successive years, and parasitism increased significantly following cessation of trapping. We suggest that modifications of existing protocol be tested and employed as appropriate on a site-specific basis to reduce management cost without compromising biological effectiveness.

## **The effect of agricultural intensity on the diet of Barn Swallow (*Hirundo rustica*) nestlings**

Jackson Kusack, Western University; Dean Evans, Western University; Greg Mitchell, Environment and Climate Change Canada; Mike Cadman, Environment and Climate Change Canada; Keith Hobson, Western University

As landscapes become more intensively managed and less heterogenous, natural levels of biodiversity are diminished. At the landscape level, the increase of intense management practices has been linked to declines in breeding bird species and insect abundances. Aerial insectivores are experiencing declines worldwide for which reduced prey insect availability resulting from increased agricultural intensity is hypothesized to be partly responsible. One way reduced insect availability can influence fitness is through variation in nestling diet, as nutrition during the nestling stage can affect survival. To investigate the effect of agricultural intensity on the diet of nestling aerial insectivores, I sampled nestling Barn Swallows from 20 colonies in southern Ontario. I used DNA barcoding of nestling fecal sacs containing prey DNA to identification prey species and stable isotopic analysis of nestling feathers ( $\delta^{13}\text{C}$ ,  $\delta^{15}\text{N}$ ) to determine general origin of prey species. These measures of diet were compared to landscape composition surrounding the breeding colonies. DNA barcoding of nestling fecal samples showed high variability in prey taxa across all samples. Cluster analysis of isotopic data showed polarized clustering, which corresponded to distinct colonies, and as agricultural intensity increased there was a significant enrichment for both  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$ . From this preliminary investigation into the effect of agricultural intensity on the diet of a nestling aerial insectivorous, it appears that there is a landscape level effect on nestling diet. This research hopes to illuminate the effect that agricultural intensity can have on aerial insectivore species breeding within modified environments.

## **Colonization and diversification of the White-browed Shortwing (Aves: Muscicapidae: *Brachypteryx montana*) in the Philippines**

Christopher Kyriazis, Loyola University Chicago; Bushra Alam, Loyola University Chicago; Mark Wjodyla, Loyola University Chicago; Peter Hosner, University of Florida; Shannon Hackett, Field Museum of Natural History;

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Herman Mays, Marshall University; Lawrence R. Heaney, Field Museum of Natural History; Sushma Reddy, Loyola University Chicago

Molecular phylogenetic approaches have greatly improved our knowledge of the pattern and process of avian diversification across the globe; however, many regions remain poorly documented. The Philippine archipelago, in particular, remains one of the least-studied 'biodiversity hotspots', despite offering an ideal natural laboratory for investigating the mechanisms driving diversification in an insular and geologically dynamic setting. We investigated the history and geography of diversification in of Philippine White-browed Shortwings (*Brachypteryx montana*), a widespread Asian tropical montane bird. Leveraging dense archipelago-wide sampling, we generated a multi-locus genetic dataset, which we analyzed using phylogenetic, population genetic, and coalescent-based methods. Our results demonstrate that 1) Shortwings colonized the Philippines from the Sunda Shelf initially on Mindanao in the late Miocene or Pliocene, 2) Shortwings diversified largely across inter-island barriers into three genetically distinct lineages, 3) colonization of Luzon, Mindoro, and Palawan occurred especially recently, with evidence for population expansion on Luzon beginning c. 90 ka 4) Shortwings colonized Palawan from the oceanic Philippines rather than Borneo, challenging the assumption of Palawan functioning exclusively as a biogeographic extension of the Sunda Shelf. Additionally, our finding that moderately divergent (c. 2.1 Ma) Shortwing lineages are coexisting in secondary sympatry on Mindanao without apparent gene flow suggests that the speciation process is likely complete for these shortwing lineages. Overall these investigations provide insight into how topography and island boundaries influence diversification in remote oceanic archipelagos and echo the results of many other studies in demonstrating that taxonomic diversity continues to be underestimated in the Philippines.

## **Age effects on the breeding performance of bridled terns breeding in south Western Australia**

Aurelie Labbe, Murdoch University; James N. Dunlop, Conservation Council of Western Australia; Michael Calver, Murdoch University; Jill M. Shephard, Murdoch University; Mike Van Keulen, Murdoch University

The effects of age on the breeding performance of marine birds has been documented in many species and they have implications for using seabirds as monitors of their environment. In this study, the effects of age on the breeding performance of Bridled Terns (*Onychoprion anaethetus*) were investigated. Two approaches were used: the breeding performances of birds from the Penguin Island colony in south western Australia were recorded along with egg and chick variables across three consecutive breeding seasons, and the chicks' diet was investigated using faecal DNA meta-barcoding methods. No difference in the egg and chick variables was found between parents of different ages and only a marginal difference in diet composition was found. This could indicate a lack of effect of age and associated breeding experience on the breeding performance of Bridled Terns, which contrasts with many other species of marine birds. Furthermore, there appeared to be a possible decoupling of biological and chronological age in this species as found in the low levels of pentosidine-containing collagen, a biological marker of age, in patagial skin samples.

## **Quantitative analysis of intraspecific variation in the nocturnal flight calls of migratory passerines**

Blaine Landsborough, University of Windsor; Rachel Hasson, University of Windsor; Jenn Foote, Algoma University; Dan Mennill, University of Windsor

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Various technologies facilitate research on the nocturnal movements of migratory songbirds; however, bioacoustic recording is currently the only monitoring technology capable of discerning species identity. Nocturnal flight calls are species-specific vocalizations produced by birds during migratory behaviour. Despite increasing interest in the potential applications of flight calls for migratory research, several features of these vocalizations remain heavily understudied, specifically the paucity of information concerning intraspecific variation in these calls. In this study, we quantify variation in the flight calls of migratory Wood-Warblers (Parulidae) and Sparrows (Emberizidae) across Canada, from Vancouver Island in the west, through the prairies, around the Great Lakes, and out to the east coast as far as Newfoundland. We investigate whether birds encode information regarding age, sex, or geographic origin within these vocalizations. To quantify variation in these vocalizations, we used two techniques to record flight calls from actively flying birds and individuals held for banding. To record wild-flying birds at night, we used an array of automated recorders to record calls produced by actively migrating birds. We generated spectrograms for thousands of calls and measured the fine spectro-temporal details of each call. We conducted spectrographic cross-correlation on conspecific flight call recordings. We then used discriminant functions analysis and principal coordinate ordination to compare recordings among conspecific individuals of different age, sex, and geographic location. To our knowledge, this is the first study to investigate and quantify intraspecific variation in the nocturnal flight calls of migratory songbirds across a broad geographic range.

## **Telling your story: Tips for developing your scicomm strategy**

Jo Latimore, Michigan State University

Scientists and natural resource professionals need to communicate with both the public and peers from other disciplines to advance research, conservation, and stewardship goals. Popular and emerging social media tools are promising pathways for building these connections, and taking a strategic approach to social media leads to better results. However, scientists rarely receive formal training that prepares them to be effective science communicators outside of their own disciplines. In this presentation, I will share tips for developing social media communication strategies appropriate for individuals or organizations, informed by experience teaching graduate science communication courses, managing social media for myself and organizations, and developing a social media strategy for a major scientific society. Steps that lead to a strong communication strategy include: (1) determining the specific need(s) that will be addressed, (2) establishing goals and measurable objectives, (3) identifying and understanding your audience(s), (4) adopting the most appropriate platforms and tools, and (5) instituting an evaluation process. Strategies for organizations should also specify content and responsibility standards to guide those responsible for communications.

## **The Hairy-Downy game revisited: An empirical test of the interspecific social dominance mimicry hypothesis**

Gavin Leighton, Cornell Lab of Ornithology; Alexander C. Lees, Manchester Metropolitan University; Eliot T. Miller, Cornell Lab of Ornithology

Explaining the generation and maintenance of phenotypes is a considerable challenge in evolutionary biology, and understanding the emergence and persistence of convergent phenotypes has been the subject of particularly intense debate. Species may converge on nearly identical phenotypes for a variety of reasons, including ecological and signaling reasons such as mimicry. With respect to signaling, a number of selective forces have been proposed to drive the evolution of mimetic phenotypes. Among these, interspecific social dominance mimicry (ISDM) is a

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new hypothesis which suggests that socially subordinate species evolve a phenotype mimicking a dominant species so as to accrue resources and avoid aggression. A recently proposed test case for this phenomenon suggests that Downy Woodpecker (*Picoides pubescens*) evolved mimetic plumage to avoid attacks from Hairy Woodpeckers (*P. villosus*). We tested the central hypothesis that Downy Woodpeckers avoid aggression from Hairy Woodpeckers with a large behavioral dataset collected by citizen scientists. Contrary to the expectations of ISDM, we found that Downy Woodpeckers were more frequently the target of Hairy Woodpecker attacks than expected by chance. Even after accounting for the expected increase in encounter rates between woodpeckers versus other birds, the mimetic Downy Woodpecker plumage does not reduce aggression from socially-dominant Hairy Woodpeckers. However, in considering the broader interspecific dominance hierarchy, Downy Woodpeckers are more dominant than expected based on their body mass. We therefore suggest that the benefits of mimicry potentially accrue from third-party species mistaking the mimic for the model, rather than the model mistaking the mimic for another model.

## **Enhancing agricultural landscapes to increase crop pest reduction by birds**

Catherine Lindell, Michigan State University; Rachael Eaton, Rice University; Steve Roels, Michigan State University; Megan Shave, Michigan State University

Food production activities cover one fourth of Earth's land surface. With a growing human population, increasing agricultural productivity is key to human well-being in the coming years. Simultaneously, maintaining and improving environmental integrity and the ecosystem services vital to agricultural production are comparable challenges. Species that damage crops are a long-standing and costly problem for farmers. For example, fruit producers in five U.S. states estimated annual losses to fruit-eating birds in five crops at nearly \$200 million. Conversely, many bird species consume crop-eating species, resulting in pest reduction and lower crop damage. In the last ten years, a substantial amount of research has investigated bird contributions to agricultural productivity. We review this work and discuss 1) the benefits of investing resources to attract pest-consuming birds to agricultural landscapes, 2) ways to enhance ecosystem service delivery by birds, and 3) questions and challenges for future research in this area. We use the term "enhance" to mean engaging in practices that increase human benefits from an ecosystem service. We define enhancements as structures or materials that increase important resources for, and/or reduce constraints on, habitat and landscape occupancy by pest-consuming birds. Enhancements include nest boxes, perches, and food resources. We can also enhance landscapes to improve pest reduction by birds through landscape management, reintroducing native species, and reducing invasive species' impacts. Challenges include determining the ecological contexts where landscape enhancement is most likely to reduce crop damage and marshaling the human resources to install, maintain and monitor effects of enhancements.

## **Signatures of climate change in 30 years of loon migration at Whitefish Point Bird Observatory**

Alec Lindsay, Northern Michigan University; Joseph D. Kaplan, Common Coast Research and Conservation

Climate change is altering the breeding ranges, breeding behavior and migration phenology for many bird species, especially those that depend on arctic and temperate habitats. Data from long-term monitoring sites provide insights on changes in avian migration. We analyzed over three decades of loon migration data collected at

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Whitefish Point Bird Observatory on the shores of Lake Superior, in Chippewa County, Michigan. These data show that over this period, Common Loon (*Gavia immer*) and Red-throated Loon (*G. stellata*) migration peaked earlier each spring (correlated with dates of lake ice-out), and that common loon migration peaked later each autumn. The numbers of migrating Red-throated Loons have been increasing in the spring, while numbers of Common Loon numbers have been decreasing. Neither species showed any significant change in numbers of birds migrating around Whitefish Point in the autumn. These trends, in conjunction with anthropogenic habitat changes and outbreaks of avian botulism in the Great Lakes, are cause for concern.

## **Variation in juvenile survival and dispersal of two woodpecker species revealed by radio telemetry.**

Teresa Lorenz, U.S. Forest Service; Philip C. Fischer, U.S. Forest Service

Woodpeckers are keystone cavity excavators in western coniferous forests, but there have been few formal studies on the fate of juvenile woodpeckers after fledging. From 2014-2016, we radio tracked 54 juvenile White-headed Woodpeckers and 6 juvenile Black-backed Woodpeckers in the Cascade Range of Washington State. For White-headed Woodpecker, 4-month Kaplan-Meier survival varied significantly among years ( $\chi^2 = 20.52$ ,  $P < 0.0001$ ), from a high of 0.89 in 2014 to a low of 0.32 in 2016. In 2014 and 2015, survival of juvenile White-headed Woodpeckers ( $n = 41$ ; 0.83) did not differ from adult survival ( $n = 34$ ; 0.93,  $\chi^2 = 1.19$ ,  $P = 0.27$ ) measured in the same months, but in prior years (2011-2013). Combining all years, autumn survival was significantly higher for White-headed Woodpecker (0.67;  $\chi^2 = 4.24$ ,  $P = 0.04$ ), than for Black-backed Woodpecker in these same sites (0.33). Dispersal distances were variable. For White-headed Woodpecker, individuals dispersed up to 80 km although the average dispersal was 16 km, and individuals commonly dispersed over unsuitable habitat (across subalpine forest/peaks). For the two Black-backed that survived, both homed to a single fire complex (total dispersal 14-16 km) within 3-weeks of fire ignition, and at 2.5 months post-fledging. Once within the burn perimeter, these individuals occupied extremely small ranges ( $< 5$  ha) in fall and before snowfall prevented access to field sites. Given the variation we observed between species and among years, we suggest large sample sizes are needed before generalizations can be made about survival and dispersal in these Woodpecker species.

## **A global review of domestic cat impacts on mainland bird populations**

Scott Loss, Oklahoma State University; Peter P. Marra, Smithsonian Migratory Bird Center

The domestic cat is the most ubiquitous invasive predator on earth. Cats have caused numerous bird, mammal, and reptile extinctions, and they pose a major hazard to threatened vertebrates worldwide. These population impacts have been most severe on oceanic islands, but cats also cause tremendous vertebrate mortality in mainland contexts. Management of cat populations in mainland areas is highly contentious and often revolves around proving cats reduce wildlife populations. Focusing on birds, we synthesize evidence from around the world suggesting that cats can indeed impact mainland vertebrate populations. Numerous observational studies illustrate associations between cat populations and vertebrate abundance, population dynamics, and extinction probability, and recent experimental evidence supports that cat predation can cause bird population declines. Emerging research also illustrates surprising ways cats may impact birds and other vertebrates more indirectly via fear and disease effects. Notably, cats appear capable of impacting bird populations not only by reducing abundance but also by suppressing populations below realizable limits and altering density dependent processes and source-sink dynamics. Decisions about cat management should shift from a “proof of impact” focus to a weight of evidence approach that acknowledges the impossibility of scientific proof, recognizes the strong evidence indicating cats can

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impact mainland vertebrate populations in multiple ways, and recognizes the need to implement evidence-driven approaches to minimize further harmful impacts. Cat management activities should entail rigorous monitoring and adaptive management that allows evaluation of success in reducing cat populations, consideration of alternative approaches, and assessment of harmful impacts to wildlife and humans.

## **Genomic mechanisms for convergence in the recurrent evolution of brood parasitism**

Matthew Louder, Hunter College, City University of New York; Mark E Hauber, Hunter College, CUNY; Michael S Brewer, East Carolina University; Claire Spottiswoode, Cambridge University; Michael D Sorenson, Boston University; Christopher N Balakrishnan, East Carolina University

Little is known about the genomic changes that enable similar phenotypes to repeatedly evolve across diverse taxonomic lineages. Obligate avian brood parasitism, in which birds lay eggs in other species' nests and rely on the 'host' for parental care, has evolved independently at least seven times in distinct lineages. This repeated loss of parental care provides a unique opportunity to reveal the molecular mechanisms responsible for the convergent evolution of behavior. In this case, convergence may involve parallel loss of selective constraint in genes associated with parental care. To identify accelerated genes along brood parasite lineages, we generated high coverage (>30x) whole-genome sequences in 4 brood parasitic species from two distinct songbird lineages as well as 2 non-parasitic relatives. For the 9601 coding sequences aligned among 13 songbird species, we did not detect convergent rate shifts above a random expectation. Furthermore, we find little evidence for accelerated evolution in candidate parental care genes. Thus, convergent evolution of this complex phenotype is likely the result of either independent genetic mechanisms, or convergent genomic changes in regulatory regions.

## **A foraging ecology hypothesis for the evolution of egg rejection in brood parasite hosts**

Alec Luro, University of Illinois at Urbana-Champaign; Mark E. Hauber, University of Illinois at Urbana-Champaign, CUNY Hunter College

Host responses to the threat and occurrence of brood parasitism, including the rejection of parasitic eggs, shapes host-brood parasite coevolutionary relationships. However, there is still uncertainty as to how and why some host species evolved the ability to recognize and reject foreign eggs while other host species have not, even when the costs of accepting and raising brood parasitic offspring are substantial. Because foraging ecology profoundly shapes the morphologies, physiologies, and sensory and cognitive abilities of each lineage, we propose that lineage-specific trait differences due to foraging specialization may also influence the evolutionary predominance of foreign egg discrimination and rejection in host species of avian brood parasites. To this aim, we have conducted a comparative analysis of the diets and egg rejection rates of 96 host species of both generalist and specialist brood parasites, and found that rejection rates of host species with mainly frugivorous or insectivorous diets were predictably higher than those of granivorous species. These findings suggest that foraging specialization may underlay the evolutionary origin and ecological prevalence of some antiparasitic adaptations across brood parasite host lineages.

## **Diving duck distribution and abundance on Lake St. Clair before and after invasion by dreissenid mussels**

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Dave Luukkonen, Department of Fisheries and Wildlife, Michigan State University; Brendan Shirkey, Winous Point Marsh Conservancy; Scott Winterstein, Department of Fisheries and Wildlife, Michigan State University

Lake St. Clair is of continental importance to migrating diving ducks (*Aythya affinis*, *A. marila*, *A. valisineria*, and *A. Americana*). Using fixed-winged aerial surveys, we monitored changes in autumn diving duck distributions and abundances before (1983-1988) and after (1989-1994, 1995-2000 and 2001-2008) Dreissenid mussels (*Dreissena polymorpha* and *D. rostriformis bugensis*) became abundant in Lake St. Clair. Use of Lake St. Clair by diving ducks during autumn migrations increased from 1.1 million use-days per year before dreissenid establishment to 2.1 million use-days per year after. Although abundance of diving ducks showed dramatic annual variation, Canvasback and scaup use of Lake St. Clair increased after colonization by dreissenid mussels, whereas redhead use of the lake remained relatively unchanged. Impacts on diving ducks were likely caused by changes in available foods as mussels became a new and major prey item for scaup, while Canvasbacks likely responded to increased submerged aquatic macrophyte foods associated with greater water clarity attributed to mussel colonization. We also observed decreased use of shallow waters (< 2 m) and increased use of intermediate water depths (2-6 m) by canvasback and scaup after colonization of the lake by dreissenids while redhead use of shallow waters remained high throughout the study. We also found negative relationships between numbers of boats encountered during aerial surveys and abundances of all three diving duck species. We hypothesize that increased food availability at appropriate depths reduced foraging constraints on canvasbacks such that disturbance acted to redistribute birds to local food patches where they were relatively undisturbed.

## **The role of ecological differentiation in accelerating reproductive isolation in Andean and Amazonian birds**

Vanessa Luzuriaga-Aveiga, University of Toronto Scarborough; Dr. Jason T. Weir, University of Toronto Scarborough

Ecological differentiation results in divergent selection pressures, with reproductive isolation evolving as a consequence of adaptation – a process termed “ecological speciation”. At high latitudes, the importance of ecological differentiation has been stressed, but, in the Neotropics few studies have been undertaken to determine if ecological mediated divergent selection commonly accelerates the process of speciation. We performed a comparative analysis that measured rates of song evolution of approximately 150 pairs of closely related species of passerine birds from the Amazon basin and adjacent Andean slopes. We estimated rates of evolutionary divergence of songs for: 1) pairs that occur at the same elevation and are presumed to have low levels of divergent ecological selection; and 2) pairs that represent elevational replacements, one species from low and the other from high elevations. Elevational differentiation in this latter group is expected to result in divergent ecological selection. Our results assess the importance of elevational gradients in contributing to faster reproductive isolation rates of behavioral traits in Andean and Amazonian ecosystems, promoting the formation of new species.

## **Migration ecology and stopover population size of Red Knots at Mingan Archipelago after exiting the breeding grounds**

James Lyons, USGS Patuxent Wildlife Research Center; Allan J. Baker, Royal Ontario Museum; Patricia M. González, Global Flyway Network and Fundación Inalafquen; Yves Aubry, Canadian Wildlife Service



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Stopover habitats must be included in conservation strategies for migratory species because stopovers provide resources of equal importance to those found during other phases of the annual cycle. Migration areas close to the breeding grounds represent a link between two phases of the annual cycle and understanding migration ecology as birds exit the breeding grounds may be particularly informative for successful conservation. We studied migration phenology and stopover ecology of *Calidris canutus rufa* Red Knots at a migration area relatively close to the breeding range of the subspecies. Using mark-resight data and a Jolly-Seber model for open populations, we described the arrival and departure schedules, stopover duration, and passage population size at Mingan Archipelago National Park, Canada. Red Knots arrived at the study area in two distinct waves of birds separated by approximately 28 days. Nearly 40% of the passage population arrived in the first wave of arrivals in early July, and approximately 48% arrived in a second wave between 27 July and 10 August. Most birds stayed in the study area about 14 days (95% credible interval, 13.1 – 15.1 days). Our estimate of the Mingan Archipelago adult passage population size was approximately 8,900 birds ( $7,764 \pm 10,220$ ); it was not possible to estimate the juvenile passage population size given the duration of our sampling. Mingan Archipelago is thus an important migration area for this endangered species and should be a priority in conservation planning. Our results demonstrate that mark-recapture/resight approaches have advantages over other methods for studying migration ecology.

## Owls of Whitefish Point

Nova Mackentley, Whitefish Point Bird Observatory; Chris Neri, Whitefish Point Bird Observatory

Whitefish Point Bird Observatory's long-term owl migration monitoring project is one of a kind. It annually documents the largest and most diverse spring owl migration in North America, a previously undocumented movement of juvenile Northern Saw-whet Owls during July and August, and significant numbers of migrant owls in the fall. Since 1994 over 16,000 owls comprised of eight species have been banded at WPBO, establishing Whitefish Point as one of the premier owl migration sites in the world. Recent research projects include an analysis of the effects of different audiolure types on the sex-bias of captured Saw-whet Owls, a closer look at molt patterns of Saw-whet Owls, insights gathered from our summer juvenile Saw-whet Owl study, and testing the accuracy of sexing Long-eared Owls using color cards by comparing the results of this technique with DNA feather analysis.

## Century-scale bird resurveys reveal complex influences of climate and land-use change on species and communities

Sarah MacLean, UC Berkeley; Steven R. Beissinger, UC Berkeley; Perry de Valpine, UC Berkeley; Andrea F. Rios Dominguez, UC Berkeley

Global climate and land-use change are projected to be two of the greatest threats to biodiversity over the coming century, but to date there has been surprisingly little empirical study on the combined impacts of these two drivers on species distributions, in part due to the scarcity of sufficiently detailed datasets beginning before the onset of contemporary anthropogenic change. We used a unique historic resource – early 19th century bird surveys conducted by Joseph Grinnell, paired with contemporary resurveys a century later – to examine changes in bird distributions in the California Central Valley, a region of heterogeneous climate change and one of the most intensively modified agricultural zones in the world. We analyzed species- and community-level occupancy using multispecies occupancy models that explicitly account for imperfect detection probability, then developed a novel,

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simulation-based approach to compare the relative influences of climate and land-use covariates on site-level species richness and similarity. Surprisingly, we show that mean occupancy, species richness, and between-site similarity have remained remarkably stable over the past century. Stability in community-level metrics masked substantial changes in individual species occupancy, where declines by some species were equally matched by increases in others, predominantly those species with generalist or human-associated habitat preferences. Despite substantial land-use change in the Central Valley, occupancy, richness, and similarity were driven more strongly by water availability (precipitation and percent water cover) than by urban or agricultural cover.

## **How seasonality in northern vs southern hemispheres affects distributions of different types of migrants**

Maggie MacPherson, Tulane University; Alex E. Jahn, Universidade Estadual Paulista

We lack a thorough understanding of the degree to which the seasonal changes in locations of animals are driven by the timing and sequence of resource availability across the annual cycle, a necessary component for conservation in a changing global climate. We used Maxent models of presence-only data gathered from individuals fit with light-level geolocators to test which environmental factors (temperature, rainfall and/or primary productivity) affect seasonal distributions of a Nearctic-Neotropical and a Neotropical austral migratory bird species: Eastern Kingbirds breeding in North America, and Fork-tailed Flycatchers breeding in South America. Climatic differences experienced by these birds suggests that their migratory strategies are also shaped by different environmental selective pressures. We found that Eastern Kingbirds track with temperature and with NDVI during their breeding season and during migration, but with rainfall during the winter. Fork-tailed Flycatchers also track predominantly with temperature and NDVI during the breeding season, but rainfall and temperature during migration, and primarily rainfall during their wintering season. This supports the idea that seasonality is important to annual routines in all migrants, but that differing aspects of seasonality may be important as cues or reflections of changing resource abundances depending on the season and hemisphere where birds are located. While past studies have shown that boreal migrants may adjust migration in response to climatic warming, an important step moving forward is to test the flexibility of migratory routines in response to changes in the amplitude or predictability of rainfall.

## **A fresh look at some old specimens: revisiting a Collared and Spotted Towhee hybrid zone**

James Maley, Occidental College; Emily Applewhite, Occidental College; Whitney L. E. Tsai, Occidental College; John E. McCormack, Occidental College

Hybrid zones provide a natural experiment on the consequences of diverging lineages coming back together and reproducing. The hybrid zones between Collared (*Pipilo ocai*) and Spotted Towhees (*P. maculatus*) in Mexico incorporate dynamics of plumage evolution, allopatry, and sympatric populations that don't hybridize. They have been studied well twice, but neither of these research projects included specimens housed at the Moore Laboratory of Zoology. We currently have 415 specimens of both species and hybrids spanning the Transvolcanic Range of central Mexico. We scored them using a system initially developed to study the hybrid zone by Charles Sibley. We sampled toe pads from 40 birds spanning the zone and sequenced ultraconserved elements to link genotype and phenotype. We found several fixed differences between birds on opposite ends and steep clinal gradients across the range. We found a mismatch in the cline between overall size and plumage score, as well as between morphological and genomic clines. Our results provide an interesting comparison to previous research.

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## Two riparian songbird species at the periphery of their breeding range

Kristen Mancuso, University of British Columbia Okanagan; Christine Bishop, Environment and Climate Change Canada; Karen E. Hodges, University of British Columbia Okanagan; Andrew Huang, Environment and Climate Change Canada; Michael B. Lancaster, Independent; A. Michael Bezener, En'owkin Centre

Peripheral populations may be of greater conservation value than populations in the range core, but little is known about the migration ecology for populations at the range periphery. Examination of the geospatial movement patterns of two riparian migratory songbird species breeding at the northwestern periphery of their range in the South Okanagan valley of British Columbia – the Gray Catbird (*Dumetella carolinensis*) and the nationally Endangered Western Yellow-breasted Chat (*Icteria virens auricollis*) – aims to identify return rates, specific migratory pathways, overwintering locations used by both peripheral populations needed to guide habitat conservation and population recovery efforts. A sample of adult birds of both species were captured, colour-banded and equipped with individual tracking devices (geolocators and GPS loggers) to track the movements of breeding birds leaving their known south Okanagan nesting territories. Both species appear to overwinter near their northwest limit of their known overwintering range, with the Yellow-breasted Chats overwintering in western Mexico, and the Gray Catbird overwintering between Mexico and southern Texas. The Gray Catbirds travel further to their overwintering grounds and have lower return rates compared to Yellow-breasted Chats. The return rates for birds with tracking devices was comparable to those without the devices, confirming these devices can be a non-detrimental and valuable tool to better understand the migration ecology of birds, even in imperilled populations. From our preliminary results, we infer that species at the periphery in their breeding range may also overwinter at the periphery of their overwintering range.

## Genomic analysis of a transposable element explosion in Woodpeckers and allies (Aves: Piciformes)

Joseph Manthey, New York University-Abu Dhabi; Stephane Boissinot, New York University-Abu Dhabi

Birds are generally depauperate in the diversity and number of transposable elements (TEs) in their genomes. Most bird species' genomes have less than 12% TE content, while the Downy Woodpecker (*Dryobates pubescens*) genome consists of > 20% TE content. Here, we sequenced low-coverage genomes for representatives of all lineages within the *Piciformes*, including Jacamars, Barbets, Toucans, Honeyguides, and Woodpeckers and asked several questions: (1) When did TEs increase in abundance within Piciformes genomes? (2) Is the TE expansion homogenous across Woodpeckers? (3) How many groups of TEs expanded? We found increased genomic accumulation of several subfamilies of CR1 retrotransposons in the genomes of *Piciformes*, totaling about 20% of their genomes. Two independent lineages, the Woodpeckers and the Toucans + Barbets, differentially accumulated CR1 subfamilies into their genomes. In both cases, TE accumulation appears to have preceded bursts in diversification rate (Woodpeckers and new world Barbets + Toucans). These results contrast with general patterns of genome evolution in birds, where TEs are generally found in small abundance across the genome.

## Shoreline habitat restoration for the endangered Piping Plover in Northern Michigan

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Dawn Marsh, US Fish & Wildlife Service; Christie Deloria-Sheffield, US Fish & Wildlife Service; Jennifer Stucker, Western Ecosystems, Inc.; Vincent Cavalieri, US Fish & Wildlife Service; Glenn Palmgren, Michigan Department of Natural Resources

Waugoshance Point, a shoreline area within Wilderness State Park in Michigan's Lower Peninsula, is designated critical habitat for nesting Piping Plovers (*Charadrius melodus*), an endangered shorebird within the Great Lakes region. Piping Plovers prefer wide, sand beaches strewn with small cobble and sparse vegetation for nesting habitat. In the early 2000's this site had up to 10 pairs of nesting Piping Plovers. This important nesting habitat, however, was eliminated due to encroaching native and non-native plants. The last Piping Plover was recorded nesting at the site in 2006. The Michigan Department of Natural Resources, with support from the US Fish & Wildlife Service and the US Geological Survey, selected three priority areas along the shoreline to restore conditions for Piping Plover. In 2013 and 2014, the vegetation and substrate in these areas was manipulated using mechanical and herbicidal treatments. Transect vegetation and substrate surveys were conducted before and after project implementation. Results from the surveys indicated that the project not only helped recreate suitable nesting conditions for plovers, but also increased numbers of the federally threatened Pitcher's thistle (*Cirsium pitcheri*). In 2015, a Piping Plover was observed on the project site and last year a pair successfully fledged chicks. The successful return of Piping Plovers to Wilderness may lead to restoration work conducted elsewhere to restore shorelines and create additional suitable nesting areas for Piping Plovers. This project could serve as a model for similar restoration work at plover nesting sites along the Great Lakes or Atlantic coast.

## **Song evolution, vocal learning, and speciation in passerine birds**

Nicholas Mason, Cornell University; Kevin J. Burns, San Diego State University; Joseph A. Tobias, Imperial College London; Santiago Claramunt, American Museum of Natural History; Nathalie Seddon, Edward Grey Institute, University of Oxford; Elizabeth P. Derryberry, Tulane University

Phenotypic divergence can promote reproductive isolation and speciation, suggesting a possible link between rates of phenotypic evolution and the tempo of speciation at multiple evolutionary scales. To date, most macroevolutionary studies of diversification have focused on morphological traits, whereas behavioral traits, including vocal signals, are rarely considered. Thus, although behavioral traits often mediate mate choice and gene flow, we have a limited understanding of how behavioral evolution contributes to diversification. Furthermore, the developmental mode by which behavioral traits are acquired may affect rates of behavioral evolution, although this hypothesis is seldom tested in a phylogenetic framework. Here, we examine evidence for rate shifts in vocal evolution and speciation across two major radiations of codistributed passerines: one oscine clade with learned songs (*Thraupidae*) and one suboscine clade with innate songs (*Furnariidae*). We find that evolutionary bursts in rates of speciation and song evolution are coincident in both thraupids and furnariids. Further, overall rates of vocal evolution are higher among taxa with learned rather than innate songs. Taken together, these findings suggest an association between macroevolutionary bursts in speciation and vocal evolution, and that the tempo of behavioral evolution can be influenced by variation in developmental modes among lineages.

## **Population estimate for Black-backed Woodpeckers in the Black Hills of South Dakota and Wyoming**

Elizabeth Matseur, University of Missouri; Joshua J. Millspaugh, University of Montana; Frank R. Thompson III, USDA Forest Service; Brian E. Dickerson, USDA Forest Service

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Black-backed Woodpeckers (*Picoides arcticus*) are rare residents of northern conifer forests. The Black Hills population has been petitioned to be listed as an endangered or threatened species, and more information on their population size in the region is needed. Our objective was to determine relationships between environmental and habitat factors and the probability of detection and abundance, and use the resulting model to map density and provide a population estimate of Black-backed Woodpeckers. We conducted 3,696 and 3,414 5-minute point count surveys from late-March to late-June in 2015 and 2016, respectively. We characterized vegetation around each point using GIS derived landscape variables that included: green top, red top, dead stem, and year since wildfire. We detected 362 Black-backed Woodpeckers across both years. We fit three-level hierarchical time-removal models that simultaneously estimate abundance, availability, and detection probability in R package “unmarked” using *gmultmix* and ranked models using Akaike Information Criterion. The global abundance model received the most support and showed a negative relationship with latitude, dead trees, and live trees and a positive relationship with dying beetle infested trees, and area 1-2, 3, and 4-5 years post-wildfire. We estimated mean density was 0.0053 individuals/ha and 0.0063 individuals /ha and there were 2,920 (LCL: 1,449; UCL: 5,917) and 3,439 (LCL: 1,739; UCL: 6,908) individual Black-backed Woodpeckers in 2015 and 2016, respectively. This study sets the stage for future analysis by combining previous research with our population estimate to predict future viability and trends for the species in the Black Hills.

## Assessing coevolution between feather mites and warbler hosts

Alix Matthews, Arkansas State University; Pavel B. Klimov, University of Michigan; Heather C. Proctor, University of Alberta; Ashley P. G. Dowling, University of Arkansas; Lizzie Diener, Tennessee River Gorge Trust; Stephen B. Hager, Augustana College; Jeff L. Larkin, Indiana University of Pennsylvania; Douglas W. Raybuck, University of Tennessee; Cameron J. Fiss, Indiana University of Pennsylvania; Darin J. McNeil, Indiana University of Pennsylvania; Than J. Boves, Arkansas State University

Host-symbiont relationships are ubiquitous in nature, yet evolutionary and ecological processes that shape these intricate associations are often poorly understood. All orders of birds engage in symbioses with feather mites, which are ectosymbiotic arthropods that spend their entire life on hosts. Due to the obligatory association with hosts, presumed limited dispersal, and primarily vertical transmission, we hypothesized that cospeciation between feather mites and hosts within one family (*Parulidae*) would be perfect (following Fahrenholz’s Rule). To test this, we assessed cophylogenetic patterns and tested for congruence between two mite lineages found on 14 migratory Warblers. We found three *Proctophyllodes* lineages and six *Amerodectes* lineages (six of which are undescribed putative species). Distance- and event-based cophylogenetic analyses suggested different cophylogenetic trajectories of the two mite genera, and although some associations were significant, there was little overall evidence supporting Fahrenholz’s Rule. Host-switching is likely responsible for incongruent phylogenies. In one case, we documented Prairie Warblers harboring two mites of the same genus (synhospitality). Furthermore, host ecology may influence the likelihood of host-switching occurring. For example, we documented relatively distantly related ground-dwelling hosts (Ovenbird and Kentucky Warbler) sharing a single mite species. Overall, our results suggest that cospeciation is not the case for feather mites and hosts at this fine phylogenetic scale, and raise the question if Fahrenholz’s Rule applies for other symbiotic systems involving hosts with complex life histories. We also provide preliminary evidence that incorporating host ecological traits into cophylogenetic analyses may be useful for understanding how symbiotic systems have evolved.

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## **The art of science communication**

Abby McBride, Independent

So you're convinced: it's time to start communicating your research with social media. But how can you stand out from the crowd and actually connect with an audience? Especially if (like me) you're daunted by the prospect of constantly posting and sharing and liking? Effective social media communication is both a science and an art – on one hand it pays to learn the protocol and use established techniques to engage an audience, and on the other hand it pays to think and act outside of the box. I will discuss ways of using both approaches to build a social media following without necessarily becoming a prolific tweeter. By being creative and playing to your strengths you can carve a niche for your social media account, and get mileage out of your science communication efforts, whether you're an addicted social media user or a reluctant one. I'll show examples from my experience as an independent science writer/artist and as the former web communications specialist for the American Ornithological Society.

## **The recent colonization of urban habitats by a forest bird**

Jennifer McCabe, University of Wisconsin-Madison; Jennyffer Cruz Bernal, University of Wisconsin-Madison; He Yin, University of Wisconsin-Madison; Volker Radeloff, University of Wisconsin-Madison; Anna Pigeon, University of Wisconsin-Madison; Benjamin Zuckerberg, University of Wisconsin-Madison; David N. Bonter, Cornell Lab of Ornithology

In spite of the increasing spread of urbanized habitats around the world and its associated implications for wildlife, little is known about the ecology of urban environments. For example, populations of accipiter hawks are increasing throughout North America and are appearing more frequently in urban landscapes, but the mechanisms for the colonization has not been documented. The successful colonization of urban habitats by these typically forest dwelling predators may reflect the characteristics of the urban landscape. Using data from Project FeederWatch, a national citizen science program, we quantified 16 years (2001-2016) of changes in the spatiotemporal dynamics of accipiter hawks in Chicago, IL. We estimated change in hawk occupancy over time and identified the landscape characteristics associated with occupancy for two accipiter hawk species, Cooper's Hawk (*Accipiter cooperii*) and Sharp-shinned Hawk (*Accipiter striatus*), using Bayesian hierarchical models and remotely sensed land cover data. We found that occupancy of accipiter hawks increased from 40% to over 75%, over the 16 years. This increase in occupancy followed a discrete pattern of colonization and saturation. We found that colonization and site persistence were strongly associated with tree canopy cover. However, as hawks colonized, their tolerance for urban landscapes increased, and in later years, they become increasingly associated with impervious surface. To advance our understanding of urban ecology, we need more comprehensive studies of urban colonization. These studies provide valuable insight into how to effectively conserve wildlife in a modern, human-altered landscape.

## **Red velvet and neon yellow: vivid color from pigment and structure in the *Ramphocelus* Tanagers**

Dakota McCoy, Harvard University; Dakota McCoy, Harvard University; Allison Shultz, Harvard University; Emma van der Heide, Harvard University; Sunia Trauger, Harvard University; Charles Vidoudez, Harvard University

Carotenoid-based coloration has long been a hallmark example of honest signaling. In *Ramphocelus* Tanagers, carotenoids produce a brilliant array of colors, from the vivid yellow feathers in the Lemon-rumped Tanager

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(*Ramphocelus icteronotus*) to velvety red in the Silver-beaked Tanager (*Ramphocelus carbo*). To what extent are these colorful signals honest indicators of pigment amount? What factors contribute to brilliant coloration in these tanagers? Does microstructure play a role, and how variable are the pigments present in the feathers? We used mass spectrometry to analyze the chemical pigments in every color patch of every species from the genus *Ramphocelus* (males and females), as well as SEM to characterize the barbule density and gross morphology. Our results have interesting implications for honest signaling, white lies, and sexual conflict in a diverse genus of birds.

## **Systematics and biogeography of the pantropical avian order Coraciiformes**

Jenna McCullough, University of New Mexico; William M. Mauck III, American Museum of Natural History; Robert G. Moyle, University of Kansas; Brian Tilston Smith, American Museum of Natural History; Michael J. Andersen, University of New Mexico

Speciose, morphologically diverse pantropical clades provide rare opportunities to explore questions about drivers of diversification in the tropics. The avian order Coraciiformes comprises 177 species in six families with diverse ecologies and morphological characteristics, but their collective evolutionary history has not been adequately explored. Apart from kingfishers, the remaining five coraciiform families are understudied by molecular systematists. Indeed, motmots and rollers have no published molecular phylogeny. Here, we present the first species-level, time-calibrated phylogeny of Coraciiformes using ultraconserved elements (UCEs) and high-throughput sequencing. Ultraconserved elements are short genomic regions with a conserved core and variable ends that are scattered throughout the genome and are conserved across the tetrapod tree of life. Our dataset comprised every species currently recognized by the current IOC checklist (v 7.1), with less than 20% of samples derived from museum skins. We recovered well-supported species trees using ASTRAL and ExaBayes that was time-calibrated in MCMCTree using stem- and crown-group fossils of rollers, todies, motmots, and kingfishers. This is the first phylogenetic analysis of all coraciiforms and includes 18 species whose relationships weren't previously known. We used BioGeoBears to investigate the biogeographic origins of the group since its divergence from Piciformes during the Eocene, as well as to explore patterns of global colonization. We discuss novel species-level relationships uncovered in our analysis and propose a robust biogeographic hypothesis for the diversification of coraciiforms.

## **Nocturnal roosting in shade coffee plantations: Neotropical migrants and the need for safe havens**

Sean McElaney, University of Western Ontario; Keith Hobson, University of Western Ontario

Shade coffee plantations provide wintering Neotropical migrants with an alternative to primary forest which has disappeared throughout most of their range. However, it remains unclear whether plantations can provide enough structure to maintain viable wintering populations of many species. We studied Swainson's Thrush (*Catharus ustulatus*) wintering in two different sites in the Colombian Andes that consisted of a mixture of montane forest and shade grown coffee plantation. Using handheld telemetry we examined how birds' (n=40) use of habitat varied between their daytime territories and their nighttime roosts. Although some birds spent the day in shade coffee most used denser (natural) forest for roosting at night. We quantified the structural characteristics of roosting habitat (canopy height, canopy cover, and understory density). Remnant patches of forest provided birds with

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presumably safer roosting sites compared to shade coffee per se. The efficacy of shade grown coffee plantations as wintering habitat can be improved if matched with remnant forest patches.

## **Macroevolutionary and population genomic perspectives on trait divergence during speciation in birds**

Jay McEntee, University of Florida; Joseph A. Tobias, Imperial College London; Catherine Sheard, University of Bristol; J. Gordon Burleigh, University of Florida

Trait evolution in birds may occur gradually or in rapid pulses interspersed with stasis, but the relative importance of these evolutionary modes in generating diversity has proven challenging to resolve. In addition, while it is often assumed that pulses of trait evolution are associated with speciation events, few studies have explicitly examined how the tempo of trait divergence varies with respect to different geographical phases of speciation. Thus, we still know little about the trajectories of trait divergence over timescales relevant to speciation, or the extent to which these trajectories are shaped by variation in geographical isolation and overlap among incipient or recent species. Here, we combine divergence time estimates, trait measurements, and geographic range data for avian sister species pairs worldwide to examine the tempo and timing of trait divergence during speciation. We show that divergence in two important ecological traits, body mass and beak morphology, is best explained by a model including pulses of divergence and periods of relative stasis. We also infer that trait divergence pulses often precede sympatry, and that pulses leading to greater trait disparity are associated with earlier transitions to sympatry. These findings suggest that early pulses of trait divergence promote subsequent transitions to sympatry, rather than such pulses occurring after sympatry has been established, for example via character displacement. Incorporating pulsed divergence models into allopatric speciation theory helps to resolve some apparently contradictory observations, including widespread instances of both rapid sympatry and prolonged geographical exclusion.

## **Full annual cycle tracking reveals the migratory routes and non-breeding distribution of a declining waterbird**

Ann McKellar, Environment and Climate Change Canada; Annie Bracey, University of Minnesota; Simeon Lisovski, University of California; David Moore, Environment and Climate Change Canada; Elizabeth Craig, University of New Hampshire; Cynthia Pekarik, Environment and Climate Change Canada; Fred Strand, Wisconsin Department of Natural Resources; Paul Curtis, Cornell University; Jeffrey Costa, Environment and Climate Change Canada; Sumner Matteson, Wisconsin Department of Natural Resources; Gerald Niemi, University of Minnesota; Francesca Cuthbert, University of Minnesota

Waterbirds are showing widespread declines globally and face threats on both breeding and non-breeding grounds. In North America, the Common Tern is a species of conservation concern because inland-breeding populations on the Great Lakes and in Manitoba are in decline. In contrast, populations breeding on the Atlantic coast are stable. Based on band-recoveries, coastal and inland populations have largely non-overlapping wintering areas, with the former wintering on the east coast of South America and the latter wintering farther west. However, inferences from banding data are limited as they provide only a snapshot in time. A migration tracking study of five terns from an Atlantic coastal population supported the findings of banding data and provided greater detail on the population's migration routes and non-breeding distribution. A more detailed understanding of the migration patterns of declining inland populations is critical to assessing threats and prioritizing areas for conservation. In this study, we used light-level geolocators to track the migration of 47 terns from five colonies spread across the



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Great Lakes region and Manitoba. Across all colonies, the most common wintering location was coastal Peru. Important staging sites included Florida and the Gulf of Mexico. Although most birds' southward migration routes were similar among colonies, there were notable differences in routes used during northward migration, which varied by breeding colony along a longitudinal gradient. Our results have important implications for where to prioritize conservation efforts for inland-breeding terns and complement recent genetic work that indicates differences in dispersal between inland and coastal populations.

## **Ten years of tracking landbirds with miniature geolocators: What have we learned and where do we go from here?**

Emily McKinnon, University of Windsor; Oliver P. Love, University of Windsor

The last ten years have seen an exponential increase in tracking studies of small migratory landbirds, leading to massive leaps in our understanding of migratory connectivity, migration behaviour, and year-round conservation needs for species at risk. We review and summarize the major themes of research and advances made by using light-level geolocators on small migratory landbirds, based on nearly 100 studies published since the deployment of the first tags on songbirds in 2007. We also provide best-practices guidelines for researchers considering the use of geolocators and other tracking devices in future studies, including recommendations for which tags are appropriate for which species, which scientific questions, and which geographic regions. The widespread use of geolocators will no doubt lead to further insights into migration systems of small birds. We highlight several important questions that can be answered with available and emerging tracking tools, which, to date, have received less attention. New tools, such as the Motus wildlife tracking system, and archival GPS units that collect precise location information, will provide breakthroughs in our understanding of stopover biology and small-scale movements, and other aspects of small landbird migration.

## **Comparative capture efficiency of portable cowbird traps**

Mary Anne McLeod, SWCA Environmental Consultants; Thomas J. Koronkiewicz, SWCA Environmental Consultants

Control of Brown-headed Cowbirds (*Molothrus ater*) is often advocated to reduce parasitism and improve nesting success of sensitive populations of passerine birds, but little information is available in the literature concerning the relative effectiveness of different types of cowbird traps or the effects of these traps on non-target species. We used portable traps to capture cowbirds in 2003–2007 at 3 study areas in southern Nevada and western Arizona. We compared the effectiveness of traps with flat tops versus funnel-shaped tops in 2005 and compared entrance slots of 2 different widths in 2006–2007. Traps with funnel-shaped tops had higher cowbird capture rates and lower escape rates than did flat-topped traps. Funnel-topped traps also had a higher capture rate of non-target species. Funnel-topped traps with a 3.8-cm-wide entrance slot had a higher capture rate for male cowbirds than did identical traps with a 3.2-cm-wide entrance slot. Capture rates for female cowbirds did not differ between slot sizes, nor did escape rates for either males or females. Capture rates for non-target species did not differ between slot widths, but wider slots captured larger bodied species that were not seen in the traps with narrower slots in the years when both slot widths were tested. Cowbird traps with a funnel-topped design should be used to maximize the number of cowbirds captured and removed from a site. A slot width of 3.2 cm may minimize non-target captures, particularly of larger bodied species, while still allowing effective removal of female cowbirds.

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## **Monitoring reveals successful management of private- and public forestlands for nesting Golden-winged Warblers**

Darin McNeil, Cornell Lab of Ornithology; D. J. McNeil, Cornell University; A. D. Rodewald, Cornell University; K. E. Johnson, Indiana University of Pennsylvania, J. L. Larkin, Indiana University of Pennsylvania, American Bird Conservancy

For species that have experienced population declines as a result of habitat loss, habitat management remains an important conservation tool for reversing negative population trends. The Golden-winged Warbler (*Vermivora chrysoptera*) is an at-risk songbird that requires early-successional nesting habitat within forest-dominated landscapes. Although several stressors are understood to be contributing to this species' population declines, nesting habitat loss across portions of its range has been cited as one of the most important. Several state and federal agencies are currently working with conservation partners to implement recently-drafted guidelines for increasing availability of nesting habitat. From 2015-17, we conducted point count and vegetation surveys at over 900 managed sites across five states: Pennsylvania, New Jersey, Maryland, Minnesota, and Wisconsin. Occupancy models suggested that occupancy was considerably higher (Occupancy= 89%, 95%CI= 80 – 95%) in the Great Lakes region than within Appalachia (Occupancy= 25%, 95%CI= 20 – 31%). Habitat modeling suggested that, within the Great Lakes (where realized occupancy was high), Golden-winged Warblers used a wider array of habitat conditions than within Appalachia where the species was less common. Occupancy within Appalachia was also strongly dependent upon sub-region suggesting that the availability of local source populations may be limiting species response to management in this region. Our results suggest that habitat management within both the Great Lakes and Appalachian regions successfully created vegetation communities used by nesting Golden-winged Warblers. Our results are presented in an adaptive management framework and highlight approaches to maximizing management success for the Golden-winged Warbler and other early-successional bird species.

## **A stage-base matrix population model for exploring Black Oystercatcher population dynamics**

Tim Meehan, National Audubon Society; Laurie Harvey, Sutil Conservation Ecology; Nicole Michel, National Audubon Society; Chad Wilsey, National Audubon Society; Gary Langham, National Audubon Society; Anna Weinstein, Audubon California

The Black Oystercatcher is a shorebird inhabiting rocky intertidal coastlines of western North America. It is a species of concern because of its limited geographic range and relatively small global population. Abundance appears to be increasing in some places and decreasing in others, and global population size is thought to be approximately stable. However, abundance observations can sometimes be misleading indicators of population status. Vital rate data, when paired with a population model, can provide additional insight into potential population dynamics. We compiled published vital rates and entered them into a stage-based matrix population model for Black Oystercatcher. Monte Carlo simulations of the matrix population model produced an average population growth rate (finite annual rate of increase,  $\lambda$ ) of 1.00 (95% confidence interval of 0.87 to 1.14). Thus, observed vital rates, and derived growth rates, were consistent with the hypothesis that Black Oystercatcher populations are globally stable. Regression-based elasticity analysis of the population model indicated that population growth rates were most sensitive to hatching success (proportion of laid eggs that hatch), fledging success (proportion of hatchlings that fledge), and breeding adult survival. Management activities intended to

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increase Black Oystercatcher populations should focus on hatching and fledging success, as other population parameters are either of less importance or are more difficult to manipulate.

## **Predicting reproductive isolation across Cardinalidae**

Libby Megna, University of Wyoming; Matthew D. Carling, University of Wyoming

Understanding how reproductive isolation arises between populations is critical to understanding the process by which species diverge. However, when two species are completely reproductively isolated, it is difficult to assess which isolating mechanisms are operating. Hybridization between species reveals information on which isolating mechanisms have failed upon secondary contact. Furthermore, one of the most salient questions in evolutionary biology is whether we can predict evolutionary processes; can we find overarching patterns in how reproductive isolation is maintained among passerine species? Here we determine if there are repeated patterns of bioclimatic niche divergence and song divergence for species in the family Cardinalidae, and if those patterns can predict patterns of hybridization between species. Ten of the 48 species in Cardinalidae hybridize. We determined hybridization status by reviewing the literature. We obtained climatic niche variables by extracting BioClim climatic data for species presence locations from eBird. Divergence in vocalizations can be a strong driver of reproductive isolation in passerine birds because song is widely used as a basis for mate choice. We obtained song recordings from the Macaulay Library for each cardinalid species and extracted syllable and song parameter data using Raven Pro. We used phylogenetically informed MCMC generalized linear mixed models to determine if song and climatic niche variables are associated with hybridization or its converse, reproductive isolation, across Cardinalidae. Preliminary results indicate that the peak frequency of songs and syllables, and duration of syllables, are associated with reproductive isolation.

## **Wild birds learn songs from experimental vocal tutors**

Daniel Mennill, University of Windsor; Stéphanie M. Doucet, University of Windsor; Heather Williams, Williams College of Maryland; Amy E. M. Newman, University of Guelph; D. Ryan Norris, University of Guelph

In only eight groups of animals on Earth, including humans and songbirds, juveniles learn to vocalize by listening to adults. Vocal learning has important implications for avian ecology – learned vocalizations are critical for defending territories and attracting mates – and evolution – learning promotes geographic variation and thereby influences population divergence and speciation. Vocal learning has been studied through laboratory experiments, but has not been studied experimentally in the wild. We present the results of a five-year experimental study of vocal learning in a wild population of Savannah Sparrows. We developed an innovative playback technology: weatherproof loudspeakers that simulate vocal tutors and broadcast novel tutor songs over long time periods. Our island study population exhibits high natal site philopatry, allowing us to tutor young animals from their birth, and then study their vocalizations when they returned to breed. We show that multiple factors influence vocal learning, including the context in which tutor songs are broadcast, and characteristics of tutor songs.

## **The history and future of Brown-headed Cowbird control and the impact on Kirtland's Warbler survival.**

Chris Mensing, U.S. Fish and Wildlife Service; Nathan Cooper, Smithsonian Migratory Bird Center; Barry Benson, U.S. Department of Agriculture - Wildlife Services; Pat Ryan, U.S. Department of Agriculture - Wildlife Services

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Nest parasitism by Brown-headed Cowbirds (*Molothrus ater*) was one of the primary threats that caused the near extinction of Kirtland's Warbler (*Setophaga kirtlandii*) and continues to threaten the species. In response to declining Kirtland's Warbler populations, cowbird control programs were initiated to remove the threat of parasitism and allow for successful warbler reproduction. As the Kirtland's Warbler population continues to grow beyond the numerical recovery goal and with evidence that the cowbird population may be decreasing, a lack of information on the true efficiency of the trapping program is becoming evident. Working with the Smithsonian Migratory Bird Center and the USDA-Wildlife Services, efforts are underway to study the response of cowbirds to decreased trapping efforts and further studies are planned. The survival and on-going recovery of Kirtland's Warbler remains dependent on some level of cowbird control. As we look towards long-term conservation of the species and ultimately removing the species from the endangered species list, it is essential to operate an efficient and cost-effective cowbird control program.

## **Maternal effects in the cowbird: host preferences and patterns of egg resource allocation across the landscape**

Loren Merrill, Illinois Natural History Survey, University of Illinois Urbana-Champaign; Scott J. Chiavacci, Science and Decisions Center USGS; Ryan T. Paitz, Illinois State University; Thomas J. Benson, Illinois Natural History Survey, UIUC

Brown-headed Cowbirds (*Molothrus ater*) deposit their eggs into the nests of other birds, which then raise the cowbird chick. Female cowbirds thus have limited options for impacting their offspring's development via maternal effects compared to most other passerines. Cowbirds can impact their offspring's phenotype by choosing among potential host nests, and by adjusting egg resources based on host nest characteristics, including features of the landscape. To examine whether cowbirds exhibit either or both of these strategies, we investigated rates of cowbird parasitism and egg investment (egg size, yolk to albumen ratio, and yolk hormones) among and within host species in a shrubland bird community. We also examined whether egg resources co-varied with nest-predation risk and land-cover types around the host nest. We found that the probability of being parasitized by cowbirds varied significantly among host species, but that parasitism rates did not differ with host size. Among host species with eggs that are larger than those of the cowbird, cowbirds were significantly more likely to parasitize nests with relatively smaller eggs, whereas parasitism rates did not vary with relative egg size in host species with eggs smaller than those of the cowbird. We also found that egg resources co-varied with both nest-predation risk and land-cover around the host nest. Together these findings provide some indication that female cowbirds can assess conditions of the host nest and surrounding landscape and adjust resources to their eggs accordingly.

## **You are "where" you eat: Spatial foraging patterns reflected in a seabird's ornament**

Nathan Michael, University of Akron; Roxana Torres, Instituto de Ecología, Universidad Nacional Autónoma de México; Andreanna Welch, Durham University; Mario Erandi Bonillas-Monge, Durham University; Laura Angélica López-Márquez, Instituto de Ecología, Universidad Nacional Autónoma de México; Alejandro Martínez-Flores, Instituto de Ecología, Universidad Nacional Autónoma de México; Jonathan Felis, US Geological Survey; Josh Adams, US Geological Survey; Anne Wiley, University of Akron

As populations of seabirds decline globally, it is critical to understand their foraging locations in order to facilitate preservation of their food resources. A thorough understanding of seabird foraging habitats may also inform our

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view of their breeding strategies, for example if sexual ornaments are shaped by where individuals feed. Foraging locations often differ in relative prey availability, and because carotenoids are derived solely from diet, geography may be an important determinant of carotenoid-based ornament condition. A declining population of Brown Booby (*Sula leucogaster*) in the Marietas Islands presents a valuable opportunity to explore these relationships; this seabird possesses a condition-dependent, carotenoid-based gular skin ornament and has access to geographically distinct foraging regions. Stable isotope analysis of  $^{13}\text{C}$  in Brown Booby feathers showed that a presumably more attractive green-skinned ornament in males is correlated with lower  $^{13}\text{C}$  values, an indicator of more offshore foraging ( $R^2=0.57$ ,  $p=0.0019$ ). Tracking of birds with GPS tags (i-gotU 120, Mobile Action) confirmed that greener males foraged in more offshore locations, often beyond the continental shelf. Compared to coastal foragers, these individuals flew greater distances, and may have exploited carotenoid-rich prey items such as the Pacific sardine, a pelagic species heavily targeted by local fisheries. Importantly, our data showed that the relationship between foraging location and ornamentation persists through multiple breeding seasons and El Niño Southern Oscillation phases. In light of changing marine environments, the link between foraging habitats and ornaments may be critical to understanding the full extent of anthropogenic influence on seabird populations.

## **The Bird-Friendliness Index: a novel metric for quantifying the success of conservation programs**

Nicole Michel, National Audubon Society; Curtis Burkhalter, National Audubon Society; Chad Wilsey, National Audubon Society; Brian Trusty, National Audubon Society; Gary Langham, National Audubon Society

Over the past forty years, grassland birds in North America have experienced stronger population declines than any other avian guild. From 2008 to 2011, nearly 10 million hectares was converted from grasslands to agriculture in the United States alone. Because 85% of grassland bird habitat is in private hands, the National Audubon Society has developed the Conservation Ranching Initiative, partnering with ranchers to implement management strategies that benefit grassland birds. In order to evaluate the success of our joint efforts, we developed a novel metric to evaluate grassland bird community response to ranching management practices, the Bird-Friendliness Index. The Bird-Friendliness Index was designed to incorporate the full suite of species-specific responses to management actions, and be flexible enough to work across broad climatic, land cover, and bird community gradients (i.e., grasslands from northern Mexico through Canada). The Bird-Friendliness Index consists of four components: density estimates of grassland and aridland birds; weighting based on conservation need; a functional evenness metric to incorporate resiliency of bird communities and their ecosystems; and a standardized scoring system to control for interannual variation caused by external factors, e.g., climate. We present an analysis of bird-friendliness of conservation ranches as well as private and public lands across the Northern Great Plains region of the United States using the Integrated Monitoring in Bird Conservation Regions dataset. We will demonstrate how this metric enables us to evaluate the impacts of conservation efforts on grassland birds, and how it can be adapted for use in a variety of systems.

## **Combining morphology and genomics to discover species limits in Panamanian Ochre-bellied Flycatchers**

Matthew Miller, Sam Noble Oklahoma Museum of Natural History, University of Oklahoma; Jorge L. Garzon, Smithsonian Tropical Research Institute; Celestino Aguilar, INDICASAT-AIP; Daniel E. Buitrago-Rosas, Smithsonian Tropical Research Institute; Luis Fernando De León, University of Massachusetts-Boston; Jose R. Loaiza,

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INDICASAT-AIP; W. Owen McMillan, Smithsonian Tropical Research Institute; Kevin Winker, University of Alaska Museum

Prior work established that Panamanian populations of Ochre-bellied Flycatchers (*Mionectes oleagineus*) comprise distinct mitochondrial (mtDNA) clades resulting from three independent colonization events out of Amazonia during the past three million years. Here, we provide a more thorough survey of mtDNA phylogeography across Panama confirming this pattern. Furthermore, we found extremely low levels of mtDNA introgression among these clades, recovering multiple mtDNA lineages in only 2 of 21 sampling locations. To determine whether this lack of mtDNA introgression was indicative of cryptic species limits, we compared mtDNA patterns with patterns from phenotypic and genomic data. Model selection of nested phenotypic discriminant functions for both male and females split Panamanian Flycatchers into 2 clusters – one in the northwest, and a second in the rest of the country. The UCE species tree recovered four clades corresponding to the four mtDNA clades. However, genetic clustering and admixture models recover three clusters corresponding to the three mtDNA clades. Although populations from core localities in northwestern, southwestern, and eastern Panama show no signs of admixture, admixture was pervasive throughout central Panama. Our results suggest that mtDNA phylogeographic patterns are predictive of population-level patterns, but not necessarily predictive of individual genetic assignment. Species concepts prioritizing reproductive isolation would recognize two species of Panamanian Ochre-bellied Flycatchers, whereas concepts that emphasize genetic clustering and allow for admixture in secondary contact would recognize three species. These results suggest a promising future for the use of UCEs for fine-scale population genomics.

## **Biogeography over time: How climate change influences Northern Cardinal bill size**

Colleen Miller, University of Wisconsin-Madison; Christopher E. Latimer, University of Wisconsin-Madison; Benjamin Zuckerberg, University of Wisconsin-Madison

Allen's Rule is a biogeographic rule predicting that appendage sizes of organisms vary along latitudinal gradients so that surface area is minimized or maximized to facilitate heat retention or dissipation in cold and hot climates, respectively. Due to its vascularization, the avian bill plays an important thermoregulatory role, and is likely to conform to these predictions. While Allen's rule has been examined in relation to bird bills over broad geographic gradients, there remains little support for morphological variation over time. Over the past century, many regions of North America have demonstrated a consistent increase in temperature due to modern climate change. Like many resident birds, the Northern Cardinal (*Cardinalis cardinalis*) is exposed to variation in climate temporally. We hypothesized that Northern Cardinal bill size decreases as latitude increases. In addition, we hypothesized that as average temperatures increase over time, Northern Cardinal bill size would also increase over time. We expected that relative humidity levels would additionally mediate this relationship. We obtained measurements of bill surface area for 568 Northern Cardinal museum specimens collected over an 85-year period and tested the effects of climate variation. We found that Northern Cardinals bill sizes increased with increasing temperatures, following the predictions of Allen's rule. We also found that male cardinals' bill size increased over time. However, we found no evidence that the relationship between ambient temperature and bill size was mediated by relative humidity. These results imply that cardinal bill size varies as a function of temperature over spatial and temporal spans.

## **Influence of vegetation cover on avian productivity and community ecology in restored prairie pothole grasslands**

Ashlee Minor, Southern Illinois University; Michael Eichholz, Southern Illinois University

East Lansing, Michigan

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Numerous conservation efforts in the Prairie Pothole Region seek to restore critical breeding habitat for nesting grassland birds. Past restoration strategies, directed primarily at waterfowl, created secure nesting habitat using a low-diversity, non-native seed mix known as Dense Nesting Cover (DNC). However, DNC may not meet the habitat requirements for other grassland dependent species and without intensive management has demonstrated susceptibility to invasive vegetation species. Recently, restoration practices have shifted towards a more ecologically-sound approach, using species-rich native plantings (16-32 species), but community-level impacts are largely unknown. This study seeks to understand the influence of vegetation cover and species diversity on grassland bird productivity and community interactions that potentially limit grassland avian populations. Weekly passerine rope drags were conducted during peak breeding seasons, May to July 2014-2016, to monitor nesting density and breeding success on 24, 4-ha study plots across southeastern North Dakota and northeastern South Dakota. Small mammal abundance was estimated using Sherman live traps during early May and late June 2014-2016, and invertebrate communities were sampled using pan trap and sweep net methods during July 2016. While increased faunal diversity was observed across all taxonomic groups with increasing vegetation species richness, nesting success and density appeared to be influenced by a greater number habitat characteristics. I present results and discussion from this study. Results of this study should provide information on the responses of grassland birds and the interacting wildlife communities to different vegetation cover types and guide grassland restoration and reseeding efforts.

## **Cryptic broad-scale movements to nocturnal wetland roost sites by breeding Bank Swallows: An automated telemetry study**

Greg Mitchell, Environment and Climate Change Canada; Myles Falconer, Bird Studies Canada; Douglas Tozer, Bird Studies Canada; Kristyn Richardson, Bird Studies Canada; Mike Cadman, Canadian Wildlife Service, Environment and Climate Change Canada

Understanding habitat requirements for declining avian species is critical for developing effective conservation strategies. Using automated radio telemetry we recently discovered that bank swallows, a declining aerial insectivore in Canada, make extensive (~30 km) breeding season movements at dusk from their breeding colonies along the north shore of Lake Erie to nocturnal roost sites at major wetland complexes at Long Point, ON. Building upon this research we evaluated how the likelihood of completing a roosting movement to Long Point varied with the distance between Long Point and a given breeding colony. To meet this objective, we radio tagged 25 and 22 adult female and male Bank Swallows, respectively, from 14 breeding colonies up to 90 km distant from Long Point and tracked movement using the Motus wildlife tracking system. We found that propensity to commute to Long Point decreased as distance to colony increased (e.g., probability of commute for males 15 km distant = 80%, 60 km distant = 5%), that males were more likely to commute relative to females, and that propensity to commute was higher later in the breeding season. Our results suggest that propensity to commute is closely linked with nestling development and that differences between sexes reflects variation in parental investment at the nest. Our results also suggest that the wetland complexes around Long Point represent an important component of breeding habitat for birds from colonies up to 50 km away. Alternative roosting strategies for birds not commuting to Long point will be discussed.

## **Responses to land use by Greater Sage-Grouse at broad scales: an example from public grazing records**

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Adrian Monroe, Colorado State University, US Geological Survey; Cameron L. Aldridge, Colorado State University and US Geological Survey; Timothy J. Assal, US Geological Survey; Kari E. Veblen, Utah State University; David A. Pyke, US Geological Survey; Michael L. Casazza, US Geological Survey

Populations of Greater Sage-Grouse (*Centrocercus urophasianus*), an obligate sagebrush (*Artemisia* spp.) species, declined substantially over the last half-century. Sage-grouse require vast landscapes during their life history, and one land use type often implicated in their decline is improper livestock grazing because herbaceous cover is important for sage-grouse nesting and brood rearing. However, there is a lack of studies linking population responses of sage-grouse to livestock management at broad scales. The Bureau of Land Management (BLM) currently oversees livestock grazing on nearly 61 million ha of rangeland across the Western United States, and their records may provide a unique opportunity to assess sage-grouse responses to livestock management. We used grazing data collected annually by BLM from 1,096 grazing allotments in Wyoming, USA, and then used annual counts of displaying males from 743 lek sites (2004-2014) to evaluate sage-grouse population trends in response to the timing and level of grazing, and interactions with local vegetation productivity. We found that livestock records corresponded with both positive and negative trends among sage-grouse populations depending on the timing and level of grazing, although these relationships may vary local vegetation productivity. Our findings suggest a benefit of broad-scale analyses when evaluating effects of livestock management by revealing patterns not readily apparent from more fine-scale studies, which could provide new insights into this ubiquitous land use across sagebrush-dominated rangelands.

## **Quiet violence: songbirds respond to playback-simulated rivals using soft songs as aggressive signals of intention**

Ines Moran, University of Windsor; Stéphanie M. Doucet, University of Windsor; Amy E.M. Newman, University of Guelph; D. Ryan Norris, University of Guelph; Daniel J. Mennill, University of Windsor

When animals compete over resources such as breeding territories, they often use signals to communicate their aggressive intentions. According to the hierarchical signaling hypothesis, animals progressively escalate interactions using specific signals to reveal their aggressive intentions during territorial interactions with conspecific rivals. In this study, we tested this hypothesis in male Savannah Sparrows, *Passerculus sandwichensis*, focusing on signals that precede physical attack against a territorial intruder. We simulated an intruder using song playback and a taxidermic model, and we explored which behaviors were associated with physical attack. Several previous studies have used this approach, and they provide evidence that many species produce songs of dramatically lower amplitude, or “soft songs”, as signals of aggressive intention. Savannah Sparrows, however, are not known to produce soft songs, and therefore they provide an interesting system for testing the hierarchical signaling hypothesis. Out of 93 playback subjects, 23 males attacked the simulated intruder and 70 did not. To our surprise, Savannah Sparrows produced soft songs, a behaviour which has not previously been described for this well-studied songbird, and the number of soft songs was a significant predictor of attack on the simulated intruder. The number of “chip” calls also predicted attack on the simulated intruder, whereas four other measured behaviors did not predict attack. Our study adds to the growing body of research that supports the hierarchical signalling hypothesis and corroborates the idea that soft song is a widespread signal of aggression.

## **Pelagic seabird species partition the north Pacific Ocean**



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Kaycee Morra, Michigan State University; Yoshito Chikaraishi, Hokkaido University; Helen James, National Museum of Natural History; Peggy Ostrom, Michigan State University; Elise Zipkin, Michigan State University; Sam Rossman, Hubbs-SeaWorld Research Institute; Anne Wiley, University of Akron

No species is exempt from the possibility of extinction, a view that informs conservation management and is particularly relevant as human pressures escalate during the Anthropocene. To effectively conserve ecological diversity we must understand how populations share resources over time and space. This is particularly difficult for our seabird study species that forage far beyond the continental shelf of the North Pacific Ocean. Yet, the tissues of oceanic seabirds offer rarely exploited foraging information that can be accessed by analyzing the nitrogen isotope values of glutamic acid and phenylalanine ( $\delta^{15}\text{N}_{\text{glu}}$  and  $\delta^{15}\text{N}_{\text{phe}}$ , respectively). The difference between  $\delta^{15}\text{N}_{\text{glu}}$  and  $\delta^{15}\text{N}_{\text{phe}}$  is a proxy for trophic position.  $\delta^{15}\text{N}_{\text{phe}}$  varies with the source of nitrogen at the food web base (e.g. nitrate versus ammonium), thereby identifying the nutrient regime in which the birds forage. Data from bone collagen records information over a year or more and data from feather keratin reflects the nonbreeding season. Bayesian analysis revealed that Hawaiian Petrels (*Pterodroma sandwichensis*), Newell's Shearwaters (*Puffinus newelli*) and Laysan Albatross (*Phoebastria immutabilis*) differ in trophic level and partition the ocean in response to spatial gradients in nutrient regimes. Two of the species also forage in a nutrient regime during the nonbreeding season that is distinct from the rest of the year. Our data offer rare insight into seabird biology. Given that our study species fly thousands of miles in search of food, the observed partitioning is contrary to traditional perspectives suggesting that foraging segregation occurs in response to competition or inability to access resources.

## The geographical ecology of clutch size in the Eastern Kingbird

Michael Murphy, Portland State University

Understanding why clutch size (CS) varies geographically remains enigmatic, but a leading hypothesis for latitudinal variation (Ashmole's Hypothesis) invokes low nonbreeding season resource availability and concomitant high mortality as drivers for larger CS at high latitudes. Widespread declines of CS with elevation are, however, inconsistent with Ashmole's hypothesis. I use museum egg sets ( $n = 1351$ ) of Eastern Kingbirds (*Tyrannus tyrannus*; "kingbird") to describe geographic variation of CS, and test Ashmole's hypothesis and the alternative that CS is shaped by conditions during breeding. CS of kingbird "populations", defined by latitude, longitude, and physiographic region, did not vary with latitude ( $24^\circ$  range), but increased with longitude (i.e., larger in west). In univariate analyses CS also increased with kingbird abundance, but declined with increasing frequency of rain. Best subsets regression analysis returned seven competitive models ( $\text{AICc} \leq 2$ ); model averaged parameter estimates indicated that CS increased with longitude (2nd-order polynomial), kingbird abundance, in recent years, and in "populations" with positive scores on BioClimate1, a composite measure of primary productivity (i.e., actual evapotranspiration) and climate for which positive scores represented low seasonality and warm, productive conditions during breeding. Results are incompatible with Ashmole's hypothesis but consistent with the breeding season hypothesis. CS increased with BioClimate1 in both eastern (longitude  $< 100^\circ$  W) and western regions, but paradoxically, western "populations" with larger CS had lower scores on BioClimate1. Larger CS in the west may be favored because conditions that impede insect flight and lower adult foraging success (rain) occur less frequently in the west.

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## **Phenotypic data reveal an Allen's (*Selasphorus sasin*) x Rufous (*Selasphorus rufus*) Hummingbird hybrid zone**

Brian Myers, San Diego State University; Kevin J. Burns, San Diego State University; Christopher J. Clark, University of California-Riverside

Hybrid zones have received significant attention in biology, but few studies have investigated how behavioral traits vary across these regions of interaction. In a hybrid zone in southern Oregon and northern California between the Allen's (*Selasphorus sasin*) and Rufous (*Selasphorus rufus*) Hummingbirds, we found that hybrids vary in morphology and behavior. We describe the hybrid zone by characterizing variation in phenotype across the area of contact and study a novel courtship behavior in Allen's Hummingbird, the pendulum display. The courtship displays of both species involve a male hummingbird performing a J-shaped dive, during which the male produces a species-specific sound with his tail feathers. These displays can be broken into distinct elements, and some dive elements are analogous to those in the pendulum display. Hybrids perform courtship displays that incorporate different elements of the displays of parental species. Our data suggest the center of the hybrid zone is in Coos Bay, Oregon, spanning several miles inland and north into the range of Rufous Hummingbird (as far north as Florence, Oregon), and south into the range of Allen's Hummingbird (as far south as Eureka, CA). Additionally, we find the breaks across the hybrid zone (pure Allen's to Allen's-like hybrid range, Allen's-like hybrid to the center, center to Rufous-like, Rufous-like to pure Rufous) correlate with variation in temperature and rainfall data. Few studies have incorporated analysis of the variation of behavior across an area of contact. By doing so, we add an additional, understudied layer of biology to the study of hybrid interactions.

## **Geographic variation in song complexity in the rock wren (*Salpinctes obsoletus*)**

Nadje Najar, University of Northern Colorado; Dr. Lauryn Benedict, University of Northern Colorado

Bird song ranges from simple to exceedingly complex and much research effort has been spent on elucidating mechanisms driving its form. Researchers have proposed song complexity to be associated with geography or migratory behavior – an interesting idea but one for which the evidence is mixed. Most authors invoke sexual selection as the factor driving the observed patterns, but in varied ways, and at least eleven distinct hypotheses have been proposed to explain how geography and song complexity are related. Rock wrens (*Salpinctes obsoletus*) are an ideal species with which to ask how latitude, migration, and song complexity interact because they have a wide distribution, migrant and nonmigrant populations, and large variable song repertoires. Despite wide variation in song repertoire sizes recorded from eleven populations (six sedentary, five migratory), song complexity does seem to vary with latitude and migratory status, albeit not in a way previously predicted. Morphological measures also vary with latitude and migration, implying there is appreciable selection pressure from these forces which may be reflected in rock wren song repertoires. Overall these findings may support the basic idea that sexual selection pressure changes with latitude or migration.

## **Determining local effects of climate change on migrating songbirds through the use of a long-term phenological dataset**

Megan Napoli, Mohonk Preserve; Elizabeth C. Long, Mohonk Preserve; Paul C. Huth, Mohonk Preserve

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With warmer dates progressively occurring earlier in the spring season, environmental time sensitive events such as bud burst from trees and songbird migration have been shifting to occur at earlier dates than previously observed. Because these events are not independent from one another, studying the phenological interspecific relationships provides valuable insight to truly understanding the health of our ecosystems. This case study investigates the usefulness of a unique long-term dataset of phenological events collected from 1940 to 2016 on the Mohonk Preserve, NY. The goal was to determine if certain songbird species first arrival dates had shifted to earlier dates over time in a localized area. To perform over-time change analyses, arrival dates were separated into three time period categories (1940-1974, 1975-1994, 1995-2016). Kruskal-Wallis analyses of variance tests were used to determine significance of change in arrival date for each selected songbird species. Species chosen for analyzation include the Red-winged Blackbird, Eastern Towhee, Eastern Phoebe, Louisiana Waterthrush, Red-eyed Vireo, and American Redstart. As expected, a shift to earlier arrival dates was seen over the three time periods, with the Red-winged Blackbird and Eastern Phoebe showing significant shifts from the earliest time period to the most recent. Although, these preliminary analyses show promise that our dataset can be valuable at determining local phenological changes, more robust analyses with other variables are necessary to fully understand complete impacts on regional phenological events. Next analyzation steps include correlating songbird mean first arrival dates with both first bud of dominant forest canopy trees and annual average spring temperature.

## **Non-native plants reduce reproductive success of an insectivorous bird**

Desiree Narango, University of Delaware, Smithsonian Migratory Bird Center; Douglas W. Tallamy, University of Delaware; Peter P. Marra, Smithsonian Migratory Bird Center

Currently, there is a dearth of information on the demographic parameters that shape urban bird populations and most studies have prioritized top-down predation rather than bottom-up resources. However, food limitation profoundly impacts reproduction and survival, and non-native plants support lower arthropod-based food than native species. Despite that non-native plants are abundant in residential neighborhoods, the extent that these plants affect individual fitness in birds remains unknown. Here, we test the hypothesis that non-native plants influence reproduction of an insectivorous bird, the Carolina Chickadee (*Poecile carolinensis*), by monitoring nests in Washington D.C. yards that varied in plant community composition. Because non-native plants support fewer caterpillars, a critical food source for breeding birds, we predicted that chickadees occupying yards with more non-native plants would have lower reproduction. We used life history Aster models to determine the influence non-native plants have on reproductive success at several conditional levels. Our models revealed that reproductive success, defined as number of young fledged, declined as non-native plants increased. At each conditional level there was a negative effect on probability of settlement, probability of nesting, and number of eggs laid. There was no effect on nest survival; however, non-native shrubs increased the occupancy of house wrens, the most frequent nest competitor in this system. Our results suggest non-native plants reduce reproductive potential of an insectivore via bottom-up effects on territory quality and have the potential to increase interactions with nest competitors. Homeowners prioritizing wildlife habitat should plant native species to encourage positive growth in insectivorous bird populations.

## **Transcriptomic impacts of parental care in White-throated Sparrow (*Zonotrichia albicollis*) nestlings**

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Daniel Newhouse, East Carolina University; Margarida Barcelo-Serra, Indiana State University; Rusty Gosner, Indiana State University; Elaina Tuttle, Indiana State University; Christopher Balakrishnan, East Carolina University

Parental care can have profound epigenetic effects on offspring fitness. Little, however, is known about the epigenetic impacts of parental care variation in offspring and how such variation may interact with offspring genotype (i.e., GxE interactions) in natural systems. The White-throated Sparrow (*Zonotrichia albicollis*, WTSP) provides an ideal system to investigate the epigenetic effects of parental care in offspring. WTSPs exist in two morphs, tan and white, controlled by a chromosomal inversion. Morphs mate disassortatively, resulting in distinct parental care types: biparental care when tan males pair with white females and female-biased care when white males pair with tan females. Both parental care types produce tan and white morph offspring, providing a unique opportunity to study how offspring genotype interacts with parental care variation. To investigate the parental care impacts in WTSP nestlings, we performed RNAseq on whole blood samples from 32 WTSP nestlings raised under the two parental care types. We find 354 genes differentially expressed (DE) between the two nest types, 93 DE genes between morphs, and 20 DE genes exhibiting GxE interactions. Genes DE and up-regulated in female-biased nests primarily have gene ontology annotations in metabolic and catabolic pathways with additional stress and immune related categories represented. We have begun to explore the transcriptomic effects of differential parental care in nestlings and show that reduced parental care alters gene expression in nestling metabolism and stress responses. This work sets the stage for future experimental work exploring epigenetic impacts of parental care in natural systems.

## **Building and landscape features affecting bird-building collisions in an urban habitat**

Kathryn Nichols, University of Minnesota

Bird collisions with buildings are the second largest anthropogenic source of direct mortality for birds (365-988 million birds killed annually in the United States). While some factors affecting collision risks with buildings for birds are well known, such as quantity of glass and vegetation adjacent to buildings, others remain elusive and/or unquantified, including relationships between building placement on the landscape, the shape of glass within a façade, and rates of bird collisions with a building. Using data on building collisions collected by citizen science monitors over a 10-year study, we assessed building collision risk factors for 2 adjacent urban areas and included the distance to major migratory flyway and habitat refuge (Mississippi River) and an edge-to-area ratio for the glass on every building façade monitored. The edge-to-area ratio metric has never been used to analyze building facades in terms of bird collisions and serves as a bridge between the architectural and ecological disciplines involved in this conservation issue. More accurate and precise measurements of key factors and making use of a long-term dataset with both high and low collision risk buildings allowed our analysis to significantly improve understanding of building and landscape features that contribute to building collision risk.

## **Local density regulates migratory songbird reproductive success through effects on double-brooding and nest predation**

Ryan Norris, University of Guelph; Bradley K. Woodworth, University of Guelph; Nathaniel Wheelwright, Bowdoin College; Amy Newman, University of Guelph

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Knowledge of the density-dependent processes that regulate animal populations is key to understanding, predicting, and conserving populations. In migratory birds, density-dependence is most often studied during the breeding season, yet we still lack a robust understanding of the reproductive traits through which density influences individual reproductive success. We used 27-years of detailed, individual-level productivity data from an island-breeding population of Savannah Sparrows (*Passerculus sandwichensis*) to evaluate effects of local and total annual population density on female reproductive success. Local density (number of neighbors within 50 m) had stronger effects on the number of young fledged than did total annual population density. Females nesting in areas of high local density were more likely to suffer nest predation and less likely to initiate and fledge a second clutch, which led to fewer young fledged in a season. Fledging fewer young subsequently decreased the likelihood of a female recruiting offspring into the breeding population in a subsequent year. Collectively, these results provide insight into the scale and reproductive mechanisms mediating density-dependent reproductive success and fitness in songbirds.

## **Diurnal body temperature patterns in free-ranging populations of two southern African arid-zone nightjars**

Ryan O'Connor, University of Pretoria; Mark Brigham, University of Regina; Andrew McKechnie, University of Pretoria

Endotherms allocate large amounts of energy and water to the regulation of a precise body temperature ( $T_b$ ), but can potentially reduce thermoregulatory costs by allowing  $T_b$  to deviate from normothermic values. Many data on heterothermy at low air temperatures ( $T_a$ ) exist for caprimulgids, whereas data on thermoregulation at high  $T_a$  are largely absent, despite members of this taxon roosting and nesting in sites exposed to operative temperatures approaching 60 °C. We investigated thermoregulation in free-ranging Rufous-cheeked Nightjars (*Caprimulgus rufigena*) and Freckled Nightjars (*Caprimulgus tristigma*) in the southern African arid zone. Individuals of both species showed labile  $T_b$  fluctuating around a single modal  $T_b$  ( $T_b$ -mod). Average  $T_b$ -mod was 39.7 °C for Rufous-cheeked Nightjars and 39.0 °C for Freckled Nightjars. In both species, diurnal  $T_b$  increased with increasing  $T_a$ . At  $T_a$  of 38 °C and above, Rufous-cheeked Nightjar mean  $T_b$  increased to 42 °C, equivalent to 2.3 °C above  $T_b$ -mod. Under similar conditions, Freckled Nightjar  $T_b$  was on average only 1.1 °C above  $T_b$ -mod, with a mean  $T_b$  of 40.0 °C. Freckled Nightjars are one of the most heterothermic caprimulgids investigated to date, with accounts of skin temperature dropping to near 10 °C. However, our data suggest that during hot conditions this species maintains  $T_b$  within a narrow range above  $T_b$ -mod, possibly reflecting an evolutionary tradeoff between decreased thermal sensitivity to lower  $T_b$  but increased thermal sensitivity to high  $T_b$ . These findings reveal how general thermoregulatory patterns at similar  $T_a$  can vary even among closely related species.

## **Incubation temperature impacts growth, physiology, and survival in nestlings of an open-cup nesting passerine**

Emilie Ospina, University of Illinois at Urbana-Champaign; Thomas J. Benson, University of Illinois at Urbana-Champaign; Loren Merrill, University of Illinois at Urbana-Champaign

Early-life conditions can have implications for somatic and physiological development, and later life survival. Among species in which one or both parents incubate, changes in incubation behavior on the part of the parent(s)

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may impact the developing offspring, and understanding how incubation temperature influences nestling growth, physiological development, and survival may be important to bird conservation. We examined how variation in incubation temperature influences nestling development in American Robins (*Turdus migratorius*). Specifically, we addressed the influence of incubation temperature on (1) hatching success, (2) nestling growth rate, and (3) development of the stress response and aspects of innate immune defenses and (4) nestling survival. From March to August of 2015 and 2016, we worked in a mixed coniferous tree farm in central Illinois, USA, and incubated eggs in one of three temperature categories: 36.1 °C, 37.8 °C, and naturally incubated. We found that nestlings from 36.1°C and 37.8 °C had lower mass and shorter tarsi, significant reductions in survival, and increased corticosterone concentration. We found no effect of incubation category on immune function, and no significant relationships between corticosterone concentration and innate immune function in nestling robins. Our results suggest that incubation temperature can influence subsequent nestling growth, physiology, and survival. Thus, environmental disturbances that disrupt incubation may have population-level impacts. This research adds to the growing body of literature suggesting the importance of sublethal stressors on fitness and population dynamics and highlights the importance of these stressors in leading to such effects on nestling survival and development.

## **The possible link between wintering grounds and continent-wide shifts in song dialects of White-throated Sparrows**

Ken Otter, University of Northern British Columbia; Alexandra Mckenna, University of Northern British Columbia; Stefanie E. LaZerte, University of Northern British Columbia, Thompson Rivers University; Scott M. Ramsay, Wilfrid Laurier University

Regional song variants can shift over time, but it is unusual for a song variant in one region to invade and replace the variants in other regions, especially over large geographic scales. One example of such an occurrence is the western doublet-ending song variant of the White-throated Sparrow (*Zonotrichia albicollis*); although initially rare relative to species-typical triplet-ending song in continent-wide surveys in the 1960s, doublet-ending songs became the sole song variant west of the Rocky Mountains sometime between 1960 and 2000. Recent data suggested the dialect was spreading eastward, so to determine the extent of this spread we analyzed the songs of over 1200 male White-throated Sparrows recorded across North America between 2000-2016. This analysis shows the progressive eastward spread of the doublet-ending dialect in the early 2000s, such that by 2016 all recordings analyzed west of central Ontario have doublet-ending songs. This represents a rate of spread of over 150km per year. To determine how this song may have spread, we attached geolocators to 50 male sparrows breeding in north central British Columbia where the doublet-ending dialect appears to have arisen. Recovered locators identified that different birds from this western region occupy two distinct wintering grounds – coastal California vs eastern Texas. The latter wintering location overlaps the known wintering grounds of birds breeding in the boreal forests above Canada's prairie regions, suggesting the eastward spread of this dialect could be facilitated via western birds serving as song tutors on eastern wintering grounds.

## **Integrating multiple data sources in species distribution modeling: a framework for data fusion**

Krishna Pacifici, North Carolina State University; Brian J. Reich, North Carolina State University; David A. W. Miller, Pennsylvania State University; Beth Gardner, University of Washington; Glenn Stauffer, Pennsylvania State University; Susheela Singh, North Carolina State University; Alexa Mckerrow, U.S. Geological Survey and North Carolina State University; Jaime A. Collazo, U.S. Geological Survey and North Carolina State University

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The last decade has seen a dramatic increase in the use of species distribution models (SDMs) to characterize patterns of species' occurrence and abundance. Efforts to parameterize SDMs often create a tension between the quality and quantity of data available to fit models. Estimation methods that integrate both standardized and non-standardized data types offer a potential solution to the tradeoff between data quality and quantity. Recently several authors have developed approaches for jointly modeling two sources of data (one of high quality and one of lesser quality). We extend their work by allowing for explicit spatial autocorrelation in occurrence and detection error using a Multivariate Conditional Autoregressive (MVCAR) model and develop three models that share information in a less direct manner resulting in more robust performance when the auxiliary data is of lesser quality. We describe these three new approaches ("Shared," "Correlation," "Covariates") for combining data sources and show their use in a case study of the Brown-headed Nuthatch in the Southeastern U.S. and through simulations. All three of the approaches which used the second data source improved out-of-sample predictions relative to a single data source ("Single"). When information in the second data source is of high quality, the Shared model performs the best, but the Correlation and Covariates model also perform well. When the information quality in the second data source is of lesser quality, the Correlation and Covariates model performed better suggesting they are robust alternatives when little is known about auxiliary data collected opportunistically or through citizen scientists. Methods that allow for both data types to be used will maximize the useful information available for estimating species distributions.

## **Habitat selection of adult female Mallards in the Lake St. Clair region during autumn and winter**

Matthew Palumbo, Western University; Scott A. Petrie, Delta Waterfowl Foundation; Michael L. Schummer, Bird Studies Canada and Long Point Waterfowl

Waterfowl select habitats for survival and courtship during the non-breeding period. Thus, waterfowl are thought to modify their timing and location of feeding and resting in response to hunting disturbance and food resources. Great Lakes Mallards (*Anas platyrhynchos*) are subject to different conditions than mid-continent mallards and require additional study and possibly different management strategies. Mallards are ideal candidates to evaluate risk-avoidance strategies during autumn-winter because they are abundant, hunted, and use a diversity of habitats differing in quality. During late-summer 2014 and 2015, we trapped adult female Mallards at Lake St. Clair, Ontario and equipped 59 individuals with backpack style GPS transmitters. We used discrete-choice modeling to analyze local scale movements ( $n = 10,155$  fixes) of these marked Mallards and to estimate the influence of landscape composition on habitat selection before, during, and after the hunting season, September - January. We categorized habitat types by ownership to describe relative differences in management practices influencing intensity of disturbance from hunting and food resource quality. Throughout our 158 d monitoring period, Mallards consistently selected for refugia on government and privately managed lands, despite differences in quality and types of food resources. Diurnal selection for privately managed habitat types of marsh, flooded agriculture, and dry agriculture decreased by 97%, 49%, and 34%, respectively, over time. Open water areas, accessible to the public were selected by Mallards before and after the hunting season. Our research provides models useful to conservation planners for future targeted management of the Great Lakes population of Mallards.

## **Examining the existence and maintenance of behavioral syndromes in Eastern Bluebirds (*Sialia sialis*)**

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Meelyn Pandit, Oklahoma State University; Dalton Richardson, Oklahoma State University; Danielle C. Perryman, Oklahoma State University; Jennifer L. Grindstaff, Oklahoma State University

Behavioral syndromes are suites of correlated behaviors that can constrain behavioral expression. Constrained behaviors in environments with high levels of human development, which expose individuals to multiple novel contexts, may lead to the expression of suboptimal behaviors that can have fitness implications. Past studies demonstrated that anthropogenic noise can affect vocalizations, but few studies have examined how anthropogenic noise may affect behavioral syndromes. This study examined the existence of behavioral syndromes in Eastern Bluebirds (*Sialia sialis*) and tested if syndrome strength varied across a gradient of anthropogenic noise. During the breeding season, we conducted multiple behavioral assays on adult bluebirds to measure parental care, aggression, and boldness, respectively. We also recorded anthropogenic noise after each behavioral assay. Males had behavioral syndromes between aggression and boldness and between parental care and boldness, while females had behavioral syndromes between aggression and boldness and between parental care and aggression. High noise habitats slightly weakened the behavioral syndromes in female bluebirds, while anthropogenic noise had no significant impact on male behavioral syndromes. These coupled behaviors may potentially explain the repeatable nest defense aggression behavior in female Eastern Bluebirds, while selection may favor more plastic aggression in males. Anthropogenic noise may weaken correlated behaviors in female bluebirds, indicating that anthropogenic disturbance may uncouple behavioral syndromes. To determine the full impact of anthropogenic noise on behavioral expression, future studies should examine the effects of experimentally elevated noise levels on individual behavioral phenotypes.

## **Assessing the reliability of the empirical literature in ecology and evolutionary biology**

Timothy Parker, Whitman College

Effective scientific progress requires a reliable scientific literature. For scientific literature to be reliable, researchers must report methods and findings in an unbiased fashion. This is not a controversial idea, but lack of transparency appears common and many scientific disciplines are suffering from an unreliable or biased empirical literature. In this talk I synthesize evidence from ecology and evolutionary biology and demonstrate that insufficient transparency is widespread and that this insufficient transparency drives substantial bias in the literature. I also discuss some of the characteristics that expose disciplines to higher rates of bias. This elevated rate of bias means that many published conclusions are unreliable and rather than contributing to scientific progress, are hindering progress by leading other researchers (and their research funding) down blind alleys. Fortunately there is growing recognition of these problems, as well as a host of ideas for reducing bias. Individual researchers can take important steps to reduce bias in their own work, but journals and funding bodies are particularly well-positioned to promote transparency and reduce bias.

## **Integrating stakeholder objectives, ecological site descriptions and monitoring data to achieve multi-species bird conservation in sagebrush rangelands**

David Pavlacky, Bird Conservancy of the Rockies

The long-term population declines of sagebrush-dependent birds have elevated the recovery of sagebrush avifauna to among the highest conservation priorities in North America. Because large percentages of sagebrush ecosystems occur on private land, the successful recovery of sagebrush avifauna depends on strong partnerships between



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landowners and resource professionals. The effective management of sagebrush rangelands for multi-species conservation requires priority setting defined by the management context and stakeholder objectives. The objectives were to maximize the 1) suitability of Greater Sage-Grouse (*Centrocercus urophasianus*) nesting habitat, 2) site occupancy of sagebrush-dependent songbirds and 3) sustainability of livestock production. We considered four management alternatives used by land managers to improve habitat conditions for Greater Sage-Grouse. The management framework relies on pre-project inventories and State and Transition Models to predict vegetation responses to shrub and grazing management. I developed multi-scale habitat and distribution models from the Integrated Monitoring in Bird Conservation Regions Program to evaluate songbird responses vegetation change. The trade-off analysis involved a Bayesian Belief Network within a Structured Decision Making framework to determine optimal state-dependent management outcomes. The results suggested grazing management to improve Greater Sage-Grouse nesting habitat also increased forage production for livestock. Although songbird species responded uniquely to management actions, the overall Brewer's Sparrow (*Spizella breweri*), Sagebrush Sparrow (*Amphispiza belli*) and Sage Thrasher (*Oreoscoptes montanus*) responses approximated Greater Sage-Grouse habitat. Ultimately, the approach is useful for answering the "what to do" and "where to do it" questions in conservation planning, toward the adaptive management and sustainable land use of sagebrush rangelands.

## **Non-stop transoceanic flights by Bobolinks during migration**

Noah Perlut, University of New England

Transoceanic flight during migration is rare in passerine species. Our previous work indicated that Bobolinks, 30-g grassland obligate songbirds, breeding in agricultural grasslands in Vermont used an eastern, land-based flyway during fall migration. However, recent geolocator data revealed that Bobolinks in Vermont more commonly took a transoceanic flight from the eastern United States directly to Venezuela or Columbia. I explored variation in migratory flights by eleven Bobolinks—including departure location and timing from North America and arrival location and timing in South America. Fall departure locations ranged from Virginia Beach, Virginia to Wilmington, North Carolina. Three birds stopped briefly in the Bahamas, Jamaica or Haiti, while the remaining eight birds flew non-stop to Venezuela. Some of these birds took similar transoceanic flights during spring migration, from northern South America to North Carolina. Core wintering areas varied among the population by 3,100 km, ranging from northern Beni, Bolivia to Chubut, Argentina. Total direct, one-way migration length varied from 6,500 to 9,700 km.

## **Critical connections: using geolocators to investigate the migration ecology of Alaska's breeding birds**

Laura Phillips, National Park Service; Carol McIntyre, National Park Service; Elizabeth Gow, University of Guelph; Scott Weidensaul; Iain Stenhouse, Biodiversity Research Institute

Alaska's geographic location makes it a unique and important location for the study of bird migration; however, knowledge of migration routes and migratory connectivity especially of passerines is limited. We developed a program of research using small tracking devices, including geolocators, on a suite of birds exhibiting shifts in distribution and abundance at breeding areas in Alaska to better understand the possible drivers of these changes as well as provide empirical data to support migration routes defined by indirect measures such as molecular or isotopic techniques. In 2015, we deployed geolocators (Biotrack ML6790) on Swainson's Thrush (*Catharus*

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*ustulatus*) and Gray-cheeked Thrush (*Catharus minimus*) in Denali National Park and Preserve. In 2016, we recaptured and obtained data from 7 Swainson's Thrush and 4 Gray-cheeked Thrush. We found analysis of light-level data from forest-dwelling birds at high latitudes with limited hours of darkness and lots of shading to be challenging. Preliminary results support indirect migration pathways for both species across North America toward ancestral breeding ranges prior to heading south to wintering areas. This study provides the first empirical data for overwintering locations of Swainson's Thrush and Gray-cheeked Thrush from breeding populations at the northwestern extent of their ranges and adds evidence for strong migratory connectivity among breeding populations of Swainson's Thrush.

## Why is sympatric speciation rare in birds?

Cody Porter, University of Wyoming; Craig Benkman, University of Wyoming

Closely related bird species often show the type of niche differentiation involved in disruptive selection and speciation with gene flow, yet sympatric speciation appears to be extremely rare in birds. In general, niche differentiation between closely related bird species is strongest in the non-breeding season, when species use alternative resources that impose strong feeding tradeoffs. Conversely, bird species with divergent morphologies are regularly found converging in their use of abundant resources that impose minimal feeding tradeoffs during the breeding season. Comparative data suggest that sympatric speciation is most likely when lineages are adapted to using different resources with strong tradeoffs while breeding, yet direct empirical tests of this hypothesis are lacking. We will test this hypothesis using a comparison of interbreeding levels between Red Crossbill (*Loxia curvirostra* complex) ecotypes during periods of variable resource tradeoffs. Preliminary data supports the hypothesis that breeding during strong tradeoffs promotes sympatric speciation. This work may help explain the rarity of sympatric speciation in birds and other taxa more generally.

## Landscape scale impacts of noise on songbird abundance and productivity

Darren Proppe, Calvin College; Amber Bingle, Calvin College; Michael Pontius, Calvin College; Stacy L. DeRuiter, Calvin College

Anthropogenic noise has been associated with declines in songbird abundance in many previous studies. However, in the handful of species utilized in multiple studies, the impacts of noise often vary between studies. While these differences could be due to methodology, it is more likely that the myriad of interacting local factors are operating differently in regional systems. Thus, a broader framework is needed to understand how noise is impacting songbird persistence at the landscape scale. We took advantage of over 35 years of banding data collected at 1000+ MAPS banding stations located across the continental United States and a recent noise model developed by the US National Park Service to assess the impacts of noise at the landscape scale. We assessed diversity in relation to noise for all species in the MAPS dataset, and determined the noise-mediated changes in abundance and productivity in 48 species for which regional information on vital rates was available. Our results suggest that, 1) diversity decreases with noise level, 2) noise impacts on species are highly variable, 3) landscape level trends are in line with the species known to adapt to urbanization, but do not consistently correlate with regional studies, and 4) that abundance is not predictive of productivity. In sum, our results suggest that caution be taken when generalizing regional results or the impact of reduced abundance. More positively, the impacts of noise on productivity are not as consistently negative as the impacts on abundance, suggesting there may be room for adaptation to noise in some species.

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## **Using LiDAR data and a Bayesian framework to model Northern Spotted Owl nest site selection**

Shane Pruett, Oregon State University; Ray Davis, USDA Forest Service, Pacific Northwest Region; Katie Dugger, U.S. Geological Survey, Oregon Cooperative Fish and Wildlife Research Unit, Oregon State University; Julianna Jenkins, USDA Forest Service, Pacific Northwest Research Station; Damon Lesmeister, USDA Forest Service, Pacific Northwest Research Station, Oregon State University; Stan Sovern, Oregon State University

Northern Spotted Owls (NSO) select late-successional forest types for nesting and roosting, and use a range of forest types within their territories. However, the invasion of Barred Owls (BO) has resulted in displacement of NSOs from historical nest sites, and it is unknown if displaced NSOs select similar forest types for nesting and roosting. Forest managers need reliable information about NSO habitat selection under the competitive pressure of BOs. Field-based quantification of NSO habitat selection is extremely costly, but newly-acquired Light Detection and Ranging (LiDAR) data provide opportunities to evaluate current nest site selection by northern spotted owls. We used 1 m resolution LIDAR data to generate a canopy height model for five NSO demography study areas in Oregon, quantified various height and structural variables within buffers of 50, 100, and 200 meters around NSO nest sites, and used BO locations as variables in our models. We paired known, used nest and roost sites with two available but unused points within the same territory, and used multinomial logit discrete choice models in a Bayesian framework to assess models at each scale. The additive effects of the amount of mature forest and the standard deviation of forest height were most supported at all scales with essentially no model selection uncertainty. The inclusion of BO presence did not improve our inferences, but our BO locations were not precise. Although displaced by an aggressive congeneric competitor, NSOs continue to demonstrate strong selection for mature, structurally diverse forest types.

## **Host species, and not environment, predicts variation in parasite prevalence, distribution, and diversity along a humidity gradient in Northern South America**

Paulo Pulgarin, Universidad de Los Andes; Juan P. Gómez, Florida Museum of Natural History, University of Florida; Scott Robinson, Florida Museum of Natural History, University of Florida; Robert E. Ricklefs, University of Missouri-St. Louis; Carlos Daniel Cadena, Universidad de Los Andes

Environmental factors strongly influence the ecology and evolution of vector-borne infectious diseases. However, our understanding of the influence of climatic variation on host-parasite interactions in tropical systems is rudimentary. We studied five species of birds and their haemosporidian parasites (*Plasmodium* and *Haemoproteus*) in 16 sampling sites to understand how environmental heterogeneity influences patterns of parasite prevalence, distribution, and diversity across a marked climate gradient in northern South America. We used molecular methods to screen for parasite infections and to identify parasite lineages. To characterize environmental heterogeneity, we used weather-station and remotely-sensed climate data. We estimated parasite prevalence while accounting for spatial autocorrelation, and used a model-selection approach to determine the effect of variables related to water availability and host species on patterns in prevalence. The prevalence, distribution, and lineage diversity of haemosporidian parasites varied across localities and host species, but we found no support for the hypothesis that the prevalence and diversity of parasites increases with increasing water availability. Host species and host×climate interactions had stronger effects on prevalence of parasite infections, and parasite lineages were strongly associated with particular hosts. Because environmental variables had little effect on the overall

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prevalence and lineage diversity of haemosporidian parasites across study sites, our results suggest that independent host-parasite dynamics influence patterns in parasitism in environmentally heterogeneous landscapes.

## **Sympatry, genetics, and song indicate multiple species in the Brown Prinia *P. polychroa* complex**

Pamela Rasmussen, Michigan State University and MSU Museum; Per Alström, Uppsala University; George Sangster, Swedish Museum of Natural History; Shashank Dalvi, National Centre for Biological Sciences; Philip Round, Mahidol University; Ruying Zhang, Chinese Academy of Sciences; Cheng-te Yao, Taiwan Endemic Species Research Institute; Martin Irestedt, Swedish Museum of Natural History; Hung Le Manh, Vietnam Academy of Science and Technology; Fumin Lei, Chinese Academy of Sciences; Urban Olsson, University of Gothenburg

The long-standing treatment of the Brown Prinia *Prinia polychroa* and Striated Prinia *P. crinigera* as two species, based mainly on presumed sympatry in Yunnan, China, has not been reevaluated until the present study, in which we integrate molecular, morphological and vocalization analyses. Using mtDNA and nuclear DNA, we found that *P. crinigera* is comprised of two non-sister groups, the *crinigera* group in the Himalayas through Yunnan, and the *striata* group in Yunnan through eastern China and Taiwan. We found that the presumed sympatry between *P. polychroa* and *P. crinigera* actually occurs instead between the *crinigera* and *striata* groups, which are broadly sympatric without evidence of intergradation in Yunnan, and therefore these genetically distinct lineages are clearly separate species. *Prinia polychroa* occurs in several allopatric populations, although we show there is no evidence for its occurrence in China. We found that topotypical *P. p. cooki* of Myanmar is a vocally, morphologically, and genetically distinctive lineage and should be considered a separate species. The Vietnamese *P. p. rocki* is almost equally distinctive, and in our view should also be treated at the species level. The population previously considered *P. p. cooki* from Thailand, Cambodia, and Laos is instead genetically closest to and vocally most similar to the widely disjunct *P. p. polychroa* of Java, and constitutes an unnamed subspecies that is a specialist on dry dipterocarp forest, a threatened ecosystem in southeastern Asia. Other taxa in this complex occur in open scrubby, grassy habitats and are thus not of special conservation concern.

## **Geolocators on 9-10 g birds: are there breeding or annual fitness effects on Cerulean and Golden-winged Warblers?**

Douglas Raybuck, University of Tennessee; Darin J. McNeil, Cornell University; Scott H. Stoleson, USDA Forest Service Northern Research Station; Than J. Boves, Arkansas State University; Cameron J. Fiss, Indiana University of Pennsylvania; Jeffrey L. Larkin, Indiana University of Pennsylvania; Gunnar R. Kramer, University of Toledo; Henry M. Streby, University of Toledo; Justin A. Lehman, University of Tennessee; David A. Buehler, University of Tennessee

Geolocators are being deployed widely by ornithologists, recently on birds as small as 9–10 g, and valuable migration data is being obtained. However, the potential effects of geocator-tagging on the breeding biology of songbirds are rarely studied, and effects on return rates appear to vary by species. During 2014 and 2015, we deployed geolocators on 49 male Cerulean Warblers in Pennsylvania, Missouri, and Arkansas. We monitored the effects of geocator-tagging across the full annual cycle by comparing apparent within-breeding season survival, nestling provisioning rates, nest survival, and return rates between tagged males and color-banded controls. We found no evidence of negative effects of geolocators during the breeding season of deployment. Similarly, in 2014 and 2015, we deployed geolocators on 35 Golden-winged Warblers in Tennessee and Pennsylvania and found no

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negative effects on territory size, nesting success, or apparent within-season survival. While studies have indicated no negative effect on return rates for geolocator-tagged Golden-winged Warblers, we found Cerulean Warbler return rates to be reduced by geolocator attachment as compared with control birds over the combined 2014-2016 years (but no statistical difference in 2015-2016). When observed, lowered return rates warrant further investigation into options for device deployment improvements, potentially by altering harness method or by keeping weight and drag to an absolute minimum. If return rates are not improved, potential for increased mortality of individuals should be weighed against conservation potential (through identification of migratory connectivity patterns and important stopover regions) at the population level, prior to continuing with additional deployments.

## **Characterizing phenotypic diversity of the Malagasy Vangas using morphometrics and undergraduate researchers**

Sushma Reddy, Loyola University Chicago; Matthew Bonfitto, Loyola University Chicago; Salman Akthar, Loyola University Chicago; Nicole Gracias, Loyola University Chicago; Talitha O. Helms, Loyola University Chicago; Zuzanna Novak, Loyola University Chicago; Gira Patel, Loyola University Chicago; Riya Patel, Loyola University Chicago; Rishikesh Savaliya, Loyola University Chicago; Nicholas Souza, Loyola University Chicago

The Malagasy vangas are considered an adaptive radiation due to their diversification into a spectacular range of ecomorphs upon colonization of Madagascar. We set out to conduct a large-scale examination of body features utilizing museum specimens and a team of undergraduate researchers. We used linear and geometric morphometrics to assess variation in body features, such as bills, toes, wings, tails, tarsi. We used these data to test various hypotheses of how traits changed in these species as they adapted to their novel ecological conditions. We developed strategies for ensuring accuracy and precision of the measurements and adapted new landmark-based methods for analyzing shapes. We were able to collect enough data to examine a variety of questions including the extent of intraspecific variation, sexual dimorphism, and trait correlation with ecology and/or phylogeny. Our analysis showed that there was a significant shift in morphospace when this group colonized Madagascar. Additionally, we found a relationship in the shape of bills and toes to foraging behavior and geography. Finally, we tested whether rates of morphological and genetic diversification were correlated across the family. Our system is a good model for collecting phenotypic data in a large-scale, incorporating young researchers, and being able to address critical questions in macroevolution.

## **Songbird courtship tactics: paired and unpaired males differ in behavior, morphology, and hormones**

Dustin Reichard, Ohio Wesleyan University; Abigail A. Kimmitt, Indiana University; Joseph F. Welkin, Cornell University; Ellen D. Ketterson, Indiana University

Variation in male courtship behavior is caused by a variety of intrinsic and extrinsic factors. Identifying the relative importance of these factors is fundamental for understanding the sources of variation in reproductive success. In this study, we compared the courtship of paired and unpaired male Dark-eyed Juncos (*Junco hyemalis*) to test whether behavior relates to male morphology, circulating hormones, the presence of eavesdroppers, and the type of mate (i.e. social or extra-pair) being pursued. We conducted simulated courtship interactions (SCI) with free-living males in which we quantified male courtship of a novel, caged female junco for 20 minutes. Then males were

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immediately captured, measured, and blood samples were collected to quantify circulating post-SCI testosterone and corticosterone levels as well as restraint-induced corticosterone. Paired males approached more rapidly and spent more time in close proximity to the female. Paired males were also more active and spent more time with body feathers fully erected, but sang fewer songs than unpaired males. Unpaired males were smaller in mass and had higher post-SCI corticosterone and restraint-induced corticosterone than paired males, but the groups did not differ in post-SCI testosterone. The presence of a paired male's mate had no detectable effect on courtship. These results indicate that paired and unpaired males engage in different courtship tactics, but the specific factors underlying those differences remain unclear. We will discuss multiple hypotheses that may explain these differences and identify future directions involving experimental manipulations.

## **Understanding habitat selection and reproductive consequences in agriculturally fragmented landscapes: the importance of spatial scale**

Bryan M. Reiley, Illinois Natural History Survey, Prairie Research Institute, University of Illinois; T. J. Benson, Illinois Natural History Survey, Prairie Research Institute, University of Illinois

When choosing between habitats of heterogeneous quality, birds should choose the best available habitat. Yet, studies show that individuals fail to choose habitats that maximize their fitness especially in drastically altered landscapes. Most studies have focused on selection at single scales, often using a single measure of fitness. However links between habitat selection and fitness may vary depending on the spatial scale and measure of fitness, especially in situations where agricultural land use has altered the surrounding landscape. Here, we examined multi-scale habitat selection and fitness measures of the Bell's Vireo and Willow Flycatcher using data collected in restored agricultural fields where we expected extensive alteration of the surrounding landscape would lead to mismatches between selection and fitness outcomes. We found evidence for selection of nest sites with dense understory, larger patches, and increasing grassland cover in the surrounding landscape. Fitness outcomes mostly aligned with species habitat selection particularly at the nest and landscape scales, though the relationship was strongest at the nest scale. Yet, we observed mismatches where nest survival was lower in preferred landscapes with more surrounding grassland cover and fledgling production was lower at nest sites with dense understory cover. We speculate that observed mismatches may be influenced by anthropogenic habitat fragmentation and may represent reproductive trade-offs. Our results demonstrate that individuals of both species can accurately select habitat that increases fitness in drastically altered landscapes but the connection between habitat selection decisions and reproductive consequences varies depending on the scale and measure of fitness.

## **Decline of a disturbance-dependent species on preserved land**

Leonard Reitsma, Plymouth State University; J. Daniel Lambert, Assistant Director, Center for Northern Woodlands Education; Mysti Martin, Tetrattech

Many species of migratory songbirds do not breed in mature, closed-canopy forests, and increasing efforts have been made to manage for such disturbance-dependent species due to documented population declines. The Canada Warbler (*Cardellina canadensis*) often colonizes forests of intermediate to old age after timber harvest and then declines when harvested areas mature beyond approximately 20 years of regrowth. We documented such a decline on a site that was heavily harvested in the early 1980s and then preserved as "forever wild" in 2001, thereafter prohibiting further timber extraction. We contrast this decline with a more stable population trend on an adjacent forested wetland dominated by Red Maple (*Acer rubrum*). Canada Warblers occur in clumped aggregates we call

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neighborhoods, and we documented entire neighborhoods disappearing from the harvested site over 16 years of continuous population monitoring. Over that time period, stems on the harvested plot increased in diameter while both shrub density and understory layer decreased. The persistence of some neighborhoods beyond the forest age classes reported in other studies may be influenced by neighborhood demographics and site fidelity. These patterns have implications for management of species of special conservation need on preserved lands that prohibit timber harvest. Adaptive managers in the Anthropocene may thus need to consider mosaics that concurrently provide old growth and human-mediated disturbance in order to balance the needs of species that depend upon either one or the other.

## **Death by strike: correlations with window strike mortality and age in avian populations**

Emma Rhodes, University of South Alabama; Joel Borden, University of South Alabama; John McCreadie, University of South Alabama

Building collisions, especially window collisions, pose a major anthropogenic threat to birds. Mortality caused by building collisions is estimated to be between 100 million and 1 billion annually. While some of the impacts of this threat have been explored, considering a possible relationship between age and mortality in window strike collisions has had minimal study. However, various other factors need to be considered including the species-specific ratio of adult to juvenile birds and how these ratios might change seasonally in periods of migration. The primary goal of this study is to determine if there is a direct age-mortality correlation in avian window strikes using a large dataset of curated museum specimens that will classify birds by age based on physiological, morphological, and plumage features. This project is a collaboration of multiple universities and museums to examine window strikes on a regional scale primarily in the Southeastern U.S. where there is a paucity of data on window strike mortality. Current findings of this project include considering species-specific ratios of age groups in avian populations as well as aging avian specimens using the method based on presence/absence of the bursa of Fabricius. With more increasing anthropogenic threats affecting bird populations, it is vital that preventive measures are taken to counter unnecessary mortality due to window collisions. In conclusion, the goal of this research is to provide significant implications on how window strike mortality affects avian populations and to identify the mechanisms behind this impact for conservation purposes.

## **Diel fledging patterns in grassland birds**

Christine Ribic, U.S. Geological Survey; Christoph S. Ng, University of Manitoba; Nicola Koper, University of Manitoba; Kevin Ellison, World Wildlife Fund; Pamela J. Pietz, U.S. Geological Survey (emeritus)

Fledging is one of the least-studied aspects of the breeding ecology of birds, particularly for grassland birds, due to the difficulty of observing chicks as they leave their nests. We used video from nest surveillance systems to determine fledging dates and times of grassland passerines from 206 nests of 17 species; 86% of the nests came from Bobolink (*Dolichonyx oryzivorus*), Eastern Meadowlark (*Sturnella magna*), Savannah Sparrow (*Passerculus sandwichensis*), Grasshopper Sparrow (*Ammodramus savannarum*), Chestnut-collared Longspur (*Calcarius ornatus*), Clay-colored Sparrow (*Spizella pallida*), and Song Sparrow (*Melospiza melodia*). We found that time of the first chick to fledge varied by species and date. Clay-colored Sparrow fledged earliest (2.75 hours after sunrise), while Eastern Meadowlark, Chestnut-collared Longspur, and Song Sparrow fledged 6-7 hours after sunrise (late

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morning). First chicks to fledge left the nest earlier when fledging happened in the early part of the breeding season, when fledging duration was also shorter. Fledging duration increased with number of chicks in the nest (duration for 2-chick nest: 19 minutes; 5-chick nest: 3.76 hours). Fledging occurred over 2 and 3 days in 20% of nests. The first chick of multi-day nests fledged, on average, later than the first chick of single day nests (7.64 hours after sunrise and 3.99 hours, respectively). Theories based on assumptions that all birds fledge at similar times of day will need to be re-examined as more data on basic life history traits become available with the use of video surveillance systems in nesting studies.

## **Viability of Kirtland's Warbler under changing management conditions**

Christine Ribic, US Geological Survey, Wisconsin Cooperative Wildlife Research Unit; Deahn Donner, US Forest Service; Donald Brown, University of West Virginia-Morgantown; Carol Bocetti, California University of Pennsylvania

The Kirtland's Warbler (*Setophaga kirtlandii*) is an endangered migratory songbird that breeds primarily in Michigan and winters in the Bahamian Archipelago. The species is an extreme habitat specialist on the breeding grounds, showing a strong preference for large, dense patches of young Jack Pine (*Pinus banksiana*) and well-drained sandy soils. Due to intensive collaborative management, the species has recovered from ca. 200 breeding males in 1971 to ca. 2,000 breeding males today. To help inform the long-term management efforts, we developed a population simulation model for the Kirtland's Warbler that incorporated both breeding and wintering grounds habitat dynamics, and projected population viability based on current environmental conditions and potential future management scenarios. Future management scenarios included continuation of current management conditions, reduced productivity and carrying capacity due to changes in habitat suitability from the creation of experimental jack pine plantations, and reduced productivity from alteration of the Brown-headed Cowbird (*Molothrus ater*) removal program. Our future simulations indicate the Kirtland's Warbler population is stable under two potential future management scenarios: 1) continuation of current management practices, and 2) spatially restricting cowbird removal to the core breeding area, assuming cowbirds reduce productivity in the remaining patches by less than 40%. Our study will assist managers with understanding the importance and influence of different Kirtland's Warbler management strategies on population stability.

## **Wildfire, climate, and invasive grass interactions negatively impact an indicator species by reshaping sagebrush ecosystems**

Mark A. Ricca, USGS Western Ecological Research Center; Peter S. Coates, USGS Western Ecological Research Center; Brian G. Prochazka, USGS Western Ecological Research Center; Kevin E. Doherty, U.S. Fish and Wildlife Service; Matthew L. Brooks, USGS Western Ecological Research Center; Travis Kroger, USGS Western Ecological Research Center; Erik J. Blomberg, University of Maine; Christian A. Hagen, Oregon State University; Michael L. Casazza, USGS Western Ecological Research Center

Iconic sagebrush ecosystems of the American West are threatened by accelerated wildfires that can kill sagebrush and facilitate invasion by flammable annual grasses, thereby creating a non-analog positive feedback loop that consumes large expanses of sagebrush that often do not recover. Thwarting this disturbance is at the forefront of national conservation efforts, yet its impacts on sagebrush-dependent wildlife populations have not been quantified rigorously over large spatiotemporal scales. Within a Bayesian framework, we analyzed 30 years of wildfire and climatic effects on population growth rates of Greater Sage-grouse across the Great Basin. Our



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modeling also accounted for variation in sagebrush recovery time after fire as determined by underlying soil properties that influence ecosystem resilience to disturbance and resistance to invasion. The cumulative loss of sagebrush to direct and indirect effects of wildfire has contributed strongly to declining populations of sage-grouse over the last 30 years. Most importantly, long-lasting effects from wildfire nullified pulses of sage-grouse population growth that typically follow years of high precipitation. If wildfire trends continue unabated, model-projections indicate populations will be reduced to 43% of their current numbers over the next 3 decades. Our results provide a timely example of how altered fire regimes are disrupting recovery of sagebrush ecosystems and leading to substantial declines of a widespread indicator species. Accordingly, we present scenario-based simulations to inform conservation actions that may help offset adverse effects of wildfire on sage-grouse and other wildlife populations dependent on sagebrush ecosystems.

## **Estimation of scavenger removal and observer detection biases in surveys for window-killed birds**

Corey Riding, Oklahoma State University; Scott R. Loss, Oklahoma State University

A major challenge in studying avian collision mortality is accurately estimating numbers of birds killed. Carcass counts underestimate mortality because they fail to account for scavenger removal and imperfect observer detection. Many bird collision studies have quantified these biases, yet little is known about the identities of scavengers or correlates of detection probabilities. Additionally, previous work may be difficult to apply because of variation related to geographic location, searcher experience, and habitats. We addressed these gaps in a bird-window collision study in Stillwater, Oklahoma by experimentally placing carcasses (1) with trail cameras to document carcass persistence and scavenger identity, and (2) during collision surveys to assess observer detection. We estimated carcass persistence and observer detection using the R package “carcass.” Daily persistence probability was 0.98, and 87% (n=69) of carcasses were scavenged. We documented 10 species of vertebrate scavengers, the most common being cats, opossums, squirrels, and skunks. Mean time to scavenging was 3.1 days, and mean persistence of remains was 11.2 days. We found no difference in time to scavenging among scavenger species, but some species may be more likely to leave collision evidence after scavenging. Observer detection was higher overall on artificial surfaces, but observer experience interacted with substrate such that inexperienced observers detected more carcasses on natural surfaces. This information can inform future research into bird-structure collisions, for example by suggesting whether scavengers that most rapidly remove carcasses are present in a study area and by highlighting substrates to focus observer training activities to minimize detection bias.

## **Mercury (Hg) exposure in insectivorous songbirds and invertebrates in a wetland community in southeast Missouri**

Katie Rittenhouse, Southeast Missouri State University; Rebecka Brasso, Southeast Missouri State University

Southeast Missouri is a region with elevated levels of atmospheric mercury (Hg) deposition and abundant wetland ecosystems. Wetlands play an important role in the Hg cycle by functioning as a sink for total Hg and as a net source of methylmercury (MeHg) production. Despite a statewide fish consumption warning, acknowledging elevated Hg in water bodies, no studies have been published documenting Hg exposure in terrestrial organisms. In an effort to fill this gap in knowledge, my research focuses on using insectivorous songbirds and invertebrates as

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biomonitors of Hg in southeast Missouri. The goals of my research are to 1) compare Hg concentrations in songbirds in a wetland ecosystem with those in a nearby non-wetland (terrestrial) ecosystem, 2) use invertebrates to examine local-scale geographic variation Hg availability within a wetland ecosystem, and 3) identify spatial and temporal variations in Hg in songbirds in southeast Missouri. To complete these goals, we erected nest box trails to recruit breeding populations of Eastern Bluebirds (*Sialis sialis*) and tree swallows (*Tachycineta bicolor*) to my study sites beginning in 2016. In addition, invertebrates were collected from different trophic levels to study the flow of Hg through the food web. Hg concentrations in adult birds were higher than nestling birds in both species. Hg concentrations were higher in adult TRES compared to nestling TRES, and higher in adult EABL compared to nestling EABL. Hg concentrations in both species were below adverse effects levels.

## **Testing whether unmanned aerial vehicles can be used to locate cryptic nests of the Marbled Murrelet**

Jim Rivers, Oregon State University; Lindsay Adrean, Oregon State University; Matthew Pickett, Oceans Unmanned; Brian Taggart, Oceans Unmanned; S. Kim Nelson, Oregon State University; Daniel Roby, US Geological Survey – Oregon Cooperative Fish and Wildlife Research Unit, Oregon State University; Matthew Betts, Oregon State University

Unmanned aerial vehicles (UAVs) are an emerging tool that can be used in many research contexts, potentially saving time, reducing costs, and minimizing risks to both scientists and the species they study. Nevertheless, there has been limited application of UAVs for surveying birds, including tests of whether they can be used to locate active nests of cryptic species within complex terrestrial habitats. We evaluated the efficacy of a UAV outfitted with a thermal infrared camera for locating nests of the threatened Marbled Murrelet (*Brachyramphus marmoratus*) in the Oregon Coast Range. We used live, Domestic Quail (*Coturnix japonica*) housed singly in a wire cage to act as a surrogate for a murrelet nest, and we placed caged quail on suitable nest platforms in locations that were unknown to our UAV flight team. Operators then searched for surrogate nests using a DJI Phantom 4 quadcopter equipped with a FLIR Vue Pro 640 infrared thermal camera. Over the course of 4 days we conducted 13 independent flights, successfully locating quail in 85% of trials, with a mean time to discovery of 32 min (range: 4-64 min) for successful tests. Lateral vegetation cover was greater within the vicinity of the two nests that were not located, suggesting that greater vegetation density may have reduced our ability to detect surrogate nests. Our initial results indicate UAVs were successful at locating surrogate murrelet nests sites under experimental conditions, and suggest they hold promise for detecting cryptic canopy-dwelling organisms within complex forest habitats.

## **Comparing geolocator-derived estimates of locations for a swallow, a warbler, a sparrow, and a thrush: Which R package to use?**

Amélie Roberto-Charron, University of Manitoba; Kevin Fraser, University of Manitoba

Light-level geolocation is a common method to track the spatio-temporal movements of birds year-round. Due to the miniaturization of geolocator units, a broad array of species can be tracked, including small songbirds (< 15g). Geolocators record light levels and time from which geographic coordinates are calculated using day length and relative time of solar noon or midnight. Light data quality can vary by species due to differences in behavior, habitat or migratory timing, causing analytical challenges. Three open-source R packages are commonly used to analyse light data: FLightR, SGAT and GeoLight. However, there is a lack of consensus regarding which package is most appropriately applied to which data, making it difficult for researchers to determine suitable methods to use. To determine what methods are best for what data we compared the three most commonly used R packages and

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analysis types for three individuals of four species with different habitat requirements and life history traits: a thrush, a warbler, a swallow and a sparrow. We determined: 1) which analysis provided accurate locations at known sites, and 2) if the migratory routes and unknown sites calculated by the different analyses are consistent. We predicted that species experiencing more shading would show increased error at known sites, and more variable migration routes and unknown locations. We predicted that species migrating during the equinox would show more variability in estimated migration routes. Through greater understand of open-access geolocator analysis programs we hope to develop recommendations for methods of analysis for future songbird geolocator research.

## **Using eBird data to estimate year-round distributions and habitat associations of Tricolored Blackbird (*Agelaius tricolor*).**

Orin Robinson, Cornell Lab of Ornithology; Daniel Fink, Cornell Lab of Ornithology; Viviana Ruiz-Gutierrez, Cornell Lab of Ornithology

Tricolored Blackbirds (*Agelaius tricolor*) are a declining species of conservation concern, primarily found in the Central Valley of California. Species distribution models (SDM) for rare species, like the Tricolored Blackbird, are exceedingly challenging because rare species often do not occupy all suitable habitat in a region, may be locally abundant but regionally rare, and can be difficult to detect. This is complicated further when the species of interest has habitat preferences that change throughout the annual cycle (e.g. migratory birds). Often, even well designed surveys for rare species result in few detections. Citizen science monitoring programs have proven to be a powerful tool in addressing data-limitations when building SDMs. While they may greatly increase the sample size of a study, citizen science data is still subject to low detections for rare species, creating the issue of class imbalance in the data set (far more absence than presence observations). Another challenge when using citizen science data is spatial bias, as most observers choose to survey close to home, convenient locations or in known areas of high biodiversity. We propose a technique that combines machine learning, spatial filtering and resampling to address spatial bias and class imbalance in citizen science data. We compare the accuracy of SDMs using this method to models using other methods and illustrate the utility of our approach by modeling the spring and winter distributions of Tricolored Blackbirds and assessing their habitat preferences in each season using data from the citizen science project eBird.

## **Winter rainfall carries over to affect spring arrival dates, reproductive success, and survival in the endangered Kirtland's Warbler**

Sarah Rockwell, Klamath Bird Observatory; Joseph M. Wunderle, Jr., International Institute of Tropical Forestry, USDA Forest Service; T. Scott Sillett, Smithsonian Conservation Biology Institute; Carol I. Bocetti, University of California; David N. Ewert, The Nature Conservancy; Peter P. Marra, Smithsonian Conservation Biology Institute

Migratory animals may be especially vulnerable to climate change due to the wide range of geographic areas that they occupy in different parts of the year. We examined the effects of non-breeding season climate on the Kirtland's Warbler (*Setophaga kirtlandii*), an endangered migratory songbird. Rainfall on wintering grounds in The Bahamas affects the abundance of important fruit resources and late winter body condition in this species (Wunderle et al). Our objectives were to determine whether late winter rainfall also carries over to affect demographic events in

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subsequent seasons. We studied Michigan breeding sites from 2006-2011, and found that male Kirtland's Warblers arrived later following drier winters in The Bahamas. Second-year males delayed spring arrival more drastically after winters with lower rainfall than adults, while males of all age classes fledged fewer offspring following drier winters. In a mark-recapture analysis, we parsed male Kirtland's Warbler annual survival ( $0.58 \pm 0.12$  SE) into different seasons, and found that the migratory periods accounted for the majority (44%) of annual mortality. We also modeled the effects of multiple climate variables on male survival. March rainfall in The Bahamas was the most well-supported model, and was positively related to annual survival in the subsequent year. Significant drying trends in the Caribbean are predicted by several models of climate change. This could have important ecological consequences, including constrained spring arrival dynamics, and reduced reproductive success and survival of the endangered Kirtland's Warbler, and potentially other Neotropical migrants wintering in the Caribbean.

## **Predation pressure for dummies: avian attacks on Clay Caterpillars across a tropical landscape**

Steve Roels, Michigan State University; Jade Porter; Catherine Lindell, Michigan State University

Increasing interest in natural biological control of herbivorous insects has led to efforts to quantify predation pressure on insects. One increasingly common technique for estimating relative predation pressure between study areas is dummy caterpillars, which are attacked by predators, such as birds, presuming them to be real caterpillars. Dummies constructed out of soft, impressionable modeling clay record damage patterns that can be assigned to predator classes, allowing for additional insight into the relative importance of birds and other predatory taxa. We exposed dummy caterpillars to predators for 10 days in six different tropical land cover types: mature, gallery, and young successional forests; native and non-native species timber plantations; and residential countryside. In total, 43% of caterpillars were attacked during the study; birds were the second most common class of predator (predatory arthropods were first). Overall, attack rates were highest in the residential countryside and lowest in the non-native timber plantation. However, there was a strong interaction between land cover type and class-specific attack rates: arthropods attacks were lowest in the residential countryside and highest in the native species timber plantation whereas bird attacks were highest in the residential countryside and lowest in the native species timber plantation. Attack rates by birds correspond to bird abundance data from point counts across the landscape. These results suggest that land managers wishing to manipulate predator activity for natural biological control will have very different considerations depending on the land cover type.

## **Molt asymmetries in large birds**

Vanya Rohwer, Cornell University Museum of Vertebrates

Regular replacement of the flight feathers is one of the most time demanding activities in the annual cycle of birds. Many large birds that maintain the ability to fly while molting have evolved complex molt strategies that maximize the number of feathers replaced while minimizing the aerodynamic costs of growing multiple feathers at once. Despite these advantages, complex molts are typically restricted to larger birds suggesting that they are costly to evolve and/or maintain. One potential cost of complex molts is greater asymmetry in the number and sequence of feathers replaced between right and left wings within individuals. Here I show that some molt strategies generate fewer asymmetries between wings than others, and that asymmetries are rarest in outer wing feathers compared to inner wing feathers. While ornithologists have long recognized the complex molts of large birds, we are only

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beginning to understand the costs associated with them and how these costs may constrain evolutionary transitions from one molt strategy to another.

## **Effects of petroleum infrastructure on abundance and productivity of grassland birds: The role of anthropogenic noise**

Patricia Rosa, University of Manitoba; Nicola Koper, University of Manitoba

As anthropogenic noise becomes more prevalent across habitats, its impacts on wildlife remains difficult to assess. Noise from petroleum infrastructure may contribute to grassland bird population declines in the Canadian Prairies. To isolate effects of noise from confounding factors associated with petroleum development, we used a high-fidelity solar-powered broadcasting playback design to recreate the soundscape. During three breeding seasons, we conducted bird abundance transect surveys and monitored nesting success at chronic oil-well playback sites, intermittent drilling activity playback sites, silent playback sites to control for the presence of the playback apparatus, and control sites without any infrastructure. This study design allowed us to disentangle effects provoked by anthropogenic noise on grassland songbirds from potential effects driven by the presence of infrastructure. We found negative effects of noise on nesting success of Chestnut-collared Longspur, Savannah Sparrow, and Sprague's Pipit at sites with continuous noise exposure. We found that intermittent drilling noise negatively affected abundance of three species (i.e. Baird's Sparrow, Chestnut-collared Longspur, Savannah Sparrow), and chronic oil-well noise had a negative effect on two of those species. Regardless of noise, the presence of the playback apparatus deterred Sprague's Pipits and attracted Vesper Sparrows. Hence, although less predictable intermittent noise from drilling activity negatively impacted abundance, nesting success was negatively affected by chronic oil-well noise. Assessing noise-related impacts by only examining differences in abundance would not have revealed fitness-related consequences endured by residing species in our system. The management implications are not straightforward; species-specific mitigation must be considered.

## **Evaluating the inference from dynamic occupancy models relative to population abundance**

Beth Ross U.S. Geological Survey, South Carolina Cooperative Fish and Wildlife Research Unit; Mevin B. Hooten, U.S. Geological Survey, Colorado Cooperative Fish and Wildlife Research Unit, Colorado State University; David N. Koons, The Ecology Center, Utah State University

Many species distribution studies are based on temporal snapshots of occurrence, which may not fully capture mechanisms related to changes in species' abundance over space and time. Recent advances in dynamic occupancy models may help resolve these issues, and better quantify mechanisms driving changes in population dynamics (e.g., colonization and extinction) using presence-absence data. Because dynamic occupancy models are still relatively new; however, it is important to evaluate their effectiveness by comparing model outputs to time series of abundance data and population growth rates across space. We used a long-term, broad-scale aerial survey dataset (the Waterfowl Breeding Population and Habitat Survey) on Lesser and Greater Scaup (*Aythya affinis* and *A. marila*) to evaluate the outcomes of a dynamic occupancy analysis relative to inference using abundance. Our results indicated that significant trends in persistence (the probability of a site remaining occupied) and colonization (the probability of an unoccupied site becoming colonized) were less prevalent across our spatial units than changes in abundance. In particular, the abundance of paired scaup declined significantly in the

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northwestern boreal forest ecoregion of Canada, but did not exhibit a decline in persistence, colonization, or occupancy probabilities. However, we did find correlated increases in persistence, colonization, and abundance in the prairie-parkland ecoregion. The relationships between dynamic occupancy and changes in abundance were spatially ambiguous, and further research could test whether such relationships are stronger in stable or increasing populations compared to decreasing populations.

## **Midwest Migration Network: coordinated regional research for migrating landbirds**

Amber Roth, University of Maine; Mark Shieldcastle, Black Swamp Bird Observatory; William Mueller, Western Great Lakes Bird and Bat Observatory; Bryan Lenz, Western Great Lakes Bird and Bat Observatory; Katie Koch, US Fish and Wildlife Service

The Midwest Migration Network, a working group of the Midwest Coordinated Bird Monitoring Partnership (<http://midwestbirdmonitoring.ning.com/>), was established in 2010 to increase the survival of landbirds by contributing to the understanding of migratory connectivity and population demographics throughout their annual cycle through a well-coordinated network of observers. A strategic plan was published in 2015 to guide the Network's activities which were refined with input from members at workshops in 2015 and 2016. The Network is focused on developing three regional research initiatives over the next two years: 1) coordinated banding of migrating landbirds in the Midwest, 2) airspace and stopover site usage based on paired radar and acoustical data, and 3) expansion of the Motus hemispheric nanotag tracking network. Until now, a standardized banding protocol targeting landbirds during the migratory periods and its broad geographic adoption have been lacking in the United States. The Network has developed this protocol for bird banding stations and other banders along with a training program launched earlier at this conference as a one-day workshop. The banding protocol includes collection of associated information simultaneous to banding activities including banding effort, point count surveys, habitat characteristics, and daily bird lists. A data storage and management system is being developed through the Midwest Avian Data Center. Future workshops are planned across the Midwest. Opportunities for collaboration among researchers and regional banders will be discussed.

## **Multi-scale bird community response to forest management in the Central Hardwood region**

Patrick Ruhl, Purdue University; John B. Dunning Jr., Purdue University; Kenneth F. Kellner, Purdue University; Jeffery K. Riegel, Purdue University; Robert K. Swihart, Purdue University

Study of the breeding bird response to silviculture has generally been limited to single species, single harvest types, or short time periods. We studied the breeding bird community response to silvicultural treatments at multiple scales over a 10-year period in 60–90 year old oak-hickory forests of Indiana. We conducted point counts in a 3603-ha study area before and after application of silvicultural treatments, and used multi-species N-mixture models to estimate bird species density and richness at two spatial scales: management units and individual harvests. At the multi-stand management unit scale, treatments were even-aged management, uneven-aged management, and a no-harvest control. The individual harvest scale consisted of clearcuts, patch cuts, shelterwood harvests, and single-tree selection. At the management unit scale, overall richness was significantly greater in the even- and uneven-aged treatments than in the control. At the harvest scale, only the clearcuts and patch cuts resulted in changes in species density, but a larger number of species were impacted and effect sizes were generally larger in these harvests than at the management unit scale. At both scales, species generally associated with early successional habitat (e.g., Eastern Towhee [*Pipilo erythrophthalmus*] and Indigo Bunting [*Passerina*

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*cyanea*]) increased, while species typically associated with mature forest habitat (e.g., Red-eyed Vireo [*Vireo olivaceus*] and Ovenbird [*Seiurus aurocapilla*]) declined. Recent telemetry data and stable isotope trophic analysis of mature forest birds banded in clearcuts suggests that the availability of early successional habitat within a forest-dominated landscape may contribute valuable resources during the postfledging period.

## **Monitoring abundance and distribution across space and time: advances in approaches and methodologies for monitoring bird populations**

Viviana Ruiz-Gutierrez, Cornell Lab of Ornithology; John Sauer

The development of models aimed at estimating patterns of abundance and distribution has been critical for improving our knowledge on the ecology and management of bird populations. The application of these models by monitoring programs, such as the North America Breeding Bird Survey, have provided valuable, long-term information on population trends and species distributions for numerous landbirds. More recently, advances in the way we collect data with the help of citizen scientists, such as eBird, have encouraged the development of statistical models that can handle year-round information, and provided unique insights into the dynamic patterns of species abundance and distribution at continental scales. Analytical approaches are also being developed that leverage recent improvements in statistical modeling to integrate information from multiple bird survey programs. Here, we provide an overview of these advances, specifically focusing on approaches that combine multiple sources of information while correcting for known sources of bias. We further illustrate trade-offs in current approaches by estimating distribution patterns of Eastern forest birds in upstate New York using structured survey data and unstructured citizen-science data. In addition, we provide suggestions for collecting future bird survey information to facilitate the applications of current advances to model species abundance and distribution patterns.

## **Using Social Media at Scientific Conferences, A Case Study of NAOC 2016**

Jordan Rutter, American Ornithological Society

Social media is a currently underutilized networking tool by science conferences, which has the ability to maximize the benefits of the event for both organizers and attendees. Twitter specifically is set up in a way that allows constant and continual sharing of information. This medium provides an optimal platform for organizers to communicate with the public (attendees or not) about the conference before, during, and after the event. Twitter also allows people to report live about program items such as symposia talks, workshops, socials, and more. In doing so not only are the attendees connecting with others present but are also spreading that information to people around the world. By using social media to talk about the conference, science in general is getting discussed more as well. New projects and collaborations are all possibilities and results of using social media in general but especially at conferences. The North American Ornithological Conference (NAOC) that took place in 2016 is a case study that demonstrates the additional success scientific conferences can have when social media is incorporated.

## **Slow markers and fast birds: a subspecific phylogeny of the New World Quail using thousands of UCE loci**

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Jessie Salter, Louisiana State University; Peter A. Hosner, University of Florida; Edward L. Braun, University of Florida; Rebecca T. Kimball, University of Florida; Brant C. Faircloth, Louisiana State University

The New World Quail family (Odontophoridae) comprises 35 species, many of which show an impressive degree of phenotypic variability. For example, males and females of some species are monomorphic, while males and females of other species are dimorphic; social and genetic mating systems vary widely; and plumage variation within species is extensive - epitomized by the 22 recognized subspecies of Northern Bobwhite (*Colinus virginianus*). Previous work proposes that Odontophoridae has higher rates of molecular evolution than other Galliformes, suggesting one potential mechanism explaining this variability. Odontophoridae also has an interesting biogeographic history; they are sister to the African Ptilopachinae, although incomplete sampling in previous studies has limited our understanding of how these quail spread throughout the New World. To better understand the relationships within this diverse group, we used next-generation sequencing of ultraconserved elements (UCEs) to collect genome-scale data for 118 subspecies in this family, including 77 historical (toepad) samples collected between 1906-1996. We use this phylogenetic framework to better understand how diversification rate and historical biogeography shaped evolution in this remarkable group of birds.

## **Modeling links between avian behavior and metabolism highlights intricacies of pace-of-life syndrome**

Timothy Salzman, University of Kentucky; Allison McLaughlin, University of Kentucky; David F. Westneat, University of Kentucky; Philip H. Crowley, University of Kentucky

As endotherms, birds must obtain enough energy to maintain necessary functions as well as maintain body temperature. We expect that metabolism and a suite of traits that depend on energy should be jointly under selection, potentially creating patterns of correlated traits, called the “pace-of-life syndrome” (POLS), both within and among species. Considerable empirical study, especially in birds, has produced variable results, and there has been little theory about this idea. We analyzed an optimality model of basal metabolic rate (BMR) in environments that varied in food availability and two types of mortality: activity-related and activity-independent. The model contained three major features: 1) performance links between BMR and use of energy for other traits, 2) feedback between activity and energy acquisition, and 3) a nested set of three allocation trade-offs involving energy flow to BMR, activity, and two types of defense against mortality risks. The model produced an intermediate, optimal BMR that was usually highest at an intermediate level of food availability. Food availability and mortality risks interacted to influence the exact value of optimal BMR. Trait correlations expected in the POLS existed only under a subset of environmental conditions, producing a ‘sloppy’ syndrome with considerable non-POLS-like variation. The results emphasize that variation in resources and mortality risks creates a diversity of correlation structures despite the central role of metabolism. In many organisms, and especially in birds, the POLS is likely to be a variable construct.

## **Beak morphology predicts vocal features in songbirds: understanding vocal responses to chronic industrial noise**

Natalie Sanchez, University of Alberta; Erin Bayne, University of Alberta

Over the past decade, there has been a growing awareness about the environmental effects of human caused noise on animals. There is little information on the effects of chronic noise on birds in the oil sands region in Alberta. In mature aspen forest many species were less likely to occur in noisy places. However, not all species were affected



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to the same degree. What makes one species more or less likely to be affected by industrial noise is important to understand as it will provide insights into what the most appropriate mitigation options might be. Vocal features and diet in songbirds have been reported as important features to explain sensitivity to noise. Since vocal performance and diet is related to beak morphology, we hypothesize that the tolerance level of passerine birds dealing with chronic industrial noise varies with their vocal performance which is limited by the morphology of their beaks. We analyzed vocal features and morphological measurements of the beak of eight songbirds to determine how the morphology of their beaks might influence their vocal performance and their relationship to chronic industrial noise in Northern Alberta. The width and the height of their beaks were associated with lower frequency songs and shorter bandwidth. Additionally, birds with these characteristics were grouped as sensitive species to chronic noise. These factors could be included in predictive models of sensitivity to chronic industrial noise at a community level, to understand further changes that might cause a decreasing in songbird populations exposed to chronic industrial noise.

## **What is sustaining higher nest predator abundance within natural gas fields?**

Lindsey Sanders, Wyoming Cooperative Fish and Wildlife Research Unit, University of Wyoming; Anna D. Chalfoun, US Geological Survey, Wyoming Cooperative Fish and Wildlife Research Unit, University of Wyoming

Understanding the mechanisms underlying avian responses to human-induced habitat change is a rare but critical endeavor for conservation and management. Energy development has become a major source of anthropogenic habitat alteration globally. In the western US, the majority of development overlaps with sagebrush steppe. Previous research in western Wyoming demonstrated decreased nest survival with surrounding habitat loss from natural gas development. Predation was the primary cause of nest failures, with 80% of observed depredation events attributed to rodents. A critical next step is to determine why some rodents are more abundant near energy development. Here, we tested two alternative hypotheses to explain increased rodent abundance near energy development: Mesopredator Release and Food Augmentation. We measured apex predator detections, rodent abundance, survival, perceived predation risk, fitness metrics (body condition, juveniles per female, adult reproductive status), diet, movement patterns, and vegetation characteristics to test these hypotheses. Contrary to the predictions of the Mesopredator Release Hypothesis, detections of apex predators and perceived predation risk of deer mice increased with energy development. Mice increased in abundance with surrounding reclaimed area and grass cover, suggesting partial support for the food augmentation hypothesis. Deer mice, however, were in poorer condition near reclaimed areas, which may have resulted from the increased predation risk associated with energy development. Our results clarify the role that the composition of reclaimed areas can play as a food resource for rodents within energy fields, and contribute to general understanding of how human-induced habitat change can influence nest predation risk.

## **10 years of California Condor nest management in Southern California**

Estelle Sandhaus, Santa Barbara Zoo; Joseph Brandt, United States Fish & Wildlife Service

California Condors were first reintroduced to southern California in 1996 after a period of extinction in the wild. Though reintroduction of condors has continued in other parts of the range, none of these populations are yet self-sustaining. Low nest success, largely due to anthropogenic factors, has been a limiting factor of the southern

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California population's growth since the onset of breeding in 2002. In response, the Santa Barbara Zoo and United States Fish and Wildlife Service initiated a formalized nest management program in 2007. A two-pronged approach of monitoring and intervention facilitates adaptive management while increasing nest success. Here we present the results of ten years of systematic nest management in this population.

## **Shift in frequency to minimize acoustic masking by anthropogenic noise affects song transmission**

Luis Sandoval, Universidad de Costa Rica; Mauricio Villarreal, Universidad de Costa Rica; Gilbert Barrantes, Universidad de Costa Rica

Species that use sound to communicate need that signals arrive at the receiver with little degradation and attenuation. In cities, noise pollution resulting from anthropogenic activities increases rapidly, making acoustic communication inefficient. Some species respond to high levels of noise increasing the minimum frequency of its vocalizations to avoid noise masking, but this may affect how sound transmit in the environment because sound with higher frequencies experiments higher levels of attenuation and degradation. We analyzed, using a transmission experiment, how minimum frequency shifts, but with the same amplitude, affect the sound transmission properties of House Wren (*Troglodytes aedon*) songs in areas with high and low noise levels. The experiments were conducted in urban territories of House Wrens in Costa Rica. We broadcasted songs with frequencies below 3 kHz (inside noise range) and the same songs with minimum frequencies artificially increased above 3 kHz (above noise range), in noisy and non-noisy territories, and at four distances. We quantified the signal-to-noise ratio, tail-to-signal ratio, blur ratio, and excess attenuation. We found that songs with frequencies below 3 kHz in low noise territories transmit with higher signal-to-noise ratio, and lower blur ratio and lower excess attenuation at longer distances. Songs with increased minimum frequencies only showed higher signal-to-noise ratio in noisy territories at longer distances. These results support the advantage of producing frequency shift to increase the communication distance in noisy environments. This represents the first detailed study to compare the frequency shift effect on song transmission on territories with different noise levels.

## **An integrated population model for multi-scale inferences about population dynamics of North American landbirds**

James Saracco, The Institute for Bird Populations; Farshid Ahrestani, Foundation for Ecological Research, Advocacy and Learning, Pondicherry, India; John R. Sauer, USGS Patuxent Wildlife Research Center, Laurel, Maryland; J. Andrew Royle, USGS Patuxent Wildlife Research Center, Laurel, Maryland; Keith Pardieck, USGS Patuxent Wildlife Research Center, Laurel, Maryland

Integrated population models (IPMs) provide a unified framework for analyzing independent data sets to provide inferences about vital rates and population dynamics. We have been developing IPMs for application to count data from the North American Breeding Bird Survey (BBS) and capture-recapture data from the Monitoring Avian Productivity and Survivorship (MAPS) program. Joint analysis of these two data sets presents unique challenges associated with accounting for sources of bias and noise induced by sampling and observation processes and differences in spatial locations of data collection between the two monitoring programs. There are also technical challenges to implementing spatially-stratified models at range-wide scales because average population counts can be close to zero in at least some strata. We present a basic modeling approach that builds on standard analyses of BBS and MAPS data while addressing challenges associated with the joint analysis of the two data sets. We apply the model to species with good representation in both data sets to highlight the value of IPMs for providing

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insights into demographic drivers of population dynamics. In addition, we consider models that include covariates of demographic rates to explore the potential of these models for informing responses of populations to environmental stressors. We suggest that the continued development and application of IPMs in the context of broad-scale monitoring data will provide a valuable tool for the conservation of broadly distributed bird species.

## **North American Breeding Bird Survey: model inferences from a complex survey**

John Sauer, USGS Patuxent Wildlife Research Center; William A. Link, USGS Patuxent Wildlife Research Center; Guthrie S. Zimmerman, US Fish and Wildlife Service; Mark C. Otto, US Fish and Wildlife Service

The North American Breeding Bird Survey (BBS) has been used to estimate population change for 546 species of North American birds. The geographic scope of the survey continues to expand, and analyses of BBS data are complicated by the addition of strata with limited and temporally incomplete data. Consequently, the BBS is analyzed using hierarchical models that accommodate the random effects and scale-specificity inherent in a continental survey. These models permit controlling for factors that influence detection of birds associated with observers and other observable covariates. Another important aspect of BBS analysis using hierarchical models is the ease with which the modeling can be expanded to incorporate additional information. We present examples of approaches to enhancing inference from BBS data, including aggregating information among species, incorporating information to directly estimate abundance, and expanding scope and strength of inference by simultaneously analyzing BBS data and data from other surveys. Models that integrate multiple data sources provide a means of enhancing the credibility of results for species of management interest, allowing efficient use of limited monitoring resources. We describe ongoing studies that combine BBS data with waterfowl, Bald Eagle, and other surveys to enhance estimation of population size and change.

## **Evaluating piping plover population viability and conservation efficacy using integrated population models**

Sarah Saunders, Michigan State University; Francesca Cuthbert, University of Minnesota-Twin Cities; Elise Zipkin, Michigan State University

Understanding and predicting population responses to environmental or management conditions is a fundamental challenge for effective conservation. We developed a coupled integrated population model-Bayesian population viability analysis (IPM-BPVA) to assess the (i) impact of demographic processes (survival, fecundity, immigration) on past population dynamics; (ii) population viability 10 years into the future; and (iii) efficacy of possible management strategies for the federally endangered Great Lakes Piping Plover (*Charadrius melodus*). Our IPM-BPVA synthesized long-term (1993 – 2016) survey, nest monitoring, and mark-resighting data. We further extended our model to incorporate latent abundance of eastern North American Merlins (*Falco columbarius*) as a covariate on adult survival via a parallel state-space model, accounting for the influence of an imperfectly observed process (i.e., predation pressure) on population viability. Plover abundance increased from 18 pairs in 1993 to 75 pairs in 2016, but annual population growth ( $\lambda$ ) was projected to be 0.95, with 67 pairs remaining in ten years. Had we not included a merlin effect, we would have erroneously concluded that the population would increase ( $\lambda = 1.02$ ) to 91 pairs by 2026. We compared three conservation scenarios: (1) chick predator (e.g., Corvidae, Laridae) control reduced quasi-extinction (<15 pairs remaining) probability from 11.9% (no proposed

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management) to 8.7%; (2) merlin control more than halved (3.5%) the probability; and (3) simultaneous control measures reduced quasi-extinction probability to 2.6%. Recovery actions should consider systematic predator control, rather than current informal protocols, especially given that regional merlin abundance is predicted to increase over the next 10 years.

## **Are acoustic cues a driver of habitat selection in grassland obligate songbirds?**

Chace Scholten, Calvin College; Kristin Strydhorst, Calvin College; Darren S. Proppe, Calvin College

Habitat selection in migratory songbirds is driven by multiple sensory cues. While visual cues such as vegetation are known to play a role in habitat selection for many species, acoustic cues may also be important. For example, the playback of conspecific song during migration is known to increase the selection of nearby breeding habitats. Conversely, high levels of anthropogenic noise are often associated with habitat aversion. In both cases, these patterns are more evident and consistent in forest and edge songbirds than in grassland obligate species. In the latter case, empirical evidence for the use of acoustic cues is not absent, but the consistency of the observed patterns is somewhat less compelling. We investigated the effect of conspecific song playback and anthropogenic noise on the establishment of breeding territories for five grassland obligates. Breeding densities were compared between a series of fields adjacent to an international airport, acoustically undisturbed grasslands in the conservation reserve program (CRP), and recently restored prairies that lacked grassland obligate species. Our initial data suggests that the salience of acoustic cues may be a weak or negligible driver of habitat selection, but late season prospecting suggested that a second year of data collection could alter the outcomes. We will present the results from two seasons of field work, and discuss the implications for the conservation of these increasingly rare grassland obligate songbirds.

## **Vocalizations in a non-passerine: what can call structure tell us about an individual King Rail?**

Katie Schroeder, East Carolina University; Susan McRae, East Carolina University

Individual recognition is important for effective communication between mates, kin, and rivals. Species living in visually obstructive habitats must rely heavily on vocal signals for recognition cues. The King Rail, *Rallus elegans*, is found in marshes with thick vegetation, but has broadband calls consisting of a single repeated syllable. We explored whether these calls had sufficient complexity and variability to allow for individual identification. We recorded individual kek calls, the mating and territorial call, from different territorial individuals in a coastal breeding population of king rails. Preliminary principle components analysis indicates that King Rail kek calls vary with respect to multiple frequency and temporal related parameters including peak frequency and pulse rate. We have identified parameter combinations that explain a high proportion of intraspecific variation, indicating the potential for individual recognition pending further analysis. This leads to the question of whether more general information can also be encoded in king rail calls. Using a combination of audio and video recording, in some case with marked birds, we are currently investigating whether body size or condition can be predicted by certain kek call parameters. This study will help us to understand how simple calls convey information.

## **Conserving forest bird populations and their services in tropical agricultural countryside**

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Cagan Sekercioglu, University of Utah; Chase Mendenhall, Stanford University; Federico Oviedo Brenes, Wilson Botanical Garden; Joshua J. Horns, University of Utah; Paul R. Ehrlich, Stanford University; Gretchen C. Daily, Stanford University

Agriculture covers a large and rapidly growing part of the tropics, but the long-term capacity of tropical countryside to sustain native biodiversity is little-known. Between 1999 and 2010, at 19 mid-elevation sites in Costa Rica we sampled 57,307 birds of 265 native bird species with mist nets. Habitats ranged from sun coffee plantations to primary rainforest of the 400,000-ha Amistad International Park. Four findings stand out. First, 49% of the bird species preferred forest to coffee, 38% preferred coffee to forest, and 13% used both habitats equally. Although 71% of the 56 most forest-dependent species were absent from coffee, 184 bird species were recorded in coffee, capture numbers were higher there than in other habitats, and populations of three forest-dependent species were increasing. Second, twice as many bird species, overall, were declining versus stable or increasing, especially in forest habitats and open coffee plantations. Third, small forest fragments (3 ha) experienced more species declines than increases, particularly among birds that were resident, insectivorous, and more specialized. Finally, a modest increase in coffee plantation tree cover (7% vs 13%) resulted in the doubling of the capture rate of the most forest-dependent birds and the halving of the capture rate of non-forest birds. Seed-eating birds attained highest proportions in coffee plantations, insectivores were best represented in primary forest, and insectivorous birds in coffee plantations increased with more tree cover. Populations of northern migrants, most numerous in coffee plantations and secondary forests, did better than those of resident species. Costa Rican countryside habitats such as coffee plantations, riparian corridors, and secondary forests host hundreds of bird species and are critical for connecting the declining bird populations of forest remnants. Better integration of agricultural countryside with protected areas is essential for the long-term sustainability of the region's bird community.

## **Summary of recent studies on the effects of conifer expansion and removal on Sage-grouse**

John Severson, US Geological Survey, Western Ecological Research Center; Peter Coates, US Geological Survey, Western Ecological Research Center; Mark Ricca, US Geological Survey, Western Ecological Research Center; Brian Prochazka, US Geological Survey, Western Ecological Research Center; Christian Hagen, Oregon State University

Greater Sage-Grouse (*Centrocercus urophasianus*) are a sagebrush obligate species that are often considered an indicator of intact sagebrush ecosystems. Conservation of this species can help protect other sagebrush obligate and non-obligate species at large spatial scales. Conifer expansion in the sagebrush ecosystem is an important threat to sage-grouse populations and their habitat. Some recent studies have provided valuable information regarding effects of conifers on sage-grouse habitat selection patterns and demography. Other studies have already begun to assess effects of specific management actions aimed at reducing this threat. Here, we provide an overview of: 1) links between avoidance patterns of conifers and impacts on adult survival of sage-grouse, 2) behavioral mechanistic movement patterns that relate to these avoidance and survival patterns, and 3) conifer removal as an effective management action that can improve sage-grouse population vital rates. These studies collectively help explain broader landscape patterns of conifer effects on sage-grouse population persistence, and point to common management goals for conifer removal treatments in sagebrush ecosystems. Although great strides have been made recently, we are still in nascent stages of understanding the direct and indirect impacts of conifer expansion. However, these accomplished efforts contribute to our ecological understanding as well as conservation of sage-grouse and other sagebrush obligate species.

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## **Nest boxes benefit a declining raptor and ecosystem services in a fruit-growing region**

Megan Shave, Michigan State University; Stephanie Shwiff, USDA/APHIS/Wildlife Services' National Wildlife Research Center; Julie Elser, USDA/APHIS/Wildlife Services' National Wildlife Research Center; Catherine Lindell, Michigan State University

Reduction of pest species via a native predator is a regulating ecosystem service that has the potential to limit crop damage and produce regional economic benefits. American Kestrels (*Falco sparverius*) are widespread, highly-mobile predators that hunt in human-dominated habitats, thus they are potentially important predators providing previously undocumented regulating services in agroecosystems. Kestrels have quickly occupied nest boxes installed in cherry orchards in northwestern Michigan, a major U.S. fruit-growing region. Kestrels using these nest boxes have shown high reproductive rates; furthermore, nest boxes have increased the presence of kestrels in the region. We hypothesized that kestrel activity associated with nest boxes and perches acts as a reliable cue of predation risk that, in combination with kestrel consumption of prey birds, can reduce fruit-eating bird abundances in cherry orchards. We conducted fixed-width transect surveys to determine that fruit-eating bird counts were significantly lower in orchards with active kestrel boxes. Perches did not have a significant effect on bird counts; however, kestrels used perches in young orchards, with peak use after the offspring fledged from the nest. Benefit-cost ratios indicated that for every dollar spent on nest boxes, \$131 to \$557 of sweet cherries is saved from fruit-eating birds. Regional economic modeling predicted that increased production of sweet cherries would result in 72 to 77 jobs created and \$3.5 million to \$3.8 million in increased income for Michigan over a five-year period. Kestrel nest boxes in sweet cherry orchards therefore provide a highly cost-effective enhancement of ecosystem services in fruit crops.

## **Snow burrowing behavior mediates temperature-induced stress in a gallinaceous bird**

Amy Shipley, University of Wisconsin-Madison; Benjamin Zuckerberg, University of Wisconsin-Madison; Michael Sheriff, Pennsylvania State University; Jonathan Pauli, University of Wisconsin-Madison

Glucocorticoid stress hormones (GCs) play a key role in regulating metabolism by mobilizing energy reserves, and can modulate animal behavior to cope with environmental stressors. When unable to escape a stressor, GCs remain elevated, which can have deleterious effects, including fat depletion, muscle atrophy, and reduced reproductive output. Poor weather conditions affect GC levels in birds, but these have primarily been documented in the breeding season. It is unknown whether variable winter weather conditions associated with climate change, such as reduced snow cover, contribute to chronic stress in birds. When snow is deep and powdery in northern forests, Ruffed Grouse (*Bonasa umbellus*) roost in snow burrows, which are known to be significantly warmer than open sites, such as tree or ground roosts. We hypothesize that grouse experience increased stress resulting from cold exposure when shallow or crusted snow eliminates the possibility of snow burrowing. We measured corticosterone metabolites in fecal droppings collected from 70 Ruffed Grouse roost sites during winter 2015-2016. Snow depth, snow density, and ambient temperature were important predictors of stress. Our top model included an interaction between roost type and ambient temperature. At the coldest temperatures, Ruffed Grouse in snow burrows were less stressed than grouse roosting outside of snow burrows. Further, as snow depth increased past the minimum depth needed for snow burrowing, grouse stress levels decreased. Exploring how birds experience stress resulting from variability in a critical winter refuge will expand our knowledge of how a changing winter environment may further impact bird populations.

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## **Badges of status in the context of social networks**

Daizaburo Shizuka, University of Nebraska-Lincoln; Alexis Chaine, CNRS; Bruce Lyon, UC Santa Cruz

Social signals evolve within the context of the animal's social networks, the patterns of social interactions within the population. We investigate the social function of crown plumage in Golden-crowned Sparrows (*Zonotrichia atricapilla*) during the non-breeding season in the context of their social network structure. We previously demonstrated that these crown plumage patches function as badges of status between unfamiliar birds. We have also shown that these sparrows live in a complex social network in which close-knit social groups of familiar individuals are embedded within a larger population. We combine further aviary and field experiments to determine how familiarity and network structure affects the function of badges of status in the wild. We use manipulative experiments to show that social recognition between familiar birds modulate the use of badges of status. We find that same plumage feature that predicts dominance in experimental studies also predicts dominance in the wild, and that observed contests are disassortative: contests occur more frequently between individuals with larger differences in crown plumage. Finally, social network analyses reveal that contests over food in the wild largely occur within social clusters, suggesting that familiarity may also be an important factor determining the function of badges of status in the wild. Our experimental and long-term observational studies to resolve outstanding questions regarding social signaling and social recognition, and presents a path for integrating manipulative experimental studies with field studies of signal function within natural social networks.

## **Impacts of energy development and disturbance on owls in the boreal forest at multiple scales**

Julia Shonfield, University of Alberta; Erin Bayne, University of Alberta

Energy development creates several types of disturbance that can impact avian species, including the physical footprint and chronic noise from facilities. Noise can mask important avian communication signals. Owls use vocalizations for communication and rely on acoustic cues to locate prey. Owl hunting success is negatively affected by noise, but it remains unknown if noise impacts habitat use and distribution on the landscape. To determine if owls avoid areas surrounding noise sources in northeastern Alberta and at what scale, we conducted passive acoustic surveys for owls using autonomous recorders. We surveyed for Barred Owls and Great Horned Owls at 72 sites with and without industrial noise sources, over an area approximating a home range (256 ha). For both owl species, occupancy at a home range scale was unaffected by noise sources on the landscape. However, Barred Owl use of areas within a home range declined with increased noise levels and increased habitat disturbance from the energy footprint, but Great Horned Owls showed no decline in use. We also surveyed 5 large areas (2,916 ha) with grids of recorders, to test how intensity of use by owls is influenced by proximity to noise sources and amount of habitat disturbance (i.e. energy footprint). Barred Owls were detected more frequently in areas with little energy impact, whereas Great Horned Owls were detected frequently in more heavily impacted areas. This research contributes to growing evidence that anthropogenic noise impacts birds and can degrade suitable habitat, though some species are more sensitive than others.

## **Common Raven use of power lines for nesting: implications for Greater Sage-Grouse conservation**

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Quinn Shurtliff, Wastren Advantage, Inc.

The Common Raven (*Corvus corax*; hereafter raven) has become increasingly prevalent in western North American sagebrush landscapes due to increased food, water, and nesting subsidies from humans, often associated with habitat fragmentation. The raven is an effective nest predator and can impact reproductive success of sensitive species, including the Greater Sage-Grouse (*Centrocercus urophasianus*). For the past three years, I have monitored all power lines and other infrastructure each spring that could potentially support raven nests on the Idaho National Laboratory (INL) Site. My objectives were to quantify the number of raven nests on infrastructure and determine if infrastructure use by raven nesting pairs is increasing. I found clear evidence that ravens have increasingly used power transmission structures as nest substrates. Further, the data provide insights into the size of territories defended by raven breeding pairs. Using this information, I estimate that the current level of raven nesting is likely far below carrying capacity. Although no studies on the INL Site have been conducted that would link raven abundance to sage-grouse reproductive success, a review of the literature suggests that increasing occupancy by ravens will cause negative impacts to sage-grouse that nest on the INL Site.

## **A comparison of bird digestive systems by diet**

Adnan Siddique, The Ohio State University; Jacqueline K. Augustine, The Ohio State University, Lima

The avian digestive system possesses unique organs and structures to accommodate a diversity of diets. In general, herbivores have longer, more complex digestive systems while carnivores have smaller, less elaborate digestive systems, but most of the research in this area examines mammalian morphology. Accordingly, the goal of this study was to determine the influence of diet on digestive system morphology in birds. I expected the size of the intestines, cecum (if present), proventriculus, and gizzard would be larger in herbivorous birds and smaller in carnivorous birds. Birds of varying diets were dissected and their digestive systems (intestines, cecum, proventriculus, and gizzard) were weighed. Additionally, each organ's percent contribution to total body weight was calculated. Diet was determined by literature and by the stomach contents of each bird. A mixed model was used for comparisons with the percentage of body mass due to organ weight as the dependent variable, bird diet as a fixed effect, and family as a random effect. Results from 34 species revealed that diet affected size of the proventriculus but not the size of the intestines, gizzard, cecum, or the total digestive system. The proventriculus size was largest in insectivores and smallest in herbivores, with omnivores having an intermediately-sized proventriculus. Contrary to previous studies, our study did not support the hypothesis that herbivorous diets lead to a larger, more elaborate digestive system than carnivorous diets in birds. Because carnivores had to be excluded from this study due to sample size, our ability to differentiate between taxonomical differences and trophic differences was hindered.

## **The new European Breeding Bird Atlas: first results of 50x50 km occurrence and 10x10 km modeled distribution maps**

Henk Sierdsema, Sovon, Dutch Centre for Field Ornithology, EBCC Spatial Modelling Group

In 2013 the fieldwork for the second European Breeding Bird Atlas (EBBA2, [www.ebba2.info](http://www.ebba2.info)) started and is foreseen to finish in 2017. The European Bird Census Committee (EBCC), a network organization of many bird monitoring organization across Europe, coordinates this huge project. Information on the occurrence is collected at two spatial scales: 50x50 kilometer ('UTM50') and 10x10 kilometer ('UTM10'). The UTM50-scale is comparable is



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to the first European Atlas (Hagemeijer and Blair 1997) where for each UTM50 a complete list for all occurring breeding birds, breeding certainty and estimates of the number of breeding pairs is foreseen. However, with almost 120,000 UTM10 squares across the continent, it is virtually impossible to carry out surveys in all these units. Consequently the only feasible approach to achieve this goal is modeling the probability of bird occurrence by means of i) gathering a sample of standardized data, ii) using these data to model the relation between birds and the environment (habitat, climate, etc.) and iii) projecting these models across the whole set of UTM10 squares in Europe. In the middle of the fieldwork period of EBBA2 a first data collection of standardized data was carried out. Almost 100,000 timed surveys from a total of 12,057 UTM10 squares distributed among almost all countries were gathered and the Spatial Modelling Group of the EBCC explored how to generate models and maps with the available data. One of the main difficulties of such pilot modelling was to cope with the huge differences in coverage across Europe since data are abundant and evenly distributed in many regions of Western Europe but scarce and concentrated in a few areas in the East. This heterogeneity in coverage is higher than it was in any of the previous modeling experiences by EBCC partners at national level. Another particular challenge to face is the coexistence of diverse field methodologies. However, the time spent in each survey was recorded in all of them and this constituted a robust unit of effort to standardize the original data and generate a first set of modeled maps for a few species. These pilot maps will certainly be improved in the final product thanks to new timed surveys and additional work on modeling.

## **Variable precipitation leads to dynamic western range limits of eastern forest songbirds at the forest-prairie ecotone**

Emily Sinnott, University of Missouri; Dr. Timothy J. O'Connell, Oklahoma State University

Ecotones are dynamic borders between vegetation types sensitive to changes in climate. The forest-prairie ecotone of south central U.S. has changed in response to historic periods of drought and pluvial conditions. This region also marks the western range limit of many eastern forest songbirds. Our objective was to quantify historic longitudinal shifts in the western extent of eastern forest songbirds' breeding ranges in response to the highly variable climate of the southern Great Plains. We used climate niche modeling to estimate current distributions of Eastern Wood-Pewee, Acadian Flycatcher, White-eyed Vireo, Yellow-throated Vireo, Red-eyed Vireo, Louisiana Waterthrush, Black-and-white Warbler, Kentucky Warbler, and Northern Parula from 30-year normal climate conditions (1980-2010) and eBird occurrence data. Species' climate niche models were then projected onto two historic climate scenarios: 1966-1972 and 1952-1958, a dry period and a severe multi-year drought, respectively. Range shifts were demonstrated using threshold models for each of the three time periods. Precipitation was the most important climate variable defining distributions of these seven eastern forest songbirds. Range limits extended further west into Oklahoma during the more recent pluvial conditions of 1980-2010, and contracted during the drier 1966-1972 period and drought conditions of the 1950s. Periods of lower precipitation in the forest-prairie ecotone are likely responsible for limiting the western extent of eastern forest species' breeding distributions.

## **Growing up and growing old: is IGF-1 a mediator of growth and aging in birds?**

Aubrey Sirman, North Dakota State University; Aurelia Kucera, North Dakota State University; Jennifer Vangorder-Braid, North Dakota State University; Britt Heidinger, North Dakota State University

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Within and across taxa, studies have demonstrated that investment in growth comes at a cost to longevity. Despite this, little is known about the physiological mechanisms that underlie this tradeoff. One physiological mechanism that may be particularly important is insulin-like growth factor-1 (IGF-1). IGF-1 is thought to impact growth and cellular aging, particularly through its effects on telomere dynamics. We tested the role of IGF-1 as a mediator of the tradeoff between growth and aging by manipulating circulating IGF-1 in House Sparrow (*Passer domesticus*) nestlings during the post-natal growth period. Experimental nestlings were injected with a physiologically relevant dose of IGF-1 in a gelatin carrier matrix from days 3- 10 post-hatch. Control nestlings were injected with only the carrier matrix. Blood samples were collected at day 3 and day 10 to measure IGF-1 and telomere length. Growth was measured every 3 days until day 10. We predicted IGF-1 nestlings would exhibit faster growth and have shorter telomeres at day 10 compared to control nestlings. We observed a treatment by age interaction ( $p=.009$ ), indicating that over time experimental nestlings gained more mass. Overall telomere length did not differ between groups ( $p=.10$ ), but experimental nestlings experienced greater telomere loss over the experimental period compared to controls ( $p=.01$ ). Together, these results suggest that IGF-1 has positive effects on nestling growth and a negative impact on nestling aging through its effects on telomere dynamics.

## **Factors influencing Northern Bobwhite density, nest sites, and nest survival on post-grazing landscapes in South Texas**

Rachel Smith, Texas A&M University-Kingsville; Leonard A. Brennan, Texas A&M University-Kingsville; Humberto L. Perotto-Baldvieso, Texas A&M University-Kingsville; Fidel Hernández, Texas A&M University-Kingsville

Northern Bobwhite (*Colinus virginianus*) require habitat structure with substantial grass cover for nesting, predator avoidance, and thermal refuge. During the past 2 decades, many land managers have reduced or completely eliminated livestock across South Texas rangelands with the goal of improving bobwhite habitat. This study was conducted in Jim Hogg County, Texas and involved 3 different areas of post-grazing habitat recovery: a 1,246 ha area rested from grazing for 15 years; a 1,133 ha area rested 3 years from heavy grazing (7 ha/AU); and a 1,254 ha area rested 3 years from moderate grazing (14 ha/AU). We estimated bobwhite density and nest survival and hypothesized these numbers would be highest on the recovered site and lowest on the heavily grazed site. Additionally, landscape structure around nest sites was examined at 5 different buffer sizes (10, 20, 30, 40, and 50m) using FRAGSTATS. The full results from these analyses will be presented. Estimated December bobwhite density increased from 2015 to 2016 on all sites and was consistently highest on the recovered site with  $1.87 \pm 0.14$  bird/ha in 2015 and  $3.68 \pm 0.25$  bird/ha in 2016. Density estimates in 2015 were  $1.82 \pm 0.14$  bird/ha and  $2.86 \pm 0.19$  bird/ha on the 3 year moderate post-grazing site, and  $0.92 \pm 0.06$  bird/ha in 2015 and  $2.01 \pm 0.14$  bird/ha in 2016 on the 3 year high post-grazing site. The 15 year post-grazing site had a higher probability of a nest surviving the 23 day incubation period at  $0.61 \pm 0.12$  compared to  $0.32 \pm 0.12$  and  $0.33 \pm 0.12$  on the 3 year moderate and 3 year high post-grazing sites respectively. These data may suggest that the cattle removal can be a useful tool for improving bobwhite habitat especially after many years of continuous grazing.

## **Avian community structure in West Coast organic agroecosystems**

Olivia Smith, Washington State University; Christina Kennedy, The Nature Conservancy; Jeb P. Owen, Washington State University; William E. Snyder, Washington State University

The role of wild birds in agroecosystems is complex. On the one hand, many experimental studies have demonstrated strong roles of birds as natural enemies which can reduce the need for pesticide usage. Birds further

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provide crop pollination services and help control rodent pests. However, wild birds are also known vectors of pathogenic *E. coli* O157:H7, *Salmonella enterica*, and *Campylobacter jejuni* which can cause food borne illness when birds defecate on crops. Birds are also well known to cause millions of dollars in crop loss due to crop damage. We took a multi-scale landscape ecology approach to better understand how to manage wild bird communities to maximize services while minimizing risks. We conducted a large-scale study on 40 organic farms over a 1700 km range along the West Coast in CA, OR, and WA to examine multi-scale landscape influences on avian community structure. We found that degree of naturalness and heterogeneity around a farm increased avian community richness and reduced the density of invasive bird species on farm. Integration of livestock on farm increased farm bird diversity, but also increased invasive species density. Integrated livestock farms had higher on farm heterogeneity and more structures for invasive species to nest in, which were likely response for observed trends. Future research will examine how landscape affects functional group richness to lead to desired outcomes.

## **Sea surface temperature as a factor in the reproductive failure of Crested Auklets on Gareloi Island in 2015**

Lucy Smith, University of New Brunswick; Christy N. Wails, Northern Illinois University; Heather L. Major, University of New Brunswick

Crested Auklets (*Aethia cristatella*) are socially monogamous seabirds in the family Alcidae that breed in large colonies throughout the Aleutian Archipelago. Studies suggest there is a relationship between large and small-scale oceanic climate indices and their influence on both prey abundance and survival, and alcid reproductive success. We used linear mixed model analysis to examine the relationship between three measures of Crested Auklet reproductive success (overall, hatching, and fledging success) at Buldir (1990-2015) and Kasatochi (1996-2008) islands, in the Aleutian Archipelago, and mean and standard deviation SST for periods corresponding to the breeding period and a nine-week lag period representing an influence on prey productivity. Additional analysis will include additional metrics of SST and chlorophyll as an indicator of marine productivity. The best model for each measure of reproductive success was calculated by AIC and used to predict the reproductive success for 2014 and 2015 at Gareloi Island and compare the predictions to observed success. Current results indicated a weak negative relationship between breeding period standard deviation SST for both overall reproductive and hatching success, and between lag period mean and standard deviation SST and fledging success. Predictions were approximately 90% accurate for 2014, but failed to predict the reproductive failure observed at Gareloi in 2015. Overall, our results support previous studies showing a link between local SST and Crested Auklet reproductive success but suggest SST was only one contributing factor in the 2015 reproductive failure, further analysis may expand this conclusion by linking SST with estimated marine productivity.

## **Previously-used nesting cavities influence occurrence and territory size of Magellanic Woodpeckers**

Gerardo E. Soto, Cornell Lab of Ornithology, Cornell University; Amanda D. Rodewald, Cornell Lab of Ornithology, Cornell University; Pablo M. Vergara, Laboratorio de Ecología y Conservación, Universidad de Santiago de Chile; Valeria Ojeda, INIBIOMA (CONICET-UNCo); Laura Chazarretad, Administración de Parques Nacionales

Spatial configuration of resources directly affects occurrence and space use of organisms in ways that can affect long-term population dynamics, especially when space for territories is limited. In this study we explored how clusters of cavities affected habitat use within territories of Magellanic Woodpeckers (*Campephilus magellanicus*), a

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territorial resident that specializes on decayed wood within mature forests. As the primary cavity excavator of the temperate South American forests, Magellanic woodpeckers roost, but rarely nest, in previously used cavities. We hypothesized that territory establishment depends both upon foraging habitat quality and availability of cavities on the landscape, as secondary cavity-nester species are rarely reported using them. After the assessment of the spatial configuration of roosting sites (i.e., cavities), we used a Synoptic Model of Space Use to measure how the decay of trees and cavity availability changed occurrence within woodpecker territories which is inversely proportional to territory size. We used data from two study sites separated by 1500 km that represented northern and southernmost parts of their ~2300 km distribution. In both study areas tree decay was an important factor shaping occurrence probability within territories. However, space use models showed that spatial configuration of roosting cavities was strongly associated with occurrence of woodpeckers. Although we did not include agonistic behavior among territory holders, our results provide insight into the ways that resource availability and distribution can influence local population densities.

## **Insights into the factors limiting disease emergence in a natural host-pathogen system**

Molly Staley, Auburn University, Chicago Zoological Society; Geoffrey E. Hill, Auburn University; Chloe C. Josefson, Auburn University; Jonathan W. Armbruster, Auburn University; Camille Bonneaud, University of Exeter

Recent outbreaks of novel diseases in humans and animals have refocused research efforts on understanding the factors that influence disease emergence. Among wild birds, one of the best-documented disease outbreaks is when the bacterial pathogen *Mycoplasma gallisepticum* (Mg) jumped from domestic poultry into House Finches (*Haemorrhous mexicanus*), giving rise to an epizootic that killed millions of birds. This host shift required both house finch exposure to Mg and, following exposure, for Mg to be able to infect and be transmitted among House Finches. We tested whether host exposure was the key limiting factor in the Mg host shift into House Finches. We experimentally gave House Finches a high-dose, ocular inoculation of Mg from poultry (Rlow; N=15) or from House Finches (1995 epizootic outbreak strain: HF1995; N=15) and monitored infection development. All finches inoculated with HF1995 became infected whereas Rlow only successfully colonized the tracheal mucosa in 12 of 15 (80%) finches. Furthermore, Rlow persisted for a shorter duration and achieved lower bacterial loads than HF1995. Rlow-infected birds also exhibited weaker antibody responses and significantly milder clinical symptoms (conjunctivitis). While 14 of 15 (93%) HF1995-infected finches became symptomatic, Rlow caused mild clinical symptoms in only 5 (33%) individuals. Given the reduced ability of Rlow to colonize and persist within House Finches, our results indicate that exposure was not the key limiting factor in the emergence of Mg in House Finches. Taken together, our results also suggest Mg genetic changes were likely necessary for persistence and transmission among House Finches.

## **Foraging patterns, prey use, and reproduction of Mountain Bluebirds in clearcut versus grassland habitats**

Jordyn Stalwick, University of Saskatchewan; Karen Wiebe, University of Saskatchewan

Mountain bluebirds (*Sialia currucoides*) and other species adapted to open landscapes are increasingly colonizing clearcuts but it is unknown whether clearcuts offer new habitats or are ecological traps. To test this, we will examine differences in foraging, nestling diet and its consequences for reproductive productivity between clearcuts and grasslands in central British Columbia, Canada. We will measure nest initiation dates, adult quality, prey use, and reproductive output. Using microcameras in nestboxes, we determined the feeding rates of parents, as well as the type and size of arthropod prey delivered to nestlings in clearcut and grassland habitats. Preliminary

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results show that clutch initiation dates are similar between habitat types. Adults in grasslands brought a greater diversity of arthropod orders to their nestlings compared to those inhabiting clearcuts. Within clearcuts, the average proportion of spiders and larva used to feed nestlings was larger than in grasslands while the proportion of beetles was larger in grasslands compared to clearcuts. In general, adult females brought smaller prey items than males and prey size increased as nestlings grew. However, parents in clearcuts switched to delivering larger prey items earlier than grassland birds. The mass of fledglings was higher in grasslands compared to clearcuts. However, of the nests that fledged offspring, the proportion of the brood that fledged did not differ between the two habitats. Thus, initial results suggest that parents in clearcuts may be able to raise a similar quantity but a lower quality of offspring compared to parents in grasslands.

## **Cueing in on migration: food modifies spring migratory behavior in a captive population of Wood Thrush**

Calandra Stanley, University of Maryland; Sara Hallager, Smithsonian's National Zoo; Peter M. Marra, Smithsonian Migratory Bird Center

Spring migratory behavior in songbirds is thought to be under strong endogenous control. Field studies suggest that food availability acts as a supplementary cue modifying this endogenous schedule, but such links can be difficult to quantify in the field. I tested the hypothesis that food acts as a cue modifying migratory schedules by investigating the prediction that food restricted diets will delay the onset and magnitude of spring migratory restlessness (zugunruhe) in a captive setting. Wild-caught adult, male Wood Thrush (*Hylocichla mustelina*, n=31) were randomly assigned to one of two feeding treatments, ad libitum or food-restricted. In spring, birds were photo-stimulated to induce migration. Birds in the food-restricted group started with significantly lower body condition but all individuals gained mass as migration progressed. There was no difference in the date of onset or overall magnitude of zugunruhe between groups. However, birds in the restricted group exhibited significantly lower zugunruhe during the early and peak migratory periods, but there was no difference in zugunruhe during the late migratory period. Overall this study suggests that food does not act to modify the onset of the wood thrush migratory schedule but does dampen zugunruhe, likely delaying spring migratory timing.

## **Using archival GPS tags to determine the ecological drivers of movements across the annual cycle**

Calandra Stanley, University of Maryland; Thomas B. Ryder, Smithsonian Migratory Bird Center; Greg W. Shriver, University of Delaware; Peter M Marra, Smithsonian Migratory Bird Center

The recent advent of miniaturized archival GPS geolocators provides unprecedented information about the spatial dynamics of long distance migratory birds throughout the annual cycle. When paired with satellite-derived remote sensing, these tags can be used to make inferences about the ecological factors underlying these movements across seasons. In this study, archival GPS tags (n = 21) were retrieved from Wood Thrush (*Hylocichla mustelina*) from five breeding populations (DE, IN, MN, NC, NY) to investigate the ecological drivers (vegetation indices, precipitation, temperature) of (1) intra-winter, and (2) spring migratory movements. During the winter season, 41% of individuals tracked were transient, moving 2- to 83- km between 2 or more home ranges. Both transient and sedentary individuals occupied home ranges of similar sizes, with little variation in dry season vegetation growth. However, transient birds occupied territories in landscapes with significantly higher forest cover, suggesting either higher competition for resources in these habitats or potential limitations on movements of

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individuals in less forested landscapes. Individuals from northern breeding populations had later departures from winter territories and arrived later to breeding territories that were more phenologically advanced, compared to southern breeders. Preliminary results suggest that timing of spring migratory movements was not related to vegetation phenology at winter sites. The increased spatial resolution of archival GPS tags provides a critical tool for linking how current and past ecological condition experienced by individuals influences the movement ecology of migratory songbirds across the annual cycle.

## **Do Black-backed Woodpeckers use green forests?**

Jaime Stephens, Klamath Bird Observatory; Jake Verschuyf, National Council for Air and Stream Improvement; Katherine Halstead, Klamath Bird Observatory; Dennis Rock, National Council for Air and Stream Improvement

Black-backed Woodpeckers (*Picoides arcticus*) are widely considered a post-fire obligate species with the availability of food resources in recently disturbed forests likely contributing to population regulation. Burned patch connectivity has been cited as necessary for population persistence and connectivity. Despite the well documented association of Black-backed Woodpeckers with burned forest habitat, their potential occurrence in vast tracts of unburned forest within the species' range remains largely unexamined. Playback call surveys were shown to be several times more effective than passive techniques for detecting Black-backed Woodpeckers. Thus, to determine occupancy of Black-backed Woodpeckers in green-unburned forests along the east slopes of the Oregon Cascade Mountains we conducted playback surveys using an existing protocol with repeated visits to 90 - 141 ha transects in 2014 and 2015. Average per-visit detection was high (0.79), with transect-level occupancy estimated at 0.77 (0.545/100ha). Higher Black-backed Woodpecker densities were associated with open tree canopies and drier forest types, and occupancy was positively related to elevation. Overall density estimates across the study area were comparable to those from burned habitat in northern California. Regional population estimates considering Black-backed Woodpecker use of green forests may be substantially higher than would be expected from burned habitat alone. High densities of Black-backed Woodpeckers in unburned forests suggest a potential conservation opportunity for the species. Further study of breeding success will be necessary to determine the full value of potential conservation opportunities for the Black-backed Woodpecker in green forests.

## **Do rainfall trends drive long-term declines in terrestrial insectivores within undisturbed Amazonian rainforest?**

Philip Stouffer, Louisiana State University; Vitek Jirinec, Louisiana State University; Cameron Rutt, Louisiana State University; Angélica Hernández, Louisiana State University

Standardized mist-net samples over 35 years at Amazonian rainforest sites free from direct anthropogenic disturbance have revealed strongly declining abundance of a suite of terrestrial insectivorous birds. Across a network of continuous forest sites, capture rates declined by >50%, and naïve occupancy of several species declined by >50%. Identifying the drivers of this pattern could help predict the generality of this troubling trend across the vast area of Amazon rainforest. Rainfall has gradually been increasing in this part of the Amazon, but the frequency of high Oceanic Niño Index (ONI), which leads to seasonal drought, has also increased. Annual capture rates of terrestrial insectivores were best predicted by a simple time trend. Birds did not respond to variation in wet season rainfall. We expected that these ground-foraging birds would be negatively affected by drier dry seasons, but we observed the opposite effect: elevated dry season rainfall decreased capture rates. ONI, the metric that would be most generalizable across the Amazon, showed considerable variation, but was not a useful

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predictor of capture rates. To understand what is happening to birds at our site, we need to determine how rainfall variation may drive both space use (which may affect capture rates) and demographic processes. Ultimately, the consequences of global climate change on temperature and rainfall patterns in the Amazon will be felt across all levels of biological organization. For birds, however, population-level consequences and their mechanisms may be difficult to link to simple climate variables.

## **Is acoustic adaptation a driver of song divergence in Galapagos finches?**

Amy Strauss, University of Massachusetts, Amherst; Jeffrey Podos, University of Massachusetts, Amherst

Vocal mating signals (songs) in the Galapagos finch radiation have diverged markedly over the course of the clade's brief history. Song today plays a key role in mate recognition and selection within this group, reinforcing or even driving speciation by maintaining reproductive isolation among closely related species. Thus, to effectively explain speciation within the Galapagos finches, it is critical to characterize factors that drive song divergence. Here we explore one such factor – acoustic adaptation. The premise of the “acoustic adaptation hypothesis” is that songs in different habitats should diverge to optimize local transmission efficiency, i.e., to minimize negative effects of acoustic degradation caused by attenuation, masking, and reverberation. To test the acoustic adaptation hypothesis in Galapagos finches, we recorded songs at close distance from nine finch species occupying two habitats -- a forested habitat and an open habitat -- and then played and re-recorded those songs at increasing distances along transects in each habitat. The acoustic adaptation hypothesis predicts that songs would transmit more effectively through their “home” habitats. We used two main methods to quantify song degradation by distance: analysis of individual frequency parameters, and spectrogram cross-correlation. Preliminary analyses indicate that while songs degrade much more rapidly in forested versus open habitats, different species' songs did not appear to acoustically match the habitats in which they are found. Therefore, the acoustic adaptation hypothesis is not supported, suggesting that other factors such as morphology, drift, or sexual selection are likely stronger drivers of song divergence in this group.

## **Using drones and thermal sensors to locate nests of grassland songbirds**

Kristin Strydhorst, Calvin College; Chace Scholten, Calvin College; Darren Proppe, Calvin College

While many songbird species are experiencing rangewide declines, trends in abundance often vary spatially. Biologists have capitalized on this to assess the value of particular habitats for songbird persistence. However, an increase in population density does not necessarily imply higher reproductive success. Thus, a more direct measure of population health can be calculated by monitoring nesting and fledgling success. Yet, studies reporting reproductive success are less common in the literature than those evaluating habitat quality based on abundance. One likely reason for this inequity is that conducting nest surveys using traditional methods is labor intensive and prone to producing small sample sizes. This problem is especially evident in grasslands, where many species use cryptic nest placement and behavior to avoid nest predation. Although visual disguise is maximized in these systems, advancing technology is expanding the range of cues that can be used to locate cryptic nests. We placed a thermal sensor, capable of detecting the heat signature of incubating adult songbirds, on a low-cost UAV (i.e., drone) to survey potential nest sites in grasslands located in Southwestern Michigan. We compared the number of

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nest located with the assistance of UAV flyovers to traditional methods - including sweep searches and behavioral monitoring. We will present the advantages and challenges of using thermal sensors and UAV technology for locating songbird nests in grassland habitats.

## **The value of scale in optimizing umbrella species**

Erica Stuber, University of Nebraska-Lincoln; Joseph J. Fontaine, U.S. Geological Survey, Nebraska Cooperative Fish & Wildlife Research Unit, University of Nebraska-Lincoln

The umbrella species concept is used as a heuristic tool to aid conservation planning when more comprehensive information is limited and pressure for expediency is great. Umbrella species are expected to confer protection on other co-occurring species with similar habitat requirements. Despite its popularity and substantial history, the effectiveness of the umbrella species concept in practice is questioned. The effectiveness of an umbrella species is affected by scale: when determining a suitable umbrella species, when collecting information regarding its habitat requirements, and in evaluating the potential protection conferred on co-occurring species. Although few studies have examined the relative importance of multiple spatial scales in explaining habitat relationships and species abundance past micro- versus macro-scales, the availability of remote-sensing data, and development of analytical methods are making these investigations possible. We employ a hierarchical Bayesian model selection approach to determine the spatial scales of habitat characteristics that best predict species abundance in grassland bird species breeding in Nebraska. Next, we use the estimated best spatial scales to explore the cost of conserving under particular umbrella species. Because not all grassland birds respond to habitat characteristics at the same spatial scales, we should be strategic in how we select umbrella species, using information about the importance of spatial scale in determining species response to habitat characteristics to set aside land to protect multiple species. We conclude that spatial scale should be considered to increase the effectiveness of umbrella species and demonstrate our approach as a tool in evaluating the potential costs associated with conservation under specific umbrella species.

## **Experimental food manipulation alters the spring migration schedule of a long-distance migratory bird**

Colin E. Studds, University of Maryland Baltimore County; Peter P. Marra, Smithsonian Migratory Bird Center

Environmental conditions in the non-breeding period can influence events later on in the annual cycle of long-distance migratory birds. Food, in particular, is a key limiting resource for overwintering migratory birds and one likely to decline with forecasted long-term drought in the Caribbean. To understand how food shortage could affect annual cycle dynamics of migratory birds, we experimentally manipulated food availability for non-breeding Ovenbirds (*Seiurus aurocapilla*) in Jamaica and monitored the affect of the manipulation on spring migration schedules by using a combination of GPS geolocators and automated telemetry. On average, food-restricted Ovenbirds lost body mass over the course of the experiment, whereas unmanipulated control birds maintained or gained mass. Body mass change was a strong predictor of the date of departure on spring migration, with food-restricted birds leaving an average of five days later compared to controls. The date of departure was strongly correlated he timing of arrival on the breeding grounds, suggesting that food-limited birds do not compensate for late spring departure by increasing the pace of migration. These results indicate that food limitation in the tropical non-breeding season could substantially alter the spring migration schedule of long-distance migratory birds.



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## Understanding the impact of predation on nest success using motion-triggered cameras

Katie Stumpf, Georgia College

Nest predation and parasitism are the most common causes of songbird nest failure and, thus, the ultimate drivers of avian population sizes. Understanding the factors that are associated with predation and parasitism and identifying the predator and parasitism community are therefore critical to ensure viable population sizes. While using nest and/or eggshell remains can help identify predators, many studies have shown that this method is not reliable. Motion-triggered cameras yield irrefutable data about the identity of nest predators and also provide details about time and stage of predation, nestling behaviors, and behavioral responses of the attending adult. I placed Wingscapes BirdCams on artificial and active songbird nests at Lake Laurel research station in Milledgeville, GA. Nest success and predation rates were comparable to songbirds nesting other southeastern mixed hardwood forests and the predator community is made up of a diverse suite of predators using a variety of nest detection cues. Comparisons between real and artificial nests revealed that adult and nestling behavior and noise rarely increase the likelihood of predation events, likely because of adult nest supervision. Nest placement can make predator detection less likely and songbirds breeding in areas with many predators and may alter nest placement to avoid predation. Unless the predator community is known, habitat management efforts should focus on maintaining a diverse habitat structure that protects from aerial and ground predators, and those that use olfactory, visual, and/or auditory cues.

## Evidence from mtDNA and song for multiple species within the Hooded Pitta *Pitta sordida* complex

Paul Sullivan, Michigan State University; Pamela Rasmussen, Michigan State University, MSU Museum; Martin Irestedt, Swedish Museum of Natural History; Per G. P. Ericson, Swedish Museum of Natural History; Frank Lambert, BirdQuest; Frank E. Rheindt, National University of Singapore

The Hooded Pitta (*Pitta sordida*) complex has several subspecies from the western Himalayas through New Guinea, with a major gap in eastern Indonesia. Its marked morphological and vocal variation has led to a recent treatment as three species, and to our integrative analysis of species limits using genetic, morphological, and vocal data. Our mtDNA analyses using toepads of museum specimens of all taxa show deep divergence between the “western” (Himalayas through Borneo, Sangahe, and Philippines) and “eastern” groups (northern Sulawesi, New Guinea, Biak). Within the western group, the most genetically distinct taxon is *Nicobars abbotti*, which is unique in its three- to four-note (vs. normally two-note of other taxa) song. The mitochondrially most distinct eastern taxon is north Sulawesi *forsteni*, which is also vocally very different from both New Guinean *novaeguineae* and Biak *rosenbergii*, the latter being the most vocally distinct of all taxa in the *P. sordida* complex. The fast, high-pitched song of the rare *forsteni*, which is here reported for the first time, supports its specific status. It is biogeographically unexpected that *forsteni* groups with New Guinea taxa rather than with the geographically proximate sanghirana, a representative of the Philippine *sordida* group. In summary, in integrating plumage, song, and mtDNA data we recommend the recognition of five species: *P. sordida* (Himalayas through Philippines); *P. abbotti* (Nicobars); *P. forsteni* (Sulawesi); *P. rosenbergii* (Biak); and *P. novaeguineae* (New Guinea). Our analyses demonstrate the importance of integrative avian taxonomy that relies on morphology, bioacoustics and molecular data.

## Reducing cowbird control costs at Fort Hood, Texas: implications for Black-capped Vireo recovery

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Scott Summers, Directorate of Public Works, Natural and Cultural Resources Management Branch, Fort Hood, TX; David Cimprich, Directorate of Public Works, Natural and Cultural Resources Management Branch, Fort Hood, TX

Cowbird control began in 1989 to help recover endangered Black-capped Vireos on a large (87,890 ha) military installation in central Texas. Eckrich et al. (1999) reported significant reductions in parasitism of vireo nests by implementing a rigorous control program that used trapping in cow pastures year-round within this relatively unfragmented landscape. Kostecke et al. (2005) reported increasing numbers of vireos resulting from this landscape-level trapping that averaged over 8,000 trapping days per year from 1997-2003. We ended year-round trapping in 2004, and further reduced trapping days from an average of 3,100 per season (2004-2011) to 1,500 during 2012-2017. Reduced trapping effort did not compromise the high number of nesting vireos (5,000-7000 males) or their historically low parasitism rates averaging 7% during 1998-2017. We demonstrate that trapping in March-April is the key period to remove locally breeding cowbirds despite both species (cowbirds and vireos) breeding into July annually. Our results have implications for managers seeking to reduce costs in their time budgets that will lead to reduced financial costs without compromising continued recovery of an endangered species.

## Competition between birds and ants for nesting cavities at low elevation in eastern Himalayas

K. Supriya, Committee on Evolutionary Biology, University of Chicago; Corrie Moreau, Integrative Research Center, Field Museum of Natural History; Trevor Price, University of Chicago

Songbirds show a mid-elevational peak in eastern Himalayas, i.e. species diversity is highest at about 2000m. By contrast, ant abundance declines steeply with elevation such that ants are essentially absent from the mid-elevations. To investigate the potential effect of ants on nesting behavior of birds, we put up 139 nest boxes at low elevation at about 200m in 2015 and 2016. We also put up 30 nest boxes at an elevation of 1200m in 2016. 62 of the nest boxes at the low elevations were occupied by a single bird species, the White-rumped Shama (*Copsychus malabaricus*) and 19 of these nest boxes were occupied by ant colonies following a nesting attempt by birds. Ants also occupied 6 of the nest boxes unused by birds. Neither birds nor ants used any of the nest boxes at 1000m. The high rate of occupancy of nest boxes at low elevations coupled with the absence of nest box use at mid-elevations suggests that ants and birds might be competing for nesting cavities at low elevations. Greater availability of nest cavities at mid-elevations may be one of the factors contributing towards the mid-elevational peak of birds in eastern Himalayas.

## Comparing approaches to identify waterbird hotspots

Allison Sussman, Michigan State University; Elise Zipkin, Michigan State University; Beth Gardner, University of Washington; Evan Adams, Biodiversity Research Institute & University of Washington; Leo Salas, PRBO Conservation Science; Kevin Kenow, U.S. Geological Survey Upper Midwest Environmental Sciences Center; David Luukkonen, Michigan Department of Natural Resources; Michael Monfils, Michigan Natural Features Inventory, Michigan State University Extension; William Mueller, Western Great Lakes Bird and Bat Observatory; Kate Williams, Biodiversity Research Institute; Michele Leduc-Lapierre, Great Lakes Commission

Several methods have been used to define and identify waterbird 'hotspots' or locations of persistent aggregation or high-use in pelagic environments. However, the various approaches can lead to different outcomes with inconsistent conclusions. As a result, we may detect a mismatch in the classification of particular locations as hotspots, culminating in conflict over long term conservation efforts. Here, we present the results of a comparative

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analysis of recent approaches for identifying waterbird hotspots. We examined the literature and selected four common measures of identifying persistent areas of high-use: two parametric, non-spatial approaches (using gamma and lognormal distributions) and two non-parametric, spatial approaches (Getis-Ord  $G_i^*$ , kernel density estimation). We applied each of the methods to aerial survey waterbird data collected in the Great Lakes from 2012-2014. To do this, we overlaid a 5km<sup>2</sup> grid across the transects and standardized the count data within cells to account for variations in survey effort. For each approach, we identified areas of high-use for seven species/species groups and then compared the results across all methods. At a coarse level (i.e., 50 km<sup>2</sup>), there was consistency among all four approaches, but much less so at a fine-scale when we examined the results at the grid cell level. We found a higher correlation between the two spatial approaches and the two non-spatial approaches than across the two method types. The method chosen to identify waterbird hotspots should therefore reflect both the ecological question and scale at which management decisions will be made.

## **Emigration toward the range center: the abundant center hypothesis in Gray Catbirds**

David Swanson, University of South Dakota

The Abundant Center Hypothesis (ACH) posits that organisms will be most abundant near the geographic or environmental center of the range. Bird distributions often follow the ACH, especially for ecological niche requirements, with lower abundance on the environmental range periphery. Mechanisms maintaining these abundance distributions, however, are not well understood. A potential mechanism supporting this distributional pattern is emigration toward the range center during successive breeding seasons, which could balance dispersal of young away from the range center. I tested this hypothesis with banding data for Gray Catbirds, predicting that banding recoveries for catbirds should show: (1) recaptures of catbirds away from the geographic block in which they were banded occurring primarily in the direction of low-to-high population abundance at the range periphery; and (2) fewer movements away from the banding block near the abundance center. Catbird banding data show that movement patterns of birds banded on the periphery of the range were generally toward areas of higher abundance and that the percent of birds recaptured within the banding block tended to be higher in the range center. These data suggest that catbirds movements during successive breeding seasons are generally toward abundance centers, whereas birds already present in abundance centers tend to remain there. These data support the hypothesis that emigration toward the range center in adult birds may contribute to maintaining the geographic or ecological distribution for catbirds. Further research is needed to determine if this pattern is a general mechanism contributing to stability of geographic distributions in birds.

## **Untangling the evolutionary history between New World ground-doves and their parasitic lice**

Andrew Sweet, University of Illinois at Urbana-Champaign; Kevin P. Johnson, Illinois Natural History Survey, Prairie Research Institute, University of Illinois at Urbana-Champaign

How important is bird evolution for shaping the evolution of their parasites? To address this question, an ideal study system would focus on the diversification patterns of two or more groups of similar parasites associated with a single host group. In this study, we focused on the “wing” and “body” lice of small New World ground-doves. Although they parasitize the same hosts, the two groups of lice are not closely related and escape from host defense using different mechanisms. We sequenced full genomes of ground-dove wing and body lice, and

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developed a novel pipeline to assemble loci for phylogenetic and population genetic analysis. We then compared each louse phylogeny to an existing ground-dove phylogeny. Both wing and body louse phylogenies exhibited congruence with their hosts' phylogeny. Some louse species also showed population structure according to host species. These patterns suggest that ground-dove evolution is a primary driver of their parasites' diversity. However, neither louse phylogeny was fully congruent with the host phylogeny. Additionally, the host phylogeny was less congruent with the wing louse phylogeny than it was with the body louse phylogeny. This difference is likely due to differences in louse dispersal ability. Biogeography was also important for louse diversity. The wing louse phylogeny was significantly structured according to biogeographic region, which implies wing louse dispersal is geographically limited. Body lice did not show biogeographic structure at the species level, but did at the population level. This shows biogeography can explain louse diversity at multiple time scales.

## **Context-dependent protective nesting association in Hudsonian Godwits (*Limosa haemastica*)**

Rose Swift, Cornell Lab of Ornithology, Cornell University; Amanda D. Rodewald, Cornell Lab of Ornithology, Cornell University; Nathan R. Senner, University of Montana

Interactions among species can vary in different environments and thus may be "context-dependent". Protective-nesting associations are one interaction where associations may reduce predation risk to species nesting near a neighbor species but may increase risk at other stages of the life cycle. Here, we examined the extent to which the benefits of heterospecific aggregations might vary with breeding stage. Specifically, we assessed the spatial distribution and fate of 43 nests of Hudsonian Godwits (*Limosa haemastica*), found in Beluga, Alaska, between 2014 and 2016 in relation to 262 nests of a potential protector and predator, the Mew Gull (*Larus canus*). We also examined the impact of the distance to gull nests on godwit chick survival to five days, when they are most prone to gull predation. Nests of godwits and gulls were significantly clustered across the landscape, despite a lack of significant spatial autocorrelation in microhabitat parameters of godwit nests. Distance to the gull colony and the number of gull nests within 200m of a godwit nest were significant predictors of godwit nest fate, which improved when located within the gull colony and when surrounded by increasing numbers of gull nests. However, godwit chick survival to day five was inversely related to the distance to the gull colony. Thus, godwits appear to benefit from a protective-association during incubation but may face a penalty after hatching due to gull predation on chicks. These results suggest Hudsonian Godwits and Mew Gulls exhibit a protective nesting association that is context-dependent based on the breeding stage.

## **He's a lover unless she's a fighter: male parental effort reflects female status and ornamentation**

Keith Tarvin, Oberlin College; Troy G. Murphy, Trinity University

Female ornamentation may function as a signal of competitive status or in mate choice, but its effects on post-mating intersexual interactions are poorly understood. If female ornamentation signals competitive status, males could benefit by investing more in offspring when mated to highly ornamented females, or alternatively could compensate for dull, competitively-poor mates by increasing parental effort. Dynamic bill color of female American Goldfinches (*Spinus tristis*) signals condition and prior competitive experience. Females avoid competing with colorful-billed females, but male goldfinches do not attend to female bill color during competitive interactions or mate choice. We tested whether male parental effort corresponds with ornamentation of their mates by experimentally augmenting or dulling female bill color during mid-incubation and early brooding and measuring subsequent parental nest attendance and provisioning rates. Augmented females fed young nestlings more

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frequently and carried more food per provisioning trip than dulled females, suggesting that their experimentally increased competitive status at shared food patches allowed them to compete for food more effectively. Males paired to augmented females did not differ in provisioning rate from those paired to dulled females, but they provided less food per trip, suggesting either that males paired with poorly competitive females compensated by increasing their own parental effort, or that males paired with highly competitive females reduced their own effort. In either case, males appear to calibrate parental effort according to female competitive status, indicating that female ornamentation directly or indirectly influences male behavior outside of mating and competitive contexts.

## **Extending state-and-transition models to include wildlife ecosystem services**

Jennifer Timmer, Colorado State University; Cameron Aldridge, Colorado State University & USGS; Retta Bruegger, Colorado State University Extension; Crystal Tipton, Colorado State University; Maria Fernandez-Gimenez, Colorado State University

State-and-transition models (STM) represent a fairly new approach to describe range dynamics with multiple stable states. STMs can be improved by including multiple sources of information, such as ecological data and local knowledge, and by addressing multiple ecosystem services. By including additional services in the models, such as wildlife habitat, land managers could predict how wildlife populations might change in response to vegetation dynamics and drivers of change like fire or grazing. Our objective was to incorporate avifauna abundance data into a locally-developed STM for dominant ecological sites in sagebrush rangelands in northwest Colorado. We stratified our study area by ecological site, or where developed ESDs were lacking, by sagebrush cover and elevation. We surveyed randomly distributed plots for songbirds and Greater Sage-Grouse (*Centrocercus urophasianus*) pellets, collected a suite of vegetation and soils data at each plot, and developed an STM based on multivariate analyses and local stakeholder input. To predict avifauna abundance per state, we developed count-based regression models with the vegetation data as predictor variables, and predicted the count of songbirds and sage-grouse pellets based on average predictor values per state. Our final STM included two shrub states, a native grassland state, and a Crested Wheatgrass (*Agropyron cristatum*) dominated state. We predicted higher abundances for sagebrush and shrub-obligate species in either the diverse shrub or crested wheatgrass-dominated state and the least in the native grassland state. Conversely, the native grassland state provided greater abundances of non-shrub-obligate species. Our model can assist local land managers and landowners to gauge impacts of land-use decisions on avifauna populations.

## **Multi-scale spatiotemporal dynamics of Black-backed Woodpeckers in Californian burned forests**

Morgan Tingley, University of Connecticut; Andrew N. Stillman, University of Connecticut; Robert L. Wilkerson, The Institute for Bird Populations; Rodney B. Siegel, The Institute for Bird Populations

Post-fire forests of western North America are highly dynamic environments, changing rapidly over time and space. It is consequently unsurprising that species that preferentially use these habitats, specifically the Black-backed Woodpecker (*Picoides arcticus*), also show complex and dynamic populations and distributional responses, reflecting the ephemeral pulse of resources initiated by fire. Such non-linear population trajectories present challenges for management and conservation, however, as prediction requires understanding how colonization and persistence vary over both spatial and temporal scales. We present a spatially hierarchical model of Black-

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backed Woodpeckers in California that allows simultaneous multi-scale analysis of within-patch (local-scale) and between-patch occupancy dynamics. Our results show that environmental covariates of colonization and persistence took different forms and levels of importance when comparing across the patch-scale to the local-scale. Our findings indicate that decreasing occupancy in older fires is a result of declining local persistence combined with a decrease in patch-level colonization probability. Thus, local populations of Black-backed Woodpeckers decline to near-extinction in older fires because resident individuals leave the population (through emigration or death), and individuals in surrounding patches are unlikely to re-colonize, providing critical insight into landscape-level dynamics of this species. Metapopulation dynamics are conventionally viewed as arising at the patch-level, but conservation and management actions are typically aimed at retaining or improving habitat at the local-level. A cross-scale examination of these processes allows managers to identify and target specific local habitat characteristics to improve overall metapopulation persistence.

## **The evolution and constraints of migration in Wood Warblers**

David Toews, Cornell University; Julian Heavyside, University of British Columbia; Darren E. Irwin, University of British Columbia

The factors that influence geographic range limits can illustrate the various ecological and evolutionary constraints imposed on a species. The range limits of migratory birds are particularly challenging to study as they occur in disjunct regions at different times of the year. Travel between breeding and wintering regions poses an energetic and navigational challenge to birds, although it is not clear how these movements influence breeding range expansion or how new migration routes might evolve. Here we ask whether the possible costs of migration limit the northern breeding expansion of Wood Warblers. We first use occurrence records from multiple warbler species that breed in the boreal forest of North America to generate environmental niche models. We tested for over-prediction of habitat suitability into the northwestern boreal forest. We identified a discordance in several eastern-restricted taxa that have predicted habitat suitability into the north and west, but where they have little-to-no occurrence records. We contrast these patterns with an example of one species that has colonized the far north by quantifying migratory connectivity in Myrtle Warblers (*Setophaga coronata*). Using biometric and isotopic data, we show a strong connection between breeding myrtle warblers in the Yukon and Alaska and those wintering along the Pacific Coast of California—a disjunct wintering population from the main concentration in the southeastern USA. Our interpretation is that—unlike most eastern wood warblers—the evolution of a Pacific Coast wintering range and migration route may have facilitated the breeding expansion of myrtle warblers into northwestern North America.

## **Community and species-level responses to energy-sector disturbances within regenerating forests**

Judith Toms, Environment and Climate Change Canada; Thea Carpenter, Environment and Climate Change Canada

Disturbances arising from energy-sector exploration and development are prevalent in the boreal forest of Alberta, Canada. These disturbances are associated with significant changes in the bird community, but the responses of individual species can be complex. Understanding the mechanisms underlying these responses can explain some of this complexity, but to date most such work has been conducted in mature and old forests. We have initiated work to understand the mechanisms underlying the response of species living in regenerating forests. Nine of 13 species had a negative association with the amount of early seral disturbance in a site. Habitat selection was assessed for eight species (Red-eyed Vireo, Swainson's Thrush, Ovenbird, Black-and-white Warbler, Tennessee Warbler,

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American Redstart, Magnolia Warbler and Yellow-rumped Warbler). All eight species significantly avoided non-vegetated disturbances, and half significantly avoided disturbances in the forb-herb structural stage. Once the disturbed areas recovered to the point where they were dominated by shrubs at least 50 cm high, the negative impacts were reduced or reversed for many species. Our results suggest that effective restoration of vegetation on disturbances can reduce the impact of energy-sector disturbances on bird communities.

## **Behavioral change and ornamental plumage in the non-breeding season in a tropical passerine**

Sarah Toner, Cornell University, The Cornell Lab of Ornithology; Trey Hendrix, Tulane University; Samantha Lantz, Tulane University; Joseph Welklin, Cornell University, The Cornell Lab of Ornithology; Facundo Fernandez-Duque, Cornell University, The Cornell Lab of Ornithology; John Swaddle, The College of William and Mary; Jordan Karubian, Tulane University; Michael Webster, Cornell University, The Cornell Lab of Ornithology

Sexual ornamentation, such as bright plumage coloration in birds, is thought to incur costs such as increased risk of predation and an energy input required for maintenance and display of signals. We might expect individuals to modify their behavior in order to mitigate those costs. Furthermore, sexual differences in behavior during the nonbreeding season are very understudied. To determine if the ornamented individuals changed behaviors in response to the costs of ornamentation, we conducted behavioral observations on male Red-backed Fairywrens (*Malurus melanocephalus*) in conspicuous ornamented and cryptic non-ornamented plumages. We used conspecific alarm call playback to provoke antipredatory vigilance responses and observed behavioral differences between ornamented and unornamented males without playback. We found no difference in response to playback between phenotypes, suggesting that they may not use behavioral changes to mitigate the increased predation risk of conspicuous ornamentation. Our non-playback observations revealed few differences between male phenotypes in vigilance behaviors; however, ornamented males engaged in allopreening and courtship displays to a greater extent than did non-ornamented males. These results suggest that, surprisingly, the presence of conspicuous ornamentation does not influence vigilance behaviors, but that the presence of bright plumage outside of the breeding season is associated with higher frequencies of certain social behaviors, namely allopreening and courtship. Future research will consider exploring the costs and benefits of these apparent changes in social behaviors, which could influence performance in the subsequent breeding season.

## **Love in the time of emerging infectious disease: inbreeding, urbanization, and West Nile virus in crows**

Andrea Townsend, Hamilton College; Conor Taff, Cornell University; Sarah Wheeler, Sacramento-Yolo Mosquito and Vector Control District; Mitch Hinton, University of California, Davis; Walter Boyce, University of California, Davis; William Reisen, University of California, Davis; Christopher Barker, University of California, Davis; Melissa Jones, University of California, Davis

Birds are facing an increasing number of novel challenges, including emerging infectious diseases and urbanization. The combined effects of these challenges are unclear, particularly when overlaid on a backdrop of inbreeding. Here, we examine the relationship between inbreeding, urbanization, and disease in a habitually inbreeding population of American crows in Davis, California. In this population, approximately 22% of parental dyads are first- or second-order kin, and inbreeding occurs more frequently than expected by random mating. Specifically, we examined the landscape and genetic predictors of an emerging epidemic disease (West Nile virus

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(WNV)) and two endemic diseases (Campylobacter jejuni infection and haemosporidian parasite burden). We found that inbred birds were more likely to die of WNV than outbred birds, but that inbreeding was not a predictor of infection by the endemic pathogens. However, birds with co-infections of WNV and Campylobacter were among the most inbred birds in the population. Urbanization appeared to reduce vector-borne pathogen risk: both WNV infection risk and haemosporidian parasite burden were lower for birds in more developed territories than in peri-urban (agricultural) territories. These data illustrate the increasing pressure that emerging infectious disease—in combination with endemic pathogens—may have on inbred populations. However, we found that urbanization could buffer wildlife from vector-borne infectious diseases, possibly because of their aggressive mosquito control programs.

## Multispecies benefits of wetland conservation for marsh birds, frogs, and species at risk

Doug Tozer, Bird Studies Canada; Owen Steele, Ducks Unlimited Canada; Mark Gloutney, Ducks Unlimited Canada

Wetlands conserved under the North American Waterfowl Management Plan, referred to here as conservation project wetlands, are critically important for migrating and breeding ducks, geese, and swans. However, the ecological goods and services these wetlands provide for society and other wildlife is rarely quantified. We used data from Bird Studies Canada's Great Lakes Marsh Monitoring Program, a long-term, broad-scale, citizen science program, to model the probability of detection and occupancy of 15 non-waterfowl marsh-breeding bird species and 7 marsh-breeding frog species at hundreds of 100-m-radius semicircular sites across dozens of conservation project wetlands managed by Ducks Unlimited Canada and its partners compared to similar nearby unmanaged wetlands throughout southern Ontario, Canada. The probability of occupancy was significantly greater at conservation project sites compared to unmanaged sites in 7 of 15 (47%) bird species and 3 of 7 (43%) frog species, being higher by a difference of 0.12-0.38 across species. Only occupancy of Mute Swan (*Cygnus olor*) and Eastern Gray Treefrog (*Hyla versicolor*) was higher at unmanaged sites, although the differences were not significant. Notably, occupancy of at-risk Least Bittern (*Ixobrychus exilis*), Western Chorus Frog (*Pseudacris triseriata*), and Black Tern (*Chlidonias niger*) was significantly higher at conservation project sites compared to unmanaged sites. The results show the power of citizen science and suggest very strongly that conservation project wetlands provide high-quality breeding habitat for several non-waterfowl marsh bird and frog species, particularly some species at risk, and could potentially help slow or maybe even reverse declining trends in occupancy in certain species.

## Scenarios for Bicknell's Thrush (*Catharus Bicknelli*) recovery in a climate-change context

Junior A. Tremblay, Environment and Climate Change Canada; Yan Boulanger, Natural Resources Canada; Dominic Cyr, Natural Resources Canada; Anthony R. Taylor, Natural Resources Canada; David P. Price, Natural Resources Canada

Climate change is expected to have a strong impact on global biodiversity including bird species. Climate change-driven range shifts are projected to be most dramatic at northern latitudes because of greater projected increases in temperature. As such, species currently restricted to boreal regions may experience range reductions if those biomes shift northward while decreasing in area, as projected for North America. Bicknell's Thrush (*Catharus Bicknelli*) is a migratory bird whose range is one of the most restricted in northeastern North America, and is classified as "threatened" under the Species at Risk Act in Canada. Bioclimatic models project a loss of more than 50% of the species habitat in Northeastern U.S. over the next 30 years. We modelled the impacts of several forest



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management and conservation scenarios, natural (i.e. wildfires and insect outbreaks) disturbances as well as climate-induced changes on tree species growth and reproduction on forest landscape structure in Bicknell's Thrush breeding range of eastern Québec and New-Brunswick. Forest attributes simulated using LANDIS-II were used in turn to infer landscape suitability as critical habitat for this bird species. Preliminary results show that proper harvesting strategies could help maintain critical habitat abundance under RCP 2.6 climate forcing. However, high suitability habitat should strongly decrease under RCP 4.5 and RCP 8.5 regardless of the harvesting strategy. However, habitat in higher elevation (>900m) could increase under RCP 2.6 and 4.5, and decrease slightly under RCP 8.5 with protection from forest management. Our results offer benchmarks for considering effective long-term conservation of critical habitat in a changing world.

## **Using automated bioacoustic techniques to improve the monitoring of Australian parrots.**

Kate Trewin, University of Melbourne, Museums Victoria; Karen Rowe, Museums Victoria; Raoul Mulder, University of Melbourne

Automating the process of species identification in long-duration audio field recordings can greatly improve the speed and reliability of ongoing monitoring, particularly for species of conservation concern. However, creating automated identifiers is challenging, as different vocalization template-matching algorithms for the same species produce varying results and are prone to high error rates, including misidentifications (false positives), and failing to detect the target species (false negatives). To test the robustness of three different vocalization template-matching algorithms on a group of species that would benefit from improved monitoring, we selected 22 species of Australian parrots, a group of birds exhibiting temporally dynamic population fluctuations as well as significant population declines over the past 15 years. Vocalizations from each species were collected from field sites across Victoria, Australia. From these recordings, we built a set of automated identifiers using three different template-matching algorithms (Hidden Markov Models, Binary Point Matching, and Spectrogram Cross Correlation). We then tested the performance of each identifier using a standardised soundscape field recording, quantifying identification errors (false positives and false negatives) and evaluating the trade-offs for each identifier in terms of specificity (reducing false positives) and sensitivity (reducing false negatives). We then used these results to evaluate which algorithm works best for each species and under what conditions, enabling recommendations for identifier use in landscape-scale monitoring of parrots. More generally, we discuss how automated recognition can be used to address a range of questions relating to monitoring and management efforts for species of conservation concern.

## **Phylogenetic relationships of New World jays using ultraconserved elements**

Whitney Tsai, Moore Laboratory of Zoology, Occidental College; Elisa Bonaccorso, Centro de Investigación de la Biodiversidad y Cambio Climático (BioCamb) e Ingeniería en Biodiversidad y Recursos Genéticos, Universidad Tecnológica Indoamérica; Emiko M. Schwab, Moore Laboratory of Zoology, Occidental College; Benjamin Scott, Moore Laboratory of Zoology, Occidental College; Amanda J. Zellmer, Occidental College; James M. Maley, Moore Laboratory of Zoology, Occidental College; Mario Cohn-Haft, Instituto Nacional de Pesquisas da Amazônia; Adolfo Navarro-Sigüenza, Universidad Nacional Autónoma de México; A. Townsend Peterson, Natural History Museum

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and Biodiversity Research Center, The University of Kansas; John E. McCormack, Moore Laboratory of Zoology, Occidental College

The New World jays (NWJs) are an assemblage of corvids endemic to the Americas in seven different genera – *Cyanolyca*, *Calocitta*, *Psilorhinus*, *Cyanocorax*, *Gymnorhinus*, *Cyanocitta*, and *Aphelocoma*. We studied phylogenetic relationships of the NWJs based on DNA sequences obtained from sequence capture of ultraconserved elements (UCEs). We targeted 5,060 loci in 87 individuals representing each species or subspecies within the NWJ genera and four outgroups in the genera *Pica* and *Perisoreus*. We generated a phylogeny based on an average of 3,142 concatenated UCE loci using RAxML. In an attempt to further resolve a group of enigmatic *Cyanocorax* jays we ran SNP phylogenetic analyses using SNAPP. Our analyses support the position of *Cyanolyca* as sister to all other NWJs. We also found that *Cyanocorax* is paraphyletic, with one highly supported group as sister to a clade including Brown Jays and magpie-jays. This clade is sister to the rest of *Cyanocorax*. The deepest split within a species that we found was between Green Jays in North versus South America.

## Use of song rate to infer breeding status in the Olive-sided Flycatcher

Emily Upham-Mills, University of Alberta; Erin Bayne, University of Alberta; Samuel Haché, Environment and Climate Change Canada

For male breeding songbirds, song rate varies throughout the breeding season and may correlate with different stages of the breeding cycle. The objective of this study was to determine if variation in song rate can be used to infer the breeding status of the Olive-sided Flycatcher (*Contopus cooperi*; OSFL), a species considered threatened in Canada. We used acoustic data collected from Autonomous Recording Units (ARUs) and human observers to estimate song rate while simultaneously monitoring the breeding status of 27 territorial OSFLs. Field work was conducted in the northwestern boreal region of Canada during the 2016 breeding season. Song rates were estimated from a total of 615 5-minute song counts representing songs from males classified as single, paired, mated with a female who was incubating, or having a nest with young. We found that mean song rate varied significantly with breeding status; single males sang on average twice as much as paired males, three times more than males during incubation and 24 times more than males with nestlings. ARU recordings are currently being analyzed, using automatic recognition software, to determine if ARU counts and human observer counts produce the same result. If acoustic recordings can be used to assess breeding statuses for target songbird species, then ARUs and recognizer software provide a cost-effective tool to infer demographic information over large spatial extents. This information can then be used to evaluate breeding success in different habitats, estimate habitat quality, and address important knowledge gaps for species of conservation interest.

## Hungry hungry House Sparrows: communicating hunger in *Passer domesticus*

Olivia Utley, Michigan State University; David Moldoff, Dr. David Westneat; University of Kentucky

Parental care is a key component of behavior in altricial birds and contributes to the fitness of parents as it affects the survival and quality of offspring. A common form of care is the provisioning of food to offspring. Previous studies have suggested that offspring do not passively accept resources, but actively enhance their own fitness by communicating their needs to parents. Many forms of communication are apparent, however the focal form of communication in recent research has been the vocalized begging by offspring. Multiple models have attempted to explain the ways in which offspring communicate their needs to parents through begging including the Honest

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Signaling Model, which suggests that begging intensity directly reflects need, and the Scramble Begging Model, which suggests that competitive ability also plays a role in begging. In previous research we have worked to understand some of the more basic assumptions of these models by examining factors that influence begging and how begging influences parental behavior. We found that hunger did affect the intensity of offspring begging, but so too did the number of nestlings and nestling age. We manipulated the hunger of nestlings in a controlled environment and determined the effects on parent behavior after the manipulation. The results will help us to understand what drives offspring to beg and how parents respond to these signals.

## **Is nest predation increased along oil pad edges in otherwise closed canopy northern forests?**

Ethan Valentine, Calvin College; Darren S. Proppe, Calvin College

Habitat edges alter the diversity of songbird communities and are often associated with higher rates of predation. However, many of the previous studies on habitat edges have been conducted along linear corridors or at the transition between field and forest patches in agricultural systems. In these systems, predators that generally utilize more open habitats gain greater access to songbirds nesting along forested edges. However, less is known about the persistence of these effects when the habitat edge is the result of a small forest opening. In this scenario, small openings may not support the additional predatory species dependent upon more open habitats, due to limited space and the lack of more typical open field prey species. But, empirical tests are lacking and if small openings are associated with increased predation rates in nearby forests, the proliferation of oil pad sites in places like Northern Michigan may impact songbird diversity beyond what is predicted by habitat loss alone. We assessed predation rates on artificial nests mimicking ground and shrub nesters in Northern Michigan forest perforated by several relatively small deforested clearings used previously for oil and gas extraction. Nests were placed at varying distances from oil pad edges and in similar spatial arrangements in unfragmented forest plots. This design allowed us to compare the overall effects of oil pads on predation rates as well as the role of nest distance from the pad. We will discuss our results and the potential indirect effects of oil pads on forest species.

## **The role of habitat in avian diversification**

Paul van Els, Groningen University; Rampal Etienne, University of Groningen

Habitat can be an important factor in driving diversification patterns. For example, diversification rates between marine versus freshwater fish, and lentic versus lotic insects differ significantly. Forests, especially tropical forests, contain the vast majority of the world's bird species (>50%), despite covering only a third of the planet. Explanations for this diversity include dense niche packing, high resource availability, specialization, climatic stability, high net productivity, and lowered dispersal capacity. However, whether forest habitat not only hosts a large number of species, but can also generate more diversity than open habitats remains an untested hypothesis. We test the hypothesis that diversification rates in forest birds are higher than in open-habitat birds using a near-exhaustive bird phylogeny (9993 species) combined with a large habitat database and a novel extension of a newly available method to infer state-dependent speciation across multiple trait states. We conjecture that forests act as source habitat through increased net diversification rates, and that transition rates from forest to open habitat are higher than vice versa, based on currently known diversity patterns. Preliminary analyses reveal that, at least at a global scale, there may not be any significant habitat-driven effect on diversification rates. From an evolutionary standpoint, this means that open habitats are no less important than forests in generating avian diversity. Ongoing work focuses on different geographic subsets of the data.

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## **Nest site enhancement can influence polygamy in the Cordilleran Flycatcher along the Dolores River in southwest Colorado**

Charles van Riper III, US Geological Survey and University of Arizona; Abigail J. Darrach, Coastal Bird Stewardship Program; Harold F. Greeney, University of Arizona

The Cordilleran Flycatcher is largely a monogamous species that nests in sheltered open cavities along riparian corridors in the inter-mountain west. Suitable nesting locations can be limiting for this species and the majority of reported nests have been from human-made structures. In an effort to test the hypothesis of limited nesting sites we conducted an experimental study in southwestern Colorado supplying nesting platforms in a grid array. We found that the Cordilleran Flycatcher readily took to our platforms and that numbers of floating birds were exceptionally high. Productivity from experimental nesting platforms was higher than in nests from natural sites while nest predation and nest parasite loads from *Philornis* was slightly higher in platform nests. We also discovered that in years of superabundant prey resources, core males in our study area utilizing experimental platforms became polygamous, while in normal and low prey years they were monogamous. Productivity of polygamous pairs was not significantly higher than monogamous birds. We conclude that augmentation of nesting substrates for the Cordilleran Flycatcher are an important tool for restoration efforts of this species, and will help support populations within changing riparian corridors throughout the west.

## **The effects of agricultural intensification on Savannah Sparrows in southern Ontario**

Heidi van Vliet, York University; Bridget Stutchbury, York University; Amy Newman, University of Guelph

Grassland birds are in decline throughout North America. A leading cause of this decline is due to habitat loss and degradation through agricultural intensification. Many studies have shown negative correlations between agricultural intensification and both species diversity and population abundances of birds. However, little is known about how agricultural intensification directly affects breeding birds and the juveniles born on farmland. This study investigates the hypothesis that agricultural intensification negatively impacts the breeding success (proportion of fledged nests), nestling body condition, and fledgling survival of an obligate grassland bird, the Savannah Sparrow (*Passerculus sandwichensis*). Nests were found and monitored throughout the summer of 2016 on both intensive agriculture and non-agricultural grassland sites located in southern Ontario. For all successful nests, nestlings were measured and radio-tagged at each nest. Fledglings were tracked to measure fledgling survival. After the first field season, it was found that the breeding success, nestling body mass, and corticosterone levels were not significantly different between agricultural sites and grassland sites. Fledgling survival was lower on agricultural sites, but it was not significantly different. A second field season is being conducted in 2017 to increase sample size and test for year effects. Thus far, the results indicate that Savannah Sparrows are not negatively impacted by breeding on intensive farmland when grassy margins are present. This research could provide information on how to manage farmland that allows for a balance between grassland bird conservation and efficient agricultural practices.

## **Paired sampling standardizes point count data from humans and acoustic recorders**

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Steven Van Wilgenburg, Canadian Wildlife Service, Environment & Climate Change Canada; Péter Sólymos, University of Alberta; Kevin J. Kardynal, Science & Technology Branch, Environment and Climate Change Canada; Matthew D. Frey, Canadian Wildlife Service Environment & Climate Change Canada

Acoustic recordings are increasingly used to quantify occupancy and abundance in avian monitoring and research. The recent development of relatively inexpensive programmable autonomous recording units (ARUs) has further increased the utility of acoustic recording technologies. Despite their potential advantages, persistent questions remain as to how comparable data are between ARUs and traditional (human observer) point counts. We suggest that differences in counts obtained from ARUs versus human observers primarily stem from differences in the effective detection radius of humans ( $EDR_H$ ) versus ARUs ( $EDR_A$ ). We describe how paired sampling can be used in conjunction with generalized linear (GLM) or generalized linear mixed models (GLMM) to estimate correction factors ( $\delta$ ) to remove biases between ARUs and traditional point counts. Furthermore, if human observers conduct distance estimation, we show that density estimates can be derived from single ARUs by estimating  $EDR_A$  as a function of  $EDR_H$  and  $\delta$ , thus providing alternatives to more complicated and expensive approaches. We demonstrate our approach using data from 363 point count stations in 105 unique boreal study sites at which field staff conducted point count surveys that were simultaneously recorded by an ARU and later transcribed in the lab. Finally, we used repeated random subsampling of the data to split the data into model creation (70%) and validation (30%) subsets to iteratively estimate  $\delta$  and validate density estimates from ARUs against densities calculated from human observers at the same independent validation locations. We modeled density of 35 species of boreal forest birds and show that incorporating  $\delta$  in statistical offsets successfully removes systematic biases in estimated avian counts and/or density between human and ARU derived surveys. Our method is therefore easily implemented and will facilitate the integration of ARU and human observer point count data, facilitating expanded monitoring efforts and meta-analyses with historic point count data.

## Could selecting nest sites to avoid brood parasitism lead to low fledgling survival in Dickcissels?

Bram Verheijen, Kansas State University; Brett Sandercock, Kansas State University

During recent decades, grassland songbirds have seen some of the largest declines in population numbers. Ongoing declines have been linked to increased landscape homogeneity caused by agricultural intensification. We tested the potential benefits of a relatively new rangeland management regime, patch-burn grazing, which creates higher levels of heterogeneity in vegetative structure. Patch-burn grazing management could increase diversity, abundance, and nest survival of grassland songbirds, but the impacts on fledglings remain unknown. Fledglings of grassland songbirds have limited mobility when leaving the nest, and survival and movements are likely driven by local variation in food availability and predation risk. With our 2-year field study in the Flint Hills ecoregion of northern Kansas, we tested the effects of heterogeneity in vegetative structure on fledgling Dickcissels (*Spiza americana*). We applied transmitters to fledglings on pastures managed with patch-burn grazing and pastures that were annually burned with or without grazing. The survival and movements of Dickcissel fledglings were strongly driven by the abundance of snakes at our site. Interestingly, we found a potential conflict of interest between life-stages, as Dickcissels that tried to avoid brood parasitism by Brown-headed Cowbirds (*Molothrus ater*) by nesting in ungrazed pastures, faced the highest rates of fledgling mortalities. Moreover, surviving fledglings showed large movements away from those sites. Variation in local abundance of cowbirds could therefore affect fledgling survival by driving nest site selection of Dickcissels. Increased heterogeneity in vegetative structure could provide songbirds with a mosaic of habitats that are suitable for nests and fledglings in close proximity.

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## **Genome-wide patterns of introgression in Saltmarsh and Nelson's Sparrows**

Jennifer Walsh, Cornell University; Adrienne I. Kovach, University of New Hampshire; Gregory Shriver, University of Delaware; Brian J. Olsen, University of Maine; Irby J. Lovette, Cornell University

Hybrid zones are excellent model systems for evolutionary studies as they provide a diversity of recombinant genotypes through generations of mutation, recombination, and gene flow. Growing empirical evidence indicates that natural hybrid zones occur across a range of taxonomic groups at rates greater than previously estimated and that hybridization and introgression are important forces that can shape the evolutionary trajectory of a species. By documenting the extent of admixture on a genome-wide scale, we gain novel insight into the extent to which differential introgression plays a role in species divergence. Here we take advantage of two species that hybridize despite relatively high genetic differentiation; the Saltmarsh and Nelson's Sparrow. Based on whole-genome sequencing of 36 individuals of allopatric and sympatric origin, we found that ongoing gene flow is shaping the genome-wide patterns of differentiation in this system. Baseline genome-wide divergence is high ( $F_{st} = 0.38$ , 531,322 fixed differences) in allopatry, but reduced in sympatry ( $F_{st} = 0.23$ , 28,780 fixed differences), supporting a role for contemporary introgression. We also documented patterns of differential introgression, with the asymmetrical exchange of genes related to visual perception, immunity, and fear response. Our findings suggest that these patterns of differential introgression may serve an adaptive role in a hybrid zone spanning a freshwater-marine gradient. Results offer insight into the role of gene flow and asymmetrical introgression in shaping variation on a genome-wide scale.

## **Cavity-nesting bird communities of southern pine ecosystems: dynamics and management**

Jeffrey Walters, Virginia Tech; Lori Blanc, Virginia Tech; Kevin Rose, Virginia Department of Game and Inland Fisheries

Nest webs describing communities of cavity-nesting birds are analogous to food webs, with tree cavities being the basal resource counterpart to autotrophs. Cavity-nesting birds consistently comprise a significant portion of avian diversity in forested ecosystems worldwide, but the tree cavity resources at the base of nest webs vary greatly in ways that affect their dynamics and management. Relative dependence on natural versus excavated cavities is an important example. The nest webs in longleaf pine ecosystems in the southeastern United States that we investigated are highly dependent on excavated cavities and contain a unique cavity resource, cavities excavated in living pines by Red-cockaded Woodpeckers, as well as cavities excavated in dead pines and dead hardwoods. The dynamics of these communities are consistent across the three areas where we have studied them, but species densities vary with the productivity of the environment. Cavity resources are partitioned among species to a considerable extent, especially among excavators, and manipulation of cavity resources has direct and indirect effects on species that reflect nest web structure. Conservation of the endangered Red-cockaded Woodpecker drives management of southeastern pine forests, and its populations are regulated by cavity availability. Thus its management focuses on cavities, in some cases including persecuting other species that use its cavities. Such persecution has had inconsistent, and in some cases negative, effects on Red-cockaded Woodpeckers. We propose an alternative, community-based approach to reducing competition between Red-cockaded Woodpeckers and other species over cavities based on understanding of nest web dynamics.

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## **Results of the Minnesota Breeding Bird Atlas: species distribution models and population estimates**

Nicholas Walton, Natural Resources Research Institute at the University of Minnesota Duluth; Gerald Niemi, Natural Resources Research Institute at the University of Minnesota Duluth; Edmund Zlonis, Division of Fish and Wildlife Minnesota DNR

The Minnesota Breeding Bird Atlas (MNBBA) was a 5-year project (2009–2013) completed by > 800 volunteers and paid researchers with the goal of documenting the distribution and abundance of Minnesota's breeding birds. We used MNBBA point count and general atlas data to derive spatially explicit species distribution models for 164 breeding bird species. We included 3 modeling strategies: 1) we estimated density using General Linear Models (GLMs) with detection probability for species with > 75 detections of singing males (75 species), 2) we estimated individuals per 10-min point count using GLMs for species with > 75 observations that are not typically detected as singing but are still reliably surveyed by point count (31 species), and 3) for species that did not fit the first two methods (58 species), we used Maxent to model relative habitat suitability. In each case, we used a suite of GIS variables including land use/land cover (e.g., LANDFIRE Existing Vegetation Type), disturbance (e.g., road density), land cover structure (e.g., vegetation height), landscape metrics (e.g., patch richness), and climate (e.g., annual precipitation). We based model selection on AICc using branching forward selection and bootstrap aggregation. After selection, we derived statewide predictive distribution maps for each species. We also estimated statewide breeding populations for the 75 species that used detection probabilities. These models will be available online at the MNBBA website. We anticipate that they will be useful for a variety of applications including bird watching, improved land management, consideration on climate change issues, and conservation.

## **Assessing owl collisions with U.S. Civil and U.S. Air Force aircraft**

Brian Washburn, USDA/APHIS/Wildlife Services; Kimberly Linnell, Montana Parks and Wildlife

Wildlife-aircraft collisions (wildlife strikes) with civil and military aircraft pose notable risks and economic losses. Previous research on wildlife strikes has emphasized a variety of birds and mammals, but no comprehensive evaluation of owl-aircraft incidents has been conducted. We queried the Federal Aviation Administration's National Wildlife Strike Database and the U.S. Air Force's Birdstrike Database from 1990 to 30 June 2014 to characterize owl-aircraft collisions within the USA and foreign countries. We found 2531 owl-aircraft collisions involving more than 20 individual species of owl. Barn owls were the most frequently struck species, accounting for 42% of all reported owl-aircraft collision events. Almost 75% of owl-aircraft collisions occurred during night-time hours. Owl-aircraft collisions typically occur within the airfield environment itself; 86% of owl strikes occurred when the aircraft was at or below 30 m above ground level. Some mitigation tools and techniques are currently available to reduce the frequency and severity of owl-aircraft collisions. An important area of future research will involve the development and evaluation of effective, publically acceptable methods of reducing owl-human conflicts.

## **Hybrid speciation results in novel male secondary sexual ornamentation in an Amazonian Manakin**

Jason Weir, University of Toronto; Alfredo Barrera-Guzman, University of Toronto; Matthew Shawkey, University of Ghent; Alexandre Aleixo, Museu Paraense Emílio Goeldi

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We report a hybrid speciation event involving the genetic admixture of the Snow-capped (*Lepidothrix nattereri*) and Opal-crowned (*L. iris*) Manakins of the Amazon basin, leading to formation of the hybrid species, the Golden-crowned Manakin (*L. vilasboasi*). We used a genome-wide SNP dataset together with analysis of admixture, population structure, and coalescent modelling to demonstrate that the golden-crowned manakin is genetically intermediate between these species, does not represent a hybrid zone, but did form through ancient genetic admixture. We used spectrometry to quantify the colouration of the species specific male crown patches. Crown patches are highly reflective white (Snow-capped Manakin) or iridescent whitish-blue to pink (Opal-crowned Manakin) in parental species, but a much less reflective yellow in the hybrid species. The brilliant colouration of the parental species results from nanostructural organization of the keratin matrix feather barbs of the crown. However, using electron microscopy, we demonstrate that the structural organization of this matrix is radically different between the parental species and that the hybrid species is intermediate. The resulting intermediate nature of the crown barbs appears to have rendered a much duller structural colouration as a result of hybridization. To compensate, strong selection then resulted in extensive thickening of the carotenoid-laden barb cortex, resulting in the yellow crown colouration. The evolution of this unique crown colour signal likely resulted in pre-mating isolation of the hybrid species from both parental species.

## **Bird song, species discrimination and the pace of speciation in tropical versus temperate latitudes**

Jason Weir, University of Toronto

Vocal divergence drives pre-mating reproductive isolation, reduces hybridization and contributes importantly to the speciation process. I performed field playback experiments on 111 pairs of landbird species or subspecies from temperate North America and the Amazon. I compared rates of song evolution and species discrimination between these areas using Brownian motion models of trait evolution to see if rates of discrimination are faster in the species dense tropics.

## **Selection of roosting habitat by wintering Sandhill Cranes along the Texas Gulf Coast**

Emily Wells, Texas A&M University-Kingsville; Bart M. Ballard, Texas A&M University-Kingsville; Shaun L. Oldenburger, Texas Parks and Wildlife Department; Daniel P. Collins, U.S Fish and Wildlife Service, South West Region; David A. Brandt, U.S. Geological Survey, Northern Prairie Wildlife Research Center; Aaron T. Pearse, U.S. Geological Survey, Northern Prairie Wildlife Research Center; Humberto L. Perotto-Baldivieso, Texas A&M University-Kingsville

Roosting habitat is a key requirement for Sandhill Cranes (*Antigone canadensis*) and the availability of quality roost sites influences distribution of populations across the landscape. The Gulf Coast Subpopulation (GCS) of Sandhill Cranes winters along the Texas coast where a variety of roost habitats are found that are unique to coastal regions including salt marsh and intertidal bays and estuaries. More information about roost site selection within such a unique region is needed to understand how local land use change will impact the GCS in the future. Our objective is to estimate roost site selection for such unique habitat types as well as for roost characteristics along the Texas coast. To address this goal, satellite transmitters (n=32 with  $\pm 18m$  accuracy) were attached to GCS Sandhill Cranes wintering along the Texas coast. Roost site selection will be estimated using locations of adult cranes during winters of 2015-16 and 2016-17 and using spatial data layers delineating habitats throughout the Texas coast. Habitat selection will be determined using Resource Selection Ratios for general habitat types and general mixed effects logistic regression to determine selection for habitat type, habitat patch size, perimeter-to-area ratio, and



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selection for % of grain crops, pastures, and wetlands within the foraging range of roosts. One location was used per night per individual and locations closest to midnight were chosen. Location data was used for 15 cranes for 2015-2016 and 17 cranes for 2016-17. This information will help land managers maintain suitable roosting habitat for GCS Sandhill Cranes throughout their wintering range.

## **Tracking as a tool for conservation of boreal landbirds - unraveling mysteries to ensure the future of a billion birds**

Jeffrey Wells, Boreal Songbird Initiative

The Boreal Forest region of Canada and Alaska, one of the largest still intact forest regions in the world, is the breeding grounds for an estimated 1-3 billion birds. Because of the vast size and remoteness of the Boreal Forest region, it has proved difficult to make range-wide inferences for most Boreal Forest bird species about population trends, demography, limiting factors, migratory routes, connectivity, and many other questions. It is exciting to see that new tracking technologies are beginning to provide information on many previously unknown aspects of the movement biology of a host of Boreal Forest bird species including declining species like Canada Warbler, Connecticut Warbler, Rusty Blackbird, and many others. From a conservation perspective, even basic information on where a species is wintering, the routes and timing of migration, the relative importance of particular geographic regions during migration, and the level of migratory connectivity is needed and is critical to developing strategies for conservation. Case studies from tracking research on Boreal Forest birds will be reviewed to showcase potential conservation applications and possible avenues for future research that could be of importance for conservation. Recommendations for species and geographic areas of the Boreal Forest region that need more migration tracking research attention will be presented.

## **Do parent birds engage in variance sensitive foraging when faced with elevated brood demand?**

David Westneat, University of Kentucky; Ariane Mutzel, University of Kentucky; Simon Bonner, University of Western Ontario; Jonathan Wright, Norwegian University of Science and Technology; Kimberley J. Mathot, University of Alberta

Variance sensitive foraging occurs when a forager is not meeting demand and shifts to more variable options, exploiting an asymmetric fitness consequences of a success. Parent birds might do this if their brood is failing to thrive. We used a brood manipulation to assess this idea in Pied Flycatchers (*Ficedula hypoleuca*). A statistical technique we call “double-hierarchical mixed modeling” allowed us to model fixed and random effects in both means and variances of food delivery to the nest. The brood manipulation increased demand on parents as evident by elevated visit rates and increased begging of offspring. However, in contrast to the predictions of variance sensitive foraging theory, we found that parents feeding enhanced broods exhibited less variance in delivery than those feeding reduced broods. We were also involved in a similar study in Great Tits (*Parus major*). This study occurred across two seasons that differed dramatically in conditions. The results in these conditions may help explain the findings from Pied Flycatchers. In the poor year, parent Great Tits feeding increased broods did elevate the variance in their delivery, whereas the opposite occurred in the year of better conditions. We suspect that in good years, increased demand reduces the time parents spend on other activities that occur on only some trips, thereby reducing variance. In poorer conditions, parents have already removed alternative activities from their

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time budgets, and so shifts to more variable foraging options may be all that is left for them to do when faced with failing offspring.

## **Demographic collapse of an island Tree Swallow (*Tachycineta bicolor*) population**

Nat Wheelwright, Bowdoin College; Liam U. Taylor, Bowdoin College; Bradley K. Woodworth, University of Guelph; Brett Sandercock, Kansas State University

Aerial insect-eating birds have declined throughout northeastern North America. To investigate the demographic factors driving population declines, we studied a breeding population of Tree Swallows (*Tachycineta bicolor*) nesting on Kent Island, New Brunswick, Canada, an isolated boreal habitat in the foggy Bay of Fundy. Tree Swallows have bred on Kent Island since 1934. In 1987, all 101 nest boxes on the island were occupied. By the early 1990s, the population had declined to 60 pairs. In 1994, heavy June rains caused total reproductive failure in the population. After that, the population continued to decline towards its present size of 1-3 pairs. In a 23-year field study (1987-2010), we surveyed Kent Island Tree Swallow nest box occupancy to obtain estimates of total population size. We also collected productivity data at each nest and marked juveniles and adults for capture-recapture analyses. We used an integrated population model (IPM) in a Bayesian framework to estimate key vital rates (fecundity, survival, and immigration), and correlated these estimates to rates of population change ("Lambda"). Annual variation in "Lambda" was not correlated with apparent survival rates of either returning adult breeders or juveniles hatched on Kent Island. Instead, "Lambda" was correlated with hatching and fledging rates on Kent Island (which may be correlated with productivity at mainland sites), and with immigration rates of males and females new to the island. Tree Swallows on Kent Island appear to be heading towards local extinction mainly due to declines in mainland populations that have served as sources for immigrants.

## **Overview of cowbird control: effectiveness, costs and concerns**

Mary J. Whitfield, Southern Sierra Research Station; Barbara E. Kus, USGS WERC

Cowbird population control for wildlife management began in Michigan in 1972 to reduce cowbird parasitism of the endangered Kirtland's Warbler. The success of this program and concern over declines of other cowbird hosts launched an explosion of cowbird research in the late 1980s and 1990s. Much of the research examined the effectiveness of cowbird control as a management tool for other species of conservation concern. It has shown that in most cases, cowbird control works well in reducing cowbird populations and increasing the reproductive success of host populations, although results are mixed on whether it has helped increase target host populations. The popularity of trapping as a control method has given rise to concerns such as the costs of cowbird trapping in terms of both money and possible effects on non-target species. The next phase of the evolution of cowbird management focuses on refinement of past practices and uses a mix of theory/model based determinations and practical methods to examine how to reduce costs without compromising biological effectiveness, how to reduce effects on non-target species, how to better define the goals of cowbird control programs and how to determine which cowbird control techniques are best for specific situations.

## **An adaptive approach to cowbird management on a southern California drainage**

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Mary J. Whitfield, Southern Sierra Research Station; Linnea S. Hall, Western Foundation of Vertebrate Zoology; Sophie S. Parker, The Nature Conservancy

To aid Least Bell's Vireo (*Vireo belli pusillus*; LBVI) recovery, land managers have used cowbird traps to remove Brown-headed Cowbirds (*Molothrus ater*) from the Santa Clara River (SCR) since the early 1990s. This effort has been successful in reducing parasitism and increasing the LBVI population. However, numbers of female cowbirds trapped have significantly decreased on the SCR in recent years. Avian point count data since 2010 also have indicated low cowbird densities, and studies of LBVI nest success have reported very low cowbird parasitism between 2013 and 2015. Based on these findings, The Nature Conservancy (TNC), agency, and non-profit partners are using an adaptive management approach to plan and implement a field evaluation of an alternative method of cowbird control. We established a control site, where we continued using cowbird traps, and a treatment site, where we removed traps and target-netted cowbirds. We conducted point counts and nest monitoring on both sites. In 2016, we did not find any significant differences in densities of cowbirds counted on the sites. However, on the control site, 102 female cowbirds were captured in 5 traps while no cowbirds were captured on the treatment site. Cowbirds parasitized only one of 15 host nests at the treatment site, and no nests (n= 41) were parasitized at the control site. In 2017, we are repeating our evaluation of target-netting and experimental monitoring of host nests. We will report the results of two years of our adaptive approach on the SCR and the lessons we have learned.

## **Movements, cavity excavation and reproductive success of flickers in response to wildfires**

Karen Wiebe, University of Saskatchewan

Many survey-based studies have documented how population densities of cavity-nesters change in response to wildfires but mechanisms involving behaviour of individuals and the effects on reproductive success are usually unknown. I developed a conceptual model explaining the persistence of cavity-nesting birds on the landscape after fires which takes into account carrying capacity (food supply) of the habitat and the philopatry and territoriality of the species. I studied the breeding density, nest site characteristics and reproductive success of Northern Flickers *Colaptes auratus* before and after low- to moderate-severity fires on replicated plots. The density and spatial distribution of nests did not change in a consistent way after fires but rates of cavity excavation increased and the decay class of trees used for excavation changed. The increased costs of excavation apparently caused delayed laying and smaller clutches in freshly-excavated versus reused cavities on the burned sites. Breeding philopatry caused a shift to older age classes in the population during the year following the fires. Depredation of nests by small mammals increased during the first three years after fires, reducing the number of young produced per nest attempt on burned plots. The study shows that even when fire does not reduce the density of breeding pairs, there may be detrimental effects detected only by monitoring the behaviour and reproduction of individuals.

## **Oceanic seabird reveals broad-scale trophic shift in the north Pacific**

Anne Wiley, University of Akron; Peggy Ostrom, Michigan State University; Helen James, National Museum of Natural History, Smithsonian Institution; Sam Rossman, Michigan State University; William Walker, Marine Mammal Laboratory, Alaska Fisheries Science Center, NOAA; Elise Zipkin, Michigan State University; Yoshito Chikaraishi, Hokkaido University

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From climate change to industrialized fishing, the open oceans have been exposed to a diversity of anthropogenic impacts. Yet, understanding the magnitude of human-induced change to the oceanic realm and its seabirds can be challenging, given a dearth of historical records and the immense size and remote nature of open ocean ecosystems. Here, we construct millennial-scale isotope chronologies from two populations of the endangered Hawaiian Petrel (*Pterodroma sandwichensis*): a wide-ranging and generalist seabird of the North Pacific. We use amino acid-specific stable nitrogen isotope data from bone collagen to understand changes in nutrient regime and petrel trophic position through time. The proxy for trophic level,  $d_{15}N_{Glu} - d_{15}N_{Phe}$ , declined between ancient and modern time bins in two populations of Hawaiian Petrel, one from Hawaii and the other from Maui (>0.99 probability of decline; ANOVA with Bayesian approach). Our  $d_{15}N_{Phe}$  data refute a previous claim that increasing nitrogen fixation in the North Pacific Subtropical Gyre controls temporal trends in Hawaiian Petrel isotope data. Instead, our results imply that open ocean trophic dynamics in the North Pacific have shifted at a broad spatial scale during the past 100 years, such that Hawaiian Petrels now eat lower on their food chains, presumably on smaller-bodied prey. We suggest this phenomenon may result from industrialized fishing and could widely affect seabirds foraging in the oceanic North Pacific.

## **Macroevolutionary and population genomic perspectives on trait divergence during speciation in birds**

Ben Winger, University of Michigan

In avian speciation, there are prominent examples of plumage differences persisting among divergent populations despite substantial gene flow. However, it remains unclear how frequently non-clinal differences in plumage are maintained versus collapse in the face of gene flow among incipient species. In particular, gene exchange should inhibit trait divergence among ecologically similar populations, but in the speciation literature the influence of gene flow on the divergence of populations facing similar selection pressures has received less attention than scenarios where differentiation occurs among ecologically disparate populations. I used a paired study design to test the influence of genomic divergence and introgression on plumage differentiation between ecologically similar allopatric replacements of Andean cloud forest birds. Through analyses of short-read genome-wide sequences in 16 co-distributed lineages, I found that plumage divergence is associated with deep genetic divergence, implicating a prominent role of geographic isolation in speciation. By contrast, lineages that lack plumage divergence across the same geographic barrier exhibit a signature of secondary genetic introgression or are more recently isolated, indicating that gene flow inhibits plumage divergence in this system. Playback experiments in the same region suggest that vocal divergence among allopatric populations is also associated with genetic divergence, though may proceed faster than plumage divergence. My results suggest that the evolutionary outcomes of cycles of isolation and divergence in this prominent theatre of avian diversification are sensitive to time spent in the absence of gene flow.

## **Characterization of an urban avian community using automatic detection of calls in acoustic recordings**

David Wituszynski, The Ohio State University; Donald Hayford, Columbus Innovations, LLC; Angelika Nelson, Borror Laboratory of Bioacoustics, The Ohio State University; Jay Martin, The Ohio State University

Acoustic recording is an emerging method of censusing bird populations. Because of the ability to deploy autonomous acoustic recorders, this method promises much higher temporal resolution than traditional point counts. However, due to the volume of data generated, automated detection of species from their calls and songs is required to take full advantage of this procedure. While progress is being made in automated detection, most work

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has been done in natural environments, where the effects of anthropogenic noise are minimal. This is particularly true of studies using commercially available classification packages; most advanced work on automated detection requires custom algorithms and considerable skill in computer processing. By contrast, our study uses autonomous acoustic recorders coupled with automated call detection in a heavily urbanized environment with near-constant anthropogenic noise. By pre-processing the data to minimize the impact of noise, we allow the use of a commercially available automated detection package to identify species at a high spatial and temporal resolution in a neighborhood of Columbus, OH. We then correlate species richness with several local and landscape-level factors, seeking to understand the drivers of local avian community assembly at a fine scale. This research provides a foundation for answering questions about how to increase biodiversity in urban environments, which serves the goal of conservation while also seeking to reconnect people with their natural environment.

## **Songbird indicators for riparian restoration success on the South Fork Kern River**

Patti Wohner, Southern Sierra Research Station; Jenna E. Stanek, Southern Sierra Research Station

High quality riparian systems in the West have declined significantly over the recent past coinciding with altered hydrology, lack of tree regeneration, and drought. Riparian restoration has been conducted for recovery of threatened and endangered California songbird species. Typically, early successional riparian willow/cottonwood sites are planted, target songbird species colonize young growth, and sites are yes off on the restoration success list. Restoration and restoration monitoring generally ceases ~10 years after completion of planting or sooner. This has been the case in the Kern River Valley (KRV) where 142 ha of new riparian forest was planted from 1986 to 1996 for Yellow-billed Cuckoo (YBCU). The YBCU population rose to 24 pairs in 1992 but now, 30 years after the first willow stick was planted, the species has not been confirmed breeding for 5 years. Speculating sites were becoming too mature and dry for YBCU, we enhanced 30 ha of mature riparian forest by adding water and new trees. During historical KRV restoration, Laymon conducted songbird territory mapping in 0 to 11 yo restored sites and mature controls. To facilitate our understanding of restoration success, we implemented territory mapping in our current enhancement sites and non-enhanced mature controls. We used Laymon's historical territory data to determine songbirds associated with YBCU territory use using factor analysis. We then used these indicator species to compare to 2 years of territory data in our current enhancement sites. We found considerable differences among current and historical songbird communities in restored and control sites.

## **Using genetic markers to determine the provenance of the New Zealand Buller's Albatross (*Thalassarche bulleri* ssp.)**

Jana Wold, Victoria University of Wellington; Peter A. Ritchie, Victoria University of Wellington; Geoff K. Chambers, Victoria University of Wellington; Chris J. R. Robertson, Wild Press; Kate McKenzie, Victoria University of Wellington

The *Diomedidae* (Albatrosses) family is comprised of 22 recognised species, 13 are of high conservation concern because they are experiencing population decline. For many taxa, these declines may be the result of fisheries interactions. Buller's Albatross ssp. (*Thalassarche bulleri* ssp.) is consistently recorded in the top five observed seabird interactions with fishing vessels in New Zealand, but it has been difficult to determine the provenance of caught birds. Currently, the Northern Buller's Albatross (*Thalassarche bulleri platei*) and Southern Buller's

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Albatross (*Thalassarche bulleri bulleri*) are described as two sub-species (Dickinson & Remsen 2013), but genetic data has not been used to assess the taxonomic relationship or the population structure of these taxa. The aim of this study was to use mitochondrial DNA (mtDNA) and genome-wide sequencing to estimate the level of genetic differences between breeding groups of Buller's Albatrosses. We found that there was a significant level of genetic differentiation between taxa ( $\Phi_{ST} = 0.621$ ). Two haplogroups were identified within Northern Buller's Albatross, while Southern Buller's Albatross samples contained a single haplogroup. All individuals sampled from fisheries bycatch ( $n = 97$ ) were assigned with maximum probability to either Northern ( $n = 19$ ) or Southern Buller's Albatross ( $n = 78$ ). Differentiation between the two sub-species was also supported by the genome sequencing data. The mtDNA marker provides an appropriate level of resolution to be used to assign provenance of *T. bulleri* ssp. samples, which will provide insights into relative impacts of anthropogenic activities on Buller's Albatross ssp.

## Response of Louisiana waterthrush and their benthic prey to shale gas development

Petra Wood, US Geological Survey; Mack Frantz, West Virginia University

We examined effects of Marcellus shale gas development on Louisiana Waterthrush (*Parkesia motacilla*) in northern WV during 2009-2011 and 2013-2015. We quantified waterthrush nest survival, territory density, and return rates on 58.2 km of 14 headwater streams. For each nest, we quantified local land cover, a waterthrush Habitat Suitability Index (HSI), and an EPA Rapid Bioassessment index for in-stream macroinvertebrate habitat. In 2011 and 2013-2014, we collected benthic macroinvertebrates to characterize waterthrush prey availability. Waterthrush territory density in 2011 was positively correlated with higher GLIMPSS scores, total benthic density, and EPT density. Unimpacted streams had greater GLIMPSS scores, greater overall and EPT richness, and less tolerant taxa compared to impacted streams. Analyses of 2013-2014 benthic data are underway and will be reported. Waterthrush demographic trends across years show decreasing territory density, return rates, and nest survival. After accounting for temporal effects (average daily rainfall), amount of shale gas development had weak negative effects on daily survival rate (DSR) of 280 waterthrush nests. Brown-headed Cowbird (*Molothrus ater*) nest parasitism rates increased since 2010; no parasitism occurred before 2010. Population level nest productivity declined, and individual level productivity was lower in shale gas disturbed areas where a source-sink threshold suggested these areas are more at risk for being sink habitat. Riparian habitat quality scores (EPA, HSI) were negatively related to the amount of shale gas territory disturbance and differed by year. Overall, our results suggest a decline in waterthrush site quality over time as shale gas development increased on our study area.

## Interactive scicomm engagement with live streaming apps

Nicole Wood, Central Michigan University

Science communication is nothing new for scientists. Traditionally researchers have communicated with their intended audiences via print or television. Emerging technologies have changed how we as a society communicate and scientists must update their communication tools, so they don't lose touch with their audiences. Social media platforms such as Facebook, Twitter, and Instagram allow researchers to engage with audiences directly, enabling for a greater exchange of information. While these apps foster a dynamic interaction, they still lack that personal touch of being able to engage with a "real live" scientist rather than just words on a screen. Apps, such as Periscope, let a broadcaster live stream an audio video feed directly to their audience via their phone, tablet, or computer and viewers can communicate back in real time to the broadcaster, during the live stream, through an integrated chat module. Live streaming can be used for a wide variety of science communication options, such as interviews,

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research presentations, and fieldwork showcases, for both inreach and outreach audiences. Science communication is an ever-evolving set of tools for the scientist's toolbox. Live streaming is an emerging tool that can be easily added and one that researchers must take advantage of to stay relevant in today's social media world.

## **Year-round climate and local weather effects on annual survival of a resident Neotropical songbird**

Brad Woodworth, University of Guelph; D. Ryan Norris, University of Guelph; Daniel J. Mennill, University of Windsor

Environmental variation plays an important limiting role for many populations of migratory and resident bird species that breed in the temperate zone. However, knowledge of how tropical bird populations respond to their environment is limited to a handful of species and sites, largely due to the scarcity of long-term demographic studies of tropical species relative to their temperate counterparts. Here, we evaluate the effects of large-scale climate indices (El Niño and the Southern Oscillation) as well as local weather (temperature and rainfall, variation in timing and length of the dry/wet seasons) on sex-specific true annual survival of a resident Neotropical songbird, the Rufous-and-White Wren *Thryophilus rufalbus*. Survival was estimated from 14 years of mark-recapture and dispersal data from Santa Rosa National Park (10°51'N, 85°36'W) in northwestern Costa Rica using a spatially-explicit Cormack-Jolly-Seber model. Of the 301 individuals marked between 2003 and 2015, 163 were encountered in at least one subsequent year. Of those 163 individuals, 60% changed territories within the 2.4 km<sup>2</sup> study area at least once during their lifetime, with dispersal distances ranging from 20 m to 4 km. By incorporating these dispersal data into our analyses, we could disentangle survival and emigration, which allowed us to estimate true (as opposed to apparent) survival and effects of climate and weather thereon. Collectively, our study will provide valuable insight into how climate and weather at different temporal scales influence survival of birds in the tropics.

## **Biomechanics of take-off in island birds**

Natalie Wright, University of Montana; Christopher Witt, University of New Mexico; Bret Tobalske, University of Montana

Smaller flight muscles and longer legs are characteristic of island birds, but the consequences of this morphology on function are unknown. We tested how reduced flight muscles and longer legs affect take-off performance by measuring flight kinematics and leg thrust forces for take-offs of wild birds on the islands of Trinidad and Tobago. Birds on the smaller island of Tobago have reduced pectoral flight muscles and longer legs, and experience lower predation pressures. We found that birds on Tobago had slower velocity and acceleration during take-off relative to conspecifics on Trinidad. Initiation of wingbeats occurred later during take-off in populations on the island of Tobago. Lower predation pressures on small, species-poor islands likely permit slower take-off velocities and smaller flight muscles. Our study produced a novel comparative dataset of take-offs for 16 species from five orders, ranging body size from 4.1g to 130g. Across this sample, maximum take-off velocity scaled with body mass to a power of 0.16, potentially offsetting adverse scaling of induced power requirements. Birds with larger flight muscles exhibited a greater reliance upon the wings relative to the leg thrust during take-off. For example, larger-muscled birds began the first wingbeat earlier in take-off and reached peak acceleration later in take-off.

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## **Shorebirds in disguise: prealternate molt-migration and extended stopover of Rusty Blackbirds**

Jay Wright, The Ohio State University; Luke Powell, Smithsonian Migratory Bird Center; Christopher Tonra, The Ohio State University

When migrant passerines undergo a prealternate molt, they almost uniformly begin and complete this molt on the wintering grounds, with individuals only occasionally completing the molt during migration. Shorebirds, however, undergo the bulk of their prealternate molt on migration, during extended stopover events. We present the first evidence of a passerine bird mirroring this shorebird molt strategy. Rusty Blackbirds, long thought to acquire their alternate plumage solely by the wearing away of feather tips, have recently been discovered to undergo a fairly extensive and obligate prealternate molt to complement feather wear. While this molt was first described on the wintering grounds, it had not been investigated during spring migration. From March 15 to May 5, 2016, we captured 56 individuals in northern Ohio and examined body and contour patches for active molt; of these, 43 individuals were examined in greater detail and assigned a molt score on a scale of 0 to 100. Nearly every bird (98%) was undergoing some degree of body molt. Molt score (mean=13.4) decreased throughout the season, and males had higher scores than females. Half of the birds were outfitted with coded nanotags and tracked to determine length of stopover. Mean minimum stopover duration was 24.9 days, and showed a strong relationship to molt score, with longer stopovers in birds with high molt scores. While spring stopover events are typically assumed to serve the purpose of refueling for further migration, these results suggest that stopover duration at this site is instead driven by the completion of prealternate molt.

## **Projected effects of climate change on avian communities in US National Parks**

Joanna Wu, National Audubon Society; Chad Wilsey, National Audubon Society; Gregor Schuurman, National Park Service; Lotem Taylor, National Audubon Society

Climate change is projected to drastically shift or reduce ranges of nearly half of North America's bird species. We used survey data from the Breeding Bird Survey and Christmas Bird Counts and 17 bioclimatic variables to construct species distribution models for 360 species in summer and 396 species in winter. We then projected climatic suitability in 2011-2040 and 2041-2070 across 274 US national parks. For each species and season, we performed a linear regression of climate suitability over time to analyze change, and found that if bird communities in national parks respond to climate change as anticipated then they are likely to see drastic changes in the next several decades. Looking at the high greenhouse-gas emissions scenario (8.5 W/m<sub>2</sub>) that is consistent with current trends, avian communities in parks may experience an average turnover of 0.27 ± 0.09 in the summer and 0.25 ± 0.11 in the winter. Gains in climate suitability in winter outpace losses across all parks; an average of 50 ± 13 species could gain suitability in the winter. Half of national parks are projected to lose climate suitability for 25% or more of their current birds in summer by mid-century, although 60% are projected to gain suitability for 25% or more species. The changes (additions and losses) would be more drastic at higher latitudes, and less drastic under a low emissions scenario (2.6 W/m<sub>2</sub>). National parks, although already protected from the threat of habitat modification, are nevertheless prone to significant climate-driven changes in avian communities.

## **Yak dung and grass structure influence the foraging ecology of Black-necked Cranes breeding on the Qinghai-Tibet Plateau**

Yongjie Wu, College of Life Sciences, Sichuan University



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Vegetation structure of grasslands, such as mean sward height and sward height heterogeneity, influences resources and foraging habitat of insectivorous birds. However, the associations between grazing pressure and consequent insect prey items within Bovine dung, as a factor affecting habitat selection of insectivorous birds is often ignored. We studied the influence of mean sward height, sward height heterogeneity, and the number of yak dung on foraging of the Black-necked Crane (*Grus nigricollis*), a large omnivore bird that breeds on the Qinghai-Tibet Plateau grasslands. Black-necked Cranes disproportionately foraged in grassland patches with short sward height, low sward heterogeneity and high amounts of dry yak dung, even though total invertebrate abundance was positively correlated with mean sward height. Coleopteran larvae dominate dry dung and is an important invertebrate resource for breeding Black-necked Cranes. Dry yak dung is an important factor influencing the optimal foraging habitat for insectivorous birds and dung associated animals may play an important role in energy and material transformation in grassland ecosystems. The grazing vertebrates and herbivore invertebrates on the grassland are competitors, omnivore birds may have evolved to switch their foraging strategy when facing different grazing pressure. The new insight of the ecological and evolutionary role for the dung of large herbivorous mammals indicated in our study help us to understand the complexity of the energy and material flow on the grassland ecosystem.

## **Distribution, ecology, and survival of Kirtland's Warblers on the wintering grounds**

Joseph M. Wunderle, Jr. International Institute of Tropical Forestry, USDA Forest Service; David N. Ewert, The Nature Conservancy; Jennifer D. White, International Inst. of Tropical Forestry, USDA Forest Service; Dave Currie, International Inst. of Tropical Forestry, USDA Forest Service; Sarah M. Rockwell, Smithsonian Migratory Bird Center; Patricia K. Lebow, Forest Products Lab., USDA Forest Service

Kirtland's Warblers (KIWA) winter in the Bahamas Archipelago, especially in the central Bahamas, where on the island of Eleuthera, monthly survival is high ( $0.977 \pm 0.002$  SE). Here, KIWAs occupy drought-prone habitats, which become drier as the winter proceeds resulting in periodic late-winter droughts, prior to spring migration. As rainfall declines, KIWA food resources (fruit and arthropods) decline, the severity of which varies among winters and sites. As food resources vary in space and time, KIWAs shift from food-poor to food-rich sites, so that by late-winter, warbler densities are positively correlated with biomass of fruits and ground arthropods. Intraspecific competition is evident in overwinter site fidelity, which differs by sex (males > females) and age class (adults > juveniles). Sex and age differences in corrected body mass and fat scores are evident from midwinter through late winter, consistent with outcomes from competition and experience. Late-winter rains have a positive effect on corrected body mass, suggesting that in drought years KIWAs have inadequate body condition, which contributes to negative carry over effects on the breeding grounds and reduces an individual's survival probability in later stages of the annual cycle as found by Rockwell et al. In some winters, droughts in The Bahamas may limit the KIWA population. These findings suggest a landscape approach to KIWA conservation is required on the wintering grounds with an emphasis on food-rich late-winter sites.

## **How important is cavity provisioning by Magellanic Woodpeckers? A case study in the world's southernmost forests**

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Amy Wynia, University of North Texas; Ricardo Rozzi, University of North Texas, Omora Ethnobotanical Park, Universidad de Magallanes, Institute of Ecology and Biodiversity; Jaime E. Jiménez, University of North Texas, Omora Ethnobotanical Park, Universidad de Magallanes, Institute of Ecology and Biodiversity

Magellanic Woodpeckers (*Campephilus magellanicus*, MAWOs) are the largest extant woodpeckers in South America, listed as Endangered or Vulnerable throughout Chile, and are a species of conservation interest. MAWOs excavate cavities in trees, providing nest and roost sites for themselves and secondary cavity-nesters (SCN) unable to excavate their own cavities. Since MAWOs provide a habitat component that may otherwise be unavailable, they are hypothesized to be a keystone species. As a first step towards testing this hypothesis, we examined the contents of woodpecker-excavated and natural cavities on Navarino Island, Chile (55°04'60"S, 67°40'00"W). During austral summers 2015-2017, we examined contents of 142 excavated and 56 natural cavities and measured several habitat characteristics at nest sites. The proportion of use by SCN in woodpecker-excavated cavities was significantly smaller than in natural cavities ( $\chi^2_{21} = 85.45$ ,  $P < 0.0001$ ), such that SCN used 12.68% ( $n = 18$ ) of woodpecker cavities and 82.14% ( $n = 46$ ) of natural cavities. Cavity width ( $W = 419.5$ ,  $P = 0.0001$ ) and nest height from ground ( $W = 605.0$ ,  $P < 0.0001$ ) were the only significant cavity-related variables between cavity types. MAWOs are not providing a significant proportion of cavities for the SCN community as it is composed of smaller birds that more likely select cavities relative to their smaller body size. Given that there are no native, terrestrial predators on Navarino, SCN may select cavities lower to the ground to avoid aerial predators (and possible depredation by MAWOs), whereas MAWOs may select their excavation site based on other processes, such as presence of wood-decay fungi.

## **Avian use of recently restored eelgrass meadows as part of a living shorelines project**

Austin Xu, California State University, Fullerton; William Hoese, California State University, Fullerton; Danielle Zacherl, California State University, Fullerton

Living shorelines restoration uses the infrastructure that some organisms create (e.g., oyster beds, eelgrass meadows) to reduce coastal erosion while simultaneously promoting ecological community diversity. Birds may benefit from living shorelines because restored habitat may increase the amount and diversity of prey species. Bird density and richness increased in response to a living shorelines project in San Francisco Bay, but this effect has not been evaluated in southern California estuaries. We studied bird use of living shorelines at four sites prior to (January 2016 – March 2016) and after (October 2016 – March 2017) eelgrass restoration in Newport Bay, CA. Each site consisted of a 130m long x 12m wide mudflat swath, divided into four 20m long treatment plots (control, oyster, eelgrass, oyster-eelgrass) with 10m buffer zones. For this study, treatments were grouped as either control or eelgrass plots, since oyster restoration has yet to occur. We hypothesized that post-eelgrass restoration, bird use would be higher in eelgrass treatments compared to control treatments. After one year, we found no significant shifts in bird density among treatments even when targeting eelgrass foragers. Richness did not change among treatments, but after restoration, bird richness was significantly higher at one site relative to the other sites. It may be too soon to detect changes in bird presence due to eelgrass restoration. With oyster restoration scheduled for May of 2017, we will continue to monitor bird use of the living shorelines sites through summer of 2018.

## **Hidden diversity in the Vangas of Madagascar**

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Jane Younger, Loyola University Chicago; Lynika Strozier, Loyola University Chicago; Chris Kyriazis, Loyola University Chicago; Dylan Maddox, Field Museum of Natural History; Steve Goodman, Field Museum of Natural History; Marie Jeanne Raherilalao, Université d'Antananarivo; Sushma Reddy, Loyola University Chicago

Madagascar is home to many unique evolutionary lineages and high levels of microendemism, attributable to a broad diversity of habitat types separated by steep environmental gradients. Unfortunately, phylogenetic and phylogeographic studies of Malagasy avifauna are scarce, with no published genetic data for nearly half of the endemic species. This signifies a substantial gap because species-level diversity is frequently underestimated in the absence of genetic analysis. We consider cryptic speciation within the endemic Vanga family to be a distinct possibility, because many of the described species have large distributions spanning a diverse range of habitats, from the spiny subdesert forests of the south to the humid evergreen forests of the east. We aimed to assess the presence of hidden species-level diversity in the Vangas, and to explore the biogeographic barriers and speciation mechanisms that have played a role in generating diversity within the family. Genetic data were collected for 10 species of Vanga from across each species' range, including representative individuals from each distinct habitat. We evaluated species limits and explored patterns of diversification by sequencing mitochondrial genes, nuclear introns, and over 4,000 ultra-conserved element (UCE) loci, using these sequences to reconstruct maximum likelihood phylogenies. Our analysis uncovered hidden diversity in some Vanga lineages (e.g. *Newtonia amphichroa*) and we suggest that taxonomic revision may be required, pending results of our morphological investigations. This work further expands the already remarkably diverse Vanga radiation.

## **Connectivity between Gulf Coast stopover and breeding locations of Ruby-throated Hummingbirds**

Theodore Zenzal, University of Southern Mississippi; Andrea Contina, Oklahoma Biological Survey; Jeffrey Kelly, Oklahoma Biological Survey; Frank Moore, University of Southern Mississippi

During autumn, over two-thirds of birds breeding in eastern North America make migratory flights to tropical wintering grounds. While migration has been well studied, information is missing on the migratory patterns of many species, notably the relationship between arrival timing at stopover sites and breeding location. Longitudinal migrations generally exhibit either a leap-frog pattern, where northern populations overtake southern populations en route, or chain pattern, where southern populations migrate south before northern populations. Preliminary studies suggest that Ruby-throated Hummingbirds (*Archilochus colubris*) exhibit chain migration but results are based on small samples. Our objective is to determine if Ruby-throated Hummingbirds exhibit a relationship between natal origin and timing of arrival at a stopover site. To meet our objective, we captured hummingbirds in Fort Morgan, AL during autumn 2010, 2011, and 2014, at which time we collected tail feathers (R4) from hatch year individuals. We used an isoscape based on precipitation models and published isotope values of breeding Ruby-throated Hummingbirds to assign individuals to breeding latitudes. We tested the relationship between capture date and latitude using generalized additive mixed models. Results show a positive relationship between date and latitude, suggesting a chain migration pattern of passage. A chain migration pattern may alleviate en route competition for resources between populations since overlap between populations is minimized. Moreover, our results show that multiple populations of Ruby-throated Hummingbirds utilize habitats along the Gulf of Mexico, stressing the importance of conserving coastal habitats.

## **Combining unmarked data types to model the population dynamics of breeding birds**

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Elise Zipkin, Michigan State University; Sam Rossman, Michigan State University; Charles Yackulic, USGS Southwest Biological Science Center

Studies of species dynamics and trends often rely on data from unmarked individuals across broad scales where local abundance and environmental variables may vary. We present a modeling framework for integrating detection-nondetection and count data into a single analysis to estimate population dynamics (i.e., survival, recruitment, immigration), abundance, and individual detection probabilities during sampling. Our dynamic modeling framework makes a key assumption that every individual present at a site has an equal probability of being detected during sampling processes, even in cases where the overall detection probability varies by the survey type. This allows all available data to be incorporated into an analysis, increasing both accuracy and precision of parameter estimates. We provide an empirical example of the model by combining long-term detection-nondetection data (1995-2014) with newly collected count data (2015-2016) from a growing population of Barred Owls (*Strix varia*) in the Pacific Northwest to examine the factors influencing population abundance over time. Model results show that the Barred Owl population grew substantially over the course of the survey period from approximately 0.13 (95% CI: [0.06, 0.48]) territorial owls per site in 1995 to 7.5 (95% CI: [4.26, 11.53]) in 2016. This increase can be largely attributed to a positive density dependent effect of recruitment and immigration. Our model provides a foundation for integrating a variety of unmarked data types and should be useful for survey design and to researchers interested in incorporating historical or citizen science data into analyses focused on understanding how demographic rates drive population abundance.

## **Ethology meets citizen science: antipredator behavior of birds to accipiter hawks in urban environments**

Benjamin Zuckerberg, University of Wisconsin-Madison; Jennifer McCabe, University of Wisconsin-Madison; Anna Pidgeon, University of Wisconsin-Madison; Volker Radeloff, University of Wisconsin-Madison; David N. Bonter, Cornell Lab of Ornithology

For over a century, ethology has been a cornerstone of evolutionary biology, animal communication, and predator-prey interactions. Studies of animal behavior rely on careful observations in controlled settings, but in an age of rapid environmental change, there is a growing need to explore animal behavior within increasingly anthropogenic and novel ecosystems. Throughout North America, Accipiter Hawks are recovering following decades of widespread population declines and are now an increasingly common visitor to urban and suburban backyards. Given their propensity to hunt at bird feeders, Accipiter Hawks represent a potentially novel predator influencing the behavior of birds. As hawks colonize cities, we would expect that prey species adjust to increased predation risk through anti-predator behaviors such as flocking or higher vigilance. We developed a low-cost playback experiment allowing citizen scientists to quantify the responses of feeder birds to vocalizations of Accipiter Hawks. During the winter of 2016/17, we teamed with the Cornell Lab of Ornithology's Project FeederWatch to distribute playback experiments to 10 participants in Chicago, IL. Participants exposed their backyard birds to either a Cooper's hawk or a non-threatening heterospecific call. Using individual and flock surveys, participants submitted over 300 observations of antipredator behaviors for 20 bird species. We found that flock sizes decreased following hawk calls where control treatments failed to elicit a similar response. The colonization of cities by Accipiter Hawks presents a unique opportunity to fuse ethology with citizen science and allow the public to observe the behavior of a predator in their own backyards.

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## **Carry-over cascade: linking winter habitat, arrival, breeding, and post-fledging survival in a migratory songbird**

Elizabeth Ames, The Ohio State University; Chris Tonra, The Ohio State University

Every year millions of birds migrate between the wintering grounds, in tropical Central and South America, and the breeding grounds, in temperate North America. Many of these Neotropical migrants complete the various stages of their annual cycle thousands of kilometers apart, and events in one of these stages can influence events in a subsequent stage. Understanding these carry-over effects is fundamental to understanding changes in migratory populations and their conservation, as many are in enigmatic decline. The objective of this study is to explore carry-over effects between wintering and breeding events, and elucidate an unexamined life-cycle stage, the post-fledging period, in a migratory songbird of conservation concern, the Prothonotary Warbler (*Protonotaria citrea*). To achieve this objective, we utilized a network of nest boxes and natural cavities across the 925-acre Hoover Nature Preserve, Columbus, Ohio. There we monitored arrival timing, breeding success, and estimated post-fledging survival in 2016 and 2017. Preliminary results from 2016 show an unusual arrival pattern with mean arrival for after second year males (April 28th) and second year males (April 27th) being approximately the same. We found a surprisingly low rate of fledging success for both natural cavity (37%; n=62) and box (12%; n=25) nests. Post-fledging survival was estimated to be 0.534 with important model variables including age since fledging, female first egg date, and male arrival date. This research helps to fill important gaps in the Prothonotary Warbler's full annual cycle and provide a critical estimate of the success of a long running nest box program.

## **Genomic data distinguish phenotypically distinct birds despite low levels of divergence**

Stephanie Aguillon, Cornell University; Richard G. Harrison, Cornell University; Irby J. Lovette, Cornell University

The Northern Flicker (*Colaptes auratus*) species complex has been historically well characterized by ornithologists, with particular interest placed on the hybrid zone between red-shafted and yellow-shafted flickers in the US Great Plains. Genetic work using allozymes and mitochondrial DNA has shown low overall differentiation and has been unable to resolve differences between the five main subgroups. This system presents an interesting and tractable opportunity to study a well-known avian hybrid zone using modern genomic techniques. Here, we use a reduced-representation genomic sequencing approach (ddRAD) to characterize genomic differentiation between three of the main subgroups: red-shafted, yellow-shafted, and gilded flickers. We sequenced individuals from populations geographically distant from the hybrid zone and across the species range. We show that genomic data has an increased ability to differentiate the three flickers, despite low levels of overall divergence. Few markers are useful for differentiation, which suggests an important role for frequent ongoing hybridization and/or incomplete lineage sorting in the evolutionary history of this group. Our results indicate more thorough genomic sequencing will be needed to further explore genomic differentiation and the functional genomic bases of the phenotypic differences between the three flickers.

## **Effect of dietary antioxidant and fatty acid levels on immune function of European Starlings following endurance flight**

Meredith Anderson, Michigan State University; Jen Owen, Michigan State University; Kristen DeMoranville, University of Rhode Island; Wales Carter, University of Rhode Island; Scott McWilliams, University of Rhode Island

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Migration is physiologically taxing to the cardiovascular, musculoskeletal, and respiratory systems. When energy is limited, a migrating bird may allocate energy toward anticipated essential requirements of migration, and away from nonessential functions like the immune system. A byproduct of prolonged exercise is oxidative damage to body tissues, including the immune system; antioxidants in birds' diets have been shown to mitigate this damage. Migrating birds rely heavily on fat oxidation for energy, an important source being n-6 polyunsaturated fatty-acids (PUFA). We hypothesize that birds that engage in endurance flight and are given a high PUFA and antioxidant-rich diet will be more immunocompetent than birds given lower amounts. Using a landbird migrant, the European Starling (*Sturnis vulgaris*), we employed a three-way factorial experiment 2 (flight) x 2 (PUFA) x 2 (antioxidant). Birds were randomly assigned to one of two flight treatments: one never flown, the other trained and flown in a wind tunnel. Within each flight treatment birds were assigned one of four diets (1) High antioxidants and high (32%) PUFA (n=23), (2) High antioxidants and low (13%) PUFA (n=20), (3) Low antioxidants and high (32%) PUFA (n=22), and (4) Low antioxidants and low (13%) PUFA (n=18). Blood samples were collected before and after treatments, and the spleen was collected during necropsy. We measured the birds' constitutive immune function using standard immune assays including absolute and differential leukocyte counts, haptoglobin concentration, hemolysis- hemagglutination assay, and spleen mass and histology. Determining the effect of diet on a migrating bird's immunocompetence is crucial for making conservation and management decisions about stopover habitat.

## **Intron study and evolution of wild songbird MHC genes: minimum essential MHC does not exist**

Antonio Arnaiz-Villena, University Complutense, The Madrid Regional Blood Center; Ester Muñiz, University Complutense, The Madrid Regional Blood Center; Jose Palacio-Gruber, University Complutense, The Madrid Regional Blood Center; Cristina Campos, University Complutense, The Madrid Regional Blood Center; Beatriz Tejedor, University Complutense, The Madrid Regional Blood Center; Manuel Martin-Villa, University Complutense, The Madrid Regional Blood Center; Valentin Ruiz-del-Valle, University Complutense, The Madrid Regional Blood Center

It is established that intron changes do not fit a regular genetic clock model. This makes them not useful for establishing phylogenies. However, study of intron changes on groups of already phylogenetically defined models, like wild songbirds: Genus *Carduelis*, *Serinus* and Tribe Carduelini, in general may give us answers to specific evolutionary questions. In the present work, we have analysed intron 2 from class I major histocompatibility complex (MHC) in order to study evolution of these wild finch MHC genes. Indels, genetic distances, average variability have been studied. A putative expected conservation of intron 2 is not found in these wild birds, instead a large variability is recorded. Although there is a trend to already phylogenetically defined songbird groups to maintain a similar intron 2, too much variability is observed. This is concordant with the hypothesis that most allelic MHC variability is achieved by gene conversion (involving introns) and not by point mutations. In addition, introns length are longer than that described for chicken (*G.gallus*). These findings together with the lack of conservation of vertebrate canonical sites in songbird MHC molecules is discussed on the bases of a very different evolutionary origin and /or evolution.

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## **An assessment of the effects of West Nile Virus on avian species**

Aislee E. Atkinson, Montana State University & Northwest College; Eric C. Atkinson, Northwest College

West Nile virus (WNV, Flaviviridae), an arbovirus, is a recently (1999) documented North American pathogen affecting both mammals and birds. We characterized over 249 avian samples representing 33 species, 19 families, and 5 orders. We focused on WNV in House Sparrows (*Passer domesticus*) and House Finches (*Haemorrhous mexicanus*) in the Clark's Fork of the Yellowstone River Valley due to similarities in these species' diets, foraging habits, residency, and range of habitat. We trapped individual birds yearround, sampled saliva (~1 microlitre) using a nylon swab, banded, measured, and released. We used a RAMP reader to test samples. Positive results read more than 30 units, <30 were negative. The sample size for this analysis equaled 110; House Sparrow (56) and House Finch (54) combined. We split samples into three seasons: breeding/young rearing season, March-June; post-fledging season, July-September; and overwinter, October-February. No association between bird species and prevalence of WNV ( $G = 0.214$ ,  $df = 1$ ,  $p = 0.643$ ) and no association between time of year (season) and prevalence of WNV ( $G = 1.971$ ,  $df = 2$ ,  $p = 0.373$ ) were found. However, the variance of viremia was significantly higher in House Finches than in House Sparrows ( $F_{53,55} = 10.474$ ,  $p < 0.001$ ). House Sparrows and House Finches exhibit similar patterns in prevalence as virus reservoirs. The latter, however, show considerable variability in circulating salivary virus loads which, if correlated with blood titers, may be important in determining suitability as maintenance and reservoir hosts, or potentially as superspreaders.

## **Mechanisms underlying migratory protandry in the sexes and plumage morphs of the White-throated Sparrow**

Andrew Beauchamp, The University of Western Ontario; Yolanda Morbey, The University of Western Ontario; Christopher Guglielmo, The University of Western Ontario

Migratory protandry is the earlier arrival of males at breeding locations compared to females and may result from faster migration speed, more northerly wintering latitudes, or earlier departure in the spring by males. Migration speed is thought to be positively related to migratory stopover duration, which may in turn be affected by the rate of energy replenishment (refuelling rate) during stopover. This study examines the mechanisms of spring migration timing across the sexes and behaviourally different "white striped" and "tan-striped" plumage morphs of the White-throated Sparrow; with the aim to examine the relationships between migratory timing, migratory speed, stopover duration, stopover refuelling rate, and wintering latitude. Plasma metabolite profiling was used to determine stopover refuelling rate. Body composition was examined using quantitative magnetic resonance analysis. Radio telemetry and the Motus Wildlife Tracking System were used to determine stopover duration, habitat use, and post departure movement. Isotopic analysis was used to compare wintering latitude between sexes and plumage morphs. Sex and plumage morphs were determined genetically. Competitor abundance during stopover was also considered as a co-variate to refuelling rate. Data collection and analysis is currently underway. This study will be the first to concurrently examine migration timing, refuelling rate, stopover duration, and wintering latitude in the White-throated Sparrow. Comparisons between morphs will provide insight into the effect of behaviour on the mechanisms of migratory timing.

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## **The Canada Jay -- a national bird for Canada**

David Bird, McGill University; Ken Otter, University of Northern British Columbia

After a two-year voting contest to solicit public opinion on which bird species would best represent Canada and to encourage debate among Canadians about the need for a National Bird, the Royal Canadian Geographical Society, in December 2016, selected the “Gray Jay/Whiskeyjack/Mésangeai du Canada” (*Perisoreus canadensis*) from among the top five contenders as their candidate for Canada’s National Bird. Subsequently, this choice was officially endorsed by the Society of Canadian Ornithologists in a November 2016 letter to the federal Minister of National Heritage, Mélanie Joly. A significant number of both ornithologists and the Canadian public, however, felt that while the bird itself was entirely worthy of being a Canadian national symbol, the present official English name, “Gray Jay”, created an impediment, particularly with its American spelling (“gray” instead of the Canadian “grey”). In stark contrast, the original official name, “Canada Jay”, would obviously be a more fitting name. An investigation by D. Strickland in 2017 (Ontario Birds 35: 3-16) into the nomenclatural or taxonomic reasoning behind the American Ornithologist Union (AOU) Checklist Committee’s decision to shift from the use of “Canada Jay” to “Gray Jay” in 1957 revealed precedence to support the notion that the original designate of “Canada Jay” should have been restored in the 1950s when the AOU abandoned separate common name designations for individual subspecies. Thus, the Canadian federal government would therefore not violate biological orthodoxy if it restores the original name “Canada Jay” should it officially declare this species to be the national bird of Canada.

## **Foraging and residency behavior of wintering American Kestrels (*Falco sparverius*) in Central Michigan**

Mike Bishop, Alma College; Krista Botting, Alma College; Amber Tuttle, Alma College

Organisms living at the edges of their ranges often exhibit characteristics that deviate from those exhibited by individuals that reside in the core areas of the species’ distribution. Our central Michigan study site (longitude/latitude of 43.38, -84.66) is at the northern limit, in the state and North America, for overwintering American Kestrels (*Falco sparverius*). Between 2007 and 2017 we observed kestrels, from January to March, using radio telemetry, to characterize their foraging and residency behavior. The study area covers approximately 48,000 ha. A total of 27 kestrels were trapped, banded and outfitted with vhf radio-transmitters. The median number of kestrels deployed with transmitters was 3/yr. Kestrel density was estimated to be ~1/10,000ha. Mean longitudinal axis length of the foraging areas was 3.47 km. Mean residency time was 15.25 days. Compared to data collected in the southern part of the kestrel’s US wintering range, northern populations appear to exhibit much lower densities, forage over larger areas, and spend less time in any given area throughout the winter. The assumption is that the driver for this difference is lower resource availability. Future efforts will attempt to address this assumption.



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## **Avian Foraging Response to Jack Pine (*Pinus banksiana*) Volatile Chemicals**

Katie Bjornen, Northern Michigan University; Alec Lindsay, Northern Michigan University

Omnivorous and insectivorous birds can improve tree and forest health by foraging on herbivorous insects that significantly damage trees. Plants respond to attack by herbivorous insects by producing and releasing volatile organic compounds (hereafter referred to as VOCs). The VOCs function both directly in anti-herbivore defense (e.g., increased secretion of a bitter or toxic chemical) and/or indirectly by attracting predators. Birds that can direct foraging activity to trees with higher insect loads should benefit through increased foraging efficiency. Avian olfactory abilities are understudied, but new research shows some avian taxa use chemical cues to alter navigation, foraging behavior, and individual recognition. We tested the hypothesis that birds detect chemical cues emitted by trees and subsequently orient their foraging effort toward trees with particular “olfactory profiles”. To do this we measured VOCs released from jack pine (*Pinus banksiana*) trees and tested whether avian foraging behavior was preferentially directed to trees that differ in the released VOCs. Further, we experimentally manipulated some trees by releasing different combinations of VOCs and measuring the avian foraging response to each treatment. Here we present results that should prove useful both for further study of avian olfaction and for forestry management.

## **Are personality traits repeatable in Golden-crowned Sparrows (*Zonotrichia atricapilla*)?**

Theadora Block, University of California Santa Cruz (UCSC)

Studies of individual animal behavior, or personality, have been an expanding field and established personalities in everything from mollusks to birds to primates. The growing importance of animal personality can be connected to its impacts in understanding why organisms may have less plasticity in their behavior and how evolution would maintain these traits. However, before inferring personality, we should first understand what measurements we use to establish certain behaviors and if they have tangible meaning in the wild. I use behavioral trials to look at individual behavior in Golden-crowned Sparrows (*Zonotrichia atricapilla*) and analyze how consistent their behaviors are within a non-breeding season. Modeling individual behavior within one year found that certain behaviors ranged from 0%-57% repeatability, however, none of these behaviors were statistically significant. Many of these measures are commonly used to make assumptions about individual behavior, so it is surprising that these measures were not significant. This study will continue examining these same individual birds over several years, and see if these trials are able to predict important ecological behaviors in the wild.

## **Transmission difference of short and long duration elements in the songs of male clay-colored Thrush in a tropical forest**

Katherine Bonilla-Badilla, Universidad de Costa Rica; Luis Sandoval, Universidad de Costa Rica

In songbirds have been suggested that the presence of songs or elements of different duration within the vocal repertoire of the same species, could be an optimization strategy for sound signal transmission. Given that each type of sound may be used to transmit to different distances or receptors. A bird family where is common the occurrence of sounds of different duration in vocalizations (i.e., elements) is Turdidae. However, the function of these elements within the communication of the species of this family remains poorly study. Our goal was to

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compare the distance range that long and short-duration elements of Clay-colored Thrush (*Turdus grayi*) songs transmit inside the habitat. We conducted a sound transmission experiment where we broadcast and re-recorded long and short duration elements present in Clay-colored Thrush songs at four distances inside the territories. We found measured four attenuation and degradation measurements (signal-to-noise ratio, tail-to-signal ratio, blur ratio, and excess attenuation) that both elements showed similar patterns of degradation and attenuation with distance. These results suggest that both short and long distance elements are adapted to transmit information for short and long range. Therefore, the presence of both elements within the song is not to communicate with receptors at different distances and its occurrence may be to create a rhythmic contrast in time and frequency to attract female's attention, and increase therefore his reproductive success.

## **Breeding season carry-over effects of forest fragmentation on Wood Thrush (*Hylocichla mustelina*)**

Brendan Boyd, York University; Sue Hayes, York University; Bridget Stutchbury, York University

The Wood Thrush is an iconic forest-dwelling North American long-distance migrant that has been steadily declining for decades. Habitat loss and fragmentation on the breeding grounds has been shown to cause short-term negative effects on immediate breeding success. However, long-term impacts on adults, or carry-over effects, have not been studied, in part due to the difficulty of tracking individuals between periods of their annual cycle, often across large geographic distances. The Motus Wildlife Tracking System is an innovative new automated radio telemetry array that, for the first time, can link breeding fragment size to fall migration and annual survival. Wood Thrush occupying small fragments are expected to experience high rates of brood parasitism and nest predation, which could directly delay fall migration due to timing constraints from late re-nesting or indirectly delay migration if adults are in poorer condition. Wood Thrush are large enough to carry radio-tags with a one year battery life, allowing detection of adults who return within the 100,000 km<sup>2</sup> study site in SW Ontario. We captured adult Wood Thrush (n=20) in large and small forest fragments in SW Ontario during the 2016 breeding season and fitted them with coded radio transmitters in order to track their movements using the Motus Wildlife Tracking System. We will present results to test two predictions (1) the initiation of fall migration will occur later for birds breeding in small versus large fragments and (2) there will be a lower annual return rate for birds breeding in small versus large fragments.

## **Abundance of fruit-eating birds in agricultural land cover**

Melissa Brady, Michigan State University; Rachael Eaton, Rice University; Shayna Wieferich, Michigan State University; Karen Steensma, Trinity Western University; Deanna Leigh, Western Washington University; Paul Curtis, Cornell University; Heidi Henrichs, Cornell University; Jay Boulanger, Cornell University; Catherine Lindell, Michigan State University

Birds are capable of causing extensive crop damage, especially to fruit crops. Despite this, there is limited knowledge on the species of fruit-eating birds found in different fruit crops across the United States. Moreover, it is unknown whether there is regional variation in species presence for crops grown in different geographical areas. There is also little knowledge about how the abundance patterns for fruit-eating birds vary by crop, region, and with differences in the surrounding land cover. This lack of knowledge can be a hindrance for those trying to find solutions to the problem of bird damage in fruit crops. In this study, we combine several large-scale data sets to investigate fruit-eating bird presence in fruit crops. Bird abundance information was collected via point counts conducted for the Specialty Crop Research Initiative, a multi-year project investigating bird damage across

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different regions in the United States. Land cover data was collected via the National Agriculture Imagery Program. We first identify fruit-eating bird species found in sweet cherries, blueberries, grapes and apples grown in 3 different regions: Michigan, New York, and the Pacific Northwest. We then investigate the impact that land cover heterogeneity and composition have on the abundance of fruit-eating birds in focal fruit crops. We also separately investigate these effects in several species that were abundant in our study, and have been found in previous studies to cause fruit crop damage: American Robins (*Turdus migratorius*), European Starlings (*Sturnus vulgaris*), and Cedar Waxwings (*Bombycilla cedrorum*).

## **Molecular confirmation of hybridization between Northern Parula (*Setophaga americana*) and Cerulean Warbler (*S. cerulea*)**

Courtney L. Brennan, Cleveland Museum of Natural History; Ryan J. Trimbath, University of Akron; Andrew W. Jones, Cleveland Museum of Natural History

Hybridization between Cerulean Warbler (*Setophaga cerulea*) and Northern Parula (*Setophaga americana*) has been suggested from field observations at several sites in eastern North America, but without genetic confirmation these observations were speculative. Here we present the first molecular evidence to confirm hybridization of these closely related species. Suspected hybrids were located in the breeding season in 2014 and 2015 in Cuyahoga Valley National Park, Summit County, Ohio, in an area where both parental species breed. Playback was used to lure the individuals into mist nets where they were banded, feather samples were collected, and morphometric and plumage data were recorded before release. Both birds showed a combination of Cerulean Warbler and Northern Parula plumage characteristics; the overall appearance resembled a Cerulean Warbler but with white eye arcs, a weak yellow wash on the breast, and some yellow mantle feathers suggesting Northern Parula parentage. DNA was extracted from contour feathers and the nuclear MUSK gene and mitochondrial ND2 gene was sequenced. Both individuals' ND2 sequences were identical to Cerulean Warbler sequences, indicating that both had a Cerulean Warbler mother. Sequences from the MUSK gene had several heterozygous loci confirming that they were sired by Northern Parulas. These hybrids were found in an area where Northern Parulas are expanding their breeding range into Cerulean Warbler's range, suggesting that this hybrid combination may become more common.

## **Connecting the dots: dustbathing in Japanese Quail through a neoichnological lens**

Erika Brewer, Centre College; Amanda Falk, Centre College

Dust bathing is a behavior that can be observed in many species and occurs when an organism settles into media and tosses it up and over its body. Although there is no evidence of dust bathing in the fossil record, it is a common behavior performed by some species of birds such as the Domestic Chicken (*Gallus gallus domesticus*). Here, Japanese quail (*Coturnix japonica*) is used in a neoichnological study to determine which media conditions are favored for this behavior. Medium-sized sand with 0%-4% water weight is more preferred than saturated substrate with small grain size (i.e., clay). Smaller grain sizes caused the bird to stick to the substrate which decreased the subject's overall locomotion and ability to dust bathe. Understanding how conditions such as water saturation and grain size affect behavior will support investigations into the fossil record for similar environmental conditions. This allows for a narrow focus on specific environments that are most likely to preserve dust baths. If

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fossil dust baths are discovered, we will be better able to understand why they occur and what evolutionary benefits avian species gain from dust bathing. As dust bathing is a behavior seen across multiple distantly related avian groups such as Horned Larks, Galapagos Hawks, and Horned Guans, we can use the fossil record to test for deep-seated behavioral homologies, or studying convergent behavioral evolution in deep time. This study will expand upon current neotechnological studies by using different avian subjects, providing a new investigative tool for tracemaking behaviors.

## **A low-cost RFID reader and electronics platform for biological research**

Eli Bridge, University of Oklahoma; Jay Wilhelm, Ohio University; Jessica Ruyle, University of Oklahoma; Ian D. Grady, University of Oklahoma; Garret P. Robinson, University of Oklahoma; William F. Oakley, University of Oklahoma; Heather K. Lepage, University of Oklahoma

Radio Frequency Identification (RFID) is a mode of short range wireless communication between an active transceiver and small, passive transponders that can emit a unique identification code and that often function without a battery. RFID has been used to study dozens of bird species ranging from hummingbirds to penguins; however cost and difficulty in implementation have sometimes restricted its use. Our team has built upon seven years of RFID-based field research to design a cheap and versatile RFID reader for use in biological research. The primary circuit board is derived from an Arduino M0, which is a hobbyist electronics platform designed to allow students and non-engineers to learn about and use microprocessors. We have taken the basic M0 design and added an RFID reader, an SD card interface, and a clock to produce a device that can serve as a simple data logger or be modified to incorporate additional sensors (e.g., temperature, GPS, weighing scales) and output controls (e.g., motors, lights, speakers, etc), which would allow the reader to coordinate complex systems such as cognitive testing apparatus and food dispensers. The new reader also has provisions for wireless communication allowing for real time data acquisition and remote control of operating parameters. We offer this design as an open-source do-it-yourself project with simple instructions and sources for all components, but we also plan to work with a vendor to make these devices available to biologists at a low cost.

## **Metal Levels in Blood of Shorebirds reflect Levels in their prey (Horseshoe Crab Eggs)**

Joanna Burger, Rutgers University; Nellie Tsipoura, NJ Audubon; Michael Gochfeld, Rutgers University

Understanding the relationship between metal level in predators and their prey is an important issue, and is usually difficult to determine because birds eat a variety of prey. However, shorebirds that stop over during spring migration along Delaware Bay (NJ) stay for only 2-3 weeks, and eat mainly horseshoe crab (*Limulus polyphemus*) eggs. We examined the relationship between metal levels in horseshoe crab eggs and those in the blood of red knot (*Calidris canutus rufa*), sanderling (*Calidris alba*) and semipalmated sandpiper (*Calidris pusilla*) from Delaware Bay. We also examine the relationship between metal levels in blood and feathers because feathers are easier to collect, and there is a rich literature on metal levels in feathers. For all three species, the levels of arsenic, cadmium, chromium, lead and mercury in blood were highly correlated with the levels of metals in the eggs of horseshoe crabs. This indicates that the levels in blood of these shorebirds quickly reflect those in their prey. Semipalmated sandpipers had the lowest levels of arsenic in blood, and the highest levels of arsenic in feathers, compared to the other species. Semipalmated sandpipers have a diet that includes some marsh invertebrates. The levels of

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cadmium and chromium in blood were significantly higher in knots than other species. For all of the metals except arsenic, the ratio of levels in blood/levels in feathers were similar among species. For arsenic, the ratio of levels in blood/feathers were significantly lower in semipalmated sandpipers than the other species.

## **A rapid measure of breeding productivity for the Canada Warbler (*Cardellina canadensis*)**

Christian Burns, Plymouth State University; Leonard R. Reitsma, Plymouth State University

Breeding productivity can be measured as the number of offspring produced by a population annually. Assessing productivity can be time intensive, or lacking demographic and habitat information. Efficient, and comparatively comprehensive measures of productivity are needed to inform conservation efforts for declining species. The Canada Warbler (*Cardellina canadensis*) is a currently declining migrant. We test a rapid method for assessing productivity, while obtaining information on demographic-specific fledging rates, return rates, and habitat measures. This study was in Canaan, New Hampshire on two “reference” plots and 3 non-reference plots. Males were aged and banded on each plot. Sites were revisited once fledging occurred on the reference plots, monitored intensively for 16 consecutive years, to measure fledging success. The male was considered having successfully fledged young if a fledgling or food provisioning by him or a female at the capture site was observed. If no provisioning, fledgling, or adult was observed, the male was considered unsuccessful. Habitat characteristics were also recorded per site. The captures and analyses were performed within two field days per plot, by two researchers. In 2015, older birds were more successful ( $df = 1, \chi^2 = 1.55, p = 0.213$ ). Of the 2016 birds, 37% were returnees, and all were more successful on territories with denser shrub-level vegetation ( $df = 69, t = -1.675, p = 0.0491$ ). In 2017, data from multiple sites across the breeding range will be collected and analyzed to compare habitat structure, demographics, and breeding success of populations throughout the range.

## **Adult bobolink dispersal following hay harvest during the breeding season**

Andrew Campomizzi, Bird Ecology and Conservation Ontario; Zoe Lebrun-Southcott, Bird Ecology and Conservation Ontario

Bobolink (*Dolichonyx oryzivorus*) rely primarily on agricultural grasslands for breeding habitat in North America. Hay fields are often harvested in June, while bobolink are nesting, causing nest failure. Adult dispersal after the hay harvest is not well understood, but quantifying habitat use and re-nesting is important for conservation planning. Through a pilot field project, we radio-tracked 5 Bobolink in southern Ontario after the harvest in 2016. We tracked 3 males for 41 to 43 days after the harvest; the other 2 birds (1 male, 1 female) presumably dispersed beyond our search range < 4 days after the harvest. The 3 adults we tracked for > 1 month did not show signs of re-nesting and were often < 800 m from the capture location; maximum distance was 2.2 km. Birds primarily used a nearby uncut hay field and a fallow field; both had breeding Bobolink. In our follow-up research, we plan to track Bobolink dispersal using hand-held antennas (for short-distance movements) and the Motus Wildlife Tracking System (for long-distance movements). Both methods enable assessment of habitat use and hand-held antennas will enable quantification of re-nesting. If few Bobolink re-nest after hay harvesting, then fields harvested before young fledge likely result in annual fecundity of near 0. Land cover types used by displaced birds may be important for providing refuge and ensuring most adults can breed again the following year. Improving our understanding of

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how breeding bobolink respond to agricultural practices during the breeding season is important for planning conservation actions.

## **Management Implications of Differential Productivity Rates at Great Lakes Piping Plover Nest Sites.**

Vincent Cavalieri, U.S. Fish and Wildlife Service; Francesca Cuthbert, University of Minnesota

The Great Lakes population of Piping Plovers was listed as an endangered species by the U.S. Fish and Wildlife Service after the population dropped to less than 20 pairs in the mid-1980s. Intense management in the 30 years since listing has helped the population rebound to 75 pairs in 2016. Significant barriers to recovery, such as pressure from human recreation and predation on adults and chicks remain however. Some Great Lakes piping plover breeding sites have much higher fledging rates than others. We evaluate productivity over time for all nest sites. We then analyze the influence of a suite of variables, such as beach ownership, beach size and amount of recreation pressure on fledging rates. Results will be used to inform management decisions.

## **Vocal, color and genetic variation across a wide hybrid zone in Andean warblers**

Laura Céspedes, Universidad de los Andes; Elisa Bonaccorso, Universidad San Francisco de Quito; Daniel Cadena, Universidad de los Andes; María Alejandra Castro, Universidad Central de Venezuela; Andrés Cuervo, Instituto de Investigación de Recursos Biológicos Alexander Von Humboldt; Javier Gómez, Universidad de los Andes; Jorge Pérez, Universidad Central de Venezuela; Christopher Witt, University of New Mexico

Studying variation in communication-related traits (color and song) across hybrid zones has importantly contributed to understanding how isolating barriers emerge during speciation. In this study, we characterized a putative hybrid zone between two closely related Andean Warblers, *Myioborus ornatus chrysops* and *Myioborus melanocephalus ruficoronatus*, using genetic, coloration, and song data. Geographic ranges of these species abut around the Colombia-Ecuador border and specimens from the region exhibit intermediate phenotypes suggesting hybridization, but descriptions of patterns of variation were lacking. We collected recordings of vocalizations and specimens in more than 20 localities across a ca. 400 km transect around the Colombia-Ecuador border. On each study skin, we measured the area of color patches and quantified color hue. To describe acoustic variation, we measured spectral and temporal parameters from recorded songs. To describe genetic variation, we sequenced the ND2 mitochondrial gene. We extended genetic sampling to encompass all known populations of this complex from Venezuela to Bolivia to describe phylogeographic structure. This putative hybrid zone is characterized by low genetic structure and contrasting patterns of variation in different color patches. Acoustic divergence is subtle and variation across sampling localities is complex. Specimens from the hybrid zone and northern populations of *M. melanocephalus* belong to a genetic group more closely related to *M. ornatus* than to southern *M. melanocephalus* populations. We are collecting genomic data that will contribute to understanding origins of this putative hybrid zone and allow to test for the role of selection on shaping variation in communication-related traits.

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## **Habitat preference and movement in lek and foraging grounds in the White-collared Manakin (*Manacus candei*)**

Mathieu Charette, Toucan Ridge Ecology and Education Society; Hannah Soder, Toucan Ridge Ecology and Education Society

Manakins are small, mainly frugivorous Neotropical passerine birds in the family Pipiridae (McKay et al. 2010). They are found in moist forest edges (Blake and Loiselle 2002) in lowland broadleaf forests in Belize, Central America. The White-collared Manakins (*Manacus candei*) are one of the least studied of the Manakins and little is known on their selection and use of lekking and foraging habitats. Like all Manakins, this species takes part in an extravagant lek mating system, which involves a carefully choreographed dance by the males, which the females use to choose a mate. In addition to requiring specific habitats to lek in (size of sapplings, etc.), this species is known to have a mutualistic relationship with plants in the family Melastomaceae (Morales-Betancourt et al. 2012). The goal of this study is to better understand the importance of habitat and behavioral needs of this species by investigating their social organization, movement, and habitat characteristics of their leks and foraging habitat. We characterised lek and foraging habitat, and quantifying use by individuals as well as movements between leks, and between leks and foraging areas. In 2015-2016 we characterised the habitat of 5 active leks and numerous foraging areas at the T.R.E.E.S field site in the Maya Mountains of Belize. In addition to this we have colour banded males (2016; n=10, 2017; n=6) and females (2016: n=12; 2017: n=6). In 2017-2018, we will continue adding colour bands and radio transmitters and will observe leks and feeding territories to quantify movement in this species.

## **Individual variation in brain region size in zebra finches: implications for a structural basis of personality**

Kathryn Chenard, University of Arizona; Renée A. Duckworth, University of Arizona

Behaviors are often considered highly flexible traits and assumed to not be subject to the same developmental constraints as morphological traits. However, the high stability of personality traits raises the possibility that structural constraints may play a causal role in personality variation. In particular wiring costs and the timing of development of different regions of the brain may lead to patterns of investment where components that are either located close together or develop at the same time covary more closely than components that are far apart or develop at different times. Here we measured the size of sub regions of the brains of adult and embryonic Zebra Finches to determine whether individuals vary in patterns in investment between these areas consistent with either wiring costs or developmental timing. We found that there is substantial individual variation in the size of brain components and evidence for both wiring costs and a role of developmental timing. Areas that are closer together covaried more than areas farther apart, but only for regions in the front of the brain. Because the front of the brain contains the latest developing cortical regions that are often most costly, our results suggest that an interaction between wiring costs and developmental timing may account for individual variation in brain morphology. This study lays the foundation for future work that will connect variation in brain morphology to differences among individuals in personality.

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## **A UCE perspective on the phylogeny of the albatrosses, petrels, and shearwaters (Procellariiformes)**

R. Terry Chesser, USGS/NMNH; Andreanna J. Welch, Durham University, Helen F. James, Smithsonian Institution; Vincent Bretagnolle, CNRS

The Procellariiformes are by far the largest group of oceanic birds, but no multi-locus phylogeny of the order is available. We are using genomic sequence capture of UCEs to study evolutionary relationships of all extant and recently extinct Procellariiformes, at and below the species level. As a first step, we analyzed sequences of a representative sample of species to construct a well-supported backbone phylogeny showing relationships among families and other major groups of Procellariiformes. Our family-level results indicated that the albatrosses (Diomedidae) are sister to the rest of the order, that the storm-petrels (Hydrobatidae) consist of two groups that are not sister taxa, and that the shearwaters and petrels (Procellariidae) are paraphyletic with respect to the diving-petrels (Pelecanoididae). Other results of interest concerned the large family Procellariidae, and indicated that the fulmarine petrels are sister to the rest of the Procellariidae, that the *Puffinus* shearwaters are paraphyletic with respect to *Calonectris* if *Ardenna* is not recognized, and that the Kerguelen Petrel *Aphrodroma brevirostris* is sister to but distantly related to the *Pterodroma* petrels. Nearly all nodes on the tree received 100% bootstrap support.

## **Migratory return rates and breeding fidelity in Eastern Bluebirds (*Sialia sialis*)**

Derek Coss, University of Maryland Baltimore County; Evangeline M. Shank, University of Maryland Baltimore County; Michael G. Rowley, University of Maryland Baltimore County; Joselyn T. Tesleu, University of Maryland Baltimore County; Kevin E. Omland, University of Maryland Baltimore County

Many migratory birds have low rates of return to their previous nesting locations and mates. These low rates are likely due to the high mortality during migration, making it impossible for re-pairing to occur. We monitored 25 pairs of Eastern Bluebirds (*Sialia sialis*) across 3 breeding seasons to determine their return and re-pairing rates. The Birds of North America (BNA) report a range of return rates from 26% in Minnesota to 70% in South Carolina. Eastern Bluebirds are partial migrants, and we suspect the populations in Maryland are short distance migrants. Previous studies of return rates of Eastern Bluebirds have primarily focused on either long distance migrants or permanent residents. Therefore, few studies have focused on the return rates of short distance migrants. The study of migration in short distance migrants is interesting because variation in migration has large effects on the evolution of breeding systems and mate choice. Our preliminary data suggest that Eastern Bluebirds in Maryland have high return and re-pairing rates. Many of the bluebirds that mated together in previous breeding seasons appear to not only re-pair the next year but also return to the same territory and nesting cavity.

## **Colony-specific genetic markers for the assessment of hunting impacts on thick-billed (*Uria lomvia*) and common (*Uria aalge*) murre**

Brody Crosby, Queen's University; Anna Tigano, Cornell University; Gregory J Robertson, Environment and Climate Change Canada; Vicki L Friesen, Queen's University

Thick-billed and common murre (*Uria lomvia* and *U. aalge*) are numerous, pelagic birds that have a circumpolar distribution and represent an integral component of temperate and arctic ocean trophic networks. Murre face a number of anthropogenic threats, including gillnet mortality, marine pollution, and climate-induced changes to



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marine food webs. An additional pressure is a legal winter hunt of approximately 100,000 murrets annually off the coasts of Newfoundland and Labrador. Murrets wintering in Newfoundland and Labrador migrate from stable colonies in eastern Canada, from declining colonies in Greenland, and possibly from declining colonies in Europe, however the impact of the hunt on individual breeding colonies is not known. To assess this impact, we are using genomic methods to assign murrets hunted in Newfoundland to colonies of origin. Restriction-site associated DNA sequencing (RADseq) and  $F_{ST}$  outlier analyses allow us to develop colony-specific markers based on samples from 300 thick-billed murrets and 200 common murrets from 20 colonies across the Atlantic breeding range. Samples from 160 hunted murrets are being genotyped for colony assignment, and preliminary genotyping has successfully assigned hunted individuals to species and regions of origin. The results of our project will be important for the management of murrets in Canada and abroad. If declining colonies are facing undue hunting pressure, changes in harvest regulations can be considered. In future years, these colony-specific genetic markers may be used to monitor and detect changes in colony composition in the murre hunt and inform development of genetic markers for other species of concern.

## **Parasitic eggshell's pigment concentrations do not match host levels in egg color mimetic Striped Cuckoos**

Miri Dainson, Hunter College and the Graduate Center; Melissa Mark, Landscape Conservation Initiative, Northern Arizona University; Mande Holford, Hunter College and the Graduate Center; Mark E. Hauber, Hunter College and the Graduate Center, City University of New York

The rejection of foreign eggs is the major line of defense in most host-parasite systems, and brood parasitic birds in many lineages have evolved host-mimetic egg coloration to circumvent egg recognition. What is the mechanism of egg color mimicry at the chemical level? Obligate parasitic Common Cuckoos *Cuculus canorus* in at least three host-races have evolved egg color mimicry by depositing similar levels of egg pigments into their shells as do hosts. Here we report on the physical and chemical basis of egg color mimicry in an independent and poorly studied host-parasite system, the Striped Cuckoos *Tapera naevia* and their hosts, the Rufous-and-White Wrens *Thryophilus rufalbus*. We found that even though parasite eggs are spectrally similar to hosts, and contain the same major blue eggshell pigment, biliverdin, the concentration of this pigment in Striped Cuckoo eggs was similar to some of its non-parasitic New World Cuckoo relatives, and different from the host. Perceptual mimicry of host-parasite eggshell appearance, therefore, need not always be paralleled at the structural and chemical level in birds.

## **Geographic variation in Woodhouse's Scrub-Jay**

Devon DeRaad, Moore Laboratory of Zoology, Occidental College; Amanda J. Zellmer; Biology Department, Occidental College; Whitney Tsai, Moore Laboratory of Zoology, Occidental College; James M. Maley Moore Laboratory of Zoology, Occidental College; John E. McCormack, Moore Laboratory of Zoology

Understanding phenotypic, genetic, and niche differences between different populations of organisms is fundamental to understanding the biodiversity of our planet. We investigated phenotypic variation across the species' range of Woodhouse's Scrub-Jays (*Aphelocoma woodhouseii*). There are currently seven described subspecies in this complex spanning from northeast California to southern Mexico. We quantified exact phenotypic differences by character scoring, and measuring body size and plumage reflectance for over 100 individuals from Mexico. Our results showed that individuals from southern Mexico (Sumichrast's group) were significantly

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divergent over morphological multivariate space, compared with individuals of the nearest subspecies (*A. w. grisea* and *A. w. cyanotis*) in northern Mexico. Compared with their northern Mexico counterparts, the Sumichrast's group individuals were generally larger in size, and displayed all brown backs, with reduced or absent blue necklaces. After establishing morphological divergence between Sumichrast's group and the rest of the Woodhouse's Scrub-Jay complex, we focused on the putative zone of contact between *A. w. cyanotis* and *A. w. sumichrasti* in central Mexico, just east of Mexico City. Morphological analyses indicate that while hybridization may occur within this narrow contact zone, it is likely very rare. Ecological niche divergence may explain the narrow contact zone, but further surveys of exact habitat occupation of each subspecies near Mexico City are warranted. Future projects should focus on the hybrid zone between *A. w. cyanotis*, and *A. w. sumichrasti*, investigating possible pre-zygotic barriers between the subspecies such as divergence in niche, call, or behavior.

## **Using MaxEnt to predict the distribution of the West Indian Whistling Duck with presence only records in Caño Tiburones, Puerto Rico**

Sheylda Diaz Mendez, Universidad del Turabo

The West Indian Whistling Duck (*Dendrocygna arborea*) is a vulnerable species in Caño Tiburones, Puerto Rico. Using a spatially balanced, probabilistic approach, I used presence records reported in eBird and ranked them by probability of WIWD occurrence. My hypothesis states that vegetation density is key in their habitat selection process and additional covariates include landcover, temperature, precipitation and distance to disturbance. Analyzed by MaxEnt and visualized using Geographic Information Systems the result is a distribution model that predicts habitat selection. I would like to discuss preliminary results and possible networking to produce a similar map for the distribution of WIWD throughout the Caribbean.

## **Eastern Bluebirds do not avoid nest cavities with mouse odors**

Cameron Dove, Davidson College; Elise Lankiewicz, Davidson College; Mark Stanback, Davidson College

For decades, songbirds were assumed to have a poor sense of smell. However, recent research has demonstrated that some songbirds in fact have an excellent olfactory sense. To test whether Eastern Bluebirds (*Sialia sialis*) use olfactory cues to avoid dangerous nest cavities, we presented bluebirds with paired boxes, one of which contained urine-soaked bedding from a mouse cage (the other box contained clean cage bedding). We ran the experiment during the summers of 2016 and 2017 (we focused on summer nesting because adjacent boxes tend to fill with chickadees and nuthatches in the spring). In both years the mouse bedding was added to boxes after the fledging of the first brood. We flipped a coin to determine which treatment the spring box received. We found no effect of either mouse urine or the location of the spring nest on summer box choice.

## **Altmetrics – what are they good for?**

Steve Dudley, British Ornithologists' Union (BOU); Tom Finch, RSPB Centre for Conservation Science; Nina O'hanson, Environmental Research Institute, University of Highlands and Islands

The speed at which altmetrics have become established is striking. They are a metric for our instant, digital age. Young researchers in particular have grown up in an 'instant society' and expect to see immediate impact of their

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research on publication. Citations can't deliver this, but altmetrics can. Altmetrics complement traditional metrics by quantifying the online 'attention' of an article across various media. The scoring of these platforms is weighted depending on audience, with news media scoring the highest and social media the lowest. More researchers are taking up social media enabling them not only to promote their own research, but also to extend their research networks. Altmetrics allow them to track their own performance and that of others talking about their research. Such connections can lead to increased research collaborations. Altmetrics are also being increasingly used by funders to measure the impact of the research they fund. Institutes understand this, and also see that altmetrics measure the attention of the work being undertaken within their walls. With this increased attention on altmetrics, here we explore two main questions: 1. Can altmetrics identify individual scoring sources which authors can influence in order to drive the attention of their own research articles? 2. Can altmetrics contribute to the citation rate of a research article? In order to answer these questions, we analysed over 6,500 research articles published in 10 ornithology journals, breaking down their altmetric scoring sources and comparing individual papers' Altmetric Attention Scores to their citations rates.

## **What's in a feather? Reconstructing mercury concentrations through time using museum specimens**

Sarah Dzielski, Cornell University; Cornelia W. Twining, Cornell University; N. Roxanna Razavi, Cornell University, Finger Lakes Institute, Hobart and William Smith Colleges; Vanya G. Rohwer, Cornell University, Cornell Museum of Vertebrates

Mercury (Hg) released into the environment from anthropogenic sources has become increasingly problematic in ecosystems worldwide. From the late 1860s until the early 1980s, global anthropogenic Hg emissions increased exponentially due to coal emissions, industrial practices and artisanal gold mining. In this study we examined how methylmercury (MeHg) concentrations vary through time in birds within New York State. We focused on the time period 1880 - 2016 to capture variation in biologically available MeHg, corresponding to peak industrial activity and environmental legislation restricting Hg emissions. We examined MeHg concentrations in the feathers of six species that have distinct habitat and dietary preferences: Belted Kingfisher (*Megacerlye alcyon*), Cooper's Hawk (*Accipiter cooperi*), Eastern Phoebe (*Sayornis phoebe*), Wood Duck (*Aix sponsa*), Ruffed Grouse (*Bonasa umbellus*), and Virginia Rail (*Ralluslimicola*). We used carbon and nitrogen stable isotopes to account for possible changes in habitat and trophic levels between species through time. Our results show predicted patterns in isotopic niches and MeHg concentrations for these species. Species feeding at higher trophic levels (e.g., Cooper's Hawk) and in aquatic habitats (e.g., Belted Kingfisher) tend to have higher MeHg concentrations than species that are mostly herbivorous or land dwelling (e.g., Ruffed Grouse). Patterns of changes in avian MeHg concentrations through time are more complex, suggesting that the effects of anthropogenic Hg emissions may be highly localized and species-specific.

## **Modelling habitat loss in Piping Plovers using an environmental agent-based model**

Brandon Edwards, University of Guelph; Daniel Gillis, University of Guelph

The Piping Plover (*Charadrius melodus*) is an endangered species of shorebird residing in North America. Anthropogenic activities and development in the Great Lakes region has played a direct role in the decrease of habitat for the Piping Plover. Using a novel approach to agent-based models wherein we treat the environment as

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agents, we aim to efficiently model the habitat loss in this species by simulating the effects of anthropogenic activities and development, the conservation efforts that have taken place over the years, and natural predation against the species. The development of the model will allow us to make a number recommendations based on varying degrees of anthropogenic activity to assist in the restoration of the piper plover population.

## **Time is of the essence: optimizing when sampling soundscapes for monitoring avian communities**

Jonathan Eiseman, Western Michigan University; Maarten J. Vohhof, Western Michigan University; Sharon A. Gill, Western Michigan University

Ecologists are exploring the acoustic resource, or soundscape, in response to the need for more accurate and replicable monitoring assessments in habitats that are managed to support biological diversity. Acoustic monitoring provides a means to assess the acoustic diversity of sites or habitats, and may reveal whether management or restoration practices benefit bird communities. Given that generating enormous libraries of soundscape recordings is possible with limited expenditure of resources, but remains challenging to manage and analyze, we need to understand how to optimize sampling regimes without compromising the accuracy of diversity measurements. Thus, we collected soundscapes over an uninterrupted 24-hour period at three grassland and two forest habitats within a nature preserve in Kalamazoo County, Michigan to explore the effects of sampling regimes on calculations of acoustic diversity. We first characterized the diurnal patterns of the soundscape and avian communities using acoustic indices designed to describe the biodiversity of a site. To assess if acoustic patterns diverged under data-restricted regimes, we calculated indices each minute over the 24-hour period and compared results to simulated recording schedules that sampled less frequently. We test whether decreasing the total time analyzed affects our ability to accurately characterize the variation in acoustic diversity, and if different recording schedules exclude information vital to understanding the diversity of avian communities present at the preserve. Preliminary results show acoustic diversity indices exhibit minor differences between full and more sparse recording schedules, suggesting restricted recording schedules can be used to calculate acoustic diversity in bird communities.

## **Habitat associations of coastal wetland birds in the Great Lakes basin**

Lisa Elliot, University of Minnesota; Annie Bracey, University of Minnesota; Gerald Niemi, University of Minnesota, Natural Resources Research Institute; Douglas Johnson, US Geological Survey

A basic understanding of regionally-specific habitat associations for individual species is a prerequisite for identifying the causal mechanisms behind regional population trends. Therefore, we are developing models of habitat association for nine declining obligate wetland bird species that use coastal wetland habitat in the Great Lakes basin, using six years (2011-2016) of data from the Great Lakes Coastal Wetland Monitoring Program. Our early preliminary results indicate that Pied-billed Grebe (*Podilymbus podiceps*) occurrence is negatively associated with forest cover in the surrounding landscape and positively associated with emergent wetland cover. American Bittern (*Botaurus lentiginosus*) occurrence is correlated with amount of inland open water. Least Bittern (*Ixobrychus exilis*) occurrence is positively correlated with the amount of grassland/pasture in the surrounding landscape, and number of surrounding wetland patches. Virginia Rail (*Rallus limicola*) occurrence is correlated with number of wetland patches and interspersed/juxtaposition. Sora (*Porzana carolina*) occurrence is negatively correlated with amount of inland water and surrounding cropland. Common Gallinule (*Gallinula galeata*) occurrence is positively correlated with the amount of inland water. Forster's Tern (*Sterna forsteri*) showed

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significantly positive correlations with amount of inland water and amount of Great Lakes open water. Black Tern (*Chlidonias niger*) and American Coot (*Fulica americana*) occurrences were not significantly correlated with any of the covariates we have assessed to date. With information about species-specific habitat associations within the Great Lakes region, it will be possible to provide a basin-wide predictive model of the distribution of obligate coastal wetland birds to priority areas for coastal wetland protection.

## **Tracking the effects of a neonicotinoid insecticide on migratory birds**

Margaret Eng, University of Saskatchewan; Bridget J. Stutchbury, York University; Christy Morrissey, University of Saskatchewan

Recent decades have seen a dramatic increase in the application of neonicotinoid insecticides, which are now the most widely used insecticides worldwide. Birds that travel long distances between their wintering and breeding grounds may be particularly susceptible to the neurotoxic effects of neonicotinoids. However, the influence of neonicotinoids on the ability of birds to successfully migrate is poorly understood. We assessed the impact of imidacloprid (IMI; a neonicotinoid commonly used in seed treatments) on the migratory behavior of seed-eating passerines during their spring migration. In 2016, we used captive orientation funnel trials to measure migratory orientation and activity of White-crowned Sparrows (*Zonotrichia leucophrys*) caught at stopover sites, and found that birds exposed to environmentally relevant concentrations of IMI reduced food consumption, experienced significant mass loss, and stopped orienting correctly in behavioural trials, whereas control birds maintained body mass and a seasonally appropriate northward orientation. In 2017 we conducted a field study in free-living White-crowned Sparrows to corroborate results from captive trials at an ecologically relevant scale. Birds were caught at a stopover sight in southern Ontario and exposed to control, low, or high doses of IMI (equivalent to 1 or 4 treated canola seeds). Following exposure birds were tagged with uniquely coded transmitter tags and released into an array of automated telemetry towers (Motus Wildlife Tracking System) to track their movements at a landscape scale. Using manual and automated telemetry data, we will be able to assess stopover duration, speed of travel between points, and direction of migratory movements.

## **The importance of the Los Angeles urban forest for sustaining migratory bird populations**

Sevan Essaian, California State University Los Angeles; Eric M. Wood, California State University Los Angeles

The Los Angeles metropolitan area (LA) is home to one of the most diverse urban forests on the planet with estimates suggesting nearly 600 native and non-native tree species are distributed throughout the region. The large diversity of trees in the urban environment is likely responsible for attracting a diverse assemblage of wintering migratory birds, which are predominantly native species that spend upwards of seven months of the annual cycle in the region foraging on the surface of trees for food items including insects and fruits. While it remains clear that LA is a hotspot for urban biodiversity, it is unknown exactly which factors influence interactions among birds and trees throughout LA. This is important to understand to help improve management of the LA urban forest for sustaining a major component of southern California biodiversity, the wintering bird community. During the winter of 2015 and 2016, we found strong support that native trees were highly preferred as foraging substrates by wintering migratory birds while non-native trees were avoided. We are building on our initial work by continuing to quantify patterns of bird and tree diversity, and describing tree-species preferences by wintering

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birds across a socioeconomic gradient throughout LA. More specifically, we have the following objectives within our study: (1) determine patterns of bird foraging success on varying tree species, (2) uncover disparities in the diversity of birds and trees along a socioeconomic gradient, and (3) investigate drivers, whether they are socioeconomic or 'natural', which may influence patterns of bird and tree diversity throughout the city.

## **Using microphone arrays to determine critical habitat and microhabitat of common avian species in steep decline**

Jeffrey Ethier, Memorial University of Newfoundland; David R. Wilson, Memorial University of Newfoundland; William Balsom, Memorial University of Newfoundland

The decline among North American landbirds has significant economic and ecological impacts. While legislation provides a framework for conservation, basic data on distributions and habitat preferences are lacking for many species. Traditional methods used to obtain this information are limited by cost, accuracy, and human resources. In this study, we investigated avian habitat and microhabitat preferences using microphone arrays that are capable of localizing vocalizing birds in three-dimensional space. Our objective was to identify the habitat and microhabitat features associated with two common species in steep decline, the Boreal Chickadee (*Poecile hudsonicus*) and the Cape May Warbler (*Setophaga tigrina*). In total, we deployed 68 eight-channel arrays at random locations in Labrador, Canada during the 2016 avian breeding season. We characterized the general habitat inside each array, and recorded a suite of weather variables at 20-minute intervals throughout each array's 24-hour recording period. In total, we detected 2.7 million vocalizations from 41 species. Boreal Chickadees were detected and localized at 47 arrays, while Cape May Warblers were detected and localized at 10 arrays. We are currently returning to those array locations and characterizing the microhabitat at the exact locations where Boreal Chickadees and Cape May Warblers were detected. We are also characterizing the microhabitat at a matching set of randomly determined control locations. Statistical analyses are ongoing, but will identify the habitat and microhabitat preferences of these two species in steep decline, which, in turn, will help to inform conservation strategies.

## **A spatially explicit model for estimating risks of pesticide exposure to bird populations**

Matthew Etterson, USEPA Office of Research and Development; Nathan Schumaker, USEPA Office of Research and Development; Kristina Garber, USEPA Office of Pesticide Programs; Steven Lennartz, USEPA Office of Pesticide Programs; Andrew Kanarek, USEPA Office of Pesticide Programs; Jennifer Connoly, USEPA Office of Pesticide Programs

Pesticides are used widely in US agriculture and may affect non-target organisms, including birds. Some pesticide classes (e.g., acetylcholinesterase inhibitors) are known or suspected to cause direct mortality to birds, while others (e.g., synthetic pyrethroids, neonicotinoids) may have sublethal impacts. We developed an integrated modeling workflow to conduct spatially explicit population level risk assessment for birds in agroecosystems that may be exposed to pesticides. The integrated workflow includes three existing USEPA models, the Terrestrial Investigation Model (TIM), the Markov Chain Nest Productivity Model (MCnest), and the HexSim modeling environment. The integrated model is parameterized using data required for pesticides under the Federal Insecticide Fungicide Rodenticide Act (FIFRA), together with species life history data available in the scientific literature. We demonstrate the model by simulating potential pesticide effects on the federally threatened California Gnatcatcher (*Poliophtila californica*), within the U.S. portion of the species range. We simulated impacts

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from two insecticides, malathion (organophosphate), and  $\gamma$ -cyhalothrin (pyrethroid), applied to wheat crops in a manner consistent with registered labels for the two pesticides. We show declines in gnatcatcher abundance and changes in the distribution of the species following applications of each pesticide, though the model does not predict extinction (within 50 years). The integrated TIM/MCnest/HexSim model is intended to allow risk assessors to evaluate spatial and temporal dynamics that are essential to understanding population persistence in complex spatial landscapes with multiple stressors

## **Does anthropogenic noise disrupt parental care in house wrens?**

Niana Faison, Western Michigan University; Eric Branch\*, Western Michigan University; Erin E. Grabarczyk, Western Michigan University; Maarten J. Vonhof, Western Michigan University; Sharon A. Gill, Western Michigan University

Accumulating evidence finds that anthropogenic noise decreases breeding success in birds. The mechanism by which this effect occurs is poorly understood, but noise could disrupt foraging by adults and thereby provisioning of young at nests, leading to lower reproductive success. We tested whether anthropogenic noise affects parental care in House Wrens (*Troglodytes aedon*) during provisioning of their nestlings. We compared provisioning rates of parents when exposed to playbacks of pink noise near nest boxes to control periods without noise playback. Pink noise has more energy in lower than higher frequencies, making it similar in structure to traffic noise but more consistent. We observed parental behaviors during 1 hr playback trials and determined the number of visits, the duration of time inside and outside boxes, and prey loading during control and noise treatments. Preliminary analyses found that house wren parents made fewer provisioning trips to feed nestlings, but they spent more time per visit both inside and outside of nest boxes during noise playbacks than control periods. Parents always brought only a single prey item, indicating no effect of treatment on prey loading. These early results suggest that noise disrupts provisioning but increases parental attendance at boxes. We speculate that increased attendance occurs under elevated noise because noise may distract parents and make it harder to detect predators, which in turn affects provisioning patterns. If so, parents may spend more time scanning their environment and may spend less time feeding their offspring under noisy conditions, contributing to lower success.

## **Influence of energetic condition and Vitamin E on West Nile Virus resistance of American Robins**

Kimberly Fake, Michigan State University; Jennifer C. Owen, Michigan State University

The environment plays a role in modulating host-pathogen interactions and ultimately the spread of infectious disease. West Nile Virus (WNV), a reemerging pathogen of global importance, is maintained in nature in wild birds. The magnitude and duration of virus circulating in the bird's blood directly impacts their ability to transmit the virus to a biting mosquito vector, which has consequences for disease dynamics. Environmental stressors, such as unavailability of food and specific nutrients, can influence a bird's response to this pathogen. Using the American robin (*Turdus migratorius*), an important avian reservoir for WNV, we will test how food limitation and vitamin E levels alter constitutive immunity and viral resistance. Wild-caught hatch-year robins will be held in captivity and divided into three different diet treatment groups, to achieve birds in (1) normal condition, (2) poor condition, and (3) normal condition with vitamin E supplementation. Following the diet treatment, all birds will be experimentally infected with WNV. Blood samples will be collected for titers of WNV and WNV-specific antibodies

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on 0-6 and 8-14 days post infection, respectively. Blood samples will also be collected at critical time points to assess constitutive measures of immune function, including white blood cell counts, natural antibody activity, complement activity, and plasma haptoglobin. We will also test the birds' plasma antioxidant capacity, oxidative damage, and plasma vitamin E concentration. Understanding how environmental variations influence a reservoir host's response to a pathogen, will lead to further understanding of epizootics that pose significant risk to humans, domestic animals, and wildlife.

## **Anthropocene's effect on habitat choice in early successional species: a preliminary study on the American Woodcock in northern New Jersey**

Kathleen E. Farley, Rutgers-Newark; Claus Holzapfel, Rutgers-Newark

Highly populated areas face the complementary effects of habitat loss and degradation leading to the potential for animals to select inferior habitat. Habitat selection tenets (e.g. Ideal Free Distribution) assume animals are well-informed regarding habitat quality before they establish territory. However, for migratory animals this assumption is unlikely to be upheld. In regions of industrial sprawl, animals are faced with identifying quality territory where former cues may no longer provide useful information. Post-industrial sites (old rail yards, landfills, former industrial complexes, superfund sites etc.) visually appear similar to early successional habitat, but these altered habitats may contain pollutants, altered hydrological regimes, delayed succession, and modified floral and fauna communities. These landscapes can exist as significant sources of available habitat within a region and may lead to a shift in habitat usage where animals equally or preferentially select post-industrial sites over non-industrial sites. To test this, during spring 2016 I monitored the activity of American Woodcock (*Scolopax minor*), an indicator species for the early successional faunal community, to determine to what extent they use post-industrial habitat. We conducted crepuscular courtship surveys from mid-March through early May across ~30 sites in northern New Jersey that were categorized as either post-industrial or non-industrial. Presence of woodcock, including numbers of actively displaying males, and frequency of courtship flights were determined across the region. Preliminary results suggest the woodcock do not discern differences between post-industrial and non-industrial habitat for courtship displays.

## **Building a Northeastern wildlife tracking network – The Northeast Motus Collaboration**

Alison Fetterman, Willistown Conservation Trust; Lisa Kiziuk, Willistown Conservation Trust; David Brinker, Project OwlNet; Scott Weidensaul, Project OwlNet and The Ned Smith Center for Nature and Art; Todd Alleger, Willistown Conservation Trust

After more than a century of research, our understanding of the movement ecology of migratory birds and other animals is still surprisingly rudimentary. Yet understanding how animals move across the landscape is critical to conserving them in a rapidly changing world. A new generation of miniaturized VHF radio telemetry technology, coupled with a rapidly expanding network of automated receiver stations through the Motus Wildlife Tracking System (Motus), has the ability to bring greater precision and efficiency to the study of migratory species such as birds, bats, and large insects. However, the greatest limitation to the current Motus array is its coastal nature. In 2016 we formed the Northeastern Motus Collaboration (NMC) to establish a network of wildlife tracking radio receivers across Pennsylvania and the interior northeastern United States, which will expand upon the current array of towers and increase researchers' ability to monitor interior flyways during migration. Over the next three years, the NMC aims to complete three phases of tower construction: 1) Install a line of 18 towers across



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Pennsylvania from Philadelphia to Lake Erie by September 2017; 2) Expand the statewide Pennsylvania network to approximately 40 towers by the end of 2018; and 3) In 2019, establish 30 or more towers northward in New York and New England, creating a more diffuse network across the northeast inland region. Once a minimum threshold of stations has been achieved, we will deploy VHF nanotags on nesting and migrant Northern Saw-whet Owls (*Aegolius acadicus*) at Project Owl-net cooperator stations in New England and eastern Canada, allowing us to track their movement in real time across continental scales. Expanding the Motus network to cover the mid-Atlantic and northeast will fill a critical geographic gap and will dramatically increase our ability to understand migration and habitat use by hundreds of species of migrants.

## **A comparison of occupancy estimates produced by morning versus evening point counts**

Melanie Florkowski, University of Michigan; Neil Gilbert, University of Alabama

It is well known that birds sing most frequently and are most detectable at dawn. Point counts, therefore, have been almost universally conducted in a four-hour window after sunrise. In this study, we investigate whether evening point counts can produce estimates of occupancy probability comparable to morning counts. Previous research suggests that avian density estimates vary by time of day. However, estimates of occupancy probability from morning versus evening data have not been compared. If evening point counts produce estimates comparable to morning point counts, ornithologists would be able to maximize survey time during the brief breeding season. We hypothesize that, while results will be species-specific, the estimates of occupancy probability will not be notably different for most species. In Summer 2017, we will conduct multi-species, fixed-radius point counts in both morning and evening hours in an agricultural mosaic in Alabama, USA. We will use a hierarchical occupancy model analyzed in a Bayesian framework to estimate occupancy probability using multiple candidate models incorporating different combinations of land-use/land-cover covariates and select the top models. We will first analyze the morning data and then use the selected models to estimate occupancy probability using the evening data. We will present the results by comparing the estimates for occupancy and detection probabilities generated by the morning and evening data. In addition to our hypothesized results, we recommend that researchers conduct pilot fieldwork to determine the variation in detectability of focal species by time of day prior to departing from standard morning point counts.

## **Determining Impacts on Least Tern Breeding Colonies Along a Gradient of Human Disturbance**

Brittany Fournet, The University of Charleston; Paul Nolan, The Citadel

Populations of seabirds and shorebirds are in steep decline including populations of the beach-nesting least tern (*Sternula antillarum*), which has decreased in number across its range. This study examines the impacts of human disturbance as a possible cause of the decrease. Human disturbance was measured at ten colonies in southwest Florida by observing flushing of terns from their nests in response to different degrees and types of disturbance. We recorded all disturbance events during our observation periods, as well as the distance of any disturbance from the colony. The colonies were divided into 15 m sections to compare impacts of disturbance on core versus peripheral parts of the colony. Different categories of disturbance included human, dog, crow, gull, other, and unknown. The different categories of disturbance events were significantly different in terms of percent of colony flushed and time spent away from the nest, with dogs and crows causing the largest response. There was no significant difference in our measure of response for the core versus peripheral parts of the colony, nor was there a significant correlation between the degree of disturbance and nesting success. Crow disturbances were typically at

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sites where trash was common on the beach. Our results suggest keeping dogs and crows away from the beach would reduce flushing of the least terns.

## **Comparison of Arrival Dates of Rail Migration in the Southwest Lake Erie Marshes, Ohio, USA**

Auriel Fournier, Mississippi State University; M.C. Shieldcastle, Black Swamp Bird Observatory; T. Kashmer, Black Swamp Bird Observatory; K.A. Mylecraine, New Jersey Audubon

Several studies have documented the arrival time of spring migration of Virginia Rails (*Rallus limicola*), King Rails (*R. elegans*), and Soras (*Porzana carolina*) on the southwestern shore of Lake Erie, though not in recent decades, and most of this information is based on anecdotal records. These three species were captured in wetlands on Ottawa National Wildlife Refuge in Ottawa and Lucas Counties, Ohio, USA, from 2004 to 2009. Virginia Rails and Soras were documented arriving in northern Ohio earlier than previous research, but not older anecdotal records. King Rails were within the bounds of all previous records. Using traps with playback may have allowed us to detect these species at earlier dates than previous research. Documenting current spring migration arrival timing of these three secretive marsh bird species is important for future monitoring, research and wetland management.

## **Loggerhead Shrike Occupancy in South Carolina**

Jennifer Froehly, Clemson University; Amy Tegeler, South Carolina Department of Natural Resources; Beth Ross, U.S. Geological Survey South Carolina Cooperative Fish and Wildlife Research Unit, Clemson University; Catherine M.B. Jacho

The Breeding Bird Survey (BBS) and Christmas Bird Count (CBC) indicate steep declines in the Loggerhead Shrike (*Lanius ludovicianus*) population for over thirty years. The BBS and CBC also indicate that the most severe decline in Loggerhead Shrikes occur in the southeastern United States. Because of these trends, Loggerhead Shrike is a species of highest priority on the South Carolina State Wildlife Action Plan of 2015, but few dedicated studies of the species have been conducted in this region. Our objective is to start to fill this data void by conducting surveys in the coastal plain of South Carolina using a passive point count and playback methodology, and to examine how land use may affect Loggerhead Shrike occupancy. In spring 2016 and 2017, we surveyed 96 roadside points adjacent to cropland or pasture habitats. We detected shrikes at 12 points through passive point counts, while 4 more patches were detected occupied when adding playback data, for a total of 16 occupied patches. We will use occupancy modeling to test biologically plausible hypotheses relating land use distribution factors at multiple spatial scales to Loggerhead Shrike occupancy. Preliminary results indicate an estimated detection rate of  $0.523 \pm 0.156$  and an occurrence rate of  $0.14 \pm 0.10$ , with occupancy being most influenced by percent forest at a 1km scale and aggregation of pasture at a 15km scale. We will project our top predictive occupancy model to the coastal plain of South Carolina to help guide future management and monitoring strategies for this species.

## **Social integration of irruptive Black-capped Chickadees into Carolina Chickadee territory**

Rebecca Garlinger, Villanova University Biology Department; Christine Eldredge, Villanova University; Chris Roche, Villanova University; Robert Curry, Villanova University

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Animal social behavior is often characterized by intricate and dynamic social interactions between individuals. Social network theory states that we can analyze dyadic interactions within a community to understand group-level social structures. Social network analysis (SNA) is a method that allows us to examine and quantitatively compare a wide range of social behaviors using network theory. We employed SNA using radio frequency identification (RFID) technology at feeders to examine social behavior in an overwintering population of resident Carolina Chickadees (*Poecile carolinensis*) and irruptive Black-capped Chickadees (*P. atricapillus*). From November 2012 through February 2013, Carolinas (N = 82) and Black-capped Chickadees (N = 14) formed seven SNA “communities” that were consistent with winter flocks in size (~ 13.7 birds per group) and home range. Communities demonstrated an average of  $17,880.2 \pm 6,125.06$  visitations, with  $1,820 \pm 192.7$  visits per bird across the site. Each of the seven communities had a preference for a different feeder location, yet 84% of all groups overlapped at feeders with at least one other visiting community. Pair-wise associations across all communities did not depend on species similarity ( $r = 0.015$ ,  $p = 0.334$ ), and both Black-capped and Carolina Chickadees showed similar numbers of associations. Resident Carolinas had stronger and more stable relationships ( $p < 0.001$ ) than Black-capped Chickadees and were more central and influential in the network. Our data suggest that resident Carolina Chickadees may not form discrete flocks, but instead form flock-like communities that allow for integration of irruptive birds.

## **Genomic Evidence for Aquatic Adaptation in the Common Loon (*Gavia immer*)**

Zach Gayk, University of Windsor; Alec R. Lindsay, Northern Michigan University

Comparative genomics has become a viable method for studying the adaptation of species to their environment at the genome level. We investigated this in Common Loons (*Gavia immer*) by finding signatures of positive selection as evidence for genomic adaptation. We used Illumina short read sequencing data from a female common loon to produce a fragmented assembly of the Common Loon (*Gavia immer*) genome. The assembly had a contig N50 of 814 bp, and a total length of 767,326,331 bp. We identified fragments of 13,821 common loon genes and another 348 coding sequences of unknown function, for a total of 14,169 common loon genes. Based on estimates from well-resolved avian genomes, this figure represents 80.7% of common loon genes. We calculated dN/dS ratios between Common Loon and Adelie Penguin, (*Pygoscelis adeliae*), Red-throated Loon (*Gavia stellata*), Chicken (*Gallus gallus*), Northern Fulmar (*Fulmarus glacialis*), and Rock Pigeon (*Columba livia*) for a high confidence set of 5,760 orthologous gene fragments to find genes under positive selection. We found 164 positively selected genes in the common loon that were enriched for a number of protein classes, including those involved in muscle tissue development, immunoglobulin function, hemoglobin iron binding, G-protein receptors, and ATP metabolism. The signature of positive selection in these areas suggests common loons may have adapted for underwater diving by (1) compensations of the cardiovascular system and oxygen respiration, (2) low-light visual acuity, (3) elevated solute exchange, and improved metabolism.

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## **Exploring patterns and drivers of acoustic diversity during the dawn chorus**

Sharon Gill, Western Michigan University; Nate Fuller, Southwest Michigan Land Conservancy; Kathleen M. Baker, Western Michigan University; Maarten J. Vonhof, Western Michigan University

The accelerating pace of conversion of natural landscapes to human-dominated ecosystems requires us to consider new ways to explore and understand diversity in natural areas. One approach is to study soundscapes, which are the collective sounds of environments; that is, sounds generated by animals, geophysical processes such as wind and rain, and humans and their activities. We recorded soundscapes of forest and grassland sites around sunrise at nine nature preserves over the summer to assess whether acoustic diversity, generated primarily by the dawn song of birds, varies over time and between habitat types within and across preserves. From recordings, we calculated the Acoustic Complexity Index (ACI), which has been shown to be a robust indicator of avian acoustic diversity. Analysis completed thus far incorporating date, time, habitat type and site finds that ACI was higher in grassland than forest habitats and changed over the season in both, but in different ways. ACI peaked after sunrise in grassland, but showed only a slight steady increase from 1 hour before to 3 hours after sunrise in forests. Generalized additive models including significant effects of date, time, and habitat, explained about 20% of the variation in ACI. Thus, our preliminary results suggest that acoustic diversity during the dawn chorus varied over time and space. We will present final results incorporating land-use, anthropogenic noise and weather in addition to those variables already considered to more fully understand patterns and drivers of acoustic diversity during the dawn chorus.

## **How the egg rolls: the geometry of avian egg movements.**

Ian Hays, Hunter College, City University of New York; Iva Ljubicic, Graduate Center of the City University of New York; Mark E. Hauber, Graduate Center of the City University of New York, University of Illinois, Urbana-Champaign

The significance of the avian egg's form for movement and spatial stability are understudied, despite its relevance to successful reproduction. A handful of prior studies focused on how pyriform eggs of the *Uria* genus of Murres roll in a small tight circle, a putative cliff-breeding adaptation, resulting from a dominant conical element of the shell's profile. These studies are problematic, however: they lack clear definitions of morphological characteristics/experimental variables; are limited to pyriform egg typologies; and have conflicting results. The aim of our study was to clarify the relationship between egg morphological traits and its movement/displacement, while ensuring validity to a broader swath of avian taxa. We identified and defined three distinct variables: width/length ( $W/L$ ), the apical width distance from the blunt end of the egg/length ( $AWD/L$ ), and how dominant a conical element is on the eggs profile (conicality). To study how eggs move, 3d printed models with single-variable modulations of form that incrementally deviate from a sphere were released onto a planar surface, at various inclinations. Digital motion tracking all egg-rolls ( $n=450$ ) showed the most conical egg model having significantly lower maximum displacement ( $p<0.001$ ) at the highest incline, than all other models. Decreasing a model's  $w/l$  value increased displacement, while lowering  $awd/l$  decreased displacement. Initial rolling results ( $n=270$ ) from 9 multi-variable egg models (modulating  $W/L$  and conicality simultaneously) showed that proportionally longer eggs might roll farther than shorter eggs with an identical level of conicality. Though *Uria* eggs are highly conical, their extreme low  $w/l$  ratio is not ideal for displacement suppression, suggesting alternate/additional selection pressures for the evolution of its unique shape.

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## **Effectiveness of CHD1 sex-linked chromosome primers in sexing Snowy Plovers on the southern Great Plains**

Kristen Heath, Texas Tech University; Warren C Conway, Texas Tech University; David A Ray, Texas Tech University; Neal Platt, Texas Tech University

On the Southern Great Plains (SGP), Snowy Plovers (*Charadrius nivosus nivosus*) are thought to be facultatively polygynous and/or monogamous. This theory has not yet been validated for these isolated midcontinental populations, and discrepancies in their assumed sexual dimorphism have been observed (females identified in the field have been molecularly revealed to be males). To better understand this phenomenon, we used DNA fragment analysis to determine the sex of 277 adult and nestling Snowy Plovers captured from 2008-2016, and collected high-resolution photographs of captured adults to examine plumage variability. We evaluated the use of two different primer combinations (P2/P8 and M5/P8) for the CHD1 sex-linked gene, using fluorescently-labeled primers to enhance PCR gel-electrophoresis and fragment analysis resolution. Amplicons > 300 bp, as with P2/P8, have been discovered to lose amplification efficiency. However, we found that M5/P8 primers, which reduce amplicon size by 130 bp and therefore increase amplification efficiency, to be a consistent and productive primer combination when sexing Snowy Plovers on the SGP. This supports other work in non-Charadriiforms that indicate the M5/P8 primer combination may be a more reliable, and consistent primer set for molecular sexing Snowy Plovers.

## **Effects of anthropogenic light and noise on the vocal behaviour and spatial ecology of birds**

Bronwen Hennigar, Memorial University of Newfoundland; David Wilson, Memorial University of Newfoundland

Anthropogenic disturbance, such as noise and light, can influence avian behaviours. For example, several observational studies have shown that the presence of noise and light from highways, airports, and cities is correlated with changes in song production, predator-prey interactions, and foraging behaviour. Yet, understanding the effects of these disturbances is challenging because multiple forms of disturbance often co-occur. For example, the noise produced by highway traffic is usually confounded by the presence of streetlights, headlights, and a highway. Furthermore, the fine-scaled spatial relationships between birds and disturbance is often difficult to observe, which further obfuscates our understanding of how birds react to disturbance. Our objectives are to: (1) test for a causal relationship between anthropogenic disturbance and the singing behaviour and spatial ecology of birds, and (2) to determine whether the possible effects of light and noise are redundant, additive, or synergistic. In this study, we manipulated anthropogenic light and noise using a 2-factor playback experiment, which resulted in four possible treatment combinations (no light or noise; light without noise; noise without light; light and noise). Treatments were broadcast throughout the night from inside microphone arrays that are capable of localizing vocalizing animals in 3-dimensional space. In total, we conducted 68 trials at random locations in Labrador, Canada. In each trial, we recorded and localized vocalizations produced before, during, and after the manipulations. Analyses are on-going, but should show the independent and combined effects of anthropogenic light and noise on the vocal behaviour and fine-scale spatial movements of birds.

## **Phylogeography of a widespread seabird (*Ardenna pacifica*) using genome-wide markers**

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Rachael Herman, University of Michigan; Donna Dittmann, Louisiana State University; Michael Harvey, University of Michigan

Pelagic seabirds are highly mobile, reducing opportunities for population isolation in allopatry that might promote differentiation and speciation. At the same time, many species are philopatric, and their tendency to return to their natal islands to breed may reduce gene flow sufficiently to permit local adaptation and differentiation. However, few well-sampled studies of geographic patterns of genetic differentiation have been possible in seabirds, primarily due to a shortage of fresh genetic samples from their remote breeding locations. Museum specimens can provide a ready source of DNA from otherwise un-sampled regions and sequence capture methods can be used to recover data from many genomic loci even in degraded museum specimens. We studied the phylogeography of a widespread seabird, the Wedge-tailed Shearwater (*Ardenna pacifica*), using a sequence capture approach. We sampled *A. pacifica* from throughout its distribution, using a combination of tissue samples and toepads from museum specimens. Using sequence capture and Illumina sequencing, we obtained data from thousands of genomic loci across samples, including museum skins. We found that *A. pacifica* showed significant genetic structure between major ocean basins, evidence that populations have differentiated despite the mobility and potential connectivity among them. We also found differences among populations in effective population size, and evidence of historical migration among populations. Our results highlight the potential of sequence capture methods for genetic studies in species for which recent samples are widely unavailable.

## **The correlation among microsatellites, genome size, metabolic rate, and body mass in birds**

Yanzhu Ji, Field Museum of Natural History; J. Andrew DeWoody, Purdue University; Shannon J. Hackett, Field Museum of Natural History

Microsatellites are hypervariable tandem repeats in eukaryotic genomes which often serve as neutral or nearly-neutral genetic markers. Compared to other taxa, bird genomes are relatively small with conserved karyotypes and low transposon activity. Given these attributes of bird genomes, we hypothesized that the content of microsatellites would be positively correlated with avian genome size. Since avian genome size is intercorrelated with body mass and metabolic rate, we therefore expected the content of microsatellites to be correlated with body mass and metabolic rate as well. Using over 60 published bird genomes and Tandem Repeat Finder, we examined the content of microsatellites from whole-genome assemblies. We correlated the length, number, and mean allele size of microsatellites with genome size, body mass, and metabolic rate. Microsatellites were not correlated with genome size. However, we found mean allele size of microsatellites to be positively correlated with metabolic rates and negatively correlated with body mass. We conclude with a discussion of biological and technical factors to help explain these observations.

## **Phylogeography of the Green-throated Mountain-gem (*Lampornis viridipallens*)**

Rosa A. Jiménez, University of California, Berkeley, Universidad de San Carlos de Guatemala; Zachary R. Hanna, University of California, Berkeley; María Fernanda Asturias, Universidad de San Carlos de Guatemala; Rauri C.K. Bowie, University of California, Berkeley

Nuclear Central America (NCA), located between the Isthmus of Tehuantepec (IT) and the Nicaraguan Depression (ND), possesses a complex topography and climatic history. Volcanic mountain ranges originated in the region through the tectonic processes of transformation and subduction and were greatly impacted by the Pleistocene

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climatic cycles. The IT and ND are dry, lowland valleys that montane species are unable to cross. These natural barriers have contributed to allopatric divergence of animal and plant lineages. However, the effect of the internal topography of NCA on lineages of montane avian species has not been well-explored as the majority of studies have included few samples from this region. In order to examine whether phylogeographic breaks exist across montane habitats within this region, we collected samples of *Lampornis viridipallens*, an endemic hummingbird species restricted to mountain cloud forests. We visited seventeen sites across the major mountain ranges in western NCA (Chiapas, Mexico and Guatemala). Genetic analyses indicated that, while there is evidence of gene flow, there are major geographic features, such as the Motagua-Polochic-Jocotan series of faults, that represent barriers to movement among mountain ranges. Our analyses also revealed high genetic diversity within two mountain ranges, the Sierra de Chamá and the Sierra Madre Volcanic Range. We found that montane cloud forest habitats in NCA act as islands in a lowland matrix to isolate populations of *L. viridipallens*, which suggests that the intricate topography within NCA has been an important driver of the diversification of the resident montane avifauna.

## **A vagrant Kingbird in Ohio represents the first known Western x Couch's Kingbird (*Tyrannus verticalis* x *T. couchii*)**

Andrew W. Jones, Cleveland Museum of Natural History; Courtney L. Brennan, Cleveland Museum of Natural History; Kenn Kaufman, Black Swamp Bird Observatory; H. Thomas Bartlett, Cleveland Museum of Natural History

In December 2015, a Yellow-bellied Kingbird (genus *Tyrannus*) was discovered on Kelleys Island in the western basin of Lake Erie (Erie Co., Ohio, USA) by Tom and Paula Bartlett. Western Kingbirds (*T. verticalis*) are fairly routine vagrants to eastern North America in fall, and this individual was initially reported as that species. Additional field observation suggested that coloration and structure were inconsistent with a pure Western Kingbird. The outer tail feathers had white margins, typically diagnostic in this genus for Western Kingbird, but the white was reduced in extent. The bill size and shape, tail shape, breast coloration, and other details differed from Western Kingbird and suggested that one parent was either a Tropical Kingbird (*T. melancholicus*) or Couch's Kingbird (*T. couchii*). The bird responded to playback of Couch's Kingbird vocalizations, but not to those of Western nor Tropical Kingbirds. In-hand examination showed that this individual was an after second-year male. The bird was banded, and we obtained feathers for DNA analysis. We amplified and sequenced the mitochondrial ND2 gene and the nuclear myoglobin intron 2 of this individual as well as several congeners. The mitochondrial data were similar to a known Couch's Kingbird. The nuclear gene had four heterozygous loci and confirmed that the other parent was a Western Kingbird. This is the first documented hybrid between these two species.

## **Ecological correlates of behavioural and social change in dichromatic Papuan Fairywrens**

John A. Jones, Tulane University; Jordan Boersma, Washington State University; Erik Enbody, Tulane University; Jordan Karubian, Tulane University

Ecological variation within a close geographic proximity may play a substantial role in shaping local behavioural phenotypes. Australo-Papuan Fairywrens (Maluridae: *Malurus*) exhibit substantial variation in habitat preference, morphological phenotype, and sociality. Our research focuses on the degree to which ecological variation (here, natural and anthropogenic habitat structure changes due to forested areas and burning of grass) influences movement, home range extent, and sociality in a dichromatic population of the White-shouldered Fairywren (*M.*

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*alboscapulatus lorentzi*). This species is notable because males are qualitatively similar in appearance across multiple subspecies throughout New Guinea, whereas female plumage variation ranges from fully dichromatic to nearly monochromatic. Our previous research with two subspecies of White-shouldered Fairywrens has revealed substantial differences in land use, body size, aggression, and overall sociality. From July-Oct 2016 and Mar-June 2017, we investigated how variation in habitat structure and patchiness of available habitat influences movement and social behaviors within dichromatic White-shouldered Fairywrens. We quantified social change relative to variation in habitat structure before and after large (human-induced) burns throughout our field site, using burns as a proxy for habitat fragmentation. We found that overall sociality decreased in areas that are highly fragmented whereas continuous grasslands remained highly social. However, after previously scorched areas of our field site had recovered, sociality appeared to increase, representative of that of continuous grassland areas. These findings are consistent with the idea that habitat structure and fragmentation across New Guinea may have played a role in shaping phenotypic divergence of White-shouldered Fairywrens.

## **Changes in song repertoire length and song elements use in response to different levels of anthropogenic noise**

Roselvy Juárez, Universidad de Costa Rica; Gilbert Barrantes, Universidad de Costa Rica; Luis Sandoval, Universidad de Costa Rica

Anthropogenic noise in urban habitats affects negatively the acoustic communication of birds, because it could mask vocalizations that birds use to communicate with other individuals. To understand how individual birds overcome the effect of noise is a key part of understanding their communication in urban habitats. Therefore, our main goals were: (1) to compare differences in richness and abundance of elements on House Wren song repertoire between populations exposed to different noise levels, and (2) to evaluate in the elements shared between populations how the frequency and time characteristics vary in relation to noise. We recorded 28 males of House Wren during two consecutive breeding seasons, at four locations exposed to different noise levels. We recorded each male on two days each breeding season for one hour per day, and simultaneously measured noise level with a sound level meter. We classified song elements based on the appearance in the spectrogram and frequency characteristics. We measured minimum and maximum frequency, frequency of maximum amplitude, and duration in each element. House Wrens inhabiting less noisy locations had larger repertoires than individuals inhabiting noisy locations. This may indicate that some elements do not transmit well in noisy environments, and therefore are not produced. Shared elements between populations showed higher minimum frequency in noisy sites, probably to avoid being masked by noise. These results provide evidence of adaptations that birds inhabiting urban environments implement to communicate acoustically.

## **Methods matter: a better way characterize the diets of insectivorous birds using fecal DNA**

Michelle A. Jusino, USFS; James Skelton, University of Florida; Mark T. Banik, USFS; Jonathan M. Palmer, USFS; Lori Blanc, Virginia Tech; Steven Good, Virginia Tech

Next-generation sequencing (NGS) offers a powerful and non-intrusive tool to characterize avian diets. However, methodological decisions and data processing have a major impact on the results obtained from NGS techniques. More informed methodologies lead to more accurate assessments and more robust conclusions. We used template DNA from a diverse set of arthropods to assess PCR biases of several CO1 primer pairs used to assess dietary information from insectivore feces. To validate our diversity estimation in mixed DNA samples, we developed a



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“mock diet”, consisting of single-copy plasmid DNA from a taxonomically diverse set of over 40 arthropod taxa, to serve as a spike-in control. The mock diet was also used as a reference to inform our bioinformatics pipeline. The most frequently used primer pair for NGS insectivore diet studies (ZBJ) had a narrow taxonomic range, and favored detection of certain arthropod taxa. In PCR tests, a novel primer pair (ANML) recovered 98% of arthropod taxa, whereas ZBJ recovered 40%. We then used ANML primers to perform NGS on fecal samples collected from 7 adult Red-cockaded Woodpeckers (*Picoides borealis*; RCWs) at Eglin Air Force Base during fall and winter 2016. We recovered 40,000 sequences, and identified 22 arthropod taxa, including many that RCWs were not known to consume. Unexpected taxa included several known and potential forest pests. Previous studies that visually examined RCW stomach lavages suggested that RCWs are ant specialists. Ants were notably missing from our NGS data, suggesting that their importance to RCWs may vary across time or populations.

## **Development and analysis of avian index of biological integrity for Kentucky wetlands**

Kaitlyn Kelly, Eastern Kentucky University; David Brown, Eastern Kentucky University

Bird communities are frequently used as bioindicators to assess environmental conditions, including in wetland habitats. We developed an avian index of biological integrity (IBI) for wetlands of Kentucky as an intensive assessment method to supplement an existing rapid assessment method used in regulatory programs. Birds are useful indicators because they are sensitive to environmental changes, abundant in various landscapes, occupy higher trophic levels, and can be sampled in a cost-effective manner. Breeding bird point count data from 140 sites were used to calculate a set of metrics, including avian community measures and guilds based on relative abundance. Metrics were tested for correlation with an independent measure of wetland condition based on landscape and site stressors. High performing, non-repetitive metrics were tested in various combinations to find avian community metrics that best predicts wetland condition. Final metrics were scaled and assembled into an IBI. We found four superior metrics to be correlated with the independent disturbance index. Insectivorous and foliage-gleaning guilds had higher relative abundance at higher condition wetlands, while omnivorous and ground-gleaning guild percentages had higher relative abundance at lower condition wetlands. Guilds represented in these metrics included more species than other metrics tested, creating a greater degree of variation within the guild to correlate to the disturbance index. Previous studies in other regions found similar results with insectivorous and foliage-gleaning guilds being intolerant to human disturbance, whereas omnivorous and ground-gleaning guilds tend to be more tolerant. This cost-effective and time-efficient IBI complements existing assessment tools for wetlands of Kentucky.

## **Nested subset patterns of avian assemblages in wetlands**

Libby Keyes, Governors State University; Rick Baisa, Governors State University; John Yunger, Governors State University

Nested subset patterns are used to describe nonrandom distributions of species in isolated habitats and require that species found in smaller, less diverse locations are also found in more species-rich assemblages. These distributions can be heavily influenced by a variety of biotic and abiotic factors, particularly habitat fragmentation that occurs as a result of urbanization and human disturbance. The size of the areas following human disturbance is a key factor in driving distribution patterns. Consequently, nested models lend themselves to the conservation

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and management of preserves, including the determination of their size and distribution. The distribution and abundance of breeding wetland birds in northeastern Illinois was surveyed during the summers of 2015 and 2016. These data were analyzed using Monte Carlo simulations, whose results indicated that the birds exhibited statistically significant non-random distribution patterns. Generally, the number of species became more diverse as habitat area increased and species found in small sites were also found in larger sites. Our results strongly suggest that wetland birds are area-sensitive species whose management strategy should focus on a few large preserves as opposed to numerous small preserves when available land is limited. Comparison to results from a similar study conducted in 1998 show no significant change in nested subset patterns despite altered levels of human disturbance, suggesting that the distribution of wetland birds appears to be stable over time.

## **Michigan's ugly duckling: quantifying color morphs in Mute Swan cygnets**

Randall Knapik, Michigan State University; David Luukkonen, Michigan Department of Natural Resources; Scott Winterstein, Michigan State University

Mute Swans (*Cygnus olor*) are large waterbirds native to Eurasia whose cygnets exhibit gray (dominant) and white color morphs controlled by a single sex-linked gene. Color morph prevalence varies in their native range (80 – 99% gray) as a result of selective breeding for white morph individuals. Human-assisted movement to North America has resulted large feral populations; however, the genetic composition of founding individuals is unknown. As a result, the color morph ratio of mute swans in Michigan's population is unknown. Previous research in their introduced range has shown differences in survival and age-at-first nesting between the color morphs which could influence management strategies. A partnership was established between Michigan State University, the Michigan Department of Natural Resources, and the U.S. Department of Agriculture's Wildlife Services to inform management strategies of the invasive mute swan. The number of cygnets of each color morph was determined at hatch for nests within five 36 km<sup>2</sup> study sites in Michigan. Forty-three percent of hatched cygnets had gray initial plumage, but the proportion of gray cygnets varied between sites (0 – 78%). A subset of fledged gray (n = 9) and white (n = 13) morph cygnets were fitted with neck collar-mounted GPS-GSM transmitters to estimate survival and movement. Survival ( $0.604 \pm 0.16$ ; 1 October – 31 March) was slightly lower than in other areas of their native and introduced range and no GPS-marked cygnets nested at 1 year of age. Results from this research are being used to refine population management strategies in Michigan.

## **Visible migration counts of the Common Nighthawk (*Chordeiles minor*) on the north shore of Lake Superior**

Stephen Kolbe, University of Minnesota-Duluth; Annie Bracey, University of Minnesota-Duluth; Gerald Niemi, University of Minnesota-Duluth; Matthew Etterson, U.S. Environmental Protection Agency

With average annual counts of over 20,000 individuals, the fall migration of Common Nighthawks (*Chordeiles minor*) along the north shore of Lake Superior is the largest known concentration of this species in the world. Visible migration counts of nighthawks were conducted for three weeks each year from 2008-2016 in Duluth, Minnesota. This daily evening count has elucidated the weather variables that most often lead to large flights: light winds, westerly winds, and warm temperatures, conditions not often associated with autumn migration. While the geographic origin of these migrants is unknown, many come from the Canadian boreal forest, where this species has undergone a significant decline and is listed as threatened. Due to the low density and crepuscular nature of this species, survey methods such as the Breeding Bird Survey or the National Nightjar Survey are ineffective for population assessments. The annual fall count on Lake Superior is likely the best and most cost-effective way to

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census Common Nighthawks breeding in the boreal forest and to determine population trends for this declining aerial insectivore.

## **Urbanization alters fear behavior in Black-capped Chickadees**

Zachary Kruyf, Calvin College; Jenna L. Atma, Calvin College; Hattie N. LaCroix, Calvin College; Jenna L. Van Donselaar, Calvin College; Darren S. Proppe, Calvin College

Our landscapes are becoming increasingly urban. Urbanization provides many benefits for humans, but it dramatically alters the habitats utilized by animals. Urban habitats also contain many novel stimuli, some which represent threats and others which are harmless. As such, urban adapted songbirds must learn quickly which threats require a fearful response. In cases where experience is correlated with a cost, fear should increase. Conversely, fear due to novelty should decrease when negative outcomes do not follow the stimulus. Black-capped Chickadees (*Poecile atricapillus*) are an excellent model to compare fear behavior because they thrive in both urban and rural habitats. We conducted a series of feeder and playback experiments to explore whether urbanization altered Black-capped Chickadee's fear responses to model cats, humans, a novel object, anthropogenic noise, and willingness to cross forest openings. We predicted that neophobic responses to cat models would increase in urban birds because interactions with cats are more common, but decrease compared to rural birds for all other stimuli because there is not an immediate fitness cost. Fear of cats increased with urbanization and fear of noise decreased, as indicated by willingness to visit a feeding station. However, other stimuli were not associated with urbanization, which may be related to the use of parks rather than more secluded locations. These plastic behavioral responses to novel stimuli may facilitate the urban success of the black-capped chickadees and may be an important indicator of whether a species can thrive in the urban environment.

## **Some factors associated with egg hatching in Tree Swallows**

Michael Lombardo, Grand Valley State University; Brianna Wilson, Grand Valley State University; Nicole Keck, Grand Valley State University; Stacy Keydel, Grand Valley State University

Egg hatching success is critical to the reproductive performance of birds. We tracked the hatching success of 7,095 individually-marked eggs laid in 1,387 Tree Swallow nests in nest boxes in west Michigan from 1992-2016. The year an egg was laid, the date it was laid, its mass, and the total number of eggs in its clutch were associated with its hatching success if it was laid by a second-year female, but not if it was laid by an after-second-year female. In second-year female nests, eggs that hatched weighed more than those that did not. The mass of eggs laid by after-second-year females was not associated with their hatching success. Eggs 1-3 were as likely to hatch as were eggs 4-6 in second-year female nests. In contrast, eggs 4-6 were more likely to hatch than were eggs 1-3 or egg 7 in after-second-year female nests. Overall, an egg's position in the clutch was not associated with its probability of hatching in the most common clutch sizes of 4-6 eggs. Whether all the eggs in a clutch hatched or not was associated with the number of eggs in the clutch and the age class of the female that laid them. Generally, complete clutches were more likely to hatch if the eggs were laid by after-second-year females. Collectively, these results suggest that depending on female age class different factors were associated with egg hatching success in Tree Swallows.

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## **Habitat associations and abundance of birds in the Black Hills and Bear Lodge Mountains of South Dakota and Wyoming**

Elizabeth Matseur, University of Missouri; Frank R. Thompson III, USDA Forest Service Northern Research Station; Joshua J. Millspaugh, University of Montana; Brian E. Dickerson, USDA Forest Service Rocky Mountain Research Station; Mark A. Rumble, USDA Forest Service Rocky Mountain Research Station

Human activity and natural disturbances, such as wildfire and mountain pine beetle (*Dendroctonus ponderosae*) infestation, have recently altered forest structure in the Black Hills. More information on relationships between avian abundance and forest structure and disturbance is needed. Our objective was to determine densities of American Three-toed Woodpecker (*Picoides dorsalis*), Black-backed Woodpecker (*Picoides arcticus*), Brown Creeper (*Certhia americana*), Red-breasted Nuthatch (*Sitta canadensis*), and White-winged Junco (*Junco hyemalis aikenii*) in relation to vegetation characteristics and disturbance at the point- and landscape-level in the Black Hills and Bear Lodge Mountains of South Dakota and Wyoming. We conducted 3,696 and 3,414, 5-minute point count surveys, from late-March to late-June in 2015 and 2016, respectively, across a gradient of forest structure and disturbance types. We estimated densities using three-level hierarchical time-removal models. Black-backed Woodpeckers and Brown Creepers were positively related to recent wildfires; however, Red-breasted Nuthatches were negatively related to percent area in 3- to 5-year-old wildfires. With the exception of American Three-toed Woodpeckers, species were positively related to percent cover of beetle killed trees. Brown Creepers, White-winged Juncos, and Red-breasted Nuthatches had mixed responses to percent overstory canopy cover. White-winged Juncos also had a positive association with percent ground vegetation, whereas, Brown Creepers were strongly linked with white spruce (*Picea glauca*) vegetation type. Maintaining some areas of natural disturbances along with heterogeneity of vegetation characteristics within stands and at the landscape-scale will benefit the diverse needs of birds in the Black Hills.

## **Synchronization and frequency features of highly overlapped duets change according to the context**

Carolina Mendez, Universidad de Costa Rica; Luis Sandoval, Universidad de Costa Rica

Territorial defense and mate guarding are two main hypotheses of duets functions. Nevertheless, acoustic characteristics of duets under both functions have rarely been quantified in detail. The aim of this work was to analyze changes in the spectrotemporal characteristics and synchronization in White-eared Ground-sparrow duets produced in both contexts: territory defense and mate guarding. If contexts affect spectrotemporal characteristics and synchronization, we expected to observe differences when compare duets of the same pair in each context. We conducted the study in 35 color banded ground-sparrows pairs in Costa Rica. We recorded pair duets produced spontaneously when members of the pair came into contact, to analyze duet features under mate guarding context. We recorded duets produced in response to simulate intrusions using acoustic playbacks, to analyze duet features under territory defense contexts. We measured minimum and maximum frequency, the frequency of maximum amplitude, and duration of duets. We measured synchronization comparing time and frequency variation in three sections of duets (i.e., start, middle, and final section) of duets produced under both contexts. Duets in territory defense contexts showed lower minimum frequencies and higher synchronization than mate guarding contexts. Our results suggest that White-eared Ground-sparrows encode context-depend information by changing frequency characteristics and synchronization of duets. In conclusion, decrease the minimum frequency and increase the synchronization of duets produce a most aggressive, and probably most effective, duets in territorial defense, given that low-frequency sounds are associated with hostile contexts.

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## **Influence of environmental gradients on the relationship between taxonomic and functional diversity in grassland birds**

Nadejda Mirochnitchenko, Nebraska Cooperative Fish & Wildlife Research Unit, University of Nebraska–Lincoln; Erica F. Stuber, Nebraska Cooperative Fish & Wildlife Research Unit, University of Nebraska–Lincoln, Joseph J. Fontaine, U.S. Geological Survey, Nebraska Cooperative Fish & Wildlife Research Unit, University of Nebraska–Lincoln

Ecologists often use biodiversity to prioritize conservation and management decisions. Because numerous definitions of biodiversity are used in ecological research, each cataloging a different aspect of diversity or measuring systems at different levels of biological organization, it is difficult to generalize findings. As various definitions of biodiversity might lead us to prioritize conservation of different areas, we propose a framework for evaluating biodiversity metrics that are directly comparable, evaluate the fundamental relationships between commonly used diversity metrics, and investigate why these fundamental relationships might become disjointed spatially. Biodiversity metrics that are functionally unrelated should not be used interchangeably without caution, whereas metrics that are stably correlated across landscape gradients might safely be interchanged in studies of diversity. Here we examine the relationship between species richness and functional group richness in bird communities across the state of Nebraska, covering a wide land use gradient. We surveyed the avian community during the breeding season using point counts and used species occurrence to quantify species richness and functional richness in nesting, foraging, and diet guilds. We use multivariate models to examine the relationship between two common metrics of biodiversity, species and functional group richness, and demonstrate how the relationship is influenced by a land use gradient. Our results will be useful to conservation biologists and wildlife managers interested in targeting areas that maximize both species and functional group richness in this declining guild of birds.

## **A multi-scale approach to detecting the response of migratory land birds to changes in habitat availability**

Frank Moore, University of Southern Mississippi; Theodore J. Zenzal, University of Southern Mississippi

Each autumn, the northern coast of the Gulf of Mexico provides habitat for birds migrating from temperate breeding locations to tropical wintering grounds. The availability of these stopover habitats is constantly changing in response to natural and anthropogenic impacts. For example, coastal counties of Mississippi and Alabama have gained urban development and lost forested habitats. Loss of stopover habitat, especially close to migration barriers (oceans, deserts), likely increases migrant density in remaining habitats and increases competition for limited food resources. Our objective is to use a multi-scale approach to determine the response of migratory birds to changes in stopover habitat availability within Alabama (Baldwin and Mobile counties) and Mississippi (Jackson County). Our approach involves: 1) Using weather surveillance radar over a broad extent to relate changes in autumn migrant stopover distributions with changes in land use over the last 20 years. We expect migrant densities to decrease in areas that experienced urbanization or deforestation, while migrant densities should increase in areas reforested. 2) Using bird banding data from 1995 – 2014 collected at the Bon Secour National Wildlife Refuge in Fort Morgan, AL, to determine if local migrant abundance matches regional patterns of migrant density. These two complementary, long-term datasets provide a unique perspective on the reliance of land bird migrants on coastal habitats.

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## **Disentangling the evolutionary history and functionality of avian assemblages in a city of the Chihuahuan Desert**

Israel Moreno-Contreras, Museo de Zoología, Facultad de Ciencias, UNAM; Héctor Gómez de Silva, Cuauhcihuatl Vital-García, Instituto de Ciencias Biomédicas, UACJ, Marco Ortiz, Museo de Zoología, Facultad de Ciencias, UNAM

Urban habitats differ in their disturbance regimes, which act as an environmental filter determining plant community species composition. Although urban avian assemblages have been thoroughly studied, there is considerably less knowledge about the evolutionary history and functionality of bird assemblages in desert ecoregions. In this study, we quantified two biodiversity metrics (phylogenetic and functional) in avian communities from Ciudad Juárez, a city located in the Chihuahuan Desert ecoregion. We sampled the three major habitat types present in Ciudad Juárez: urban green areas (parks, golf courses), agricultural fields, and desert scrub, between July 2012 to August 2015. We also used spatial and non-spatial regressions to test for relationships between phylogenetic and functional and predictor variables describing current climate, elevation, human population density, human impact, habitat heterogeneity, and log-transformed introduced alien bird richness.

## **Variation in tail spot size in Hooded Warblers: sexual dimorphism but no evidence of sexual selection**

Ronald Mumme, Allegheny College; Anne Jacobs, Georgia Southwestern State University; Abby Hileman, Shaver's Creek Environmental Center

Hooded Warblers startle potential insect prey by constantly flicking their tails while foraging, revealing the contrasting white tail spots on the outer rectrices. Tail spot size, however, shows considerable inter-individual variation that is highly repeatable across annual molts and significantly related to both age ( $ASY > SY$ ) and sex ( $M > F$ ), even after statistically controlling for variation in tail length. We tested the hypothesis that the sexual dimorphism in tail spot size was a result of sexual selection by means of a field experiment at our study site in NW Pennsylvania. As females were arriving in early May in 2014-15, we captured 24 territorial males and either temporarily reduced the extent of white in their tail ( $N = 13$ ) or treated them as sham-reduced controls ( $N = 11$ ). Reduction of tail spot size had no significant effect on pairing success (100% in both groups), date of pairing, first egg date, or mate quality (measured by minimum age of the mate). Although it is possible that male tail spot size may affect extra-pair mating success, our results suggest that the sexual dimorphism in tail spot size may not be a product of sexual selection. Instead, we suggest that the sexual dimorphism may be related to strong sex differences in preferred habitat on the Caribbean wintering grounds; because males prefer closed-canopy tropical forest and females prefer open scrub habitat, natural selection for optimal foraging performance in different light environments may be responsible for the sex difference in tail spot size.

## **Effects of human disturbance level on yolk carotenoid allocation in Carolina Chickadees**

Jennifer Newbrey, Columbus State University; Jaleesa Clarke, Columbus State University; Michael G. Newbrey, Columbus State University

Human disturbance can negatively affect the reproduction of birds, with birds breeding in areas with high levels of disturbance typically experiencing lower reproductive success than those in less disturbed habitats. A novel way to assess the effects of human disturbance on avian reproduction is to measure variation in concentrations of yolk

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carotenoids (i.e., biologically active, yellow, orange, and red pigments) from birds breeding in habitats of varying levels of disturbance. We studied variation in yolk carotenoid concentrations, egg metrics, female morphological characteristics, and measures of reproductive success of Carolina Chickadees (*Poecile carolinensis*) breeding at four sites with varying levels of human disturbance in west-central Georgia, USA. Carotenoids had never previously been studied in Carolina Chickadee eggs, so we first identified the yolk carotenoids for the species. We found four yellow dietary carotenoids in the egg yolks of Carolina Chickadees: beta-carotene, beta-cryptoxanthin, lutein, and zeaxanthin. We found significant differences in concentrations of total carotenoids and beta-carotene across sites, with chickadees breeding at the site with the lowest level of human disturbance having the highest concentrations of carotenoids. Surprisingly, chickadees that bred at Columbus State University, a high disturbance site, also had high yolk concentrations, suggesting that other habitat features also influenced carotenoid allocation. No significant differences were found in egg metrics, female morphological characteristics, or measures of reproductive success across sites. Future research will focus on direct quantification of human disturbance at the study sites to better understand the role that disturbance plays in affecting carotenoid allocation and chickadee reproduction.

## **Investigating the genomic consequences of a precipitously declining Florida-scrub Jay population**

Tram Nguyen, Cornell University; John W. Fitzpatrick, Cornell Lab of Ornithology; Andrew G. Clark, Cornell University

Understanding the genetic consequences of population decline is an ongoing challenge in evolutionary biology, ecology and conservation. Describing the relationship between genetics and shrinking population sizes is more important than ever as global change, habitat loss, and fragmentation threaten more and more species. The prevailing conservation genetics paradigm predicts that shrinking populations are increasingly subject to genetic drift and stochastic processes that reduce genetic variation, which in turn, can cause inbreeding depression, reduced resistance to disease, and increased susceptibility to environmental stochasticity. Models abound about the impacts of population decline, but empirical evidence remains scarce, especially in natural populations over long time periods due to the shortage of genomic resources. With the advent of next-generation sequencing, it is now possible to obtain precise measurements of both neutral and functional genetic variation in order to trace genetic responses to population decline. We leverage genome-wide single-nucleotide polymorphism (SNP) and demographic data to assess changes in genetic diversity, level of inbreeding, and degree of relatedness within and between two Florida scrub-Jay (*Aphelocoma coerulescens*) populations of varying sizes and trajectories over an 8 year period to investigate fundamental ecological and evolutionary questions about the genomics of population decline in the wild.

## **Dynamic color in a black-and-white world: Penguin beak spots as biosentinels in the Antarctic**

Paul Nolan, The Citadel; Brogin Van Skoik, The Citadel; Tom Hard, University of Oxford

Animals' external characteristics, including behaviors, sexually-selected ornaments, and integumentary colors, reveal details of their age, physiology, and/or body condition. Ornamental coloration of the beak and feet, in particular, signal health status that can vary dynamically on a time frame of minutes or hours. Gentoo penguins (*Pygoscelis papua*) display a deep red beak spot, with substantial variation between individuals shown

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experimentally to reflect concentration of carotenoid pigments. Carotenoid pigments may be used in mating displays or in the immune system, meaning that birds showing the deepest red are in the best condition. We sampled 50+ birds at each of 10 breeding colonies on the Antarctic peninsula, taking care not to sample the same bird twice. Using a color standard placed next to the bird in each photo, we standardized light levels of the photos before measuring hue, saturation, and brightness. We calculated colony-wide mean values along each of those parameters, and found substantial variation between the colonies. We compare those means with other publicly-available data to assess possible causes of the variation, considering prey availability, tourism visits, latitude, and ambient temperature changes as possible correlates. Our work will not only allow better management of human activities such as tourism and fishing in the Antarctic, it may help us predict future changes on the Antarctic peninsula.

## **Environmental heterogeneity and metabolic flexibility in Horned Larks and House Sparrows**

Paige Oboikovitz, University of South Dakota; David Swanson, University of South Dakota

Bird species vary in their physiological and behavioral capacities to cope with changing environmental temperatures. Summit metabolism ( $M_{sum}$  = maximum cold-induced metabolic rate) may vary geographically and temporally within and among bird species, with species living in colder environments generally having greater metabolic capacities. Seasonal adjustments of metabolic capacities also occur in birds, with elevated capacities in winter than in summer for species wintering in cold climates. Behavioral selection of favorable microclimates can moderate seasonal exposure to temperature variation, but opportunities for such microclimate selection may vary among birds, depending on their habitat. In this study, we compared seasonal minimum (basal metabolic rate, BMR) and maximum ( $M_{sum}$ ) metabolic rates of Horned Larks (*Eremophila alpestris*) and House Sparrows (*Passer domesticus*). Horned Larks occupy open areas, with little protection from weather conditions, whereas House Sparrows occupy more sheltered habitats. We hypothesized that greater seasonal variation in operative temperatures ( $T_e$  = field climatic conditions) would occur in open field sites occupied by Horned Larks than for the more sheltered sites occupied by House Sparrows and that Horned Larks, consequently, would show greater seasonal flexibility in metabolic rates than House Sparrows. Preliminary data are consistent with these predictions, with open areas showing greater seasonal differences in  $T_e$  than more sheltered areas and larks showing greater seasonal variation in metabolic capacities than sparrows (Winter  $M_{sum}$ /Summer  $M_{sum}$ : 53% for Horned Larks, 28% for House Sparrows). These data are congruent with the idea that temperature serves as a primary driver for metabolic variation in birds.

## **Breeding habitat of the critically endangered Bahama Oriole: new documentation of extensive breeding in pine forests.**

Kevin Omland, University of Maryland, Baltimore County; Daniel C. Stonko, Bahamas National Trust; Lehron Rolle, Bahamas National Trust; Michael G. Rowley, UMBC; Jennifer L. Christhif, UMBC; Scott B. Johnson, Bahamas National Trust; Leslie Brace, Bahamas National Trust; Shelley Cant, Bahamas National Trust

The Bahama Oriole (*Icterus northropi*) is a critically endangered species endemic to The Bahamas and currently found only on the Andros island complex. With the elevation of the Bahama Oriole to full-species status in 2011, research suggested that there might be fewer than 300 individuals remaining in the global population. The Bahama Oriole was also termed a “synanthropic species” based on data suggesting that the species nested almost exclusively within anthropogenic residential and agricultural habitats in introduced coconut palms (*Cocos*



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*nucifera*). These conclusions were based on population surveys primarily focused on settled areas near the coasts. However, we documented multiple pairs of orioles with breeding territories deep in pine forests, and we present the first records of Bahama Orioles nesting in pine forests – in both a Caribbean Pine tree (*Pinus caribaea*) and native understory thatch palms (*Leucothrinax morrisii*). Given the predominance of the pine forests on Andros, this newly documented breeding habitat has important implications for estimating the population size. Furthermore, native pine forests are clearly among the habitats that need to be considered for the long-term survival of this oriole. We are conducting extensive point counts this field season to better document the density of orioles across the different habitats on the island.

## Variation in fruit consumption by landbirds at a stopover site during fall migration

Jen Owen, Michigan State University; David Sandhal, Michigan State University; Aya Pickett, Michigan State University; Yushi Oguchi, Michigan State University

Migration is an energetically costly journey that many landbirds make each fall and spring. Their ability to meet the demands of the migratory period rely on their ability to find food and deposit sufficient fat to fuel their flights. In the fall, many landbirds meet their energetic requirements through the consumption of fruits. Fruit-bearing shrubs are widely distributed, but the quality of their fruit varies, including the level of macronutrients and antioxidants, and their overall energy potential for a migrating bird. We collected fecal samples from several frugivorous landbirds, American robin (*Turdus migratorius*), gray catbird (*Dumetella carolinensis*), and Swainson's thrush (*Catharus ustulatus*), during autumn migration at a stopover site in mid-Michigan. Using mistnets birds were captured from mid-August to mid-October over 4 years (2012-2016). Immediately after extraction birds were placed in boxes with sheets of white paper where they would defecate. The papers were collected and preserved in a freezer until they could be analyzed. Fruit type was then determined by comparing collected samples with samples of known berries in the field, using color, seeds, and sometimes smell. The primary fruits consumed were Common Spicebush, European Buckthorn, Gray Dogwood, and Highbush Cranberry. We observed significant variation in the species of fruit consumed within a season and between years. In years when the spicebush was fruiting, it represented a high proportion of the bird's diet despite their low stem counts in the habitat. In the intervening years, the consumption of buckthorn was much higher relative to its abundance in the habitat. The energetic potential of the fruit of spicebush exceeds that of the buckthorn. This variation in availability and quality of fruit has consequences for a bird's ability to put on sufficient fat for their migration south, as well as maintain a healthy immune system during the migratory period.

## Say what? Inter-annual, inter-specific song switching in Golden- and Blue-winged Warblers

Kyle Pagel, University of Toledo; Gunnar R. Kramer, University of Toledo; Cassandra L. Ziegler, Minnesota Cooperative Fish and Wildlife Research Unit, University of Minnesota; Katelyn Maley, Minnesota Cooperative Fish and Wildlife Research Unit, University of Minnesota; Henry M. Streby, University of Toledo

Golden- and Blue-winged Warblers (*Vermivora chrysoptera* and *V. cyanoptera*, respectively) represent a closely related species complex but likely comprise a single species. Despite minuscule genetic differences, the two species exhibit distinct plumage and song phenotypes. They hybridize regularly where their breeding distributions overlap and although hybrids and individuals with phenotypically pure plumage traits have been observed singing the

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“wrong” song (i.e., a Golden-winged Warbler singing a Blue-winged Warbler song, or vice versa), we are unaware of any documented cases of individuals switching song types in subsequent years (i.e., a Blue-winged Warbler singing a typical Blue-winged Warbler song during one year and singing a typical Golden-winged Warbler song during a subsequent year). Herein, we describe our observations of inter- and intra-annual song switching by Golden- and Blue-winged Warblers. From 2015-2016, we recorded individually marked, Golden- and Blue-winged Warblers from Pennsylvania, USA (n=1) and Ontario, Canada (n=1) singing the primary song of both species in different years. In 2015, we also recorded a Golden-winged Warbler in Ontario switching between a typical Golden-winged Warbler primary song and a typical Blue-winged Warbler primary song within the same singing bout, and once during a single song. Our findings suggest song type may be more flexible than previously thought. Further research is required to understand the prevalence, context, and drivers of song switching in *Vermivora* warblers. We hypothesize about potential implications of song switching in evolutionary, behavioral, and population monitoring contexts.

## **Long-term retention of clutch desertion by Yellow Warblers in the absence of cowbird parasitism**

Brian Peer, Western Illinois University; Michael Kuehn, University of California Santa Barbara; Stephen Rothstein, University of California Santa Barbara

Adaptive traits are commonly assumed to decline when they no longer provide fitness benefits. However, behavioral adaptations may persist under relaxed selection because their costs may be small. Defenses that hosts exhibit against brood parasitism provide an ideal system for studying trait evolution under relaxed selection because there is a clear relationship between the trait and selection pressure. The Yellow Warbler, *Setophaga petechia*, frequently deserts clutches parasitized by the Brown-headed Cowbird, *Molothrus ater*. We experimentally parasitized warblers in three populations that differed in exposure to cowbirds to test for nest desertion. Warblers exposed to cowbird parasitism in western Montana deserted experimentally parasitized nests significantly more frequently (36.8%) than naïve conspecifics breeding 90 km away in eastern Idaho where cowbirds were very rare (13.0%), to which they were genetically similar. Sympatric warblers may desert clutches more frequently because individuals have had prior exposure to cowbird eggs or the presence of cowbirds indicates a greater probability of parasitism. Warblers isolated from brood parasitism for about 6,300 years in central Alaska, deserted 27.3% of experimentally parasitized nests and this rate did not differ significantly from sympatric or naïve populations. These results suggest that Yellow Warblers in the allopatric population have retained clutch desertion behavior despite their prolonged isolation from cowbirds.

## **Possible relationship between vocal communication system and fat reserve in wintering birds: A test of the optimal body mass**

Nuwanthika Perera, Wichita State University; Christopher M. Rogers, Wichita State University

Fat reserve is a key adaptation in wintering small birds that maximizes individual fitness in a variable environment. Optimal body mass models suggest that the winter fat reserve maximizes winter survival by balancing costs and benefits of fat deposition. Costs of a high fat reserve include reduced predator avoidance and increased predator-exposure while feeding. The benefit of high fat reserve is increased survival when resources are scarce. Flocking integration may play an important role in determining the fat reserve of birds. We are testing the hypothesis that if bird species have a high vocal repertoire, then they will have high flocking integration and communication efficiency, which reduces predation risk and allows the species to maintain high fat reserves. This

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hypothesis was tested by recording the vocalizations of the Dark-eyed Junco and American Tree Sparrow in Kansas. The junco is typically fatter in winter than the tree sparrow and is predicted to have a larger vocal repertoire within its winter flocks. A Marantz digital recorder with a Sennheiser directional microphone was used to record vocalizations at feeding stations. Raven software was used to describe different vocalizations within each species. Tree Sparrows produced one call type per 30 minute observation period whereas juncos produced 2 - 4 call types. There was no difference in call rate per bird per minute in two species ( $t = 1.6178$ ,  $P = 0.134$ ). These results generally support the hypothesis that greater vocal repertoire allows bird species to maintain higher winter fat reserves.

## **Baby birds take flight: ontogeny of intermittent flight in Zebra Finches**

Christine Petersen, University of Montana; Natalie Wright, Kenyon College; Bret Tobalske, University of Montana

Many birds, especially passerines and woodpeckers, use a form of intermittent flight called flap-bounding. Flap-bounding is characterized by a bird holding its wings in a flexed position, tightly against its body between flapping phases during forward powered flight. Birds that bound use this technique at various speeds, potentially to their metabolic and aerodynamic advantage. We sought to describe the development of this skill quantitatively in order to determine when juveniles are able to fly like adults. We closely monitored the flight development of captive-bred Zebra Finches after they fledged, collecting data every 1-2 days. A variable-speed wind tunnel was used to test their abilities at low to high flight speeds. We also tested fledgling abilities flying horizontally in a flight corridor. From this, we collected empirical data on wing-beat frequency, bounding frequency, bound duration, and take-off velocity and acceleration. We found that Zebra Finches begin flap-bounding only a few days after fledging, but develop this flight style slowly. After three weeks out of the nest, the bounds of juvenile Zebra Finches remain distinguishable from those of adults.

## **Variation in organ size between migratory and non-migratory birds**

Erin Place, The Ohio State University at Lima; Jacqueline K. Augustine, The Ohio State University at Lima

Migration status has been observed to influence organ size. Previous studies have shown that compared to non-migratory birds, migratory birds have larger heart mass, pectoral muscle mass, gizzard mass, and intestine mass. The purpose of this study was to determine if migratory species had larger heart, pectoral muscle, gizzard, proventriculus:gizzard ratio, intestine, liver, and proventriculus size than non-migratory species. Thirty-one species of birds were salvaged, frozen, thawed and weighed. The heart, proventriculus, gizzard, pectoral muscle, liver, intestines, and cecum were dissected and weighed. We conducted a standard least squares regression test to determine whether organ size, calculated as percent of body mass, varied among long-distance migrants, short-distance migrants, and non-migratory birds. Taxonomic Family was a random effect in the analyses. Only the proventriculus:gizzard ratio varied with migration status, with non-migratory birds having lower values than migratory birds. Therefore, my hypothesis that organ size should be larger in migratory birds was not supported. My results are similar to other studies that found that the proventriculus:gizzard ratio is smaller in non-migratory species than migratory species. Differences between the current study and previous studies may be due to the number of species examined, the types of species examined, or the inclusion of additional covariates such as diet in previous studies.

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## **An instance of hybridization and parental interaction of Great-tailed and Common Grackle (*Quiscalus*)**

Alexis Powell, Emporia State University; Jack Kirkley, University of Montana Western

The Great-tailed Grackle (*Quiscalus mexicanus*) and Common Grackle (*Q. quiscula*) are phylogenetically distant among grackles and were historically allopatric. Northward range expansion of the Great-tailed Grackle brought these species into contact < 100 years ago, but has not led to any notable interactions. We report a brood of two hybrid offspring of a male Great-tailed and female Common Grackle at the periphery of these species' ranges, in Dillon, MT, in 2015. Hybrids of Great-tailed Grackle with Boat-tailed Grackle (*Q. major*), Brewer's Blackbird (*Euphagus cyanocephalus*) and Red-winged Blackbird (*Agelaius phoeniceus*) are known, whereas hybridization of Common Grackle has never been reported. Both parents defended and fed the fledglings at the nest tree, the latter behavior extraordinarily unusual for a male Great-tailed Grackle. After the young left the tree and moved ~2 km across town, the male alone fed them for at least six more weeks. During that time, the young began attaining black secondary coverts as expected for Common Grackle or male Great-tailed Grackle. Analysis of DNA from a feather of one offspring confirmed it was male, had Common Grackle mitochondrial DNA, and had hybrid nuclear DNA. In 2016, the male Great-tail courted a female Common Grackle that was also attended by a male Common Grackle. She produced five young, but all were pure Common Grackles, not hybrids. Notably, another male Great-tailed Grackle in the vicinity was observed feeding a lone nestling in one of the three nests he defended, suggesting that such behavior occurs more frequently than has been appreciated.

## **Hormone-Mediated Life-History Tradeoffs Demonstrated in Dark-eyed Juncos**

Susan Reed, Indiana University-Bloomington; Adam Fudickar, Indiana University; Sarah Wanamaker, Washington State University; Ellen Ketterson, Indiana University

Hormones are well-known intermediaries of life-history tradeoffs, suggesting a substantial relationship between hormones and fitness. The results of previous studies suggest that the hormone testosterone can mediate tradeoffs between survival and reproduction. Here, we explore how this tradeoff is expressed in free-living Dark-eyed Juncos (*Junco hyemalis*). Across two breeding seasons, we measured individual male differences in maximum testosterone production using a standardized gonadotropin-releasing hormone (GnRH) challenge protocol. GnRH challenges provide a repeatable measure of an individual male's ability to produce testosterone. We then compared individual testosterone production to apparent survival and number of offspring (both social and extra-pair offspring), predicting a positive relationship between testosterone and number of offspring, a negative relationship between testosterone and survival, and overall stabilizing selection in which the fitness optimum is represented as the population mean of GnRH-induced testosterone production levels. Analyses to determine how natural selection acts on the ability to produce testosterone are still underway.

## **Vocal and genetic variation within a chickadee contact zone in central Illinois**

Shannon Regan, Eastern Illinois University; Eric Bollinger, Eastern Illinois University; Zhiwei Lui, Eastern Illinois University; Fahad Alshammari, Eastern Illinois University

Black-capped and Carolina Chickadees are distributed parapatrically from New Jersey to Kansas, forming narrow hybrid zones in areas of sympatry. Genetic studies in Pennsylvania and Ohio have concluded that these contact

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zones are slowly moving north, presumably due to climate change. The ranges of these species have been relatively stable based on vocalizations, but within Illinois, long-standing contact zones have never been genetically tested. We will conduct genetic analyses of adults and nestlings from four different sites within and on both sides of the contact zone. We will also be recording and analyzing vocalizations produced by birds within this contact zone to compare with our genetic findings and to results from previous studies. This study will clarify the underlying mechanisms for genetic and vocal variations to aid in further research surrounding the possible disconnect between cultural and genetic findings and also the effects of climate change on bird populations throughout North America.

## **Songbird nest success is positively related to vegetation structure and tree thinning in managed pine-oak savanna and woodland in the Ozark Highlands, Missouri**

Melissa Roach, University of Missouri; Frank R. Thompson III, U.S. Department of Agriculture, Forest Service, University of Missouri; Todd Jones-Farrand, Gulf Coastal Plains and Ozarks Landscape Conservation Cooperative

High quality savanna-woodland communities have largely disappeared from the Midwest while many early-successional bird species are simultaneously declining in abundance. Efforts to restore pine savanna and woodland have increased in Missouri within recent years, and understanding breeding bird response to this restoration is important for specific management strategies, such as increasing species richness and abundance, to be effective. We estimated nest survival rates for six songbird species with varying natural histories in relation to temporal, vegetation, and management covariates in restored savanna and woodland in southern Missouri during the 2014 and 2015 breeding seasons. Eastern Towhee (*Pipilo erythrophthalmus*) daily survival rate (DSR) was not related to any temporal, vegetation, or management covariate. Prairie Warbler (*Setophaga discolor*) DSR was related only to nest stage and day of year. Yellow-breasted Chat (*Icteria virens*) DSR was positively related to tree thinning. Eastern Wood-Pewee (*Contopus virens*) and Summer Tanager (*Piranga rubra*) DSR was negatively related to mean canopy cover. Pine Warbler (*Setophaga pinus*) DSR was positively related to sapling density. Additionally, we combined species into shrub- and canopy-nesting guilds. The shrub-nesting guild experienced greater DSR in areas that had been thinned while the canopy-nesting guild had greater DSR in areas with less basal area and less canopy cover, a result of thinning activities. Our results demonstrate positive relationships both directly and indirectly with management treatment and suggest that pine savanna and woodland restoration in Missouri is providing high quality breeding habitat for both early-successional species and woodland generalists.

## **What you should know about the ornithology collection at the University of Iowa**

Trina Roberts, University of Iowa; Cindy Opitz, University of Iowa; Cody Crawford, University of Iowa

Research collections at the University of Iowa Museum of Natural History (SUI) are currently emerging from a long period of unintended obscurity and scientific disuse. Intensive efforts by museum staff are now greatly improving curatorial and storage conditions and data visibility for this historic and underutilized collection. We provide an overview of the museum's major ornithology collections, which include mounted birds and study skins (about 14,000 specimens), eggs and nests (about 17,000 sets or specimens), related data, and documentary materials from expeditions and collectors. Data quality and accessibility for this collection are extremely variable, but are currently better overall for study skins than for eggs and nests. Here, we describe the taxonomic, geographic, and

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temporal coverage of our research collection, as well as some of its key historic aspects. Taxonomically, our collection includes 25 avian orders and 149 families, with slightly more than 50% of specimens being passerines. More than 50% of the SUI bird specimens were collected before 1901 and more than 85% before 1961. About 82% of our specimens are from North America, with 75% from the United States, 50% from the Midwest, and about 30% from Iowa itself. We also describe some of the current efforts to revitalize this collection, including rehousing, digitization, and data crowdsourcing.

## **Using birds as ecological indicators to evaluate the success of riparian restoration via Beaver Dam Analogues (BDAs)**

Sarah Rockwell, Klamath Bird Observatory; Jaime L. Stephens, Klamath Bird Observatory

The North American beaver, once thought to be a pest, is now recognized as a keystone species playing a vital role in maintaining diverse stream and riparian habitats, and improving water retention and groundwater recharge. Beaver dams can expand the size and complexity of wetlands, enhancing habitat for wildlife. Since 2014, beaver dam analogues (BDAs) have been built in the Scott River, CA, and its tributaries in order to mimic these beneficial effects. Birds are considered excellent ecological indicators, and studying the bird community allows us to assess the success of this riparian restoration, and potentially identify habitat components that have not yet been achieved. We are measuring bird abundance and diversity at five BDA sites and one control site in the Scott Valley. Two years of surveys immediately following BDA implementation at each site will provide baseline bird metrics prior to riparian development. We completed 18 standardized 5-min. point count surveys during each of three site visits in spring 2016, and eight 20-min. area search surveys during three site visits in fall 2015 and 2016. Preliminary results include 55 bird species detected during the spring breeding season, and 108 species detected during fall migration, including birds listed as endangered (Willow Flycatcher) and threatened (Bank Swallow) in the state of California. In 2017, we will complete the second year of spring point count surveys. Follow-up surveys will occur five-six years post-restoration. If BDAs are successful at enhancing riparian and wetland vegetation, we expect birds dependent on these habitats to benefit.

## **Population genetic characteristics of Seaside Sparrows (*Ammodramus maritimus*) in Texas**

Mckenzie Roeder, Austin Peay State University; Christopher E. Hill, Coastal Carolina University; Sabrina Taylor, Louisiana State University; Stefan Woltmann, Austin Peay State University

Seaside Sparrows (*Ammodramus maritimus*) in Texas are represented by two subspecies that occupy different portions of the coast. The Louisiana Seaside Sparrow (*A. m. fisheri*) occupies the northern and central parts of the Texas coast to somewhere north of Corpus Christi, and the Texas Seaside Sparrow (*A. m. sennetti*) occupies a smaller area south of Corpus Christi. An apparent intergrade zone occurs around Corpus Christi (Woltmann et al. 2014). We analyzed genetic (microsatellite) data from representative populations of both subspecies collected in 2003-2006 and 2012 in order to (1) describe general population genetic characteristics of the different populations, (2) estimate effective genetic population sizes ( $N_e$ ), and (3) ask whether any of the populations have experienced recent population bottlenecks (as might be expected in small populations impacted by hurricanes). Allelic richness (NA) was lower in both samples of *A. m. sennetti* (~ 6.3) than in samples from all other populations (range 8.6 – 10.1), and observed heterozygosity ( $H_o$ ) followed a similar pattern (~0.75 vs ~0.81). Effective population size estimated with the temporal method suggested lower  $N_e$  in *A. m. sennetti* ( $N_e = 131$ , 95% CI = 50-?) compared to *A. m. fisheri* ( $N_e = 274$ , 95% CI = 131-??). Although Texas Seaside Sparrows occupy a very small

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geographic area, the population genetic characteristics we measured do not raise any obvious conservation concerns at this time. Ongoing genetic monitoring is, however, recommended.

## **Make movement advancements for autonomous radio telemetry networks**

Jeremy D. Ross, Oklahoma Biological Survey, University of Oklahoma; Jessica E. Ruyle, University of Oklahoma; Eli S. Bridge, Oklahoma Biological Survey, University of Oklahoma

In the interest of expanding the accessibility of autonomous telemetry networks to biologists, we have developed new approaches to the assembly and operation of transmitting and receiving hardware. Our transmitter design incorporates commercially-available electronic components at a cost well below commercial options. We are able to readily program these to produce a variety of radio transmission frequencies, binary "barcode", and context-operation patterns for a variety of field biology purposes, including incorporation into autonomous telemetry networks such as Motus. Our receiving antenna design is likewise much cheaper than commercial products, having been mostly sourced from materials at local hardware stores with only the coaxial cables and connectors purchased from specialized outlets. It was designed for optimal operation at the standard frequency of the Motus network (166.38 MHz). Relative to commercially-available options currently used in the Motus network, our antenna design produces a much more favorable signal-to-noise difference, mostly by reducing baseline static noise. Altogether our innovations should not only increase the accessibility of autonomous telemetry for limited-budget biological studies, but they also improve the technology being implemented so that the amount of information transmitted and possible applications for the system can be greatly expanded.

## **Conservation and management of the North American Black Tern (*Chlidonias niger surinamensis*) in Michigan**

Erin Rowan, Detroit Audubon; Caleb Putnam, Audubon Great Lakes, Michigan Department of Natural Resources

The North American Black Tern (*Chlidonias niger surinamensis*) has experienced severe population declines in the Upper Great Lakes and Prairie Pothole regions of the U.S. over the past 30 years. The species is now listed as 'Endangered' in several states and as a 'Species of Conservation Concern' in most others. In particular, this species' numbers in Michigan are perilously low, and Wisconsin populations have been in serious decline for the past 30 years, without a clear understanding of the underlying causes. In response to population declines, Black Tern was identified as a focal species for conservation planning in the Upper Mississippi River and Great Lakes Region Joint Venture Waterbird Habitat Conservation Strategy. Similarly, the Upper Mississippi Valley/Great Lakes Waterbird Conservation Plan considers Black Tern a species of "high" conservation concern. Population demographic information for most Black Tern colonies in the Great Lakes Region is lacking. To address this knowledge gap, Audubon Great Lakes and Detroit Audubon began a long-term mark-recapture study in 2013 at the largest remaining colony of Black Terns in Michigan at Saint Clair Flats. Additional population monitoring studies began in Ogontz Bay in 2016 and are projected to start in Wigwam Bay in 2018. This state-wide research aims to identify the population pressures that are contributing to the decline of the Black Tern in the Great Lakes Region. The results of this study to-date indicate that productivity in Michigan is high, however further study is needed to determine adult and juvenile survivorship, site fidelity and colony exchange.

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## **Form follows function: the effect of function on signal evolution in the genus *Malurus***

Shailee Shah, Columbia University; Emma I. Greig, Cornell Lab of Ornithology, Mike S. Webster, Cornell University

The function of a vocalization can influence its acoustic structure in many ways and ultimately constrain its evolutionary trajectory. We examined the effect of function on signal evolution by comparing the structure of calls with three different functions across nine species of fairy wrens (Maluridae: *Malurus*). We hypothesized that calls would vary across species depending on their function. In terms of context and information, calls conveying the presence of threat would be constrained by factors affecting sound transmission, whereas calls maintaining contact with conspecifics would be constrained by species-specificity. In terms of intended recipient, calls used for heterospecific communication would converge more than calls used for conspecific communication to enable signal recognition. Alarm calls known to elicit heterospecific response (“seet” calls) were more similar across species than “chatter” or “contact” calls, which are used, respectively, as mobbing and contact calls. Variation in “contact” calls showed phylogenetic signal as expected under a Brownian motion model of evolution, and higher phylogenetic signal than “seet” and “chatter” calls. Because they are used for conspecific communication, “contact” calls may experience selection consistent with traits facilitating species recognition in *Malurus*. Conversely, “seet” calls may experience directional selection due to constraints on propagation and detectability of the alarm signal. They may converge further to facilitate heterospecific communication. Finally, “chatter” calls, despite their use in heterospecific communication as mobbing calls, may also be used in conspecific contexts that select for divergence. We conclude that difference in function can lead to different patterns of signal evolution.

## **Studying novel functions of female song: Vocal response to nest predators in female Eastern Bluebirds (*Sialia sialis*)**

Evangeline Shank, University of Maryland, Baltimore County; Derek Coss, UMBC; Michael Rowley, UMBC; Joselyne Tonleu, UMBC; Kevin Omland, UMBC

Odom et al. (2014) recently demonstrated that female song is widespread and ancestral in all songbirds. Ornithologists have long known that that females sing in many tropical songbirds. However, studies of female song in temperate regions remain scarce. In the past, several researchers reported female Eastern Bluebirds singing in the presence of predators. I recorded 15 pairs of bluebirds throughout the 2016 breeding season. Using these recordings, I compared seven standard song measurements to compare the complexity of male and female songs. I found that male and female songs were not structurally different based on these various measures of frequency and duration. I propose to look at the function of Eastern Bluebird songs in the presence of various predator models to determine the function of female song. Additionally, I will test for the occurrence of female song in other contexts, (e.g. territory defense and mate guarding) by presenting male and female bluebird models. Preliminary results suggest that female bluebirds increase their song rate in the presence of black-rat snakes, a common nest predator. I will continue to collect data throughout the 2017 breeding season to compare behavioral and song rate data of female Eastern Bluebirds in response to various mount presentations.



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## **American Woodcock reproductive rates in relation to forest structure at local and landscape scales**

Alexandra Shoffner, Michigan State University; David Luukkonen, Michigan Department of Natural Resources, Michigan State University; David Williams, Michigan State University; Scott Winterstein, Michigan State University

Long-term declines in American Woodcock (*Scolopax minor*) abundance have been documented in Michigan as well as range-wide since consistent monitoring began in 1968. Available demographic estimates for woodcock indicate that declines in abundance may be linked to declines in reproductive rates associated with changes in breeding habitat characteristics. To better understand the relationship between habitat and woodcock population dynamics, we will determine the effects of local and landscape-scale habitat characteristics on woodcock reproductive rates in two distinct ecological regions of Michigan. We located female American Woodcock and their nests using trained volunteer woodcock banders and their pointing dogs. We assessed nest success and documented predators of woodcock and their nests by placing trail cameras at nests. We measured survival by capturing, radio-tagging, and monitoring adult female and juvenile American Woodcock. We measured and evaluated variables relevant to woodcock reproductive rates, such as temperature, precipitation, body condition, as well as variables describing habitat structure at local and landscape scales. We will present preliminary findings from this recently initiated study. Future results will be used to recommend habitat treatments that enhance woodcock reproductive rates and thus help halt or reverse woodcock population declines.

## **Estimating apparent survival and factors influencing population dynamics of Neotropical birds**

Elsie Shogren, Kansas State University; Alice Boyle, Kansas State University

Neotropical bird communities are renowned for their diversity, and species have adapted to remarkably constant abiotic environments compared to those at higher latitudes. Thus, global climate change and shifting precipitation regimes have the potential to disproportionately affect avian population dynamics in tropical regions. Basic demographic parameters remain unknown for many species in the Neotropics; describing these parameters and the response of species to variation in annual precipitation is key to understanding population dynamics and potential effects of changing climate. I used Cormack-Jolly-Seber live-recapture models to estimate apparent survival and recapture probability for eight bird species in a montane tropical forest. I constructed capture histories from data collected across seven years of mist-netting effort on the Caribbean slope of Costa Rica. For all species, constant and time-since-marking models were top-ranked. I also modeled annual precipitation and effort as covariates, to test their effect on estimates of apparent survival. Models including precipitation received some support in most species, but direction of response varied by species. Ground foraging birds had negative relationships between precipitation and estimates of apparent survival, while species foraging at higher levels in the forest showed neutral or positive relationships between precipitation and estimates of apparent survival. These results provide novel estimates of apparent survival for three bird species and additional information to supplement previously published estimates for the remaining species. The observed patterns highlight the complexity of interactions between abiotic factors and diverse biotic communities in a Neotropical ecosystem where varied and dramatic effects of climate change are expected.

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## **Foraging observations and insights on Neotropical migrant warblers from Ecuador**

Eric Sibbald, Cornell University; Eliot T. Miller, Cornell University; Robert C. Dobbs, USGS

Many neotropical migrants are declining due to anthropogenic changes, from a variety of factors on the breeding and wintering grounds. Unfortunately, for many species very little is understood about the habitat use and foraging niches of neotropical migrants while on the wintering grounds in comparison to the breeding range. Historically, the breeding ground has been where most of the research on the species has taken place, focusing on all aspects of life history. However, the habitat for many species on the breeding ground is far different than on the wintering ground, and therefore is important to look at to understand population changes. Our project involved collecting and analyzing foraging observations from neotropical warblers in Ecuador, which primarily consisted of Blackburnian Warbler (*Setophaga fusca*), Cerulean Warbler (*Setophaga cerulean*), and Canada Warbler (*Cardellina canadensis*). These observations have allowed us to identify the foraging niches for these species, and compare how they differ and what they need. We have been able to compare male and female, adult and juvenile, and flocking vs. non-flocking birds as well, and therefore identify what habitat is critical for these species in the neotropics while they are on their wintering grounds.

## **Cerulean Warbler habitat use in northeast Iowa**

Paul Skrade, Upper Iowa University; Chase H. Grabau, Upper Iowa University; Cory J. Thielen, Upper Iowa University; Jon W. Stravers, Driftless Area Bird Conservation

The Cerulean Warbler (*Setophaga cerulea*; CERW) is a species of conservation concern across its breeding range. However, in northeast Iowa near the Mississippi River there is a population that appears to be doing quite well. In 2006 a concerted effort was made to document avian species in the region and subsequent surveys in Yellow River State Forest (YRSF) yielded surprising numbers. In 2015, 185 different territorial males were located within the boundaries of the state forest. An initial landscape-scale analysis of those territory locations found that the birds preferred territories on a slope (mean 29.2% grade), with no preference for any particular aspect, and that are close to water (mean distance 148.8 m). However, the main territory association was with areas of the state forest classified as “limited management”. This forest is managed for productivity as well as recreation and wildlife habitat and the limited management areas tend to have larger deciduous trees. In the 2016 field season avian point count surveys for CERW and vegetative sampling in YRSF were conducted within the males’ territories to gain a better understanding of the fine-scale habitat preferences. These included determining the dominant tree species by abundance and diameter at breast height (DBH) as well as a count of young trees to predict future forest composition. Maples were the most abundant overall but it evident that males were selecting territories that contained large walnuts and oaks and sites with overall greater tree diversity.

## **Nesting Success of Hooded Warblers in Exotic Shrubs: Multi-Trophic Interactions in the Forest Understory**

Gregory A. Smith, Kent State University at Stark; Ryan J. Trimbath, University of Akron; Daniel R. Garrett, University of Sherbrooke

Temperate forests of North America are being altered by the combined effects of two ecosystem engineers: white-tailed deer, *Odocoileus virginianus*, and exotic earthworms. We used an exclosure study in Northeast Ohio to quantify the impacts of deer and earthworms on forest plant community structure, and use the results to inform a

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study of nesting success in Hooded Warblers (*Setophaga citrina*). Our results suggest that interactions between deer and earthworms serve to reduce native plants and increase exotic plants. Unfortunately, past research suggests that avian nests in exotic shrubs are more susceptible to predation and represent an ecological trap. Hooded Warblers, a forest understory obligate, provided a model with which to test this idea. In our study, Hooded Warblers primarily selected exotic plants for nesting sites (73% of 133 nests), even when native substrates were available. We analyzed the influence of nest-site choice on nest success at the nest and patch scale and found no relationship between nesting success and exotic species. However, we did find that nests in exotic plants initiated later in the season were more likely to fledge offspring. For our system, landscapes dominated by exotic shrubs do not appear to be ecological traps for Hooded Warblers. In such disturbed landscapes, where the availability of native understory plants is limited, exotic plants may provide a reasonable opportunity for successful nesting, especially later in the season. In some instances, exotic plants may provide the only available nesting substrate. Such ecological interactions speak to the complexities of invasive species management.

## **Effects of urbanization on prevalence, diversity, and parasitaemia of avian Haemosporida parasites**

Jamie Smith, Western Michigan University; Dr. Kathleen Baker, Western Michigan University; Dr. Sharon Gill, Western Michigan University; Dr. Maarten Vonhof, Western Michigan University

Urbanization drives ecological and evolutionary change by decreasing biodiversity and altering relative abundances, disrupting community structure and influencing species interactions. Host-parasite interactions are particularly susceptible to the effects of urbanization as competent host and vector populations must overlap for transmission to occur, and urban areas may support smaller, less diverse vector communities. We explored the effects of urban land use on patterns of blood parasitism by Haemosporida in birds and tested the hypothesis that urban birds would experience lower prevalence, intensity, and diversity of parasites. We collected blood samples from 726 songbirds (Passeriformes) across an urbanization gradient in southwest Michigan using a randomized, spatially-balanced sampling strategy. We used principal components analysis to define three components that explained variation in urbanization, vegetation, and water availability. Samples were screened for parasite presence using molecular and microscopy techniques. We identified 71 parasite lineages of three Haemosporida genera (*Haemoproteus*, *Plasmodium*, and *Leucocytozoon*) and found that 41% of birds were infected with one or more lineages. Preliminary data suggest that Haemosporida prevalence and diversity both decreased with increasing urbanization, and parasite diversity declined with decreasing water availability. Prevalence also varied between host species, from 0% in White-Breasted Nuthatches to 85% in Chipping Sparrows, and between parasite genera; *Plasmodium* was the most prevalent genus (24%) and *Leucocytozoon* the least (6.4%). Our results suggest that anthropogenic land use change and the distribution of water on the landscape can alter the distribution and success of vector-borne parasites, with important implications for the dynamics of host populations and communities.

## **Effects of environmental temperature and human disturbance on incubation behavior and egg temperatures of Least Terns (*Sternula antillarum*)**

Robert Snowden, University of North Carolina Wilmington; Raymond Danner, University of North Carolina Wilmington

Beach-nesting seabirds often face direct thermoregulatory demands from the variable environmental conditions at their breeding sites. High temperatures not only increase the likelihood of thermoregulatory stress for adults at exposed nests, but also challenge their ability to maintain suitable incubation conditions. Beach-nesting seabirds are also typically subject to human disturbances at many breeding sites, which may inhibit behaviors that could

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help regulate nest temperature, and therefore exacerbate thermal stress on eggs. My project seeks to understand how environmental temperatures and human disturbance affect the ability of beach-nesting Least Terns to maintain optimal incubation temperatures through behavioral mechanisms. I hypothesize that 1) Least Terns will adjust incubation behavior to response to increasing environmental temperatures; 2) human disturbance affects these incubation behaviors, and therefore egg temperature; and 3) there is a critical environmental temperature above which terns fail to behaviorally-regulate egg temperatures, and disturbance events at such critical temperatures increase the likelihood of egg temperatures reaching harmful levels. I am currently monitoring Least Tern colonies on beaches near Wilmington, North Carolina, where I am quantifying egg temperatures by deploying data-logger-equipped artificial eggs in target nests. I am concurrently conducting visual surveys to quantify potential thermoregulatory incubation behaviors at those nests, and also am recording behavioral responses to human-induced disturbance events. By quantifying thermal tolerance limits, this study can provide important management information in anticipating impacts of increased environmental temperatures on seabird productivity, and could help determine if additional precautions are necessary to protect seabird colonies from human disturbance.

## **Geometric morphometrics and the evolution of bill shape in Babblers (Timaliidae)**

Nicholas Souza, Loyola University Chicago; Matthew Bonfitto, Loyola University Chicago; Sagar Chaudhari, Loyola University Chicago, Julie Witkowski, Loyola University Chicago, Michael Hanson, Loyola University Chicago, Sushma Reddy, Loyola University Chicago

The systematics of the Timaliidae has undergone remarkable changes in recent years. In addition to dramatic rearrangements in the relationships across the family, many of the traditional genera grouped together based on bill morphology or ecology are not monophyletic, including groups categorized by these features such as Scimitar-, Tit-, and Tree-babblers. This implies that these seemingly characteristic bill shapes are highly labile or evolved multiple times (parallelism). We undertook a morphometric study using standard linear measurements and 2D lateral landmark-based analyses to examine bill shape variation across these species. We investigated whether these features can be considered convergent (same feature evolved multiple times) or whether there are constraints to bill and body traits that mirror their phylogenetic relationships. We used multivariate statistics to examine whether 1- the superficial designations of curved, thin, thick can be discriminated in morphospace, 2- the shape within clades was discrete or more similar to their ecological categories, 3- there are aspects of bill shape that are constrained or changing in modular fashion to explain the high amount of variation in this group. Although bill shape is considered to be highly indicative of feeding ecology, only a few quantitative analyses have characterized and examined the evolution of this key trait across a diverse family.

## **Do Barn Swallows settle in an ideal free distribution?**

Mark Stanback, Davidson College; Esther Niemasik, Cornell University

Although Barn Swallows (*Hirundo rustica*) are not territorial in the traditional sense and are willing to nest quite close to adjacent pairs of swallows, there are limits to their tolerance of neighbors. In previous work, we showed that Barn Swallows are very willing to nest in artificial nest cups as close as 122 cm from active nests, but prefer not to nest 61 cm from such nests. In the current study, we attached nest cups in pairs on the underside of a pier. Cups within pairs were 61 cm apart; adjacent cup pairs were 122 cm away. Because the number of breeding pairs exceeded the number of cup pairs, some birds were forced to nest 61 cm from active nests. If Barn Swallows settle

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in an Ideal Free Distribution, we should expect all cup pairs to be settled by a single pair of birds before any are settled by a second pair of birds. We monitored Barn Swallow settlement at 18 cup pairs for seven years. We found that Barn Swallows do not settle randomly with respect to near-neighbor distance. As predicted from an Ideal Free Distribution, they showed a significant aversion to “doubling up” at cup pairs and did not do so until most cup pairs were already occupied.

## **Changing phenology of landbird migration at Chicago, Illinois: multiple datasets**

Douglas Stotz, Field Museum of Natural History; Paul Clyne, Chicago, IL; Michael Speer, Notre Dame University

We investigate the changing timing of landbird migration around Chicago using three datasets. We compared migration counts along the Chicago lakefront in Lincoln Park by William Drueth (1928-1943) to compilations by Paul Clyne in Jackson Park (1981-2005). Of 90 species in both datasets for spring migration, 46 arrived more than a week earlier and 38 earlier by less than a week in the Jackson Park sample. We used a sample of window kills from McCormick Place on the Chicago lakefront to compare changes in migratory arrival and departures between the early 1980s and the late 2000s for 5 very common species (Veery, Ovenbird, Common Yellowthroat, White-throated Sparrow, and Swamp Sparrow). In spring, all arrived earlier, peaked earlier and departed earlier by 2 to 7 days in the 2000s sample. No differences were noted in timing of fall migration, and no changes in the relative timing of sexes occurred between the time periods. We also used e-bird data from Cook County, Illinois to examine timing of arrival, peak and departure of 113 species of landbirds in the extraordinarily warm spring of 2012. 75 species showed evidence of earlier migration (averaging 1 week earlier) in at least one of these parameters compared to an average of the previous 10 years. Species wintering in the southeastern US were more likely to arrive early than species that winter in Middle America. Species that winter in South America showed less evidence of a response to the warm spring in timing of migration.

## **Light, noise or social factors? Exploring influences on the onset of dawn song in House Wrens**

Carley Stuart, Western Michigan University; Erin E. Grabarczyk, Western Michigan University, Maarten J. Vonhof, Western Michigan University, Sharon A. Gill, Western Michigan University

Every morning, male songbirds wake from sleep and begin their daily activities, one of which is to sing. Male songbirds sing to advertise themselves and their territories, making singing a critical feature for breeding and fitness. Social factors, such as the mate’s breeding stage and that of their neighbors, as well as environmental factors, such as temperature, influence when male songbirds start to sing. Recent changes in environments caused by humans, including increased noise and light pollution, could also affect the timing of dawn song, with birds waking earlier due to increased light and noise exposure. We recorded the onset of dawn singing by male House Wrens (*Troglodytes aedon*), measured light and noise pollution around nest boxes, and considered whether these or social factors influenced when house wrens gave the first song of the day. On average, males first sang 30 min after sunrise. Our preliminary analysis of male song during the first month of the breeding season found that timing of the first song was not related to night-time sky brightness or sound pressure levels measured between 0-2 kHz. Instead of noise and light pollution, pairing status influenced when males begin to sing, with paired males singing earlier than unpaired birds. Unlike species that sing prior to sunrise, our results suggest that noise and light pollution do not alter the onset of dawn singing by House Wrens.

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## **JP Chickadee project: big data from a little bird**

Ivan Swart, Northern Michigan University; Alec Lindsay, Northern Michigan University; James VanOrman, Northern Michigan University

Black-capped Chickadee (*Poecile atricapillus*) behavior has been studied in with captive individuals, or color-banded wild populations. Recent developments with RFID technology provide a new mechanism for compiling large datasets of movement records, social affiliations, foraging behavior, nesting behavior, and more. We have initiated a study of Black-capped Chickadees in a semi-urban environment, documenting behavior with RFID tags and readers built into seed feeders. Here we present a first-pass analysis of these data, looking at 1) the stability of within-sex dominance structures of winter foraging flocks, 2) the relationship between dominance hierarchies within winter foraging flocks and how those correlate with pairing of mated individuals during the breeding season, and 3) of the fine-scale analysis of the temporal and spatial patterns observed as social affiliations in foraging flocks dissolve into paired associations between breeding individuals. Along with novel insights into chickadee social behavior, these preliminary data demonstrate the expanded analytical capabilities provided by the use of RFID technology in the study of multiple facets of Black-capped Chickadee natural history.

## **Are you my mommy: assigning parentage in populations with kin structure and incomplete parent sampling**

Caroline Thow, University of California, Santa Cruz; Bruce Lyon, University of California, Santa Cruz; Caitlin Wells, University of California, Davis; John Eadie, University of California, Davis

Identifying parents of offspring from a candidate parent pool is essential for estimating reproductive success, providing insight into the evolution of alternative reproductive strategies such as cooperative breeding, extra-pair paternity, and conspecific brood parasitism (CBP). CBP occurs when females lay eggs in nests of conspecifics without providing further care. CBP is widespread but especially prevalent in waterfowl, where females are philopatric and may parasitize relatives, parasites may not nest, and male sampling is infrequent. Molecular parentage assignment programs are powerful tools, but may falsely exclude parents when the population contains relatives or sampling is incomplete, biasing assignments towards relatives or sampled individuals and creating patterns unrepresentative of system dynamics. Recent studies suggest that CBP may be kin-directed and cooperative rather than parasitic, but to verify this we must test the accuracy of parentage assignment programs under common conditions in CBP. We investigated the reliability of maternity assignments in CBP using simulated Wood Duck (*Aix sponsa*) populations of known pedigree. We ran maternity analyses excluding males and/or non-nesting females in two popular programs: Colony and Cervus. Excluding males did not affect either program, but the absence of non-nesting females increased false assignments. Misassignment rates peaked when we removed males and non-nesting females, with Cervus misassigning 20% of offspring to individuals unrelated and related to the true mother. Even including all females, both programs made occasional mismatches to relatives. These results suggest that CBP may be overreported, particularly between relatives, and investigations using genetics to assign parentage should interpret results cautiously.

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## **Monitoring songbird stopover in fragmented forest-agricultural systems**

Jessica Tinklenberg, Purdue University; John Dunning, Purdue University; Jeff Buler, University of Delaware

Populations of Nearctic-Neotropical migratory landbirds have declined in recent decades, in part due to factors impacting the migration period. Thus, recent work has emphasized the migratory period as a conservation priority. The ability to identify heavily-used, high-quality migratory stopover sites is a necessary first step to understanding the ecological roles of stopover habitat. Several studies have begun to describe critical stopover areas in well-known migration hotspots (e.g., the Gulf of Mexico). However, the stopover ecology of birds in the vast expanse of seemingly low-quality agricultural land in Midwestern United States remains unknown. Through this project we aim to determine 1) where important stopover areas occur within the fragmented forest-agricultural matrix of Indiana, 2) what is the role of small forest patches as stopover habitats, and 3) how distributions and populations of migrants passing through Indiana have changed over the last decade using archived weather surveillance radar data and previously-collected bird abundance survey data. By integrating surveys of bird abundance data from 2005-2007 and both archived and current NEXRAD (next-generation weather surveillance radar) reflectivity data (2005-2007, 2015-2017), we are developing a map of migrating landbird stopover densities during fall and spring, and identifying priority areas for targeting conservation of migratory birds and their habitats across most of Indiana. Identifying these important stopover habitats in Indiana will allow us to better conserve migratory landbird species that migrate through the agricultural Midwest.

## **Migratory Movements and Wintering Locations of a Threatened Population of Black-crowned Night-Herons**

Christopher Tonra, The Ohio State University; Laura Kearns, Ohio Division of Wildlife; Kristie Stein, The Ohio State University

Black-crowned Night Herons (*Nycticorax nycticorax*) in the Great Lakes have been declining since the 1970's. While much attention has been given to the effects of Double-crested Cormorants (*Phalacrocorax auritus*) on nesting colonies and colony restoration, very little is known about the migratory connectivity and flyway utilization of this population. We utilized satellite telemetry and the Motus Wildlife Tracking system to determine wintering locations and migratory behavior/routes of adult and juvenile night-herons from colonies in the western basin of Lake Erie. All birds tagged utilized the Atlantic Flyway during fall migration, primarily passing over the crest of the Appalachian Mountains. We found substantial variation in migration phenology, particularly fall departure dates and frequency of stopover. The majority of adults overwintered in Florida, while two birds divided their overwintering range between Florida and Zapata Marsh, Cuba. Juvenile behavior appeared similar to adults, with the exception of making several multi-directional dispersal movements prior to southward migration, based on Motus network tower hits. We discuss the conservation implications of these findings, including the need for multi-state cooperation in protecting this declining population.

## **The effect of blood parasites on Nuttall's White-crowned Sparrow song**

Joleen Tseng, San Francisco State University

In the Nuttall's White-crowned Sparrow (*Zonotrichia leucophrys nuttalli*), song plays an important role in territory defense and mate attraction. Different populations have their own unique dialect which has been extensively

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described in the San Francisco Bay area for over 50 years. Dialects are learned from neighboring adult birds and are not inherent, meaning that dialects are subject to variation due to geographic location and the proper development of song-learning centers in the brain. Some avian blood parasites have been shown to affect brain development and have the potential to affect the formation of complex song in some birds; however, the effects vary widely in different species. It is still unclear how great of an impact blood parasites have on birds, especially for species that are regularly exposed to blood parasites. The great diversity of blood parasite life histories and infection strategies unfortunately leads to immense variation in symptoms, making it difficult to generalize their effect for even a single family of birds. With this in mind, I will focus on comparing song quality between infected and non-infected Nuttall's White-crowned Sparrows with two different dialects. I hypothesize that infection will lower the quality of their song and the effect will be different in the two dialects. The results from this study will help us to continue teasing apart the effect blood parasites have across different bird populations. Blood parasites are present on nearly every continent and have potential to cause the extinction of unsuspecting species. To understand the interactions they have with our local wildlife would greatly benefit future management and conservation plans to preserve biodiversity.

## **Impacts of mammalian predators on species- and niche-based community assemblages in the world's seabird biodiversity hotspot**

Christy Wails, Northern Illinois University; Stephanie Borrelle, Auckland University of Technology; Rachel Buxton, Colorado State University; Holly Jones, Northern Illinois University

Islands support some of the greatest numbers of endemic species but are highly vulnerable to anthropogenic activities, including the introduction of invasive, predatory mammals. Mammal eradication is a primary conservation tool to protect island communities, yet little is understood about how communities reassemble and how assembly patterns influence island ecosystem. We examined species- and niche-based community assemblages of seabirds nesting across nine outlying island archipelagos of New Zealand – the world's seabird biodiversity hotspot – in relation to mammal introductions and eradications. We grouped seabirds into functional 'niche-based' groups based on marine and terrestrial habitat use for all seabirds distributed across New Zealand (orders Sphenisciformes and Procellariiformes; Pelecaniformes families Pelecanidae, Sulidae, Phalacrocoracidae, Fregatidae, and Phaethontidae; and Charadriiformes families Stercorariidae, Laridae, and Sternidae). To assess whether recovery was occurring at restored islands and determine if seabird communities were similar between restored and invaded or uninvaded sites, we developed generalized linear mixed-effects models (GLMMs) comparing species- and niche-based community assemblages using data from uninvaded and currently invaded islands. We found that island biodiversity indices of species- and niche-based communities differed significantly with greater diversity among species-based community composition. Although our results suggest there are considerable differences between species-based communities, this trend was more strongly related to geography whereas niche-based communities were tied to island histories, with niche-based assemblages on recovering islands being more similar to that of uninvaded systems. Our results demonstrate the importance of considering species functional roles when evaluating ecosystem recovery.



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## **Determining breeding home ranges of a rare, high-elevation specialist, the Bicknell's Thrush (*Catharus bicknelli*), in north-central New Brunswick**

Christopher Ward, University of New Brunswick; Tony Diamond, University of New Brunswick; Joe Nocera, University of New Brunswick

The Bicknell's Thrush (*Catharus bicknelli*) is a rare, neotropical migratory songbird which breeds in high elevation stunted growth forests in north-eastern United States and eastern Canada. In New Brunswick, Bicknell's Thrush occupy industrial forest stands undergoing vigorous regrowth post-clear-cutting, and have experienced a decline of 11.5% annually from 2002-2011. Current population estimates of the Bicknell's Thrush comprised of point-count surveys combined with rough habitat models are inaccurate for the region. Assessing population density and habitat use is a vital next step since outlining their geographic occurrence in order to improve population estimates. Using a mix of passive and active radio telemetry to track individual birds, home ranges are calculated throughout the breeding season while monitoring tracked female's nests. The result is a dynamic home range where changes in spatial use can be determined between breeding stages. The calculation of home ranges also included determination of overlap, continuity and contiguity, thereby allowing the estimation of population density within their geographic occurrences. A clearer understanding of how Bicknell's Thrush use their space within their geographic occurrence range in New Brunswick can improve the understanding of ongoing conservation monitoring of this federally threatened bird by government and non-government agencies within the province.

## **Analysis of an avian disease network in the Greater Yellowstone Ecosystem: Opportunities for undergraduate student engagement while testing null models**

Becky R. Watkins, Northwest College; Kayla Harakal, Northwest College; Chloe D. Winkler, Northwest College; Aislee E. Atkinson, Montana State University; Eric C. Atkinson, Northwest College & University of Wyoming

Supported by INBRE (NIH), nearly 20 undergraduate students have participated in original avian disease monitoring at Northwest College since 2013. We sampled over 262 birds of 33 species, 19 families, and 5 orders in the Greater Yellowstone Ecosystem for West Nile virus, avian malaria, enteric bacterial communities, and intestinal coccidia. This sampling effort is ongoing with screenings for malaria and enteric pathogenic bacteria in early stages, while environmental sampling for biting dipterans including mosquitoes, black flies, and biting midges to assess vector communities has started. Thus far, WNV level was not related to family ( $F_{6,207} = 0.467$ ,  $p = 0.832$ ) and, surprisingly, American Robins (*Turdus migratorius*) show little viremia. Passerine salivary virus levels varied through the year with peaks in March, June, and July. Notably, early peaks precede emergence of suitable vectors. Differences in white blood cell counts among species were also apparent (i.e., House Sparrow, *Passer domesticus*, < House Finch, *Haemorrhous mexicanus*). Genetic screening for avian malaria may show promise in elucidating correlations between leukocyte abundance as heretofore, visual screens of blood smears for malaria presence do not. To statistically assess disease, bird, and vector interactions across the landscape, we modeled multiple bipartite networks based upon vector, parasite, and host relationships gleaned from the literature and MALAVI. Data gathered in this study were then modeled and compared against this hypothetical null model.

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## **The Rangeland Watershed Initiative: Building partnerships to enhance bird habitat on private lands**

Carrie Wendt, Point Blue Conservation Science; Kelly Garbach, Point Blue Conservation Science

Approximately 50% of current viable bird habitat in California is on privately owned land, making farms and rangeland an increasingly important refuge for birds and wildlife. The Rangeland Watershed Initiative (RWI) is a partnership between Point Blue Conservation Science and the Natural Resource Conservation Service (NRCS) that works directly with farmers and ranchers to enhance and protect bird habitat on private lands throughout Central and Northern California. Our team of 14 Partner Biologists work in NRCS offices as conservation planners. In addition, we monitor ecosystem function on rangelands by measuring the diversity and abundance of focal bird species as ranchers change management practices and enhance bird habitat. We use presence and abundance of indicator birds as a metric of ecosystem health. RWI currently conducts breeding bird surveys, both point counts and area searches, on approximately 70 ranches across 19 counties in California. The goals of this research are to monitor changes in bird and vegetation communities as ranchers change grazing practices and implement NRCS incentive programs. Initial results indicate that diversifying forage plants, installing cross fencing, and watering facilities away from streams and ponds may improve bird habitat as well as livestock health. This research highlights the importance of building partnerships and working on privately owned agricultural lands that birds depend on.

## **Bridging the research-management divide: A collaborative spatial approach to conservation for species at risk using the Canada Warbler (*Cardellina canadensis*)**

Alana Westwood, Dalhousie University; Dan Lambert, High Branch Conservation Services; Len Reitsma, Plymouth State University

The Canada Warbler (*Cardellina canadensis*) is a small passerine facing population declines across its range. It is listed as Threatened in Canada and a Species of Greatest Conservation Need in nearly every U.S. state in which it occurs. Though habitat associations differ across the range, in Bird Conservation Region 14 (Atlantic Northern Forest), this species predominantly breeds in wet deciduous and mixedwood forests. Conservation and management of this migratory species requires a concerted, multi-jurisdictional effort. Forest managers and conservationists both have the same needs: identifying locations to apply interventions, and determining the appropriate intervention for that type of site. We provide a tool to support both objectives by pairing spatial conservation solutions with corresponding habitat management guidelines. Building upon efforts in the northeastern U.S. portion of BCR 14, we engaged in an iterative consultation process with 31 experts and stakeholders from 9 provinces and states. Using predicted Canada Warbler density in BCR 14 (Boreal Avian Modelling Project; Haché et al. 2014), we developed maps of spatial opportunities for three scenarios, ranging from strict in-situ conservation to active habitat management. We used Zonation (Moilanen 2007) to locate desirable areas within each scenario based on expert weighting and connectivity as related to regional protected areas systems, fragmentation, and dispersal. We present spatial solutions across these three conservation and management scenarios, as well as their complementary habitat guidelines for protected areas and managed forests.

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## **Complex drivers of Grasshopper Sparrow (*Ammodramus savannarum*) nest success**

Sarah Winnicki, Kansas State University; W. Alice Boyle, Kansas State University

Grassland bird populations have experienced more consistent and widespread declines than any other bird guild in North America, and the most promising path to mitigating and reversing these declines lies in developing effective management strategies based on understanding of key demographic rates. We sought to identify the factor(s) which affected the nest success of Grasshopper Sparrows (*Ammodramus savannarum*), grassland-obligate songbirds native to North and Central America. Over three summers we located and monitored sparrow nests (N=274) at the Konza Prairie Biological Station. Using RMark, we created a set of competing known fate models which assessed the relative importance of six hypothesized drivers of nest success: temporal variation, edge effects, vegetative cover, clutch size/investment, breeding male density, and Brown-headed Cowbird (*Molothrus ater*) brood parasitism. Our top-ranked model contains every hypothesized factor except for density, and demonstrates the importance of representing ecological complexity in analyses of demography.

## **Habitat associations of warblers migrating along the Lower Texas Coast**

Samantha Wolfe, Caesar Kleberg Wildlife Research Institute, Texas A&M University; Arlene J. Arnold, Caesar Kleberg Wildlife Research Institute, Texas A&M University; Matthew J. Schnupp, King Ranch, Inc.; Bart M. Ballard, Caesar Kleberg Wildlife Research Institute, Texas A&M University

Although our knowledge of passerine habitat requirements during the breeding season is vast, less research has been conducted on habitat associations during migration. The lower Texas coast provides important stopover habitat for many birds, and its position adjacent to the Gulf of Mexico makes it the first landing spot for many trans-Gulf migrants. Thus, it is important to understand characteristics of stopover habitat in this region to aid future migratory bird conservation efforts. At least 42 out of the 49 wood warbler species (family *Parulidae*) that reside in North America can be found in Texas at some point during the year, making this an ideal group to investigate. En-route migrants are believed to assess the quality of an unfamiliar landscape through physiognomic traits. Thus, we investigated habitat (e.g., physiognomic classes) associations of wood warblers along the lower Texas coast. Warblers were surveyed during spring and autumn migration from 1991–1993, and again from 2006–2008. Surveys were conducted along 110-500 m transects placed within 5 common physiognomic classes along the lower Texas coast. Using DISTANCE 7.0, densities (birds/ha) of warbler species were determined in each class. Overall, 27 warbler species were observed during the study period, with the highest number of species occurring on wooded transects (n = 23). The most commonly observed species were Common Yellowthroat (*Geothlypis trichas*; n = 60) and Black-and-White Warbler (*Mniotilta varia*; n = 46). Results from this study will help us understand what type of habitat is valuable to each warbler species during migration.

# Poster Presentations



## **Stable isotope and mercury analyses of the Galapagos Islands seabird community**

Anna Zarn, University of North Carolina-Wilmington; Carlos Valle, University of San Francisco Quito, Steven Emslie, University of North Carolina Wilmington

Tropical oceans have limited food resources when compared to polar or temperate oceans, which impact the foraging habits of tropical seabirds. Understanding foraging strategies through delta-15N and delta-13C stable isotope analysis is a valuable technique for investigating dietary shifts in seabirds. Mercury (Hg) analysis can be performed in conjunction with stable isotope analysis for a more thorough understanding on contaminant exposure with foraging behavior. Because the Galapagos Islands seabird community is directly impacted by El Niño Southern Oscillation (ENSO) cycles, understanding their foraging behavior before, during, and after these events is important for future conservation plans. However, little research has been done with Galapagos seabirds at the community level. This study addresses the following questions: (1) is there inter-island variation in diet within species as indicated by differences in stable isotope and Hg values, (2) what is the relationship between trophic level and Hg exposure among species, and (3) is there a shift in stable isotope values, and thus diet, in species before, during, and after the 2015 ENSO event? Eight seabird species (*Sula sula*, *Sula nebouxii*, *Sula granti*, *Phaethon aethereus*, *Fregata minor*, *Oceanodroma tethys*, *Cregarus furcatus*, *Puffinus subalaris*) were sampled for breast feathers and analyzed for delta-15N and delta-13C isotope signatures and Hg content. These species encompass a broad range of life-history characteristics and diets, providing a framework for assessing food-web dynamics. Preliminary results indicate some species have shifted diets as predicted with the 2015 ENSO event while others show no impact. Additional sampling will be conducted in 2017.

# Presenter Contact List



**Virginia Abernathy**  
Australian National University  
Canberra, AU  
9374092611  
Vabernathy123@gmail.com

**Stephanie Aguillon**  
Cornell University  
Ithaca, US  
5202492556  
sma256@cornell.edu  
@s\_m\_aguillon

**Erik Andersen**  
The University of Arizona, School of  
Natural Resources and the Environment  
Tucson, US  
5202372102  
erikandersen@email.arizona.edu

**Brandon Armstrong**  
Michigan State University  
East Lansing, US  
6167063734  
armst116@gmail.com

**Eric Atkinson**  
Northwest College  
Powell, Wyoming, US  
3077546018  
Eric.atkinson@nwc.edu  
@EricCAtkinson

**Jacqueline Augustine**  
The Ohio State University at Lima  
Lima, US  
4199958237  
augustine.63@osu.edu  
@osuprairiechick

**Christine Barton**  
Oklahoma State University  
Stillwater, US  
7573331395  
affe54@vt.edu

**Elizabeth Abraham**  
Kaua'i Forest Bird Recovery Project  
Hanapepe, US  
4195098035  
liz@kauaiforestbirds.org  
@abraham\_eliz

**Melissa Althouse**  
SUNY College of Environmental Science  
and Forestry  
Syracuse, US  
999-999-9999  
Missy2005B@msn.com

**Chad Apol**  
Calvin College  
Grand Rapids, US  
N/A  
caa9@students.calvin.edu

**Antonio Arnaiz-Villena**  
University Complutense,  
Madrid, SP  
+34 3941642  
arnaizantonio@gmail.com

**Tom Auer**  
Cornell Lab of Ornithology  
Ithaca, US  
906-370-7582  
mta45@cornell.edu  
tom\_auer

**Colleen Barber**  
Saint Mary's University  
Halifax, CA  
902-496-8126  
colleen.barber@smu.ca

**Sahas Barve**  
Old Dominion University  
Carmel Valley, US  
6506690350  
sahasbarve@gmail.com  
@SahasBarve

**Evan Adams**  
Biodiversity Research Institute  
Portland, US  
207 839 7600  
evan.adams@briloon.org

**Elizabeth Ames**  
The Ohio State University  
Columbus, US  
9377258505  
ames.50@osu.edu

**Caleb Arellano**  
University of Texas Rio Grande Valley  
Brownsville, US  
815-973-8949  
caleb.arellano01@utrgv.edu

**Antonio Arnaiz-Villena**  
University Complutense  
Madrid, SP  
+34 606993161  
arnaizantonio@gmail.com  
<http://chopo.pntic.mec.es/biolmol>

**Jackie Augustine**  
The Ohio State University at Lima  
Lima, US  
4199958237  
augustine.63@osu.edu  
@osuprairiechick

**Margarida Barcelo-Serra**  
Indiana State University  
Terre Haute, US  
812-241-7623  
mbarceloserra@sycamores.indstate.edu

**Brooke Bateman**  
National Audubon Society  
Madison, US  
6086095743  
bbateman@audubon.org  
BrookeLBateman

# Presenter Contact List



**Tessa Behnke**  
University of Nevada, Reno  
Reno, US  
7079722712  
tbehnke@nevada.unr.edu

**Breanna Bennett**  
Villanova University  
Villanova, US  
5707787076  
bbennet4@villanova.edu  
@TheTinyBirdGirl

**Kristin Bianchini**  
Toxicology Centre, University of  
Saskatchewan  
Saskatoon, CA  
306-966-4932  
k.bianchini@usask.ca

**David Bird**  
McGill University  
North Saanich, CA  
1-778-351-0352  
david.bird@mcgill.ca

**Misha Blizard**  
University of Chicago  
Chicago, US  
2108370080  
blizard@uchicago.edu

**Theadora Block**  
University of California Santa Cruz  
(UCSC)  
Santa Cruz, US  
7079216812  
theadorab@gmail.com  
@gcsparrow

**Carol Bocetti**  
California University of Pennsylvania  
California, PA, US  
724-938-5967  
bocetti@calu.edu

**Matt Bonfitto**  
Loyola University Chicago  
Chicago, US  
6308630343  
mbonfitto@luc.edu  
@pics\_of\_birds

**Katherine Bonilla Badilla**  
Escuela de Biología, Universidad de  
Costa Rica  
San José, CR  
50688587120  
kia.2604@gmail.com

**Brendan Boyd**  
York University  
Peterborough, CA  
705 927-6744  
bpboyd@lakeheadu.ca

**Melissa Brady**  
Michigan State University  
East Lansing, US  
nope.  
ladybrady@gmail.com

**Erika Brewer**  
Centre college  
Danville, US  
(859)-404-1512  
Erika.brewer@centre.edu

**Lindsay Brown**  
University of Nebraska Omaha  
Omaha, US  
(402) 490-0617  
labrown@unomaha.edu

**Joanna Burger**  
Rutgers University  
PISCATAWAY, NJ, US  
732-828-9390  
BURGER@BIOLOGY.RUTGERS.EDU

**Mike Butler**  
Lafayette College  
Easton, US  
610-330-5762  
butlermw@lafayette.edu  
@MWButler2

**Maxwell Butler**  
Oberlin College  
Oberlin, US  
608-469-6131  
max.butler84@gmail.com

**Sergio A. Cabrera-Cruz**  
University of Delaware  
Newark, US  
3022876480  
scabrera@udel.edu  
@serchenheim

**Sergio A. Cabrera-Cruz**  
University of Delaware  
Newark, US  
3022876480  
scabrera@udel.edu

**Leonardo Campagna**  
Cornell University  
Ithaca, US  
(800) 843-2473  
lc736@cornell.edu

**Andrew Campomizzi**  
Bird Ecology and Conservation Ontario  
Toronto, CA  
NA  
andy@beco-birds.org

**Laura Céspedes**  
Universidad de los Andes  
Bogotá, CO  
3175169016  
ln.cespedes508@uniandes.edu.co  
@lcespedesarias

**Anand Chaudhary**  
Baylor University  
Waco, US  
2549819123  
Anand\_Chaudhary@baylor.edu

**Glen Chilton**  
Jame Cook University  
Townsville, AU  
61-7-4781-5195  
glen.chilton@jcu.edu.au

# Presenter Contact List

**Carla Cicero**

Museum of Vertebrate Zoology,  
University of California, Berkeley  
Berkeley, US  
510-642-7868  
ccicero@berkeley.edu  
@cheechero

**Nathan Cooper**

Smithsonian Migratory Bird Center  
Washington, US  
9897451573  
nathanwands@gmail.com  
Nature\_Is\_Grand

**Kristen Covino**

Canisius College  
Buffalo, US  
716-888-2546  
covinok@gmail.com  
@CovinoKristen

**Jen Cruz**

University of Wisconsin -Madison  
Madison, US  
6085728891  
cruzbernal@wisc.edu  
@jencruz

**Marie-Eve Cyr**

University of Manitoba  
Winnipeg, CA  
514-791-6274  
cyr345@myumanitoba.ca

**Alana Demko**

University of Windsor  
Windsor, CA  
226-787-9398  
demko@uwindsor.ca

**Hannah Clipp**

University of Delaware  
Newark, DE, US  
443-987-0037  
hclipp@udel.edu

**Jacob C. Cooper**

The University of Chicago & The Field  
Museum  
Chicago, US  
NA  
jccooper@uchicago.edu

**Brody Crosby**

Queen's University  
Kingston, CA  
6139292939  
b.crosby@queensu.ca  
@brody\_crosby

**George Cummins**

Northern Arizona University  
Flagstaff, US  
7573040337  
gcc24@nau.edu

**Kayla Davis**

Virginia Tech  
Blacksburg, US  
9109950249  
kaylad89@vt.edu  
@kladavis

**Andrew Dennhardt**

Michigan State University  
East Lansing, US  
5173533030  
dennhard@msu.edu

**Samantha Collins**

Louisiana Department of Wildlife and  
Fisheries, Rockefeller Wildlife Refuge  
Grand Chenier, US  
978-500-0497  
scollins@wlf.la.gov

**Derek Coss**

University of Maryland Baltimore  
County  
Baltimore, US  
301-302-9340  
dcoss1@umbc.edu

**Carter Crouch**

Caesar Kleberg Wildlife Research  
Institute, Texas A&M University-  
Kingsville  
Kingsville, Tx, US  
940 7046008  
cartergcrouch@gmail.com

**Claire Curry**

Oklahoma Biological Survey, University  
of Oklahoma  
Norman, US  
9403955230  
curryclairem@gmail.com

**Amelia-Juliette Demery**

San Diego State University  
San Diego, US  
8183976060  
ajdemery@mail.sdsu.edu  
@ademery

**Devon DeRaad**

Occidental College, Moore Laboratory  
of Zoology  
Los Angeles, US  
4802545321  
devonderaad@gmail.com  
@Dev\_Der

# Presenter Contact List



**Amanda Dolinski**  
Michigan State University  
East Lansing, US  
9098562780  
dolinsk5@msu.edu

**Shane DuBay**  
University of Chicago  
Chicago, US  
8043345411  
dubaysg@uchicago.edu

**Sarah Dzielski**  
Cornell Lab of Ornithology  
Ithaca, US  
5859439224  
sad88@cornell.edu

**Rory Eggleston**  
Duke University/UT Rio Grande Valley  
Laramie, US  
3074608938  
rory.eggleston@gmail.com  
@reggles15

**Elisa Elizondo**  
Louisiana State University  
Baton Rouge, US  
2147349627  
lisa.elizondo@okstate.edu  
@FollowsFeathers

**Matthew Etterson**  
US Environmental Protection Agency  
Duluth, US  
218.529.5158  
etterson.matthew@epa.gov

**Kimberly Fake**  
Michigan State University  
East Lansing, US  
517-353-3030  
fakekimb@msu.edu

**Bryant Dossman**  
Department of Natural Resources,  
Cornell University  
Ithaca, US  
6146577241  
bd342@cornell.edu  
BryantDossman

**Steve Dudley**  
British Ornithologists' Union (BOU)  
Peterborough, UK  
+44 0 7767787287  
stevedudley@bou.org.uk  
@stevedudley\_ | @IBIS\_journal

**Brandon P.M. Edwards**  
University of Guelph  
Guelph, CA  
5194663753  
edwardsb@uoguelph.ca  
bedwards144

**Mandy Ehnes**  
Nipissing University / BioForest  
Technologies  
Sault Ste. Marie, CA  
705 971 4401  
mehnes14@gmail.com

**Aspen Ellis**  
University of Michigan  
Ann Arbor, US  
734-904-3749  
boriellis@gmail.com

**David Ewert**  
The Nature Conservancy  
Lansing, Michigan, US  
517.316.2256  
dewert@tnc.org

**Amanda Falk**  
Centre College Biology Program  
Danville, US  
859-238-5304  
amanda.falk@centre.edu

**Cameron Dove**  
Davidson College  
Davidson, US  
919-584-2002  
cadove@davidson.edu

**Steve Dudley**  
British Ornithologists' Union (BOU)  
Peterborough, UK  
+44 0 7767787287  
stevedudley@bou.org.uk  
stevedudley\_

**Amanda Edworthy**  
Washington State University  
Pullman, US  
971-232-7248  
amanda.edworthy@wsu.edu

**Jonathan Eiseman**  
Western Michigan University  
Kalamazoo, US  
6502747299  
jonathan.eiseman@wmich.edu  
@Aegyptimusic

**Erik Enbody**  
Tulane University  
New Orleans, US  
5174203558  
eenbody@tulane.edu  
@erikenbody

**Harold Eyster**  
University of British Columbia  
Vancouver, CA  
7347190359  
harold.eyster@ires.ubc.ca

**Michael Falkowski**  
Colorado State University  
Fort Collins, CO, US  
970-491-3575  
falkow@colostate.edu



# Presenter Contact List



**Kathleen Farley**  
Rutgers University-Newark  
Newark, US  
973 353 1305  
kefarley@rutgers.edu  
woodcockwatchNJ

**Melanie Florkowski**  
University of Michigan  
Ann Arbor, US  
7345529914  
mflorkow@umich.edu

**Erik Funk**  
San Diego State University  
San Diego, US  
619-916-7354  
erikrfunk@gmail.com

**Brock Geary**  
Tulane University  
New Orleans, US  
337-739-6621  
brock.j.geary@gmail.com  
@brock\_geary

**Sharon Gill**  
Western Michigan University  
Kalamazoo, US  
2693875613  
sharon.gill@wmich.edu  
@birdsoundscapes

**Valentina Gómez-Bahamón**  
University of Illinois at Chicago  
Chicago, US  
7739482334  
vgomez21@uic.edu

**Erin Grabarczyk**  
Western Michigan University  
Kalamazoo, US  
4193569440  
erin.e.grabarczyk@wmich.edu

**Laura Farwell**  
West Virginia University  
Morgantown, US  
2063048442  
lsfarwell@mix.wvu.edu  
mountain\_laura

**Auriel Fournier**  
Mississippi State University  
Biloxi, US  
4193076261  
aurielfournier@gmail.com  
@RallidaeRule

**Victoria Garcia**  
Old Dominion University  
Norfolk, US  
(757) 683-5461  
vgarcia@odu.edu  
@vg667

**David Gesicki**  
Bowling Green State University  
Bowling Green, US  
440-328-6683  
dgesick@bgsu.edu

**Deborah Goldberg**  
University of Michigan  
Ann Arbor, US  
7347631732  
degold@umich.edu

**Geoff Gould**  
The Ohio State University  
Columbus, US  
720-556-0930  
gmg1382@gmail.com  
@LPC\_OSU

**Erin Grabarczyk**  
Erin Grabarczyk - Western Michigan  
University  
Kalamazoo, US  
419-356-9440  
erin.e.grabarczyk@wmich.edu

**Cameron Fiss**  
Indiana University of Pennsylvania  
Indiana, US  
7178603243  
ldmq@iup.edu

**Jennifer Froehly**  
Clemson University  
Clemson, US  
207-310-1201  
jfroehl@clemson.edu

**Megan Garfinkel**  
University of Illinois at Chicago  
Chicago, US  
2152604529  
mgarfi2@uic.edu

**Neil Gilbert**  
University of Alabama  
Tuscaloosa, US  
2487946458  
n.a.gilbert92@gmail.com  
@ngil92

**Camila Gomez**  
Universidad de Los Andes  
Bogota, CO  
5.7321218925e+011  
c.gomez13@uniandes.edu.co  
@selvaorgco

**Elizabeth Gow**  
University of Guelph  
Guelph, CA  
none  
eliz.gow@usask.ca

**Tierra Groff**  
San Francisco State University  
San Francisco, US  
415-342-1337  
tierrag2@gmail.com

# Presenter Contact List



**Joan Hagar**  
U.S. Geological Survey  
Corvallis, US  
5417500984  
joan\_hagar@usgs.gov

**Megan Hart**  
Austin Peay State University  
Clarksville, TN, US  
19316273128  
mhart6@my.apsu.edu  
@meganhart92

**Sue Hayes**  
York university  
Toronto, CA  
647 669-1175  
suehayes@yorku.ca

**Erin Heller**  
Virginia Tech  
Blacksburg, US  
804-314-8089  
elheller@vt.edu

**Jason Hill**  
Vermont Center for Ecostudies  
Norwich, US  
802-649-1431  
jhill@vtecostudies.org

**Sarah Hird**  
University of Connecticut  
Storrs, US  
8604866299  
sarah.hird@uconn.edu  
sarahmhird

**Anne Houtman**  
Rose-Hulman Institute of Technology  
Terre Haute, US  
8128778776  
houtman@rose-hulman.edu  
@anneforsure

**Natasha Hagemeyer**  
Old Dominion University  
Virginia Beach, US  
4102798990  
nhage004@odu.edu  
ladybiologist

**Mark Hauber**  
University of Illinois at Urbana-  
Champaign  
Urbana, US  
2123964488  
mhauber@illinois.edu  
@cowbirdlab

**Ian Hays**  
Hunter College, City University of New  
York  
brooklyn, US  
1 646 345 8371  
ianr.hays@gmail.com

**Bronwen Hennigar**  
Memorial University of Newfoundland  
St.Johns, Newfoundland & Labrador,  
CA  
905-431-4332  
bh6401@mun.ca

**Geoffrey Hill**  
Auburn University  
Auburn, US  
334-332-4930  
ghill@auburn.edu  
@Geoffrey\_E\_Hill

**Kathy Hixson**  
Southeast Missouri State University  
Cape Girardeau, US  
434-944-3503  
kmayhix@gmail.com  
@kathymhixson

**Jessica Howell**  
University of Saskatchewan  
Saskatoon, CA  
9033738948  
jessica.howell@usask.ca

**Laurie Hall**  
U.S. Geological Survey  
Fremont, CA, US  
831-233-2795  
lahall@usgs.gov

**Samantha Hauser**  
University of Louisiana at Lafayette  
Lafayette, US  
9734547494  
samantha.hauser1@gmail.com  
@SamanthaSHauser

**Alexandra Heathcote**  
University of Manitoba  
Winnipeg, CA  
2048019231  
alheathcote@outlook.com

**Jim Herkert**  
Illinois Audubon Society  
Springfield, US  
217-544-2473  
jherkert@illinoisaudubon.org

**Anna Hiller**  
Louisiana State University Museum of  
Natural Science  
Baton Rouge, US  
5305743121  
ahille2@lsu.edu  
@AnnaHiller92

**Peter Houde**  
New Mexico State University  
Las Cruces, US  
575 646 6019  
phoude@nmsu.edu

**Lawrence Igl**  
USGS Northern Prairie Wildlife  
Research Center  
Jamestown, US  
701-253-5511  
ligl@usgs.gov

# Presenter Contact List



**Tara Imlay**  
Dalhousie Univeristy  
Halifax, CA  
9022256575  
tara.imlay@gmail.com

**Julianna Jenkins**  
US Forest Service  
Corvallis, US  
541-750-7498  
juliannajenkins@fs.fed.us  
Jmajenkins

**Zach Kahn**  
University of Windsor  
Windsor, CA  
6139858463  
zakahn25@gmail.com  
@kahnected

**Kaitlyn Kelly**  
Eastern Kentucky University  
RICHMOND, US  
7249893551  
kelly.kaitlynj@gmail.com  
@KatieKelly0330

**Randall Knapik**  
Michigan State University  
East Lansing, US  
5743601652  
knapikra@msu.edu

**Gunnar Kramer**  
University of Toledo  
Toledo, US  
651-808-5557  
gunnarrkramer@gmail.com

**Aurelie Labbe**  
Murdoch University  
Perth, AU  
61452511362  
Aurelie.MT.Labbe@gmail.com  
@amtlabbe

**Helen James**  
Smithsonian Institution  
Washington, DC, US  
202-633-0792  
jamesh@si.edu

**Alison Johnston**  
Cornell Lab of Ornithology, University  
of Cambridge  
Ithaca, US  
4.4776522738e+011  
aj327@cornell.edu  
@ali\_johnston

**Adam Kehoe**  
Montana State University, Department  
of Ecology  
Bozeman, US  
9063645021  
adam.r.kehoe@gmail.com

**Cody Kent**  
Tulane University  
New Orleans, US  
4196890414  
ckent3@tulane.edu  
@cm\_kent

**Nicola Koper**  
Natural Resources Institute, University  
of Manitoba  
Winnipeg, CA  
204-951-8597  
nicola.koper@umanitoba.ca

**Nicole Krauss**  
Washington State University  
Pullman, US  
952-412-1537  
kraussne@gmail.com

**Blaine Landsborough**  
University of Windsor  
Windsor, CA  
519-300-1242  
blainelandsborough@gmail.com

**Julie Jedlicka**  
Missouri Western State University  
St. Joseph, US  
8162714552  
jjedlicka@missouriwestern.edu

**Roselvy Juárez**  
Universidad de Costa Rica  
San José, CR  
(506) 84891763  
roselvy.juarez@gmail.com

**Gregory Keller**  
Gordon College  
Wenham, MA, US  
978-867-4852  
greg.keller@gordon.edu  
@environmentao

**Libby Keyes**  
Governors State University  
Tinley Park, US  
7085675510  
libby.inthefield@gmail.com

**Richard Kostecke**  
The Nature Conservancy  
Austin, US  
254-258-0936  
rkostecke@tnc.org

**Barbara Kus**  
U.S. Geological Survey  
San Diego, US  
619-225-6421  
barbara\_kus@usgs.gov

**Jo Latimore**  
Michigan State University  
East Lansing, US  
5174321491  
latimor1@msu.edu  
@JoLatimore

# Presenter Contact List



**Gavin Leighton**  
Cornell Lab of Ornithology  
Ithaca, US  
215-285-7967  
gml86@cornell.edu  
@GMcLeanLeighton

**Michael Lombardo**  
Biology Department, Grand Valley  
State University  
Allendale, MI 49401, US  
616-331-2501  
lombardm@gvsu.edu

**Scott Loss**  
Oklahoma State University  
Stillwater, US  
405-744-4607  
scott.loss@okstate.edu  
@LossLabOSU

**Matthew Louder**  
Hunter College, City University of  
New York  
Spring, TX, US  
6604417509  
mckimlouder@gmail.com  
MIMlouder

**Alec Luro**  
University of Illinois at Urbana-  
Champaign  
Urbana, US  
2077124754  
alec.b.luro@gmail.com

**Vanessa Luzuriaga-Aveiga**  
University of Toronto Scarborough  
Toronto, CA  
647-466-4703  
vanessa.luzuriagaaveiga@mail.utoronto.ca

**James Lyons**  
USGS Patuxent Wildlife Research  
Center  
Laurel, MD, US  
301-497-5567  
jelyons@usgs.gov

**Maggie MacPherson**  
Tulane University  
New Orleans, US  
5042502318  
mmacphe@tulane.edu  
@B1rdz\_Lady

**Kristen Mancuso**  
University of British Columbia Okanagan  
and Environment and Climate Change  
Canada  
Kelowna, CA  
250-864-5788  
kmancuso88@gmail.com  
@kmancuso88

**Joseph Manthey**  
New York University Abu Dhabi  
Abu Dhabi, AE  
785-551-8405  
jdmanthey@gmail.com  
jdmanthey

**Dawn Marsh**  
U.S. Fish and Wildlife Service  
Marquette, US  
906 226 1212  
Dawn\_Marsh@fws.gov

**Alix Matthews**  
Arkansas State University  
Jonesboro, US  
5013515559  
matthews.alix@gmail.com

**Abby McBride**  
Independent  
Machiasport, ME, US  
2076079809  
abbymcb@gmail.com  
@sketchbiologist

**Dakota McCoy**  
Harvard University  
Cambridge, MA, US  
724-766-4014  
dakotamccoy@g.harvard.edu  
McCordinator

**Jenna McCullough**  
University of New Mexico  
Albuquerque, US  
2088300864  
mcculloughj@unm.edu  
@Jenna\_Merle

**Ann McKellar**  
Environment & Climate Change  
Canada  
Saskatoon, CA  
306-975-4799  
ann.mckellar@canada.ca

**Emily McKinnon**  
University of Windsor  
Windsor, CA  
2042189057  
emilymckinnon12@gmail.com  
@BirdBiologist

**Mary Anne McLeod**  
SWCA Environmental Consultants  
Flagstaff, US  
928-774-5500  
mmcleod@swca.com

# Presenter Contact List



**Darin McNeil**  
Cornell Lab of Ornithology  
Ithaca, NY, US  
2697884156  
djm462@cornell.edu

**Libby Megna**  
University of Wyoming  
Laramie, US  
2699449488  
lmegna@uwyo.edu  
@LibbyMegna

**Carolina Méndez**  
Universidad de Costa Rica  
San Jose, CR  
506 88812044  
caritomendvasq@gmail.com

**Chris Mensing**  
U.S. Fish and Wildlife Service  
East Lansing, US  
517-351-2555  
chris\_mensing@fws.gov

**Loren Merrill**  
Illinois Natural History Survey,  
University of Illinois Urbana-  
Champaign  
Champaign, US  
805-450-1744  
loren21@illinois.edu  
BirdDoc\_Merrill

**Nathan Michael**  
University of Akron  
Akron, US  
N/a  
Npm19@zips.uakron.edu

**Nicole Michel**  
National Audubon Society  
San Francisco, US  
4159418149  
nmichel@audubon.org  
@Nicole\_Michel

**Matthew Miller**  
Sam Noble Oklahoma Museum of  
Natural History & Department of  
Biology, University of Oklahoma  
Norman, US  
405-325-2578  
mjmillier@ou.edu  
@amazonmatt

**Colleen Miller**  
University of Wisconsin-Madison  
Madison, US  
6085724988  
crmiller4@wisc.edu  
Miller1Rose

**Ashlee Minor**  
Southern Illinois University -  
Department of Zoology, Cooperative  
Wildlife Research Laboratory  
Carbondale, US  
618-453-6947 (office)  
Ashlee.Minor@siu.edu

**Adrian Monroe**  
Colorado State University  
Fort Collins, US  
757 784 8430  
adrian.monroe@colostate.edu  
@apmonr

**Ines Moran**  
University of Windsor  
Windsor, CA  
7789184928  
moran11@uwindsor.ca

**Kaycee Morra**  
Michigan State University  
East Lansing, US  
2489355650  
morrakay@msu.edu

**Ron Mumme**  
Department of Biology, Allegheny  
College  
Meadville, PA, US  
814-332-2382  
rmumme@allegheny.edu

**Michael Murphy**  
Dept. of Biology Portland State  
University  
Portland, US  
503-953-0865  
murphym@pdx.edu

**Brian Myers**  
San Diego State University  
San Diego, US  
(626) 367-4718  
bmyers@mail.sdsu.edu

**Desiree Narango**  
University of Delaware/Smithsonian  
Migratory Bird Center  
Newark, DE, US  
410-458-4530  
Dnarango@udel.edu  
@DLNarango

**Jennifer Newbrey**  
Department of Biology, Columbus State  
University  
Columbus, GA, US  
706-507-8096  
newbrey\_jennifer@columbusstate.edu

# Presenter Contact List



**Daniel Newhouse**  
East Carolina University  
Greenville, NC, US  
630-649-3817  
newhoused12@students.ecu.edu  
oldhouse5

**K. Samantha Nichols**  
University of Minnesota & University of  
St. Thomas  
St. Paul, US  
609-610-1086  
Nicho561@umn.edu

**Ryan Norris**  
University of Guelph  
Guelph, CA  
519-824-4120 ext. 56300  
rnormis@uoguelph.ca  
@NorrisLab

**Paige Oboikovitz**  
University of South Dakota  
Vermillion, US  
7085222233  
Paige.Oboikovitz@coyotes.usd.edu

**Ryan O'Connor**  
University of Pretoria  
East Lansing, US  
5172859966  
oconn163@gmail.com  
@Ryan\_OConn

**Emilie Ospina**  
University of Illinois at Urbana-  
Champaign  
Champaign, US  
6315619207  
emilie.ospina@gmail.com

**Matthew Palumbo**  
Western University  
London, CA  
850-766-9396  
mpalumb7@uwo.ca

**Meelyn Pandit**  
Oklahoma State University  
Stillwater, US  
3176703774  
meelyn.pandit@gmail.com  
@meelyn\_pandit

**Timothy Parker**  
Whitman College  
Walla Walla, US  
5095264777  
parkerth@whitman.edu

**Brian Peer**  
Western Illinois University  
Macomb, US  
563-424-9594  
BD-Peer@wiu.edu  
@prothoproject

**Nuwanthika Perera**  
Wichita State University  
WICHITA, US  
9188157364  
dxgamage@shockers.wichita.edu

**Noah Perlut**  
University of New England  
Biddeford, US  
207.602.2778  
nperlut@une.edu

**Christine Peterson**  
University of Montana  
Missoula, US  
4065523922  
christine.peterson@umconnect.umt.edu  
xtinepeterson\_

**Erin Place**  
The Ohio State University  
Wapakoneta, US  
4192061536  
Place.80@hotmail.com

**Cody Porter**  
University of Wyoming  
Laramie, US  
5179605909  
cporte16@uwyo.edu

**Alexis F.L.A. Powell**  
Emporia State University  
Emporia, US  
651-308-0555  
alveypowell@yahoo.com

**Darren Proppe**  
Calvin College  
Grand Rapids, US  
616-526-6662  
dsp5@calvin.edu

**M. Shane Pruet**  
Oregon State University  
Corvallis, US  
541-750-7086  
pruetmi@oregonstate.edu  
@DrunkenCorvid

**Paulo Pulgarin**  
Universidad de Los Andes  
Bogotá, CO  
3166276460  
pc.pulgarin51@uniandes.edu.co  
@paulopulgarin

**Douglas Raybuck**  
University of Tennessee  
Knoxville, US  
8142296272  
draybuck@utk.edu

**Sushma Reddy**  
Loyola University Chicago  
Chicago, US  
7735083675  
sreddy6@luc.edu  
@phylodiversity

# Presenter Contact List

**Susan Reed**

Indiana University Bloomington  
Bloomington, US  
2195776901  
susan22.reed@gmail.com

**Shannon Regan**

Eastern Illinois University  
Charleston, IL, US  
651-328-1051  
shnnnregan313@gmail.com  
shanmregan

**Len Reitsma**

Plymouth State University  
Plymouth, US  
603 523 7735  
leonr@plymouth.edu

**Emma Rhodes**

University of South Alabama  
Foley, US  
2515974782  
emmarhodes09@gmail.com

**Christine Ribic**

US Geological Survey, Wisconsin  
Cooperative Wildlife Research Unit  
Madison, US  
608-263-6556  
caribic@wisc.edu

**Corey Riding**

Oklahoma State University  
Stillwater, US  
2088505435  
corey.riding@okstate.edu

**Katie Rittenhouse**

Southeast Missouri State University  
Cape Girardeau, US  
717-679-5839  
rittenhouseka@gmail.com  
KatAnnRit

**Melissa Roach**

University of Missouri  
Columbia, US  
4346102115  
roach.mc1@gmail.com

**Amélie Roberto-Charron**

University of Manitoba  
Winnipeg, CA  
2049529524  
arobertocharron@gmail.com  
@ARobertoCharron

**Trina Roberts**

University of Iowa  
Iowa City, US  
319-335-1313  
trina-roberts@uiowa.edu  
@trinaeroberts

**Orin Robinson**

Cornell Lab of Ornithology  
Ithaca, US  
2514013784  
ojr7@cornell.edu  
@Robinoj

**Orin Robinson**

Cornell Lab of Ornithology  
Ithaca, US  
2514013784  
ojr7@cornell.edu  
@Robinoj

**Steve Roels**

Michigan State University  
Bath, Michigan, US  
N/A  
roelsste@msu.edu

**Beth Ross**

USGS South Carolina Coop Unit,  
Clemson University  
Clemson, US  
8646564141  
bross5@clemson.edu  
bethross

**Amber Roth**

University of Maine  
Orono, US  
2075812856  
amber.roth@maine.edu

**Erin Rowan**

Detroit Audubon  
Detroit, US  
313-800-1578  
erowan@detroitaudubon.org

**Jordan Rutter**

American Ornithological Society  
Silver Spring, US  
2022108827  
jerutter@gmail.com  
@JERutter

**Jessie Salter**

Louisiana State University  
Baton Rouge, US  
847-387-9377  
jsalte5@lsu.edu  
@jsalt92

**Tim Salzman**

University of Kentucky  
Lexington, US  
(859) 323-9499  
salzman.tim@uky.edu

**Natalie Sanchez**

University of Alberta  
Edmonton, CA  
5875947355  
sanchezu@ualberta.ca  
@Nati\_SanchezU

**Lindsey Sanders**

WY Coop Research Unit, University of  
Wyoming  
Laramie, US  
8312460709  
sanders.lindsey@gmail.com

# Presenter Contact List



**Estelle Sandhaus**  
Santa Barbara Zoo  
Santa Barbara, US  
805-252-6483  
esandhaus@sbzoo.org  
@esandhaus

**Sarah Saunders**  
Michigan State University  
East Lansing, US  
7082206590  
saund123@msu.edu

**Katie Schroeder**  
East Carolina University  
Greenville, NC, US  
4847690161  
schroederk15@students.ecu.edu  
@katieschro8

**John Severson**  
USGS Western Ecological Research  
Center  
Reno, US  
530-908-2546  
jpseverson@usgs.gov

**Shailee Shah**  
Columbia University  
New York, US  
6073793756  
sss2254@columbia.edu  
shailee\_shah93

**Evangeline Shank**  
University of Maryland, Baltimore  
County  
Baltimore, US  
5139107681  
eshank1@umbc.edu

**Megan Shave**  
Michigan State University  
East Lansing, US  
7742742064  
shavemeg@msu.edu

**Amy Shipley**  
University of Wisconsin-Madison  
Madison, US  
419-283-1731  
shipley2@wisc.edu

**Daizaburo Shizuka**  
University of Nebraska-Lincoln  
Lincoln, NE, US  
402-472-1544  
dshizuka2@unl.edu  
@ShizukaLab

**Julia Shonfield**  
University of Alberta  
Edmonton, CA  
780-200-1224  
shonfiel@ualberta.ca  
@JuliaShonfield

**Quinn Shurtliff**  
Wastren Advantage, Inc.  
Idaho Falls, US  
208-851-2893  
quinn.shurtliff@wastrenadvantage.com

**Eric Sibbald**  
Cornell University  
Ithaca, US  
Not Available  
ets48@cornell.edu

**Adnan Siddique**  
The Ohio State University  
Centerville, US  
9376021599  
adnanh.siddique@hotmail.com  
@AladdinSiddique

**Emily Sinnott**  
University of Missouri  
Columbia, US  
314-795-9975  
easkt7@mail.missouri.edu

**Aubrey Sirman**  
North Dakota State University  
Fargo, US  
4074085744  
aubrey.sirman@ndsu.edu  
@HeidingSparrow

**Paul Skrade**  
Upper Iowa University  
Fayette, US  
5634255222  
skradep74@uiu.edu  
paulspeeps

**Olivia Smith**  
Washington State University  
Pullman, US  
5174030417  
olivia.m.smith@wsu.edu

**Jamie Smith**  
Western Michigan University  
Kalamazoo, US  
2693528986  
jamie.d.smith@wmich.edu  
@smithjamied

**Robert Snowden**  
University of North Carolina  
Wilmington  
Wilmington, US  
541-285-8768  
ros4607@uncw.edu

**Nicholas Souza**  
Loyola University Chicago  
Chicago, US  
4193509252  
nick.p.souza@gmail.com

**Jordyn Stalwick**  
University Of Saskatchewan  
Saskatoon, CA  
13068674391  
jordyn.stalwick@usask.ca



# Presenter Contact List



**Mark Stanback**  
Davidson College  
Davidson, US  
704-894-2325  
mastanback@davidson.edu

**Philip Stouffer**  
Louisiana State University  
Baton Rouge, US  
9856349224  
pstouffer@lsu.edu

**Erica Stuber**  
University of Nebraska - Lincoln  
Lincoln, US  
4024193896  
efstuber@gmail.com

**K Supriya**  
Committee on Evolutionary Biology,  
University of Chicago  
Chicago, US  
3122593392  
ksupriya@uchicago.edu  
supriyaknair

**Andrew Sweet**  
University of Illinois at Urbana-  
Champaign  
Champaign, US  
9782908689  
adsweet2@illinois.edu  
@drew\_Sweet21

**Caroline Thow**  
University of California, Santa Cruz  
Aptos, US  
5102958822  
Cara.mira@gmail.com  
@CaraThow

**Judith Toms**  
Environment and Climate Change  
Canada  
Edmonton, CA  
780-951-8807  
judith.toms@canada.ca

**Calandra Stanley**  
University of Maryland and  
Smithsonian Migratory Bird Center  
Washington DC, US  
2027136785  
callie@umd.edu

**Amy Strauss**  
University of Massachusetts, Amherst  
Amherst, MA, US  
510-734-2607  
amyvstrauss@gmail.com  
avstrauss

**Katie Stumpf**  
Georgia College & State University  
Milledgeville, US  
9207408019  
katie.stumpf@gcsu.edu

**Allison Sussman**  
Michigan State University  
East Lansing, US  
301-502-4244  
sussman7@msu.edu

**Rose Swift**  
Cornell Lab of Ornithology, Cornell  
University  
Ithaca, US  
9259890721  
rjs484@cornell.edu

**Morgan Tingley**  
University of Connecticut  
Storrs, US  
8604862984  
morgan.tingley@uconn.edu  
mwtingley

**Sarah Toner**  
Cornell University  
Ithaca, US  
smt232@cornell.edu  
@PallidHarrier

**Jaime Stephens**  
Klamath Bird Observatory  
Ashland, US  
541-201-0866  
jlh@klamathbird.org

**Kristin Strydhorst**  
Calvin College  
Grand Rapids, US  
6169202141  
kgs4@students.calvin.edu

**Paul Sullivan**  
Michigan State University: Department  
of Integrative Biology  
East Lansing, Michigan, US  
2313921703  
sulli474@msu.edu

**David Swanson**  
University of South Dakota  
Vermillion, US  
605-677-6175  
david.swanson@usd.edu

**Keith Tarvin**  
Oberlin College  
Oberlin, OH, US  
440-775-8306  
keith.tarvin@oberlin.edu

**Jessica Tinklenberg**  
Purdue University  
Lafayette, US  
616-920-9312  
jtinklen@purdue.edu

**Andrea Townsend**  
Hamilton College  
Clinton, US  
315-859-4828  
aktownse@hamilton.edu

# Presenter Contact List

**Doug Tozer**

Bird Studies Canada  
Port Rowan, Ontario, CA  
519-586-3531 ext. 168  
dtozer@birdscanada.org

**Emily Upham-Mills**

University of Alberta  
Edmonton, CA  
5198314110  
euphammils@ualberta.ca

**Paul van Els**

RUG  
Groningen, NL  
31658879579  
paulvanel@gmail.com

**Jeffrey Walters**

Department of Biological Sciences,  
Virginia Tech  
Blacksburg, Virginia, US  
540231-3847  
jrwalt@vt.edu

**Becky Watkins**

Northwest College  
Powell, Wyoming, US  
3077546018  
beckyw25@drtel.net

**David Westneat**

University of Kentucky  
Lexington, KY, US  
8593239499  
david.westneat@uky.edu

**David Wituszynski**

Department of Food, Agricultural, and  
Biological Engineering, The Ohio State  
University  
Columbus, US  
603-275-5060  
wituszynski.1@osu.edu

**Kate Trewin**

University of Melbourne, Museums  
Victoria  
Melbourne, AU  
403682264  
trewink@student.unimelb.edu.au  
BirdKateAU

**Olivia Utley**

Michigan State University  
East Lansing, US  
5023225076  
utleyoli@msu.edu  
shes4thebirds

**Charles van Riper III**

US Geological survey & University of  
Arizona  
Tucson, US  
(520) 749-1813  
charles\_van\_riper@usgs.gov

**Nicholas Walton**

University of Minnesota - Natural  
Resources Research Institute  
Duluth, US  
218-788-2782  
ngwalton@d.umn.edu

**Emily Wells**

Texas A&M University- Kingsville,  
Caesar Kleberg Wildlife Research  
Institute  
Kingsville, US  
7073260234  
emily.wells@students.tamuk.edu

**Nathaniel Wheelwright**

Bowdoin College  
Brunswick, Maine, US  
207-725-3583  
nwheelwr@bowdoin.edu

**Jana Wold**

Victoria University of Wellington, NZ  
Argyle, US  
(940) 595-3647  
wold.jana@gmail.com

**Whitney Tsai**

Occidental College - Moore Laboratory  
of Zoology  
Los Angeles, US  
3232592673  
wtsai@oxy.edu

**Ethan Valentine**

Calvin College  
Grand Rapids, US  
5135025979  
evalentine800@gmail.com

**Bram Verheijen**

Kansas State University  
Manhattan, US  
999-999-9999  
bramverheijen@ksu.edu  
@Bram\_Verheijen

**Brian Washburn**

USDA-APHIS-Wildlife Services  
Sandusky, US  
419-625-0242  
brian.e.washburn@aphis.usda.gov

**Carrie Wendt**

Point Blue Conservation  
ScienceConservation Science  
Chico, US  
530-534-0112  
cwendt@pointblue.org

**Ben Winger**

University of Michigan  
Ann Arbor, US  
7347633379  
wingerb@umich.edu

**Petra Wood**

USGS  
Morgantown, US  
304-293-5090  
pbwood@wvu.edu

# Presenter Contact List



**Brad Woodworth**  
University of Guelph  
Guelph, CA  
+1 902-825-9037  
bwoodwor@uoguelph.ca  
@bkwoodworth

**Amy Wynia**  
University of North Texas, Department  
of Biological Sciences  
Denton, US  
6165509366  
amy.wynia@gmail.com

**Elise Zipkin**  
Michigan State University  
East Lansing, US  
5178448039  
ezipkin@msu.edu  
@ZipkinLab

**Natalie Wright**  
Kenyon College  
Gambier, OH, US  
352-262-2807  
nataliestudiesbirds@gmail.com  
coereba

**Jane Younger**  
Loyola University Chicago  
Chicago, US  
773-999-8567  
jyounger@luc.edu  
@jane\_younger

**Benjamin Zuckerberg**  
University of Wisconsin-Madison  
Madison, US  
608-263-0853  
bzuckerberg@wisc.edu

**Yongjie Wu**  
Sichuan University  
Chengdu, CN  
3124688082  
wuyongjie@scu.edu.cn

**T.J. Zenzal**  
University of Southern Mississippi  
Hattiesburg, US  
(217)-300-3095  
tjzenzal@gmail.com

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