

Version 17 Aug 2013

# Abstracts

One Hundred and Thirty-first Stated Meeting of the  
**American Ornithologists' Union**  
held in conjunction with the  
Eighty-third Annual Meeting of the  
**Cooper Ornithological Society**  
14 - 17 August 2013  
at  
Chicago, IL



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## PLENARY TALKS

### Wednesday Plenary Julia A. Clarke



**The evolution of birds: new insights from the fossil record. JULIA A. CLARKE**, *Department of Geological Sciences, Jackson School of Geosciences, University of Texas at Austin, Austin, TX.*

Late Jurassic and Early Cretaceous fossil deposits from China have offered exceptional insight into the early evolution of flight. However, new fossils germane to informing a separate question, the timing and pattern of the emergence of the major lineages of extant birds, have remained limited by comparison. Nonetheless, in the last 20 yr significant advances in our understanding of this record have been made. Most of the well-preserved relevant fossils are Eocene in age while far fewer sample the Late Cretaceous and Paleocene. The earliest known fossils that may be part of the avian crown clade are Late Cretaceous (Campanian -Maastrichtian) in age. The known avifauna from some deposits of this age from both the Northern and Southern Hemisphere are predominantly comprised of derived ornithurine birds, close relatives of the extant radiation or parts of it. This pattern is not observed earlier in the Cretaceous. Despite this general pattern, the particular affinities of many of these taxa remain controversial; most are known from isolated remains. Current sampling of Paleocene and Oligocene deposits has limited our understanding of the response of extant lineages to the Cretaceous/Paleogene mass extinction event ~ 65 Ma and Eocene/Oligocene global cooling ~34 Ma. However, some patterns are emerging. For example, taxa abundant in the Eocene of North America are stem members of major extant lineages with diverse and disjunctive extant biogeographical distributions. As our understanding of the fossil record increases, it continues to indicate major shifts in avian diversity and distributions over the course of the Cenozoic. Distributions and ecologies characterizing the crown clades of many major lineages may be comparatively recent icehouse Earth phenomena. Synthetic consideration of data from molecular divergence approaches as well as from the paleobotanical record and that of other vertebrate clades is needed to better inform patterns and potential causal factors in avian diversification.

#### Thursday Plenary

**Catherine H. Graham**



**Processes underpinning biogeographic patterns in birds of the Americas.** **CATHERINE H. GRAHAM**, *Department of Ecology & Evolution, Stony Brook University, Stony Brook, NY.*

Evaluating the relative importance of ecological, evolutionary and biogeographic processes in the generation and maintenance of biological diversity remains a fundamental challenge in biodiversity science and is especially important given on-going climate change. In this lecture, I will combine taxonomic, phylogenetic and functional components of alpha and beta-diversity of Neotropical birds (with an emphasis on hummingbirds) using a suite of improved modeling tools from community phylogenetics and species distribution modeling to begin to evaluate mechanisms underlying current patterns of diversity. I will focus on the Americas where strong environmental gradients and varying degrees of isolation provide ample opportunity to evaluate how different mechanisms, including dispersal limitation via geographic barriers, conservatism

of functional traits and rapid radiation of lineages, might influence contemporary patterns of diversity. I present a series of case studies to show what can be learned by applying these new tools and suggest how they will inspire new directions in the field.

#### Saturday Plenary

**Staffan Bensch**



**Evolution and ecology of avian malaria parasites.** **STAFFAN BENSCH**, *Molecular Ecology & Evolution Lab, Department of Biology, Lund University, Lund, Sweden.*

Avian malaria (*Plasmodium*) and related haemosporidians (*Haemoproteus* and *Leucocytozoon*) show the highest species diversity in the tropics however there are many species that have active transmission in temperate regions as far north as the Arctic polar circle. Molecular analyses of the parasites' cytochrome b gene (cyt b) have revealed that the global diversity of avian haemosporidians is vastly higher than previously appreciated from morphological investigations. How to define species based on mitochondrial sequences is a matter of discussion but estimates from the molecular diversity suggest that the number of species of avian haemosporidians is similar to the number to the global diversity of

bird species. Because each host species is a unique environment for a parasite it will require precise adaptations for the parasite's successful multiplication and transmission. It is therefore not surprising that the vast majority of avian malaria parasites are host specialists. The more surprising is the existence of some remarkable host generalists, with the 2 cyt b lineages of the morphospecies *Plasmodium relictum*, GRW4 in 53 hosts and SGS1 in 58 hosts, as the most striking examples. In this talk I will give a rich background to the diversity and distribution of avian haemosporidians and highlight some of the methods we are using to investigate the causes and consequences of variation in host specificity.

### Young Professional Awards

**YPA** **Streby**



**Measuring productivity in songbirds: tradeoffs between nest success and fledgling survival mean we need to study both stages.** **HENRY M. STREBY**, *University of California - Berkeley, Berkeley, CA.*

In studies of Neotropical migratory songbirds, measures of individual fitness and population productivity usually include only data on nest success, without consideration for survival of fledglings that remain under adult care for weeks beyond the nest. Recent radio telemetry studies have demonstrated that fledgling survival is directly influenced by habitat characteristics associated with the nest of origin, suggesting that nest-site choice may be driven by evolutionary

selection pressures on both nest success and fledgling survival. Here I describe a system in which female Golden-winged Warblers choosing nest sites face opposing selection pressures on nest success and fledgling survival. In this system, nest success is high in shrublands and low in forest, but fledglings from nests in forest have high survival and those from nests in shrublands have low survival. Female Golden-winged Warblers choose nest sites not to maximize either nest success or fledgling survival, but instead balance these 2 fitness components to optimize seasonal productivity (i.e., the number of young raised to independence from adult care). Moreover, because they can renest after initial nest failure, but only successfully nest once in a season, Golden-winged Warblers do not choose nest sites that evenly balance nest success and fledgling survival. Rather, nests initiated early in the season are located farther into forest, thereby prioritizing fledgling survival, whereas later nest sites are farther into shrublands, thereby prioritizing nest success. This time-dependent switch from high to low risk-tolerance in nest-site choice maximizes songbird fitness in the same way a well-timed switch in human investor risk-tolerance can maximize one's nest egg at retirement. Importantly, nesting data or fledgling data alone would have yielded erroneous conclusions about breeding habitat selection and productivity in this species. Our observations provide a relatively simple explanation for the commonly observed "mismatch" between nest-site choice and nest success in songbirds. That is, nest success is not a reliable surrogate for reproductive fitness when it trades off with fledgling survival, and therefore we should not expect that nest sites are chosen to maximize nest success. These results demonstrate the importance of studying songbird productivity from egg to independence for drawing accurate conclusions about individual fitness, population productivity, habitat selection, and the effectiveness of our management and conservation activities.

**YPA Riehl**



**Cheaters and collaborators: the evolution of communal nesting in the Greater Ani (*Crotophaga major*).** CHRISTINA RIEHL, *Museum of Comparative Zoology, Harvard University, Cambridge, MA.*

Most cooperatively breeding birds live in family groups, in which cooperation is thought to be partly maintained by kin selection. In the Greater Ani (*Crotophaga major*), however, several unrelated pairs build a single nest in which they rear a shared clutch of young. Communal nesting comes with benefits – it decreases the likelihood of nest predation – but individual group members also use an array of competitive tactics to increase their own reproductive fitness. These include extra-pair copulations, egg ejection, extra-group nest parasitism, and infanticide of nestlings. Under what

circumstances are these tactics adaptive, and how does cooperation persist in the presence of selfish behaviors?

## SYMPOSIA

### Symposium 1

#### The assembly of the North American avifauna

*Conveners J. A. Clarke and Ben Winger*

#### s1.1 Clarke, Winger

Symposium on the Assembly of the North American avifauna: Introductory remarks. JULIA A. CLARKE, *Dept. Geophysical Sci., Univ. Texas, Austin, TX* and BEN WINGER, *Bird Division, Field Mus. and Committee on Evol. Biol., Univ. Chicago, Chicago IL.*

No abstract.

#### s1.2 Cracraft, Sanin, Claramunt, B T Smith

The assembly of the North American avifauna: theory, method, and empirical approaches. JOEL CRACRAFT, CAMILO SANIN, SANTIAGO CLARAMUNT, *Am. Mus. Nat. Hist., New York, NY*, and BRIAN T. SMITH, *Mus. Nat. Sci., Louisiana State Univ., Baton Rouge, LA.*

Understanding how large-scale biotas are assembled over time has primarily come from ecological theory and analysis in which the taxonomic composition of an assemblage at large spatial scale is assumed to arise from ecological dynamics at small scale. History is typically relegated to supertree

analyses of community overdispersion or underdispersion, the results of which are again explained by ecological dynamics. Progress in understanding assembly analysis at all spatial scales, even those at the community level, requires adopting a fully historical approach. Indeed history can be seen as the philosophical null against which ecological explanations should be evaluated. The imprint of history is manifest in the fact that clades of species are nonrandomly distributed in space and time – patterns of distribution and topographic drivers of allopatry are structured phylogenetically. A picture of the assembly of the North American avifauna will require integrating a spatiotemporal analysis of phylogenetic history with paleogeographic, paleoclimatic, and paleoenvironmental history. We will take an initial empirical step toward this type of integrative approach using nonpasseriform birds as an example.

### **s1.3 B T Smith, Cracraft**

Large-scale biogeography of the North American avifauna. BRIAN TILSTON SMITH, *Mus. Nat. Sci., Louisiana State Univ., Baton Rouge, LA*, and JOEL CRACRAFT, *Am. Mus. Nat. Hist., New York, NY*.

The North American avifauna is an ecologically and taxonomically diverse biota that is distributed from the Arctic tundra to tropical rainforests. This avifauna is arguably one of the most intensively studied biological systems, yet questions regarding the deep evolutionary history of the continents' avifauna remain largely unexplored. Phylogenies from a diverse array of birds indicate that the North American avifauna is likely a composite of both lineages that dispersed from South America and the Old World along with those that evolved *in situ*. However, identifying the patterns that underlie the origins and biogeographic distributions of the North America avifauna require further examination. In this talk we will explore the origins of the continents' avifauna by assessing temporal and spatial patterns of diversification with the objective of summarizing large-scale patterns on the deep evolutionary history of the North American avifauna.

### **s1.4 N A Smith**

Assembly of the pelagic avifauna of North America: including insights gleaned from the fossil record of the Pan-Alcidae. N. ADAM SMITH, *Natl. Evol. Synthesis Center, Durham, NC*.

Extant pelagic avifaunas are restricted to members of Procellariiformes, 'Pelecaniformes', Gaviiformes and Charadriiformes. The pre-Pleistocene pelagic avifauna was both taxonomically and morphologically more diverse and included flightless charadriiforms (*Mancallinae* and *Pinguinus*), flightless pelecaniforms (Plotopteridae) and the enigmatic soaring Pelagornithidae. Geologic and climatic changes provide explanations for decreased diversity in the northern Atlantic; however, the northern Pacific has remained relatively environmentally stable since at least the Middle Miocene and the reasons for extinction of Pacific seabird taxa remain uncertain. In many cases the fossil record of marine birds is superior to that of terrestrial clades. First and last appearance records facilitate exploration of the chronology of the evolution of the pelagic avifauna and the abundance of seabird fossils provides data regarding paleo-distributions. In terms of abundance, diversity, and geographic and temporal distribution, the fossil record of the Pan-Alcidae (Charadriiformes) is the most informative for any clade of seabirds. North American Pan-Alcidae are known from nearly 17,000 fossils from approximately 8 localities and span more than 35 million years of evolutionary history (Eocene-Pleistocene). Extinct pan-alcids ( $n = 31$ ) outnumber extant species ( $n = 23$ ) and every extant genera is represented by related fossil forms. Surprisingly, this rich source of evolutionary data has been frequently excluded or misinterpreted in previous systematic studies and resulting estimates of phylogeny and divergence times are potentially biased by several factors. Combined phylogenetic analysis of extant and extinct Pan-Alcidae and divergence estimates based on vetted fossil calibrations provide new insights into pan-alcid evolution and the evolution of the pelagic avifauna.

### **s1.5 Oswald, Steadman**

Historical diversity and extinction of New World passerines: evidence from Pleistocene fossils. JESSICA A. OSWALD, *Dept. Biol. and Florida Mus. Nat. Hist., Univ. Florida, Gainesville, FL*, and DAVID W. STEADMAN, *Florida Mus. Nat. Hist., Univ. Florida*.

Overhunting by humans and climate change from the last glacial-to-interglacial transition have been implicated, either separately or in concert, to account for the megafaunal extinctions ca. 12,000 yr ago. In North and South America more than 50 genera of large mammals were lost. We believe that the resulting trophic cascades in combination with climate change influenced the distribution and diversity of songbirds (Passeriformes) in multiple ways. Species of Icteridae are often highly represented at fossil

sites likely due to their winter/dry season flocking propensity and their preference for marshy habitats. Both factors are ideal for fossil preservation making them a great system to study how passerine species diversity and distributions have changed over time. Based on our fossil identifications and a meta-analysis of identified fossils, icterids suffered high levels of extinction and range contractions at the end of the Pleistocene. This is exemplified by the extinct species *Euphagus magnirostris* first discovered at the Rancho La Brea Tar Pits in s. California and also identified by us at Neotropical fossil sites 5,000 km away. While not necessarily due to the same causes, it is clear that passerines were affected by similar factors that led to the demise of so many other species of birds (predators, scavengers) that were dominant during the Pleistocene. We urge further exploration for passerine fossils at megafaunal fossil sites as well as the preparation of more passerine skeletons in museum collections. Approaches combining fossils with genetic data will help to unravel the historic mechanisms that have shaped the modern distributions of passerines.

### **s1.6 Barker**

It matters how you slice it: a new molecular perspective on the timing and success of interhemispheric dispersal in oscine passerine birds. F. KEITH BARKER, *Dept. Ecol., Evol. & Behav., Univ. Minnesota, St. Paul, MN.*

Diversification of lineages is often analyzed at a global scale, which may prevent identification of locally successful lineages that have not diversified impressively from a global perspective. On the other hand, analyzing among-lineage patterns of diversification on geographically relevant scales is complicated by dispersal, especially in a group with high dispersal potential such as birds. I took a regional perspective on global diversification dynamics of oscine passerines, by inferring interhemispheric (Old World-New World) interchanges, estimating the timing of these dispersal events, and comparing post-dispersal net diversification of dispersing lineages. The majority of dispersal events appear to have occurred in the last 10 Ma, although some dispersals may have occurred as far back as the Eocene. Most lineages arriving in the New World have diversified on a trajectory consistent with a constant-rates birth-death process with a relatively high extinction fraction. By contrast, several relatively old North American lineages have not diversified at all, and one widely-distributed lineage – the Emberizoidea – has diversified at a rate far exceeding comparably-aged New World lineages. Analysis at the level of hemispheres is a crude step toward placing avian diversity into a more realistic geographic context. However, even this incremental improvement offers significant improvements in our understanding of avian diversity. Future, more fine-grained analyses enabled by more complete and robust phylogenies will offer even better.

### **s1.7 Winger, Ree**

Geographic range evolution and diversification in migratory North American birds. BEN WINGER, *Bird Division, Field Mus. and Committee on Evol. Biol., Univ. Chicago, Chicago IL*, and RICHARD REE, *Dept. Botany, Field Mus.*

The field of biogeography seeks to explain why organisms are distributed where they are how they came to be found there. For seasonal migratory species that exist in 2 or more geographically and ecologically disparate regions at different times of the year, the task of understanding the evolution of geographic range is further complicated. A large proportion of North American bird species are seasonal migrants that spend the non-breeding season in the neotropical region. Therefore, to resolve the biogeographic history of the extant North American avifauna, we must better understand the relationship between the evolution of migratory behavior and the evolution of geographic range within and across lineages. We developed a novel phylogenetic model of geographic range evolution to explicitly test the biogeographic history of migratory species. The model uses a maximum-likelihood framework to simultaneously examine changes in breeding range and non-breeding range distribution during both anagenesis and cladogenesis. We used this model to investigate the biogeographic history of the largest radiation of North American migratory species: the Emberizinae, or New World Nine-Primaried Oscines. We also performed character-state dependent diversification analyses, and we discuss the influence that colonization of North America during the evolution of migratory behavior may have had on patterns of diversification in this lineage.

### **s1.8 Rabosky, Winger, Lovette, Barker, Burns, Klicka, Lanyon**

The temporal and spatial dynamics of speciation during the New World nine-primaried oscine radiation. DANIEL RABOSKY, *Dept. Ecol. & Evol., Univ. Michigan, Ann Arbor, MI*, B. M. WINGER, *Committee Evol.*

*Biol., Univ. Chicago, Chicago, IL, I. J. LOVETTE, Lab. Ornithol., Cornell Univ., Ithaca, NY, F. K. BARKER, Dept. Ecol., Evol. & Behav., Univ. Minnesota, St Paul, MN, K. J. BURNS, Dept. Biol., San Diego State Univ., San Diego, CA, J. KLICKA, Dept. Biol., Univ. Washington, Seattle, WA, and S. M. LANYON, Dept. Ecol., Evol. & Behav., Univ. Minnesota.*

The New World nine-primaried oscines (emberizoids) encompass a spectacular range of morphological and ecological diversity and include such familiar forms as wood-warblers, blackbirds, cardinals, and tanagers. Collectively, the clade constitutes one of the most species-rich avian radiations and accounts for nearly 15% of all passerines. The sheer diversity of the group makes them an excellent model system for understanding the evolutionary assembly of the New World avifauna as well as of continental biotas more generally. We studied the temporal and spatial dynamics of speciation in the emberizoids using a multilocus, time-calibrated phylogeny that was 94.4 % complete at the species level. We developed a novel analytical framework for modeling rates of species diversification that simultaneously accounts for variation in macroevolutionary rates both through time and among lineages. Our approach helps disentangle the relative importance of extrinsic ecological and intrinsic lineage-specific factors that have mediated the tempo of emberizoid diversification during the past 21 million years. Although we find weak evidence for a latitudinal gradient in diversification, the dominant signals in the data include strong temporal trends in speciation as well as "boom-and-bust" pulses within particular subclades. Our results highlight the new insights that can be gained into classic problems in ecological biogeography by combining large datasets with new methods for macroevolutionary analysis.

### **s1.9 Weir**

Latitudinal gradients in time to reproductive isolation of New World birds. JASON T. WEIR, *Dept. Biol. Sci., Univ. Toronto Scarborough, Scarborough ON.*

Reproductive isolation is necessary for newly formed taxa to coexist geographically and serves an important role in the diversification process. Here I ask whether rates of evolution in traits important for reproductive isolation vary across latitudinal gradients in New World birds. Using data from hybrid zones, bird vocalizations, morphometric measurements, and climatic niche I show that key aspects of avian evolution important for both pre- and post-zygotic isolation evolve fastest where species richness is lowest -- at high latitudes. These results challenge the notion that fast evolutionary rates are responsible for the latitudinal gradient in species richness, and instead suggest that strong divergent selection pressures at depauperate high latitudes accelerates trait divergence and speciation.

### **s1.10 Ksepcka, Grande, Clarke**

Advances in the understanding of Early Cenozoic avian evolution from the Green River avifauna. DANIEL KSEPCKA, *Natl. Evol. Synthesis Center, Durham, NC*, LANCE GRANDE, *Field Mus., Chicago, IL*, and JULIA A. CLARKE, *Dept. Geophys. Sci., Univ. Texas, Austin, TX.*

Fossils from the Eocene Green River Formation provide a remarkable window into the early evolution of many major clades of birds. More than 200 avian fossils are now known from this formation, including the oldest and most complete skeletons of groups including rollers, frigatebirds and oilbirds, as well as specimens preserving exquisite feathers. Phylogenetic analyses have unlocked the utility of these fossils for studies of biogeography, character evolution, and temporal calibrations. A crucial but often overlooked aspect of the Green River avifauna is that fossils studied to date overwhelmingly represent stem taxa. Thus, these fossils provide evidence for Eocene divergences between many key clades and their sister clades, but should not be interpreted as evidence for the presence of crown radiations of groups such as parrots and mousebirds during the Eocene. Stem lineage fossils are nonetheless critical to a complete understanding of the evolution of birds, because they often reveal unique features, inferred behaviors and geographic distributions that are not represented in any extant representatives of a clade, and thus cannot be predicted by applying comparative methods to extant taxa alone. This presentation will focus on several examples of new advances spurred by the study of Green River fossils relating to mousebird biogeography, wing evolution in Pan-Apodiformes, and the timing of evolution of many North American clades.

### **s1.11 Mitchell**

Ecological diversity of the 52-million year old Green River birds. JON MITCHELL, *Committee on Evol. Biol., Univ. Chicago, and Field Mus., Chicago IL.*

The Green River Formation from the Eocene of Wyoming and Utah (52 million yr old) represents

the oldest well-preserved avifauna in North America, bearing over a dozen genera known from complete skeletons. The Green River deposits have a phylogenetically disparate avifauna, with stem members from several clades including a frogmouth, hoatzin, sunbittern, parrot and paleognath as well as rails and anseriforms. This avifauna is extraordinarily distinct from any found in the modern world, taxonomically, but the ecological diversity has never been rigorously assessed. By combining a recent phylogeny with large databases of both modern bird morphology (limb measures and beak characters for 1200 specimens from over 500 species) and ecology (diet, habitat preference, body mass and foraging mode), I have built a phylogenetically-informed framework for inferring functional diversity. The functional diversity of birds within the Green River Fm is substantially less than that of modern assemblages from across North America, but much greater than expected given the number of species, especially compared to other fossil deposits (Pleistocene of North America). Preliminary modeling of preservational biases suggest that, despite fossilization, the Green River assemblage was composed of fewer terrestrial faunivores and more large-bodied taxa than modern assemblages. In total, these results show that by the Eocene the birds of North America were ecologically quite diverse, but that the distribution of taxa in ecological space was substantially different from modern assemblages, even with preservational biases accounted for, in large part due to the lack of passeriform birds.

## Symposium 2

### The science of wild bird feeding

Conveners D. Horn and T. Wilcoxon

#### s2.1 Horn, Johansen, Wilcoxon

Bird feeding practices and seed and feeder use of wild birds. DAVID J. HORN, STACEY M. JOHANSEN, and TRAVIS E. WILCOXEN, *Dept. Biol., Millikin Univ., Decatur, IL.*

Despite its popularity, many bird feeding traditions lack data. We surveyed hobbyists about their bird-feeding experience, and examined seed and feeder use by wild birds. Between 2005 - 2008, we had 1,291 individuals from 48 US states and 7 Canadian provinces who completed our survey, and 173 individuals from 38 US states and 3 Canadian provinces made 20,077, 45-min observations at bird feeders, recording 106 species and 1,282,424 bird-visits. Our respondents fed birds because it brought nature (84%) and accompanying sound (81%) to the area, as a hobby (79%), and to help the birds (79%). Respondents felt attracting more bird species (69%), a greater number of birds (41%), and no pests (35%) would make their bird-feeding experience more satisfying. Three seed types most commonly used in bird seed blends are most attractive to birds: black-oil sunflower, medium sunflower chips, and white proso millet. Other seeds such as red milo are less attractive. Chickadees (*Poecile* spp.), nuthatches (*Sitta* spp.), and larger finches (*Haemorhous* spp.) were most abundant at black-oil sunflower, smaller finches (*Spinus* spp.) were most abundant at Nyjer® and sunflower chips, and sparrows (*Spizella* spp.) were most abundant at white proso millet. Bird feeding traditions have been widely reported in books, magazines, newspaper articles, and websites. These traditions are often conflicting and have not been verified empirically. Studies such as this can be used to develop scientifically-based recommendations that can lead to a better bird feeding experience and reduce known negative ecological consequences associated with feeding birds.

#### s2.2 Rompré, Klasing, Iseri, White

Comparison of fortified and unfortified wild bird seed mixes. GHISLAIN ROMPRÉ, *The Scotts Co., Marysville, OH*, KIRK C. KLASING, VANESSA J. ISERI, *Dept. Animal Sci., Univ. California, Davis, CA*, and GRETCHEN WHITE, *The Scotts Co.*

In the wild, birds select among a large variety of seeds, insects and other food items in order to obtain optimal amounts and proportions of the essential nutrients. In many developed countries almost half of the households provide supplementary food for wild birds, most commonly a mixture of domestic seeds. Experiments testing the relative nutritional value of commercial seed mixes in wild populations have not been published in the literature because logistics and costs of such studies. Therefore, we tested the nutritional value of commercial seed mixes by feeding a representative seed mix to non-reproducing adult Zebra Finches and also to reproducing Japanese Quail. In the captive feeding experiments, a seed mix was fed either alone or with a pellet specifically formulated to correct the calculated nutrient deficiencies in the seed mix. Clinical signs consistent with vitamin and mineral

deficiencies were observed in quail fed the Seed diet after only a few weeks. In the case of Zebra Finches, such signs occurred after 2 mon. In quail, results indicate that the eggs from hens fed Seed only were considerably lower in quality and would result in less fit hatchlings than the eggs of hens fed the Fortified diet. In general, birds have weak ability to select between food items to obtain the correct amount of micronutrients. It is likely that the Fortified diet would be a better complement to the natural diet of wild birds for purposes of producing healthy chicks as compared to the Seed diet.

### **s2.3 Wilcoxon, Horn, Flamm, Hogan, Hubble, Huber, Knott, Salik, Wassenhove**

Health effects of supplemental feeding in a free-living community of birds. TRAVIS E. WILCOXEN, DAVID J. HORN, JOSEPH C. FLAMM, BRIANNA M. HOGAN, CODY N. HUBBLE, SARAH J. HUBER, MADELINE H. KNOTT, FAARIA SALIK and SAMANTHA J. WASSENHOVE, *Dept. Biol., Millikin Univ., Decatur, IL.*

Despite the popularity of bird feeding and the consistent presence of human-provided food for wild birds, the true value of commercial birdseed to the health of free-living birds remains unknown. Some studies have indirectly examined the influence of feeding on avian populations; however, most existing studies have focused on a single species. Over an 18-mon period, we examined body condition, nutritional condition and measures of immune, reproductive, and stress physiology in 11 songbird species before and after addition of bird feeders at feeder naïve sites. Comparisons were made to similar sites without feeders that were monitored simultaneously to address naturally-occurring environmental or seasonal changes independent of the presence of supplemental food. Our findings demonstrate many positive impacts of feeder access on the health of birds, while some measures did not differ between sites with feeders and sites without feeders. Finally, a small number of negative impacts, including increased disease prevalence at feeders, were also observed.

### **s2.4 Commons, Carlson, Lundstrom, Horn, Wilcoxon**

The effects of supplemental feeding on forest bird populations in central Illinois. KELLY A. COMMONS, REBEKAH D. CARLSON, LISA A. LUNDSTROM, DAVID J. HORN and TRAVIS E. WILCOXEN, *Dept. Biol., Millikin Univ., Decatur, IL.*

Over 50 million Americans over the age of 16 feed wild birds and other wildlife. However, the extent to which supplemental feeding impacts wild bird populations is not well understood. From spring 2011 to summer 2012, we examined how wild bird feeding influences the bird populations at forested sites in central Illinois. Specifically, we compared 3 forested sites where we provided supplemental food to 3 forested sites for which no supplemental food was available. We monitored changes in the population size of both resident, feeder and migratory, non-feeder species using fixed-radius, 10-min, double-observer point counts. Among 14 species of resident, feeder and migratory, non-feeder birds, we found few changes in bird populations to the forested sites as a whole that could be attributed to bird feeding. Similarly, we found little evidence that birds alter their location within a forest relative to the location of the supplemental food. In a companion study, we found that visits to bird feeders by resident, feeder birds increased from 2011 to 2012. Collectively, supplemental feeding resulted in increased visits to feeders, but may have limited impact to bird populations beyond local spatial scales.

### **s2.5 White, Zollner, Dunning, Horn, Rompré**

Influence of land cover and spatial scale on occupancy at backyard bird feeders. GRETCHEN L. WHITE, PATRICK A. ZOLLNER, JOHN B. DUNNING, *Dept. For. & Nat. Res., Purdue Univ., West Lafayette, IN*, DAVID J. HORN, *Dept. Biol., Millikin Univ., Decatur, IL*, and GHISLAIN ROMPRÉ, *The Scotts Co., Marysville, OH.*

Previous studies have shown that birds select habitat based on characteristics at multiple spatial scales. Therefore, presence or absence of a species at a site might be influenced by fine scale characteristics, but also features that occur at a larger landscape scale. A species' selection criteria may also vary seasonally. To better understand this phenomenon we used data from a multi-year, citizen scientist study that monitored birds at backyard bird feeders across the US to provide detection histories for 13 species. Occupancy modeling was used to determine the influence of land cover types at multiple spatial scales (500 m, 1 km, 3 km, 5 km, and 7 km) on species' probability of occurrence in human altered landscapes (e.g., residential backyards), while incorporating detection probability. Models were built for each season, at each spatial scale with low and medium intensity urban percent cover as covariates as well as other land cover types (forest, shrub, etc.), that are previously known to be preferred habitat types



for each species. In general, results supported known habitat preferences, however in many cases the strength and directionality (positive or negative) of influence changed across seasons. In light of growing human populations and increasing influence of human development, a refined description of habitat preferences has the potential to highlight the importance of understanding changes in seasonal habitat preference in the context of urban planning when avian biodiversity is a priority. Our results have the potential to provide important insights as we contemplate the impact of future human-avian interactions in human-altered habitat.

#### **s2.6 Fischer, Miller**

Direct and indirect effects of supplemental food on House Finch populations. JASON D. FISCHER and JAMES R. MILLER, *Prog. Ecol.,Evol. & Cons. Biol., Dept. Nat. Res. & Env. Sci., Univ. Illinois, Urbana, IL.*

Anthropogenic foods are frequently credited with affecting population dynamics of birds, but few studies have tested this assertion at large spatial scales. Human-derived foods could directly impact population sizes or indirectly affect them by mediating the influence of another factor such as disease. We assessed the effects of bird food availability on House Finch populations in the e. US using data from the National Survey on Fishing, Hunting, and Wildlife-associated Recreation and the Christmas Bird Count. In 1994, a novel disease outbreak (mycoplasmal conjunctivitis) substantially reduced House Finch populations, creating an opportunity to test whether bird feeding indirectly exacerbated or ameliorated the impacts of the disease. House Finch densities were positively related to the density of people providing food for birds, suggesting that the availability of bird seed can limit the size of finch populations. Following the disease epidemic, House Finch declines were greatest where the density of people feeding birds also fell dramatically. This pattern suggests that a reduction in feeder numbers may have intensified the negative effects of mycoplasmal conjunctivitis on finch populations. If other species are similarly affected by anthropogenic foods, then the collective actions of individuals have the potential to strongly influence population dynamics and community structure of wildlife in human-modified landscapes.

#### **s2.7 Small, Bridge, Schoech**

Short-term effects and long-term consequences of supplemental food on a free-living threatened species, the Florida Scrub-Jay. THOMAS W. SMALL, *Dept. Biol., Univ. Memphis, Memphis, TN*, ELI S. BRIDGE, *Univ. Oklahoma, Norman, OK*, and STEPHAN J. SCHOECH, *Dept. Biol., Univ. Memphis.*

Providing supplemental food to free-living animals often results in increased reproductive output and population growth. Because of this, supplementation has been used as a conservation tool to mitigate population declines and rebuild critically small populations. Although the short-term effects on population size can be highly desirable, little is known about the long-term consequences of food supplementation. Increased food availability can increase the rate of development of young as well as alter the type and intensity of parental care, both of which can modify an individual's lifelong phenotype. In long-term studies of Florida Scrub-Jays, we have observed that the magnitude and time course of corticosterone (CORT) secretion during a restraint stress can vary greatly among individuals, and there is evidence that this characteristic is shaped early in life and persists throughout adulthood. Further, these differences in physiological stress response are correlated with numerous life history and behavioral traits, such as an individual's life span and degree of neophobia, suggesting that stress responsiveness is an aspect of a broader physio-behavioral phenotype. To investigate the effect of early life food supplementation on an individual's phenotype, we developed a novel "SmartFeeder" that administers mealworms to specific individuals within a population by recognizing the birds' radio-frequency identification (RFID) tags. Although supplemented nestlings had weights and CORT levels similar to controls during supplementation, supplemented birds demonstrated lower stress-induced CORT levels at approximately 50 d post-fledging. These differences appear to persist to at least 2-yr of age and continuing research will determine if this effect correlates with behavioral differences and individual success.

#### **s2.8 Appelt, B Jones, Baker**

Feeder cameras provide a fine scale approach for temporally examining feeding relationships between exotic monk parakeets and other species. CHRISTOPHER W. APPELT, BRITTANY JONES, *Dept. Biol. Sci., St. Xavier Univ., Chicago, IL*, and CHRISTOPHER A. BAKER, *Dept. Psychol., St. Xavier Univ.*

Monk Parakeets have established populations in numerous locations within the US and throughout the rest of the world. However, nothing is known about whether they affect avian communities (positively or negatively) in the areas they colonize. In Chicago, they appear completely dependent upon

bird feeders during the harshest winter months (Jan and Feb), possibly creating competition at feeders. Therefore, we employed feeder cameras at 4 locations (2 frequented by Monk Parakeets and 2 without parakeets), to record foraging activity of feeder-using birds during winter 2011 - 2012. Human observations and results from the cameras were strongly correlated particularly based on maximum number of individuals of each species observed in 5 min intervals ( $r > 0.9$ ). Based on 5 min intervals, we observed significant main effects of site, site type, bird species, time of day as well as a significant site type x bird species x time of day interaction. As predicted, 2 sites yielded robust parakeet activity while the others had none. Furthermore, the parakeet sites yielded more feeding activity overall. The only significant correlations we found across all species were positive (but weak) and were observed more often at the parakeet sites. This study demonstrates that feeder cameras can provide copious amounts of rich, around-the-clock feeding data with high accuracy simultaneously recorded at multiple sites without the presence of a human observer. This is the first study to provide a detailed temporal feeding pattern for Monk Parakeets. It also suggests that Monk Parakeets are not reducing the feeding activity of other species at feeders.

### **Symposium 3**

#### **North American Breeding Bird Survey research**

*Conveners J. R. Sauer, K. L. Pardieck, M.-A. Hudson, and A. C. Smith*

##### **s3.1 Pardieck**

What's old is new: partnerships key to BBS success. KEITH PARDIECK, *US Geol. Surv., Patuxent Wildl. Res. Center, Laurel, MD.*

Long-term wildlife monitoring programs have long availed themselves of the power of partnerships to answer large-scale landscape level questions. For example, decades before terms like 'crowd sourcing' and 'citizen science' had entered the popular vernacular, Chandler Robbins aligned many partners to forge the scientifically rigorous, multi-national North American Breeding Bird Survey (BBS) – a grand collaboration between legions of skilled bird watchers and scientists. Today the BBS serves as the primary source of large-scale, long-term population data for hundreds of breeding bird species, occupying a much needed niche as the backbone of North American land bird conservation efforts. New opportunities and challenges abound ahead though, some offering the prospect of expanding the survey beyond its enduring 47-yr mission of measuring bird population trends, and all require a continued culture of strong partnering in order to realize them. In this presentation I provide examples of both how and why collaborators play an essential role in advancing the BBS's ability to better measure bird populations.

##### **s3.2 Flather, Pidgeon, Gutzwiller**

Using the North American Breeding Bird Survey in landscape assessments to support Forest Service planning. CURTIS H. FLATHER, *US Forest Serv., Rocky Mountain Res. Sta., Ft Collins, CO*, ANNA M. PIDGEON, *Dept. Forest & Wildlife Ecol., Univ. Wisconsin, Madison, WI*, and KEVIN J. GUTZWILLER, *Dept. Biology, Baylor Univ., Waco, TX.*

The US Forest Service is responsible for sustainably managing multiple uses of natural resources on national forests and grasslands. To meet this stewardship responsibility the agency is required to complete periodic national assessment that report both recent historical and anticipated future changes in natural resources. These mandated assessments must consider all land ownerships to provide the landscape context within which individual national forests and grasslands are embedded. Birds have long been used as sentinels of landscape change owing to the availability of temporally and geographically extensive monitoring data epitomized by programs like the North American Breeding Bird Survey (BBS). In order to examine how birds may respond to alternative futures, these assessments must integrate economic, social, and ecological data that originate from different sources with varying objectives. We will focus our review of BBS contributions to landscape assessments on strategies we have used to link disparate data on bird response and potential drivers of bird community change, and the improvements in bird response models we have observed as we considered the contribution of land use, housing, climate, and vertical habitat structure to our understanding of bird community change. We will conclude with our thoughts on future research directions including the need to identify policy and management triggers that may be derived from bird-landscape threshold relationships.

### **s3.3 Bateman, Gorzo, Pidgeon, Radeloff, Akcakaya, Flather, Albright, Vavrus, Thogmartin, Heglund**

Use of multiple data sources in identifying drivers of abundance in an irruptive species, the Dickcissel. BROOKE L. BATEMAN, JESSICA GORZO, ANNA PIDGEON, VOLKER RADELOFF, RESIT AKCAKAYA, CURTIS H. FLATHER, THOMAS P. ALBRIGHT, STEPHEN J. VAVRUS, WAYNE THOGMARTIN and PATRICIA HEGLUND, *Dept. Forest & Wildl. Ecol., Univ. Wisconsin-Madison, Madison, WI.*

Increasing pressure from anthropogenic and climatic change will make it more difficult to identify and maintain key habitats for species. This may be particularly so for species that naturally exhibit high variability in abundance and distribution like the Dickcissel, a grassland bird. The irruptive nature of the Dickcissel is thought to be linked to drought conditions within the core breeding range, causing populations to move in search of more suitable conditions. We aim to identify the effect that weather has on regulating the spatial abundance patterns of this species. First, we generated a temporally-fine-scale species distribution model for the Dickcissel using weather data (1950 - 2011) and Global Biodiversity Information Facility (GBIF) occurrence records. Using North American Breeding Bird Survey (BBS) data, we calculated Dickcissel mean annual abundance and deviance of abundance from the long-term average (1979 - 2012) for the core and peripheral regions of the birds range. To examine the effect of extreme weather on Dickcissels, we used North American Land Data Assimilation Systems (NLDAS) weather data to quantify anomalous droughts and heat waves for the same time period in the core and edges of its range. We observed that Dickcissel habitat, as determined by weather, varied greatly through time, although the range core had the most consistent weather across all years. Our results show that low weather suitability is always accompanied by low Dickcissel abundance, suggesting that weather plays a role in limiting its distribution. Dickcissel irruptions (as measured by positive deviance) in the northern range edges were related to extreme anomalies of drought and heat waves in the range core. When weather is unsuitable at one location this species moves to more suitable areas, which may be well outside of its core distribution. In a changing climate with weather becoming more erratic, conservation strategies for irruptive and weather-sensitive species may have to be more widespread than the core range would suggest and may well go unoccupied for many years.

### **s3.4 A Smith**

Revisions to BBS analyses for the northern part of the continent, and their potential for broader application. ADAM SMITH, *Natl. Wildl. Res. Center, Ottawa, ON.*

Many BBS analytical strata in n. Canada have sufficient routes to estimate population trends and annual indices for some species; however, estimates of trends and annual indices for these strata can be highly imprecise, which can have an undesirable influence on the precision of a national or survey-wide estimate. In addition to these large and sparsely-surveyed strata, the north-eastern edge of the BBS survey area also includes some of the most steeply declining populations of aerial insectivores on the continent. We have also been working to reconcile estimates of population trend – average rate of change over time – and population trajectory – temporal pattern in annual indices – which for many aerial insectivore populations, strongly depend on the statistical model. In working towards improved estimates and inference for sparse-northern strata, as well as models that are more sensitive to non-linear patterns in trajectory, we have made some modifications to the analysis. We feel these modifications are also likely relevant to and useful for the analysis in the southern strata, because they: 1) improve estimates of the annual indices (both the absolute scale of the indices and their relative scaling among strata); 2) improve the accuracy of trend estimates, in some extreme cases; 3) improve the inference of long-term and short-term trends for large regions with temporal gaps in coverage; and 4) better accommodate non-linear long-term trends by modeling the temporal autocorrelation in year effects.

### **s3.5 Rosenberg, Fink, Iliff, Wood, Sullivan, Hochachka, Kelling**

BBS and eBird: Roles and synergies among established and emerging surveys. KENNETH V. ROSENBERG, DANIEL FINK, MARSHALL ILIFF, CHRIS WOOD, BRIAN SULLIVAN, WESLEY M. HOCHACHKA and STEVE KELLING, *Lab. Ornith., Cornell Univ., Ithaca, NY.*

We explore how the eBird checklist program and database can play a greater role in the monitoring of North American birds, as a complement to the BBS and other more established programs. Through May 2013, >7 million checklists containing information on bird distribution, abundance, and observer effort were submitted from >1.2 million locations in the US and Canada. eBird's broad

spatiotemporal extent and fine detail offer a unique source of information about year-round bird distributions, especially valuable during the non-breeding season and migration periods when standardized BBS data are not available. Accounting for the unstructured nature of the data collection process (e.g., non-uniform distribution of observations and imperfect detection) is challenging and requires tradeoffs between scope of inference and strength of assumptions necessary for analyses. Nevertheless, spatial information from eBird analyses have complemented long-term trend information from BBS analyses in the development of conservation assessments, such as determination of stewardship responsibilities for birds across agencies and other ownership categories for the US State of the Birds Report. Multi-year eBird data also help us understand temporal variation in regional abundance and habitat associations, as well as changes in migration timing or routes. As eBird grows, we see multiple avenues for synergies with BBS and other more standardized monitoring efforts in the areas of data management, visualization tools, analysis, and modeling. The network of 150,000 eBird volunteers in North America, including many young, active, and experienced birders, also can help ensure more complete coverage of BBS routes into the future.

### **s3.6 Sauer, Link**

What are we missing? Emerging research themes and statistical methods: the need for an ongoing forum for discussion of BBS-based research. JOHN R. SAUER and WILLIAM A. LINK, *US Geol. Surv., Patuxent Wildl. Res. Center, Laurel, MD.*

This symposium was developed in response to our perception of the need for an ongoing series of symposia related to research associated with the North American Breeding Bird Survey (BBS). BBS is the primary source of breeding-season population data for >400 species of North American birds, and presentations based on original research or summary results from BBS data are commonplace at ornithological meetings. The profusion of research projects using BBS data leads to concerns about a lack of communication among researchers. Better communication will minimize overlap in studies and help to limit use of inappropriate analysis methods. In this presentation, we present a commentary on the current analysis of BBS data and provide several examples of ongoing research on survey analysis methods that should be of general interest to researchers studying the BBS. Hierarchical models presently used for BBS analyses provide a convenient means for controlling for factors influencing counts along BBS routes and facilitate integration with other modeling activities. These controls for detectability, along with additional modeling approaches such as N mixture models, provide new opportunities for evaluating environmental influences on BBS counts. We discuss benefits and pitfalls associated with these approaches. Observer effects on counting are a critical component of BBS analyses, and we discuss modeling of observer duration on BBS routes and hierarchical approaches to evaluating changes in observer efficiency over time. We also describe the expansion of the survey over time and explore the consequences of these spatial and temporal changes in survey extent for the analysis of the BBS.

## **Symposium 4**

### **Golden-winged Warbler conservation and management**

*Conveners H. M. Streby, D. A. Buehler and D. E. Anderson*

#### **s4.1 Buehler, Streby, Andersen**

Welcome, explanation of the symposium, and introduction to Golden-winged Warblers. DAVID A. BUEHLER, *Univ. Tennessee, Knoxville, TN*, HENRY M. STREBY, *Univ. California, Berkeley, CA*, and DAVID E. ANDERSEN, *US Geol. Surv., Minnesota Coop. Fish & Wildl. Res. Unit, Dept. Fish., Wildl. & Conserv. Biol., Univ. Minnesota, Minneapolis, MN.*

Henry Streby (moderator) will introduce the symposium and give a general outline of the day, and then introduce David Buehler. Dr. Buehler will give a general introduction to the Golden-winged Warbler, the GWWA Working Group, and the impetus of the ***Studies in Avian Biology*** volume. Dr. Buehler will cover a broad introduction to the species so subsequent speakers can concentrate on their research during the limited speaking time.

#### **s4.2 Will, Rosenberg, Buehler, Thogmartin, Chandler**

Range-wide distribution and population status of Golden-winged Warbler. TOM WILL, *US Fish & Wildl. Serv., Minneapolis, MN*, KENNETH V. ROSENBERG, *Cornell Lab. Ornith., Ithaca, NY*, DAVID A.

BUEHLER, *Univ. Tennessee, Knoxville, TN*, WAYNE THOGMARTIN, *US Geol. Surv., Upper Midwest Environ. Sci. Center, La Cross, WI*, and RICHARD CHANDLER, *US Geol. Surv., Patuxent Wildl. Res. Center, Laurel, MD*.

With an estimated breeding population in 2010 of 210,000 pairs, the Golden-winged Warbler is among the most vulnerable and steeply declining of North American passerines. Its breeding distribution has been highly dynamic, with populations expanding and then contracting over the past 150 yr in response to regional habitat changes, interactions with closely related Blue-winged Warblers, and possibly climate change. Since 1966, the population has declined by 2.6%/yr. Range-wide surveys and other breeding records since 2000 documented hybrids and mixed Golden-winged/Blue-winged populations in a zone at roughly 44° N latitude from Minnesota to n. New York, as well as surrounding the now-disjunct band of steeply declining Golden-winged Warbler populations in the Appalachians from s. New York to n. Georgia. Phenotypically pure Golden-winged populations occurred north of this hybrid zone and in the Cumberland Mountains region of West Virginia and Tennessee, at higher elevations in Pennsylvania, and in w. North Carolina. Population modeling predicts a further decline to roughly 37,000 individuals by 2100, with the species likely to persist only in Manitoba, Minnesota, and possibly Ontario. Recent wintering ground surveys show highest numbers in Honduras, Nicaragua, and Costa Rica, but fewer than expected in Colombia; winter distributions may have shifted as breeding distributions moved north. Conservation of this species may rely on protection or management of "safe haven" breeding sites where Golden-winged Warbler persist in sympatry with Blue-winged Warbler with limited or no hybridization, as well as protection of mid-elevation tropical forests in Central and South America.

#### **s4.3 Crawford, Rohrbaugh, Roth, Lowe, Barker Swarthout, Rosenberg**

Influences of landscape-scale habitat and climate on range-wide distribution of breeding Golden-winged and Blue-winged Warblers. DOLLY CRAWFORD, *Mohave Community Coll., Kingman, AZ*, RON ROHRBAUGH, *Cornell Lab. Ornith., Ithaca, NY*, AMBER ROTH, *Michigan Tech. Univ., Houghton, MI*, JIM D. LOWE, SARA BARKER SWARTHOUT, and KENNETH V. ROSENBERG, *Cornell Lab. Ornith.*

Understanding a species' landscape-scale habitat associations is critical in interpreting many facets of its ecology and behavior, and in conservation planning and policy. We examined the distributions of Golden-winged and Blue-winged warblers as a function of physiographic and climatic variables. A dataset of 31,555 "recent" (1998 - 2010) occurrence points for the 2 species was collected from 5 primary sources and analyzed at range-wide, regional (Great Lakes and Appalachian), and sub-regional (focal area) scales. These occurrence data were modeled with 16 variables related to temperature and precipitation, land cover characteristics, and elevation. Environmental parameters related to warbler distributions were modeled using an ensemble forecasting approach. The model with the highest level of support was calculated as the un-weighted, average probability distribution from among 4 models with the highest AUC and kappa criteria. This mean model was then used to project the species' distribution. At the range-wide scale, the distribution model with the highest support included land cover and climate predictors such as percent deciduous and coniferous forest, percent cropland, percent human development, vegetation height, and maximum summer temperature. In general, we found Golden-winged Warblers tended to occupy habitat that is cool and dry, at moderate to high elevations (~330 - 762 m) and composed of at least 50% deciduous forest. There were negative associations with coniferous forest, row-crop agriculture, and human development. In the Appalachian region, elevation was the most important predictor of distribution with Golden-winged Warbler occupying higher elevations compared to Blue-winged Warbler.

#### **s4.4 Roth, Pugh, Crawford, Rohrbaugh, Barker Swarthout, Lowe**

Quantifying forest lands as Golden-winged Warbler breeding habitat in the US. AMBER ROTH, *Michigan Tech. Univ., Houghton, MI*, SCOTT A. PUGH, *US Forest Service, Houghton, MI*, DOLLY L. CRAWFORD, *Mohave Community College, Kingman, AZ*, RON W. ROHRBAUGH, SARA BARKER SWARTHOUT and JIM D. LOWE, *Cornell Lab. Ornith., Ithaca, NY*.

Conservation actions for the Golden-winged Warbler include increasing the quantity and quality of habitat on the breeding grounds. In the Golden-winged Warbler Status Review and Conservation Plan, acreage goals for current and future Golden-winged Warbler breeding habitat were generated from an algorithm based on population estimates rather than from actual land cover data. In contrast, the current study used the detailed and nationally consistent forest data inventoried by the US Forest Service, Forest Inventory and Analysis program (FIA). The FIA dataset is the most reliable rangewide data available for

tracking habitat acreage and trends. We focused our analysis on inventoried forest land suitable to Golden-winged Warbler which excludes some suitable habitat such as abandoned farmland and fields, reclaimed minelands, and wetland shrub habitats. We estimated current breeding habitat on forest lands in the US based on landscape-scale criteria known to influence Golden-winged Warbler occurrence, specifically forest cover and stand composition. Within these landscapes, we estimated potential habitat acreage based on hardwood-dominated forest stands and suitable habitat acreage based on the subset of seedling-sapling size-classes. FIA data generated larger suitable habitat acreage estimates than reported in the conservation plan. We differentiated habitat quality within suitable habitat based on retained green-tree attributes within seedling-sapling stand size-classes. Despite the recent trend toward increased usage of green-tree retention in forest management, nearly 60% of current hardwood-dominated seedling-sapling acreage is lower quality breeding habitat with no large retained hardwood trees.

**s4.5 Terhune, Buehler, Aldinger, Bakermans, Confer, Larkin, Loegering, Percy, Roth, Smalling**  
Effects of Golden-winged Warbler habitat management on other avian species. THERON TERHUNE, *Tall Timbers Res. Sta., Tallahassee, FL*, DAVID A. BUEHLER, *Univ. Tennessee, Knoxville, TN*, KYLE ALDINGER, *West Virginia Coop. Fish & Wildl. Res. Unit, West Virginia Univ., Morgantown, WV*, MARJA BAKERMANS, *Indiana Univ. of Pennsylvania, Indiana, PA*, JOHN CONFER, *Ithaca Coll., Ithaca, NY*, JEFF LARKIN, *Indiana Univ. of Pennsylvania*, JOHN LOEGERING, *Univ. Minnesota, Minneapolis, MN*, KATIE PERCY, *Univ. Tennessee, Knoxville, TN*, AMBER ROTH, *Michigan Tech. Univ., Houghton, MI*, and CURTIS SMALLING, *North Carolina Audubon Soc.*

A long recognized ecological tenet of birds is their association with particular habitat types and interspecific associations among different species. Interspecific associations of species transpire when the co-occurrence of 2 or more species are more or less likely than expected due to chance alone. Species association, in either the positive or negative direction, can also occur as a direct consequence of biotic interactions such as mutualism, competition and predation. Positive interspecific associations provide a practical case for the use of indicator and sensitive species to dictate broad-scale habitat management with the intent to benefit a broader ecological community. The Golden-winged Warbler provides a classic example where identification of positive interspecific associations can champion resources of various species and target management to benefit the larger ecosystem. We used a Bayesian clustering technique to determine positive or negative species association of >75 birds species. The Golden-winged warbler positively co-occurs with numerous other songbirds suggesting that they are a good candidate for consideration as a flagship and umbrella species. We impute that where effective habitat management produced quality breeding grounds for Golden-winged warblers these same areas yield profitable habitat for many other species of equal concern. As such, dedicated habitat management for Golden-winged warblers will contribute to the restoration of a diminishing ecosystem and promote biodiversity conservation.

#### **s4.6 King, Chandler, Smalling, Will**

Non-breeding Golden-winged Warbler habitat: status, conservation, and needs. DAVID KING, *Univ. Massachusetts, Amherst, MA*, RICHARD CHANDLER, *US Geol. Surv., Patuxent Wildlife Res. Center, Laurel, MD*, CURTIS SMALLING, *North Carolina Audubon Soc.*, and TOM WILL, *US Fish & Wildl. Ser., Minneapolis, MN*.

Anecdotal reports as well more recent quantitative findings suggest Golden-winged Warblers are most abundant in mid-elevation moist forests. They appear to be tolerant of moderate levels of disturbance, inhabiting both primary and secondary forest, however their occupation of agricultural habitats such as shade coffee is contingent on the presence of nearby forest habitat. Recent trends in deforestation in Latin America offer gloomy prospects for the future of Golden-winged Warbler habitat in the region in the short term. Nevertheless, recent innovations in agroforestry practices offer potential tools to conservationists for restoring and maintaining habitat for Golden-winged Warblers. One example is Integrated Open Canopy Coffee, in which coffee is grown with sparse or not shade adjacent to forest patches of equivalent size, furnishing all the benefits trees in shade coffee do (e.g., fertilization from leaf drop, protection from wind and erosion), yet not imposing the low yields and certification costs associated with shade coffee. In addition to promoting the conservation of forest habitat required by Golden-winged Warblers and other species, this system increases income to farmers by increasing yields as well as providing carbon credits for conserved forest. Increased income to farmers is important because recent findings also indicate deforestation rates in Central America are inversely proportional to socioeconomic

development. Future work will be directed at implementing IOC coffee across the non-breeding range of the Golden-winged Warbler, as well as developing other strategies (e.g., processing coffee with renewable energy) to decrease rural poverty for the benefit of both humans and birds alike.

#### **s4.7 Bennett, Roth, Bump**

Habitat associations of the Golden-winged Warbler in Honduras. RUTH BENNETT, AMBER ROTH and JOSEPH BUMP, *Michigan Tech. Univ., Houghton, MI.*

The global population of the Neotropical migrant Golden-winged Warbler has declined steadily over the past 50 yr. While factors influencing this decline have been well researched on the breeding grounds, little is known about the distribution and habitat requirements of this warbler in its non-breeding range. Recent efforts to quantify non-breeding habitat requirements have focused on the area from Nicaragua to Colombia and Venezuela, though the species' winter range extends as far north as the Yucatan Peninsula, Mexico. To address the gap in knowledge from the northern portion of the non-breeding range, we conducted point-count surveys at 140 locations, targeting Golden-winged Warblers in Honduras during the winters of 2011 - 2012 and 2012 - 2013. Our results show that in the northern portion of the non-breeding range, Golden-winged Warblers occupy habitats previously considered to be suboptimal, including pine-oak forest and semi-deciduous broadleaf forest. We also observed marked spatial segregation between sexes, with male detection frequency peaking at mid-elevation broadleaf forest and female detection frequency peaking in lower, drier forest types. These results demonstrate the need to consider the entire non-breeding range in research efforts to inform conservation planning, as Golden-winged Warbler habitat associations vary across the non-breeding range.

**s4.7 Terhune, Buehler, Aldinger, Bakermans, Confer, Larkin, Loegering, Percy, Roth, Smalling**  
Golden-winged Warbler breeding habitat selection at nest-site and territory scales. THERON TERHUNE, *Tall Timbers Res. Sta., Tallahassee, FL*, DAVID A. BUEHLER, *Univ. Tennessee, Knoxville, TN*, KYLE ALDINGER, *West Virginia Coop. Fish & Wildl. Res. Unit, West Virginia Univ., Morgantown, WV*, MARJA BAKERMANS, *Indiana Univ. of Pennsylvania, Indiana, PA*, JOHN CONFER, *Ithaca Coll., Ithaca, NY*, JEFF LARKIN, *Indiana Univ. of Pennsylvania*, JOHN LOEGERING, *Univ. Minnesota, Minneapolis, MN*, KATIE PERCY, *Univ. Tennessee*, AMBER ROTH, *Michigan Tech. Univ., Houghton, MI*, and CURTIS SMALLING, *North Carolina Audubon Soc.*

Avian habitat selection occurs at multiple spatial scales to incorporate essential life history requirements of a given species. Golden-winged Warbler breeding habitat is characterized by largely forested landscapes containing natural or anthropogenic disturbance elements which maintain forest conditions in early stages of succession. Golden-winged breeding habitat occurs in a variety of settings, ranging from shrub swamps and forest swamps in the upper Great Lakes, to regenerating forests following timber harvest, to grazed pastures, and to reclaimed lands following mining toward the southeastern portions of their range. We sought to identify the structural components of Golden-winged habitat by measuring habitat characteristics across 7 study sites which spanned the breeding range of the species. We measured habitat at the nest-site scale with a series of nested plots characterizing herbaceous vegetation (grasses and forbs), woody shrubs and saplings, and overstory trees. We measured similar parameters within territories on plots located along transects which spanned the territory. We used conditional logistical regression to identify which parameters appeared to be important in habitat selection and simple saddlepoint approximation (SSA) to aid in management interpretation of important parameters for each study site. Study site was an important determinant for which parameters were significant in habitat selection, although selection for most parameters was consistent across several if not all of the sites. The amount of woody cover at the nest-site scale was consistently important across sites, although not always in the same direction. Grass and forb cover, cover in *Rubus* spp. brambles, and vegetation density were also identified as important components of Golden-winged nest-site habitat. Based on SSA, thresholds for these parameters have been identified to aid in designing habitat management prescriptions to promote creation or restoration of Golden-winged habitat.

#### **s4.9 Aldinger, Terhune, Buehler, Bohall Wood, Bakermans, Confer, Flaspohler, Larkin, Loegering, Percy, Roth, Smalling**

Golden-winged Warbler nesting ecology and productivity: a range-wide assessment. KYLE ALDINGER, *West Virginia Coop. Fish & Wildl. Res. Unit, West Virginia Univ., Morgantown, WV.*, THERON TERHUNE,

*Tall Timbers Res. Sta., Tallahassee, FL, DAVID A. BUEHLER, Univ. Tennessee, Knoxville, TN, PETRA BOHALL WOOD, US Geol. Surv., West Virginia Coop. Fish & Wildl. Res. Unit, West Virginia Univ., MARJA BAKERMANS, Indiana Univ. of Pennsylvania, Indiana, PA, JOHN CONFER, Ithaca College, Ithaca, NY, DAVID FLASPOHLER, Michigan Tech. Univ., Houghton, MI, JEFF LARKIN, Indiana Univ. of Pennsylvania, JOHN LOEGERING, Univ. Minnesota, Minnesota, MN, KATIE PERCY, Univ. Tennessee, Knoxville, TN, AMBER ROTH, Michigan Tech. Univ., and CURTIS SMALLING, North Carolina Audubon Soc.*

The loss of early-successional breeding habitat in North America has proven detrimental to numerous Neotropical migratory bird species, including Golden-winged Warblers. Despite attempts to restore early-successional habitats, many of these species continue to decline range-wide. Understanding how nest survival and productivity are linked to habitat parameters is critical to the successful development of conservation strategies. Range-wide spatially explicit information is warranted to best guide management and recovery efforts. We quantified reproductive success of Golden-winged Warblers and factors limiting success at a range-wide scale. We estimated daily survival rates (DSR) on multiple sites located in 6 different states (TN, MN, NC, NY, PA, WI, and WV) and evaluated competing models in nest survival across sites based on various spatial and temporal factors using the nest survival model in program MARK. Model selection, using Akaike's Information Criterion (AIC), identified site, year, nest height and grass cover as strong explanatory values for nest survival. Nest survival (range: 0.42 - 0.82) varied by site and year and was inextricably linked to habitat quality. The proportion of grass cover was a strong indicator of nest success; DSR remained consistent up to 40% grass cover, then steeply declined above that threshold. Measures of productivity such as clutch size varied more as a function of year than site. Habitat management efforts for Golden-winged Warblers that result in a balance of habitat components (e.g., amount of grass and woody cover) will optimize breeding productivity.

#### **s4.10 Frantz, Aldinger, Duchamp, Simmons, Nuttle, Larkin, Vitz, Bohall Wood**

Space and habitat use by breeding Golden-winged Warblers in the central Appalachian Mountains. MACK W. FRANTZ, *Indiana Univ. of Pennsylvania, Indiana, PA*, KYLE ALDINGER, *US Geol. Surv., West Virginia Coop. Fish & Wildl. Res. Unit, West Virginia Univ., Morgantown, WV*, JOSEPH DUCHAMP, THOMAS SIMMONS, TIMOTHY NUTTLE, JEFFERY LARKIN, *Indiana Univ. of Pennsylvania*, ANDREW VITZ, *Powder Mill Nature Preserve, Rector, PA*, and PETRA BOHALL WOOD, *US Geol. Surv., West Virginia Coop. Fish & Wildl. Res. Unit, West Virginia Univ.*

Although spot-mapping is an effective method for delineating core breeding territories, a recent radio telemetry study in Minnesota found that male Golden-winged Warblers frequently left their spot-mapped territories. We compared differences in space and habitat use of individual male Golden-winged Warblers that were monitored using both spot-mapping and radio telemetry in Pennsylvania and West Virginia. We recorded 629 telemetry observations among 22 male Golden-winged Warblers in Pennsylvania and 496 telemetry observations among 8 males in West Virginia. Telemetry delineated use areas (100 and 50% MCPs) were larger than spot-mapped territories with 39% of telemetry locations outside of the spot-mapped territory and up to 1.5 km away. Telemetry use areas overlapped several spot-mapped territories, however spot-mapped territories overlapped little with each other. More telemetry locations were in mature forest compared to spot-mapped locations. Although the exact motive for a Golden-winged Warbler to leave its spot-mapped territory is unknown, observations suggest foraging, extra-pair copulation, and reconnaissance for post-breeding movement as possible motives. Sapling abundance was greater in telemetry use areas (mean  $22.5 \pm 2.1$ ) than in spot-mapped territories (mean  $11.8 \pm 1.9$ ) in Pennsylvania. In managed grazing lands in West Virginia, tree abundance was greater in telemetry use areas ( $31.4 \pm 7.1$ ) than in spot-mapped territories ( $5.8 \pm 3.6$ ). Results from our study areas with low territory densities support those reported for a high-density population in Minnesota. Thus, spot-mapping alone does not completely reflect Golden-winged Warbler space and habitat use and misses the importance of mature forest in proximity to spot-mapped territories.

#### **s4.11 Streby, Peterson, Andersen**

Golden-winged warbler post-fledging habitat use and survival in the western Great Lakes region. HENRY M. STREBY, *Univ. California, Berkeley, CA*, SEAN M. PETERSON, *Minnesota Coop. Fish & Wildl. Res. Unit, Univ. Minnesota, Minneapolis, MN*, and DAVID E. ANDERSEN, *US Geol. Surv., Minnesota Coop. Fish & Wildl. Res. Unit.*

Information about songbird fledgling survival and habitat associations is important for understanding seasonal productivity and for developing appropriate management recommendations. We



monitored Golden-winged Warbler (GWWA) fledgling movements and survival daily from fledging until independence from adult care, and we recorded habitat characteristics at multiple spatial scales for each fledgling location at 2 study sites in central Minnesota and 1 site in se. Manitoba. We modeled fledgling survival (logistic exposure method) and used model ranking to determine which habitat characteristics were most strongly associated with survival. In addition, we used compositional analysis to assess post-fledging cover-type selection after adjusting area availability for age-specific fledgling movement capability. GWWA fledgling survival was influenced primarily by age and nest location relative to forest edge, and secondarily by smaller-scale habitat features (e.g., local vegetation density). Fledgling survival was significantly higher in mature forest than in upland or wetland shrublands. Fledgling survival was lowest in the first few days outside the nest, making nest location relative to forest edge an important factor related to fledgling survival. Early (first few days) fledgling movements were directed toward mature forest, unless the nest was in mature forest, in which case early movements were not directional in relation to cover type. In general, GWWA fledglings used mature forest in higher proportion relative to its availability and their survival was highest in mature forest despite nest success being relatively low in that cover type. These results indicate that mature forest is an important component of GWWA habitat in the Western Great Lakes region, and they exemplify the importance of including nesting and post-fledging data when assessing productivity and habitat requirements for breeding songbirds.

#### **s4.12 Peterson, Streby, Andersen**

Sex-based differences in strategies of post-fledging parental care in Golden-winged Warblers. SEAN M. PETERSON, *Minnesota Coop. Fish & Wildl. Res. Unit, Univ. Minnesota, Minneapolis, MN*, HENRY M. STREBY, *Univ. California, Berkeley, CA*, and DAVID E. ANDERSEN, *US Geol. Surv., Minnesota Coop. Fish & Wildl. Res. Unit*.

Brood division in the post-fledging period is a widespread behavior in birds that is not well understood. We studied post-fledging brood division in Golden-winged Warblers (GWWA) at 2 sites in central Minnesota and 1 site in se. Manitoba from 2010 - 2012 to assess differences in strategies between male and female parents. We radio-marked fledglings to monitor broods from fledging until independence from adults. Male- and female-reared fledglings exhibited significantly different space use. By independence, female-reared fledglings on average traveled over twice as far from the nest as male-reared fledglings. Initiation of spatial division between parents was marked by a brief period of directional movement observed in female-reared fledglings, but not in male-reared fledglings. Fledgling survival, parental behavior, fledgling behavior, and habitat use were similar between male- and female-reared fledglings, suggesting that quality of care and habitat selection were similar between parents. Our results demonstrate that male and female GWWA have different strategies related to parental care. These differences in parental care strategies result in fledglings within a brood exhibiting dramatically different patterns of spatial use, which influences the appropriate scale at which management actions need to be focused.

#### **s4.13 Peterson, Streby, Andersen**

Influence of landscape composition on Golden-winged Warbler full-season productivity. SEAN M. PETERSON, *Minnesota Coop. Fish & Wildl. Res. Unit, Univ. Minnesota, Minneapolis, MN*, HENRY M. STREBY, *Univ. California, Berkeley, CA*, and DAVID E. ANDERSEN, *US Geol. Surv., Minnesota Coop. Fish & Wildl. Res. Unit*.

Declines in Golden-winged Warbler (GWWA) populations are largely thought to be due to a combination of habitat loss and competition from Blue-winged Warblers. Management of GWWA currently focuses on providing appropriate habitat to maximize productivity. However, habitat requirements and productivity measures for this species currently do not include fledgling habitat use and survival. To address this deficiency, we assessed full-season productivity of GWWA at 2 sites in central Minnesota and 1 site in se. Manitoba during 2010 - 2012 by monitoring nest success and fledgling survival using radio-telemetry. We modeled nest success and fledgling survival using logistic-exposure methods that incorporated measurements of landscape composition around the nest and areas surrounding locations used by fledglings. We further divided fledgling survival into early and late post-fledging periods because factors related to survival appeared to vary as a function of fledgling age. We used biologically informed, fixed-radius circles around the nest to describe landscape composition in the early post-fledging period. We similarly used landscape composition within the area surrounding locations used by fledglings in the late post-fledging period to identify landscape composition associated with high fledgling survival.

We then estimated full-season productivity across the landscapes in our study areas based on our models of fledgling survival, and compared our estimates of full-season productivity with estimates of productivity based solely on nest success. Our assessment indicated that some early-successional habitat that was highly productive during the nesting period had low post-fledging survival. Based on our evaluation of full-season productivity of GWWA, we suggest that habitat management of this species should focus on areas that feature a mosaic of early-successional uplands and mid- to late-successional or mature forest.

#### **s4.14 Hobson, Van Wilgenburg, Roth, Flaspohler, Vallender**

Linking breeding and wintering grounds of Golden-winged Warbler using stable isotope analyses. KEITH A. HOBSON, STEVEN L. VAN WILGENBURG, *Environment Canada, Saskatoon, SK*, AMBER ROTH, DAVID FLASPOHLER, *Michigan Tech. Univ., Houghton, MI*, and RACHEL VALLENDER, *Environment Canada, Gatineau, QC*.

A fundamental requirement for the conservation of migratory species is an understanding of how populations are linked throughout the annual cycle. This has proven all but impossible with the Golden-winged Warbler using conventional banding due to poor recovery rates. The occurrence of spatially structured variation in stable-hydrogen isotopes in precipitation ( $\delta^2\text{H}_p$ ) which are subsequently incorporated into the feathers provides a forensic method to link migratory birds between sites of capture and the geographic location of molt. We calibrated a spatially explicit base map of variation in  $\delta^2\text{H}_p$  using a sample of 113 known or presumed origin (ASY) Golden-winged Warbler feathers ( $\delta^2\text{H}_f$ ) from across the species breeding range. A model of amount-weighted growing-season  $\delta^2\text{H}$  in precipitation predicted at least 70% of variation in  $\delta^2\text{H}_f$ . We subsequently analyzed  $\delta^2\text{H}$  in feathers collected from birds wintering in Honduras (27), Nicaragua (17), Costa Rica (48), and Venezuela (2) and used a likelihood of origin assignment approach to depict most probable breeding or natal origins. We found high overlap in origins across the wintering grounds suggesting panmixis. However, we also observed weak evidence for a possible leap-frog migration pattern with the northernmost origin birds wintering the farthest south. The implications of our results to the conservation of this species and for future research will be discussed.

#### **s4.15 Rohrbaugh, Streby, Andersen, Larkin, Buehler**

Symposium summary and future directions in Golden-winged Warbler research and conservation. RON ROHRBAUGH, *Cornell Lab. Ornith., Ithaca, NY*, HENRY M. STREBY, *Univ. California, Berkeley, CA*, DAVID E. ANDERSEN, *US Geol. Surv., Minnesota Coop. Fish & Wildl. Res. Unit, Univ. Minnesota, Minneapolis, MN*, JEFF LARKIN, *Indiana Univ. of Pennsylvania, Indiana, PA*, and DAVID A. BUEHLER, *Univ. Tennessee, Knoxville, TN*.

Ron Rohrbaugh and David Buehler will summarize conclusions from the *Studies in Avian Biology* chapters presented at the symposium and from several chapters not presented. They will then discuss research needs and future directions for Golden-winged Warbler conservation and management.

### **Symposium 5**

#### **Physiological and functional advances in avian coloration**

*Convener M. Butler*

#### **s5.1 Butler, McGraw**

Physiological roles of a pigment used in eggshell coloration. MICHAEL W. BUTLER, *Lafayette Coll., Easton, PA*, and KEVIN J. MCGRAW, *Arizona State Univ., Tempe, AZ*.

The bulk of avian coloration research has focused on those pigments found in the integument, most notably the melanins and carotenoids. However, birds also produce eggs with a wide variety of colors and patterns using 2 tetrapyrrolic pigments, protoporphyrin and biliverdin. Biliverdin, which has a blue-green appearance, is a potent antioxidant and the ability of females to deposit biliverdin into eggshells to signal their or their eggs' quality to males is an area of active research. However, the bulk of this research has focused on the biomechanics or behavioral ecology of eggshell coloration, and there has been a comparative lack of research examining the physiological costs of production and/or deposition of biliverdin. In order to explore the underlying assumption that only high-quality females can produce and/or deposit biliverdin, we examined metrics of female quality and compared them not only to biliverdin-based eggshell coloration, but also to the concentration of biliverdin in the bile. We found that bile biliverdin concentration of Mallards is correlated to multiple components of female phenotype; females with a

greater concentration of biliverdin in the bile had a reduced ability to produce antibodies to a novel antigen, but had more carotenoid-rich beaks. Females with greater circulating carotenoid levels laid eggs that had more biliverdin-rich shells, and those eggs with more biliverdin-rich shells had yolks that were more carotenoid-rich, but smaller. These results demonstrate that biliverdin may be associated with not only egg quality, but female quality as well, although the directions of these relationships raise a variety of questions. Ongoing and future work, and the relationship between biliverdin in the gall bladder and the shell gland, will be discussed.

### **s5.2 Stoddard, Stevens, Kilner, Town**

The proof is in the pattern: what the intricate egg patterns of cuckoos and their hosts reveal about coevolution. MARY CASWELL STODDARD, *Organ. & Evol. Biol. and Mus. Comp. Zool., Harvard Univ., Cambridge, MA*, MARTIN STEVENS, *Centre for Ecol. & Conserv., Coll. Life & Environ. Sci., Univ. Exeter, Exeter, UK*, REBECCA KILNER, *Dept. Zool., Univ. Cambridge, Cambridge, UK*, and CHRISTOPHER TOWN, *Computer Lab., Univ. Cambridge*.

Ornithologists now have a rich set of tools for quantifying avian color and brightness, yet very few tools have been developed for analyzing texture and pattern (i.e., the 2- or 3-dimensional spatial arrangement of color and brightness). How do birds perceive patterns, and what consequences does this have for the evolution of diverse visual signals? In this talk, we will present new tools for quantifying animal patterns – based on digital image analysis, Fourier transform, and computer vision algorithms – and apply them to the diversely patterned eggs laid by the brood parasitic Common Cuckoo (*Cuculus canorus*) and its hosts. Because many hosts have evolved the ability to detect and reject foreign eggs, the cuckoo's ability to lay a mimetic egg is essential to its success. Do cuckoos effectively match the spatial patterns of pigmentation on host eggs? Next we explore whether hosts, in turn, modify their own egg patterns to make them more recognizable. Overall, the egg patterns of cuckoos and hosts encode detailed information about cuckoo-host coevolutionary history, providing insights traditional studies of color cannot. Future work on avian coloration should incorporate pattern and texture, which are relevant not just to eggs but also to complex plumage displays, chick mouth markings, nest camouflage, and bower decoration.

### **s5.3 Eliason, Maia, Bitton, Shawkey**

Linking form and function to elucidate the evolution of iridescent colors in birds. CHAD M. ELIASON, RAFAEL MAIA, *Dept. Biol. & Integrated Biosci. Prog., Univ. Akron, Akron, OH*, PIERRE-PAUL BITTON, *Dept. Biol. Sci., Univ. Windsor, Windsor, ON*, and MATTHEW D SHAWKEY, *Dept. Biol. & Integrated Biosci. Prog., Univ. Akron*.

Extensive evidence suggests that complex traits like beetle horns and cichlid jaws originate through simple rearrangement of existing parts (evolutionary tinkering). However, this process can be problematic for traits that require coordinated integration among parts to maintain function. By contrast, independence among parts (modularity) can promote diversification. Variable feather colors in birds likely evolve by intersexual selection and are produced by 2 general mechanisms: light absorption by pigments (pigment-based colors) and light scattering from nanostructured feather materials (structural colors). The latter often form through self-assembly of melanin-containing organelles (melanosomes) within barbule cells. Because selection acts on functional properties (color) rather than directly on morphology, the functional architecture of these traits can greatly influence their capacity to evolve. However, few studies have compared color variability among nanostructural classes, and it remains unclear whether and how the observed variation at different levels of organization affects color potential. Here, we show that changes in form, both at the melanosome and nanostructure level, affect the form-function relationship. We tested this by comparing proximate color mechanism among species with (i) similarly-shaped melanosomes (solid rods) arranged in different ways (disordered in *Polyplectron* and ordered in *Anas*) and (ii) differently-shaped melanosomes (hollow rods in *Meleagris* and *Cinnyricinclus leucogaster* and solid rods in *Anas*) arranged in similar configurations (ordered). These findings suggest that hierarchical modularity has enhanced the capacity for color evolution in birds as a whole but that this capacity is unevenly distributed among nanostructural classes, either due to physical constraints or differences in functional architecture. This finding may help explain why bird colors are diverse yet limited relative to what they can perceive. We thus anticipate that these results will be useful in interpreting broader patterns of morphological and optical diversity across Aves.

#### **s5.4 Maia, Shawkey**

From nano(structure) to macro(evolution): what the development and mechanisms of iridescence can tell us about plumage color diversification. RAFAEL MAIA and MATTHEW D SHAWKEY, *Dept. Biol. & Integrated Biosci. Prog., Univ. Akron, Akron, OH.*

The exuberant and diverse colors of avian feathers are classic examples of how natural and sexual selection shape the evolution of ornamental traits. Recent advances have highlighted the importance of proximate mechanisms in regulation and constraint of the evolution of different color types. Iridescent plumage colors are produced through light scattering by organized nanostructures of keratin and melanin granules (melanosomes) within feather barbules. Birds have evolved extensive modifications to the shape and composition (hollowness) of melanosomes, allowing extensive variation in color production through variations in the size, arrangement, and composition of melanosomes, and therefore providing a labile template for selection to act upon. Here we explore how this nanostructural arrangement emerges during development, showing that organization takes place in the final stages of feather growth, and potentially through self-assembly mechanisms. This implies that the expression of different colors can be obtained simply through differences in the relative concentrations of different components and the timing of feather maturation. Secondly, we explore how innovations to this template can influence color diversification in hummingbirds and African starlings. We show that modified melanosomes allow for faster rates of color evolution across a broader color palette, as the optical complexity of these structures allows for different aspects of coloration to be modified independently. As a consequence, these innovations also provide opportunities for faster lineage diversification. These results highlight the importance of understanding how complex phenotypes are produced to elucidate how they can be selected upon and diversify.

#### **s5.5 Dakin, Montgomerie**

How iridescent plumage ocelli influence Peacock mating success. R. DAKIN and R. MONTGOMERIE, *Dept. Biol., Queen's Univ., Kingston, ON.*

Each of the multi-colored eyespots (ocelli) on the Peacock's (*Pavo cristatus*) train has a dark purple center surrounded by blue-green and bronze structural colors. To investigate the function all 3 of plumage colors, we used a model of avian color vision to quantify those colors as females would perceive them during courtship. Males display at 45° to the right of the sun's azimuth (on average) with the female directly in front, so we investigated how the eyespot colors would be perceived when illuminated at 30°, 45° and 60° to the right of a female observer. We studied 34 males displaying at leks in 3 North American populations, and quantified their copulation success. Eyespot coloration explained half of the observed variation in peacock mating success, with the hue and iridescence of the blue-green patch being the most important color variables. Females often visit males with unattractive plumage colors initially, but they are less likely to return to those males later on. In contrast, they tend to return to visit the males with attractive colors repeatedly. These results provide insight into how females use male color signals, and point to the potential importance of memory. They also raise questions about the function of multiple eyespot colors, since the influence of the bronze and purple eyespot colors on mate choice is minimal at best.

#### **s5.6 Toomey, Enright, Riedl, Schwartz, Witt, Harrison, McGraw, Corbo**

Complementary shifts in carotenoid metabolism and opsin tuning facilitate avian color discrimination. MATTHEW B. TOOMEY, JENNIFER M. ENRIGHT, *Dept. Path. & Imm., Washington Univ. School of Med., St. Louis, MO*, KEN M. RIEDL, STEVEN J. SCHWARTZ, *Dept. Food Sci. & Tech., Ohio State Univ., Columbus, OH*, CHRISTOPHER C. WITT, *Dept. Biol., Univ. New Mexico, Albuquerque, NM*, EARL H. HARRISON, *Dept. Human Nutr., Ohio State Univ., Columbus, OH*, OLLE LIND, ALMUT KELBER, *Dept. Biol., Lund Univ., Lund, Sweden*, KEVIN J. MCGRAW, *School of Life Sci., Arizona State Univ., Tempe, AZ*, and JOSEPH C. CORBO, *Dept. Path & Imm., Washington Univ. School of Med.*

The majority of bird species rely on vision as their primary sensory modality and make use of an dazzling variety of colorful visual signals. These displays are often created through metabolism and deposition of diet-derived carotenoid pigments. Metabolically modified carotenoid pigments also play a fundamental role in avian vision. Carotenoids pigment the brilliantly colored oil droplets of bird photoreceptors and filter light as it passes through the cell. The types, concentrations, and absorbance spectra of the carotenoids in the oil droplets within each of the cone photoreceptor subtype differ and are complementary to the visual pigment within each type. This precise coupling of carotenoids and visual pigment allows for a level of spectral tuning and color discrimination that could not otherwise be achieved.

The apocarotenoid galloxanthin pigments the oil droplet of the blue-sensitive cone and was first described more than 60 yr ago, however its biosynthetic origins have remained unclear. Here, we present evidence that  $\beta$ -carotene oxygenase 2 mediates the formation of galloxanthin in the avian retina. We have also observed that the apocarotenoid composition of the retina differs among bird species such that retinas with violet-sensitive cones contain galloxanthin whereas UV-sensitive species contain an apocarotenoid with a short-wavelength shifted absorbance spectrum. This shift underlies interspecific differences in the oil droplet filtering of the blue-sensitive cone that complements the shift between violet and UV vision by maintaining the spacing of the spectral sensitivity of the cone subtypes across the visible spectrum. These results suggest that selective carotenoid metabolism in the avian retina has co-evolved with changes in opsin spectral tuning to maintain even sampling of light of different wavelengths and facilitate color discrimination.

### **s5.7 Bloch, Morrow, Chang, Price**

Evolution of SWS2 visual pigments in birds: from genes to function. NATASHA I. BLOCH, *Dept. Ecol. & Evol., Univ. Chicago, Chicago, IL*, JAMES M. MORROW, *Dept Cell & Syst. Biol., Univ. Toronto, Toronto, ON*, BELINDA S. W. CHANG, *Dept. Cell & Syst. Biol., and Dept. Ecol & Evol. Biol., Univ. Toronto*, and TREVOR D. PRICE, *Dept. Ecol. & Evol., Univ. Chicago*.

Visual pigments and color vision of birds have been thought to be rather invariant, with the exception of the SWS1 pigment, sensitive to violet/ultraviolet wavelengths. Here, we study the avian SWS2 opsin [Short-wavelength type 2] sequence evolution and spectral tuning across 23 species belonging to 2 distantly related clades of warblers, the New World (Parulidae) and the Old World (Phylloscopidae) warblers. These 2 clades occupy ecologically similar roles (forested habitat) on different continents and last shared a common ancestor around 30 Ma. We reconstructed ancestral sequences and expressed them *in vitro* together with warbler SWS2 pigments to infer the course of evolution of this pigment between as well as within the clades. SWS2 shows similar levels of non-synonymous variation within both warbler clades, and several sites exhibit clear signatures of positive selection. Despite having accumulated 6 substitutions at meaningful sites between clades, all warbler species and ancestors have similar SWS2 spectral sensitivities. Extending our analysis across birds in general, we show SWS2 spectral tuning is correlated with habitat. Species in more open habitats (mainly finches) have short-wavelength shifted tuning with respect to forest species. This is consistent with the presence of more short-wavelength shifted light in these habitats. Our results imply that the similarities in SWS2 spectral tuning in the 2 warbler clades are a result of shared ancestry and ecology, and that the finches SWS2 became short-wavelength shifted after splitting off from the New World warbler lineage and moving in to open habitats.

### **s5.8 Murphy, Pham, Queller, Tarvin**

Honesty of a female status signal and physiological investment into aggression: baseline testosterone and bill color in female American Goldfinches. TROY G MURPHY, TIFFANY T PHAM, PHILIP S QUELLER, *Dept. Biol., Trinity Univ., San Antonio, TX*, and KEITH A TARVIN, *Dept. Biol., Oberlin Coll., Oberlin, OH*.

Status signals are linked to fighting ability and enable competitors to gain access to resources without risking injury in aggressive combat. The relationship between testosterone (T), a hormone that mediates aggression, and signals of status is well studied in males, but little is known about hormonal mediation of female status signals. Both female and male American Goldfinches express carotenoid-based orange bill color during the breeding season, and the seasonal change in bill color from gray-brown to orange is T-dependent in both sexes. Previous work on this species has demonstrated that females use orange bill color to communicate competitive ability during intersexual competition during the breeding season; however, the underlying physiological factors that regulate the reliability of this signal are unknown. We test the hypothesis that female bill color signals physiological investment in aggression, allowing receivers to directly assess a competitor's preparedness for aggression based on bill coloration, and thus predict a positive relationship between bill color and baseline T in females. We also explore the relationship between T and male bill color, although bill color does not function as a status signal in males. We found a strong positive relationship between T and bill saturation in females, and a similar pattern between male T and bill brightness. These results are consistent with the hypothesis that female bill color is a reliable signal of competitive status and that females, like males, can evolve ornamental traits that signal information about their physiological preparedness for aggression.

#### **s5.9 Thomas, McGraw, McGoverin, James**

Vibrational spectroscopic analyses of unique yellow feather pigments (spheniscins) in penguins. DANIEL B. THOMAS, *Smithsonian Inst., Washington, DC*, KEVIN J. MCGRAW, *Arizona State Univ., Tempe, AZ*, CUSHLA M. MCGOVERIN, *Temple Univ., Philadelphia, PA*, and HELEN F. JAMES, *Smithsonian Inst.*

Most integumentary pigmentation in birds is due to carotenoids or melanins, but a few avian lineages use unique molecules to develop ornate coloration. Recently it was discovered that penguins use a class of nitrogen-rich, UV-fluorescent compounds to develop yellow plumage coloration. However, the chemical characteristics and full molecular structure have yet to be determined. Here we use Raman spectroscopy to further investigate the chemistry of yellow penguin feathers and gain insight into functional groups within the pigment. Using feathers from King and Macaroni penguins, we show that the pigment contains carbon atoms bound in an aromatic ring, and may include a nitrogen-containing aromatic heterocycle. Hence, like many other pigment classes, this pigment may function as an antioxidant, and experiments with pH manipulation suggest that the aromatic ring is part of a larger conjugated system. The functional groups we have identified in the penguin pigment are consistent with a pterin or a porphyrin, which are compounds that are synthesized endogenously and that perform important physiological roles within a wide range of species.

#### **s5.10 Newbrey, Reed**

Effects of female condition on the allocation of carotenoids to egg yolks and feathers in the Yellow-headed Blackbird. JENNIFER L. NEWBREY, *Columbus State Univ., Columbus GA*, and WENDY L. REED, *North Dakota State Univ., Fargo, ND*.

A female bird's physical condition can affect the allocation of carotenoids to reproduction and feather coloration, which can in turn affect offspring growth and survival. We examined relationships between yolk and feather carotenoid concentrations and various indices of female quality (i.e., body condition, heterophil-to-lymphocyte ratio, hematocrit, date of nest initiation, egg mass, reproductive success) in the Yellow-headed Blackbird, a brightly colored passerine. We found that female blackbirds that were less stressed (i.e., lower heterophil-to-lymphocyte ratio) had higher concentrations of  $\beta$ -carotene in their eggs than females that were more stressed. In addition, females with higher hematocrit values had higher concentrations of feather carotenoids. Timing of breeding was also related to variation in yolk carotenoid concentrations; later-breeding females produced eggs with lower concentrations of  $\beta$ -carotene but higher concentrations of lutein, which could reflect seasonal differences in carotenoid availability. Concentrations of yolk and feather carotenoids were not correlated, which suggests that individual carotenoids may have different functions in eggs and plumage in the Yellow-headed Blackbird. Carotenoid concentrations and female condition variables were not significantly related to the reproductive traits measured, but small sample sizes of females that fledged young may have limited our ability to detect effects.

### **Symposium 6**

#### **Avian diversification in the Old World tropics**

*Conveners S. Reddy and B. Marks*

#### **s6.1 Reddy, Marks**

Introduction to Symposium. How well do we know the Old World tropics? SUSHMA REDDY, *Loyola Univ. Chicago, Chicago, IL*, and BEN MARKS, *Field Mus., Chicago, IL*.

There is a critical need to understand global patterns of biodiversity to increase knowledge of evolutionary history and predict the effects of anthropogenic impacts. Longstanding questions about differential diversity, distinguishing temperate and tropical regions or Eastern and Western Hemispheres, require comparative data on a global scale. Given the large number of bird species that have been studied using modern tools, many recent studies have begun to examine patterns of avian diversification. Using the availability of genetic data as an indication of the amount of effort, analyses show substantial differences across the globe. Not surprisingly, regions with highest species diversity also have the most number of species with no genetic information. However, when considered as percentage of total diversity, the Old World tropics stands out as a region with the lowest proportion of species studied. Additionally, taxonomy, which many studies use in lieu of phylogeny, is grossly erroneous and incorrect

assessments of species-limits, monophyly, and phylogenetic relationships have further obscured the diversity of in this region and subsequent interpretations of biogeography, trait evolution, and diversification patterns. There is an urgent need to study diversification in the Old World Tropics and the talks in this symposium will highlight recent studies focusing on this region.

### **s6.2 Bowie**

The scramble for Africa's montane highlands: patterns of colonization and diversification. RAURI C. K. BOWIE, *Univ. California, Berkeley, CA*.

The montane forests of Eastern Africa are scattered discontinuously along a 5000 km chain of mountains running from the Ethiopian Plateau in the north to the South African coast. Isolated to the west are 2 further areas of endemism, the Cameroon and Angolan Highlands. Such a fragmentary distribution of montane forest is primarily a consequence of relief, as only a few isolated areas are high enough for montane conditions (low temperature and high precipitation) to develop. Recent work has established that the evolution of plants on the mountains of Africa can be attributed to not only recruitment from the African lowland flora, but also to a large extent from northern areas with temperate environments (Holarctic). Using a large multi-gene dataset of 2 exemplar bird families (Nectariniidae, Pycnonotidae) I explore patterns of diversification among African's major montane areas of endemism. Results indicate that in contrast to plants, the diversification of African montane birds occurred primarily *in situ*.

### **s6.3 Block, Hackett, Bates, Goodman, Raherilalao**

Explosive or non-explosive adaptive radiation? Cryptic diversity alters diversification rate estimates for the Bernieridae, a Malagasy passerine radiation. NICHOLAS L. BLOCK, SHANNON J. HACKETT, JOHN M. BATES, STEVEN M. GOODMAN, *Field Mus., Chicago, IL*, and MARIE JEANNE RAHERILALAO, *Univ. d'Antananarivo, Antananarivo, Madagascar*.

Time-calibrated phylogenetic trees are increasingly being used to infer diversification rates and processes that have led to extant diversity. The diversification analyses performed on these ultrametric trees can be particularly useful for studying and defining adaptive radiations. A common feature of adaptive radiations is an initial, "explosive" burst of speciation followed by a decline in diversification rates, and this pattern is included in some definitions of adaptive radiation. However, other factors can lead to a similar pattern, including incomplete sampling of taxa and protracted speciation. If a radiation contains significant cryptic diversity, it may have an increased likelihood of showing a false signal of diversification slowdown due to these other 2 factors. Using the first complete phylogeny for the Bernieridae, an endemic Malagasy passerine adaptive radiation, we provide the first empirical example of the effect of cryptic lineages on diversification analyses. We show that the Bernieridae contain high levels of intraspecific cryptic diversity that change our understanding of the diversification dynamics in the family's evolutionary history. As currently defined, Bernieridae comprises 11 species, and diversification analyses of these 11 species show a significant signal of diversification rate slowdown consistent with an explosive adaptive radiation. However, inclusion of the several cryptic Bernieridae lineages alters results of diversification analyses and shows the Bernieridae to be an adaptive radiation that diversified at a relatively steady rate. To our knowledge, Bernieridae represents the first avian adaptive radiation documented as having a relatively continuous diversification rate.

### **s6.4 Price, Mohan**

Causes of the mid-elevation peak in east Himalayan songbird diversity. TREVOR D. PRICE, *Univ. Chicago, Chicago, IL*, and DHANANJAI MOHAN, *Wildlife Inst. India, Dehradun, India*.

The east Himalayas may contain the highest density of songbird (oscines) species in the world, ~350 in 10,000 km<sup>2</sup>. This diversity is unevenly distributed along the elevational gradient, with about 60% more species present at 1500 - 2000 m, than at the lowest elevations (150 m) or at 3,000 m, which both have similar numbers. We consider historical and ecological explanations for this pattern. Phylogenetic information indicates that the east Himalayan species assemblage is old, implying communities close to saturation. Further, despite the mid-elevation peak, average age of species, as assessed using a complete phylogeny, declines monotonically from bottom to the top of the mountain. Thus historical factors seem of lesser importance than current ecological factors. Among these factors, morphological variation across species increases monotonically (in the opposite direction to species age), which suggesting that resource diversity is not the driver of the mid-elevation peak, at least as measured by this metric. We show that the peak is entirely attributable to insectivorous species and correlates with the

abundance of arthropods, as reported by Ghosh-Harihar (2012, *Ecol. Res.* 28: 125-130). We argue arthropod abundance and possibly arthropod diversity are important drivers of the east Himalayan mid-elevation peak in bird diversity.

#### **s6.5 Sorenson, DaCosta, Stryjewski, Balakrishnan, Spottiswoode**

Contrasting patterns of divergence and diversification in African brood parasites. MICHAEL D. SORENSON, JEFFREY M. DaCOSTA, KATIE F. STRYJEWSKI, *Boston Univ, Boston, MA*, CHRISTOPHER N. BALAKRISHNAN, *East Carolina Univ., Greenville, NC*, and CLAIRE N. SPOTTISWOODE, *Univ. Cambridge, Cambridge, UK*.

The diversity of obligate brood parasites is greatest in the Old World tropics, where relatively stable environments may have facilitated host-specific adaptation and the divergence and diversification of parasitic lineages associated with different hosts. Comparative phylogenetic and population genetic analyses, however, reveal strongly contrasting patterns of genetic divergence in different groups of parasitic birds, reflecting the role of behavior in shaping evolutionary processes. Indigobirds and other brood parasitic finches (genus *Vidua*) diversified recently and rapidly, with behavioral imprinting on hosts driving a process of speciation by host shift. In contrast, the sister taxon to *Vidua* is the monotypic Cuckoo Finch (*Anomalospiza imberbis*), which represents a relatively ancient parasitic lineage. We recently reported (Spottiswoode et al. 2012, *Proc. Natl. Acad. Sci.* 108: 17738-17742) the coexistence of highly divergent mtDNA haplotypes in the Greater Honeyguide (*Indicator indicator*); ancient female lineages (~15% divergent in ND2 sequence) are perfectly associated with ground-nesting and tree-nesting hosts, respectively, but show little or no differentiation at nuclear loci. Analyses of the Cuckoo Finch reveal a similar pattern; in Zambia, female lineages associated with *Prinia* and *Cisticola* hosts, respectively, are ~9% divergent in ND2 sequence. In both Greater Honeyguides and Cuckoo Finches, highly divergent female lineages have apparently adapted to different hosts, expressing divergent phenotypes for egg traits that influence fitness. Possible genetic mechanisms allowing for host-specific adaptation without speciation include maternal inheritance of egg traits and “divergence-with-gene-flow” between partially isolated populations.

#### **s6.6 Bates, Engel, Kahindo**

Assembly of an African continental montane avifauna: an assessment of the Albertine Rift avifauna. JOHN M. BATES, JOSH ENGEL, *Field Mus., Chicago, IL.*, and CHARLES KAHINDO, *Univ. Bukavu, Bukavu, Democratic Rep. Congo*.

Understanding the assemblage of regional continental avifaunas has long been a major challenge for biogeographers. Phylogenetic and phylogeographic data provide valuable insight into this endeavor. We discuss results from our studies of multiple lineages of Albertine Rift montane birds and provide an assessment of the avifauna as a whole. The region, which straddles the e. Democratic Republic of Congo and w. Uganda, Rwanda and Burundi, is home to almost 700 species of birds. Our results highlight the complex history associated with the assembly of the region and the value of stepping back and assessing overall contributions to total avifaunas as a valuable step in understanding the history of any given region.

#### **s6.7 Kimball, Braun**

Patterns of diversification in the Phasianidae. REBECCA T. KIMBALL and EDWARD L. BRAUN, *Univ. Florida, Gainesville, FL*.

The largest family in the Galliformes, the Phasianidae, has been extensively studied in a variety of contexts due to the presence of economically important species in this family, such as the chicken and turkey, many aspects of phasianid evolution remain unclear. The family has 3 major clades, 2 of which include both African and Asian species. The third major clade is primarily composed of Asian species but also includes the grouse and turkeys (some of which have a New World distribution). While there have been many phylogenetic studies focused on this family in recent years, most of these have had limited taxon sampling or focused on key taxa of interest for specific questions (e.g., pheasants) rather than understanding the family as a whole. Here, we present analyses of a supermatrix that includes >80% of the species in the Phasianidae, with sampling from all but 2 extant genera. The supermatrix analyzed contains 15 nuclear introns as well as substantial amounts of mitochondrial data. Analyses of diversification rates revealed multiple rapid evolutionary radiations in the Old World, occurring at multiple different times during the evolution of the phasianids. The galliform fossil record is relatively poor, and we also discuss uncertainty in establishing the timing of these diversification events. Combining the available



molecular data from phasianids with other types of information about these taxa promises to make them a fascinating model system for Old World avian diversification.

#### **s6.8 Moyle, Hosner, Oliveros, R Jones**

Insights into the origins and diversification of the Philippine avifauna. ROBERT G. MOYLE, PETER A. HOSNER, CARL H. OLIVEROS and ROBIN JONES, *Univ. Kansas, Lawrence, KS*.

The Philippines hosts high diversity and endemism, yet its avifauna has received relatively little attention from modern systematists. Several years of intensive field surveys across the archipelago have allowed us to assess species limits, phylogenetic relationships, and historical biogeography in several diverse radiations. Similar to findings in many tropical areas, our studies show that species diversity has been severely underestimated, and endemism is far higher than appreciated. It is also apparent that the paradigm that ocean depth partitions diversity only partially explains diversity patterns in birds. We found deep genetic structure and non-monophyly within islands and divergent populations on land-bridge islands. Confirming earlier views, the avifauna of Palawan appears to be largely derived from the Greater Sunda Islands rather than the oceanic Philippines, although deep genetic divergences separate some Borneo and Palawan sister taxa.

#### **s6.9 Voelker, Bowie**

Diversification in an Afro-Asian songbird clade reveals multiple trans-oceanic dispersals and a southern to northern colonization pattern in Africa. GARY VOELKER, *Texas A&M Univ., College Station, TX*, and RAURI C. K. BOWIE, *Univ. California, Berkeley, CA*.

We reconstruct a molecular phylogeny for the *Erythropygia-Copsychus* clade (scrub robins, magpie-robins and allies), using 3310 bp from 4 gene regions (2 mitochondrial, 2 autosomal). Bayesian analysis resulted in a well-supported phylogeny, in which several taxonomic issues are evident: *Erythropygia* is not monophyletic (2 non-sister clades), the monotypic genus *Cercotrichas* is imbedded within one *Erythropygia* clade, and *Trichixos* and *Saxicoloides* (both monophyletic) fall within *Copsychus*. Molecular clock calibrations (BEAST analysis) sets the origin of the clade to the late Miocene (6.3 Mya). Ancestral area reconstructions suggest an African origin for the lineage, with the South African region being the most likely area when Africa is subdivided. Subsequent divergences indicate northward expansion in Africa (and to Eurasia in one clade) by both *Erythropygia* clades, and trans-Indian Ocean colonization of Southeast Asia by *Copsychus* and allies. Three additional over-water dispersals are required to explain distribution patterns within *Copsychus*. Overall our results indicate, 1) a remarkable number of over-water dispersal events for a non-migratory songbird group, 2) an exceptionally rare (for birds) direct Africa to Asia dispersal event, and 3) evidence of southern to northern African expansion within both *Erythropygia* clades; this result runs counter to most avian intra-generic molecular biogeographic studies, which tend to show southern Africa as endpoint for intra-African biogeographic range expansions.

#### **s6.10 Hosner, Oliveros, Moyle**

Resolving the complex evolutionary history of a Philippine passerine: insights from thousands of anonymous nuclear loci. PETER A. HOSNER, CARL H. OLIVEROS and ROBERT G. MOYLE, *Univ. Kansas, Lawrence, KS*.

Disparate patterns between mitochondrial DNA sequences and phenotype are well documented in birds, yet the evolutionary processes underlying these conflicting patterns are poorly understood in empirical systems. The Yellow-bellied Whistler, *Pachycephala philippinensis*, is widely distributed in the Philippine archipelago. It inhabits many large islands, as well as several small peripheral isolates. Plumage and morphology are uniform across large islands; populations inhabiting peripheral isolates are larger and darker. Phylogeny inferred from mtDNA sequences suggests complex population structure; individuals form 9 well-resolved geographic clades. Some mitochondrial clades correspond to described subspecies and to well-documented biogeographic regions; other mtDNA clades do not. Each peripheral isolate forms its own mitochondrial clade. To determine if gene flow unites phenotypically similar mitochondrial clades, presumably preventing phenotypic differentiation, we sequenced thousands of nuclear loci from 48 individuals using a Genotype By Sequencing protocol. We inferred population structure and phylogeny (utilizing concatenated and coalescent frameworks) and estimated gene flow using the isolation with migration model. Phylogenomic results support 2 main groups consistent with gross phenotype: one group comprised of populations from large islands, one group comprised of

peripheral isolates. We conclude that most mitochondrial clades are united by gene flow, which has prevented phenotypic differentiation throughout much of the archipelago. Our study highlights the role of peripheral isolates in avian diversification.

#### **s6.11 Kirschel, Gonzalez, Moyle**

A molecular phylogeny of *Pogoniulus* tinkerbirds contradicts current taxonomy based on morphology and plumage. ALEXANDER N. G. KIRSCHER, *Univ. Cyprus, Nicosia, Cyprus*, JUAN-CARLOS T. GONZALEZ, *Univ. Oxford, Oxford, UK*, and ROBERT. G. MOYLE, *Univ. Kansas, Lawrence, KS*.

As in many birds, species limits in *Pogoniulus* tinkerbirds appear to have been based on morphological differences and plumage traits, particularly with respect to allopatric populations. We present a molecular phylogeny of *Pogoniulus* tinkerbirds that sheds light on the evolutionary history of the genus. It suggests several cryptic species exist, with patterns contrasting starkly with current taxonomy. Certain morphological and plumage traits in particular do not reflect phylogenetic relationships, both within and among current species limits. Most notably, *Pogoniulus chrysoconus* is paraphyletic with respect to *P. pusillus*, with the 2 disjunct distributions of the latter likely representing distinct species themselves. *P. bilineatus* and *P. leucolaimus* should be reinstated to good species with one caveat, *P. bilineatus jacksoni* with a golden rump, is actually nested within *P. leucolaimus*. We also present the results of phylogenetic analyses of *P. makawai*, known from a single specimen. We discuss the molecular phylogeny in the context of phenotypic variation in plumage, morphology and song, and focus on the importance of the East African rift in delineating species boundaries.

#### **s6.12 Fjeldså**

The early expansion of songbirds (Oscines) in Asia and Africa. JON FJELDSÅ, *Univ. Copenhagen, Copenhagen, Denmark*.

The availability of digital distributional data and large phylogenies now allows global analyses of large groups such as songbirds (Oscines). The worldwide expansion out of the Australasian area of origin started as an island radiation in the area where New Guinea is now located, but the subsequent radiation in the Old World tropics is difficult to interpret. In addition to an early radiation in the Oriental Region, there is evidence of a rapid interchange, in the early Miocene, between Asia and Africa, and possibly also some events of colonization from Australasia directly to Africa. By comparing geographical diversity patterns for different root-path groups, this paper will illustrate the complex spatial patterns of expansion and interchange among the biogeographic regions, and how the incredible species diversity of the Sino-Himalayan montane region evolved by long-term accumulation of old species in the deep valleys and Pleistocene speciation along the ridge-tops.

### **Symposium 7**

#### **Avian Parasites: models for understanding processes and patterns of diversification**

*Conveners J. Weckstein S. Bush and K. P. Johnson*

#### **s7.1 K P Johnson, Shreve, V S Smith**

Repeated adaptive radiation in avian feather lice. KEVIN P. JOHNSON, *Illinois Nat. Hist. Surv., Univ. Illinois, Champaign, IL*, SCOTT M. SHREVE, *Dept. Entomol., Univ. Illinois, Champaign, IL*, and VINCENT S. SMITH, *The Natural History Museum, London, UK*.

Repeated adaptive radiations have been documented for a variety of lineages on islands and in lakes. Because hosts may act as islands for diverging parasite lineages, repeated adaptive radiations may also occur in host-parasite systems. The feather lice of birds have diverged in the way in which they escape from host preening defenses, into head, wing, and body ecomorphs. Using a molecular phylogenetic tree, we show that different ecomorphs parasitizing the same group of birds are sister taxa more often than expected by chance. Ecomorphs of these parasites are also convergent across different groups of birds, such that phylogenetic analysis based on morphology tends to group together lice of the same ecomorph. Adaptive convergence for escape from host defense may be more common in parasite systems than previously thought, because morphological convergence can obscure evolutionary relationships.

#### **s7.2 Weckstein, Lutz, Valqui, Aleixo, Bates**

When cospeciation isn't common: the importance of biogeography and host-specificity in host-parasite coevolutionary studies. JASON D. WECKSTEIN, *Field Mus. Nat. Hist., Chicago, IL*, HOLLY L. LUTZ, *Cornell Univ., Ithaca, NY*, THOMAS VALQUI, *Centro de Ornitología y Biodiversidad*, ALEXANDRE ALEIXO, *Museu Paraense Emílio Goeldi*, and JOHN M. BATES, *Field Mus. Nat. Hist.*

Cophylogenetic studies of hosts and parasites have traditionally focused on testing the hypothesis of cospeciation for several reasons. First, cospeciation is a classic example of biological evolution and has historically been invoked by both taxonomists and evolutionary biologists as the common pattern in coevolutionary history. Second, the hypothesis of cospeciation is the easiest of the cophylogenetic phenomena to test. To test the hypothesis of cospeciation one asks whether there are more codiversification events in a cophylogenetic comparison than expected by chance alone. While some classic cophylogenetic studies have found significant levels of cospeciation, many other studies have found that seemingly "permanently" associated hosts and parasites did not exhibit high levels of cospeciation. We present sketches of 2 of our cophylogenetic studies of birds and their "permanent" parasites, *Ramphastos* toucans and their *Austrophilopterus* chewing lice, and *Nothoprocta tinamous* and their *Lamprocorpus* chewing lice. In both systems cospeciation is not the predominant coevolutionary phenomenon. For the *Ramphastos* toucans and their lice, sympatric host species share the same species of lice. For *Nothoprocta*, host species have parapatric distributions, with 2 species overlapping at mid-elevations, and yet this limited host geographic overlap is sufficient to allow peripatric species to share the same species of lice. For both focal parasite groups, this relative lack of host related structure where there is strong geographic structure in the parasite evolutionary trees suggests that this lack of cospeciation is either caused by recent host-switching or ongoing gene flow between different host species.

### **s7.3 Koop, DeMatteo, Parker, Whiteman**

Birds as islands: is variation in the Galapagos Hawk's mating system a driver of feather louse population genetic structure? JENNIFER A. H. KOOP, *Univ. Arizona, Tucson, AZ*, KAREN DeMATTEO, PATRICIA G. PARKER, *Univ. Missouri, St. Louis, MO*, and NOAH K. WHITEMAN, *Univ. Arizona*.

Lice and their vertebrate hosts are models for understanding co-speciation and co-evolution. However, these studies have been conducted at the macroevolutionary scale and while the patterns, such as co-speciation, that have emerged out of these studies are fascinating, we do not have a good understanding of the microevolutionary processes that produced the patterns. In the case of parasites such as chewing lice, standing levels of genetic variation within and among host individuals and host populations are in part due to the amount of contact between hosts, which facilitates gene flow. We used microsatellite markers to examine the population genetic structure of a feather louse (Philopteridae: *Degeeriella regalis*) collected from Galapagos Hawks (*Buteo galapagoensis*) across the Galapagos Archipelago, Ecuador. We investigated the influence of host mating system, habitat islands (individual birds), and geographic islands in structuring louse and hawk populations. We found that mating system, habitat islands, and geographic islands all likely play important roles in structuring parasite populations. Our study shows that host ecology can be a driver of parasite microevolution and could explain macroevolutionary patterns, such as co-speciation.

### **s7.4 Bush, Kim, Aguilar, Clayton**

Experimental evolution of cryptic coloration in parasites. SARAH E. BUSH, DUKGUN KIM, M. ALÉ AGUILAR and DALE H. CLAYTON, *Dept. Biol., Univ. Utah, Salt Lake City, UT*.

Over macroevolutionary time feather lice, which are permanent parasites of birds, have evolved cryptic coloration. A recent comparative study showed that louse color matches feather color in lice because it helps them avoid preening, which is the host's main form of defense (Bush et al. 2010, *Am. Nat.* 176: 529-535). Here we report the results of an experimental evolution study to test whether lice transferred to different color hosts will suffer fitness consequences when placed on the "wrong" colored host. We also test whether lice evolve cryptic coloration in microevolutionary time. Our study involved Rock Pigeons (*Columba livia*) and their feather lice (Phthiraptera: Ischnocera). Rock Pigeons are an ideal host to test hypotheses about cryptic coloration because Rock Pigeons vary in color from white to black. Lice were transferred to white and normal colored Rock Pigeons that could and could not preen. After 10 generations, we quantified the color of the lice on each bird. Lice on white birds were significantly lighter than lice on normal colored Rock Pigeons, but only if the birds could preen. Our results experimentally demonstrate the evolution of cryptic coloration in lice. Furthermore, our results confirm that preening is

the selective force driving lice to match the color of the host's feathers.

#### **s7.5 Knutie, McNew, Bartlow, Clayton**

Why pick a fight when you can tolerate your enemy? defense mechanisms of Darwin's finches and Galapagos Mockingbirds against introduced nest flies. SARAH A. KNUTIE, SABRINA M. McNEW, ANDREW W. BARTLOW and DALE H. CLAYTON, *Dept. Biol., Univ. Utah, Salt Lake City, UT.*

Resistance and tolerance are fundamentally different strategies for defense against parasites. Mechanisms of resistance, such as immune responses, reduce parasite load. Mechanisms of tolerance, such as increased red blood cell production, do not reduce parasite load; instead, they increase the ability of the host to absorb parasite damage without suffering a fitness reduction. Because resistance mechanisms reduce parasite fitness, they exert selection for more virulent parasites that can circumvent host defense. Tolerance mechanisms do not select for more virulent parasites. Why, then, do hosts evolve resistance instead of tolerance? One possibility is that tolerance is more energetically expensive than resistance. If this is true, then small-bodied host species should invest more in resistance mechanisms because they cannot afford to invest in tolerance. We tested this hypothesis in a comparative field experimental study of introduced parasites of Medium Ground Finches (*Geospiza fortis*) and Galapagos Mockingbirds (*Mimus parvulus*). *Philornis downsi* is an invasive parasitic fly that deposits eggs in bird nests. Hatched fly larvae feed on the blood of nestlings and brooding adult birds. We compared the impact of flies on the reproductive success of finches and mockingbirds. Our results show that mockingbirds are more tolerant than finches, despite the fact that fly densities in mockingbird nests are higher than in finch nests. Flies have negative effects on the growth and fledging success of finches, but little effect on mockingbirds. We consider proximal factors that may underlie the difference in tolerance.

#### **s7.6 Ellis, Ricklefs**

Ecological and evolutionary relationships between haemosporidian parasites and their avian hosts. VINCENZO A. ELLIS and ROBERT E. RICKLEFS, *Univ. Missouri-St. Louis, St. Louis, MO.*

Previous work has found little evidence of cospeciation between avian hosts and haemosporidian parasites (Ricklefs et al. 2004, **Syst. Biol.** 53: 111-119). Current work in our lab suggests that host-switching, most often between the ranks of genera and families, is associated with species formation in haemosporidian parasites. Consistent with this result, we find that infection prevalence and host immune response to infection are generally evolutionarily labile as shown by an absence of phylogenetic signal in these traits. Even on the order of a decade, we have found dramatic change in the prevalence of haemosporidian parasites in the Ozarks of s. Missouri and the West Indies. Locally, haemosporidian prevalence appears positively related to the relative abundance of their hosts, and current research is investigating the nature of that relationship on regional scales.

#### **s7.7 Witt, Galen**

Avian malaria diversity across hosts and environments in the Peruvian Andes. CHRISTOPHER C. WITT and SPENCER C. GALEN, *Mus. Southwestern Biol. and Dept. Biol., Univ. New Mexico, Albuquerque, NM.*

Biogeographic patterns of diversity in avian malaria are poorly known because relatively few host communities have been deeply sampled. We surveyed bird communities for avian malaria at 16 sites in Peru, comprising elevational gradients of >4000 m on the east and west slopes of the Andes, respectively. Malaria lineage richness and prevalence peaked at middle elevation humid sites, in contrast to the host pattern of monotonic decline in species richness with elevation. Malaria diversity, prevalence, and phylogenetic community composition were associated with elevation and rainfall, but not latitude. Abundance and host breadth of malaria lineages were correlated, a finding that is consistent with previous surveys. Most lineages were rare and found in a single host species, whereas a few abundant lineages were host generalists that also occurred across a wide range of environments. At each locality, we examined the contribution host species, genera, and families to the malaria richness and phylogenetic diversity. Each malaria genus exhibited a different pattern of host specificity, and we demonstrate that deep sampling of the bird community is required to demonstrate host specificity with confidence. Across hosts, there is evidence of deep phylogenetic inertia in susceptibility to malaria, but there is also tremendous variation in prevalence among closely related host species.

#### **s7.8 Fleischer**

Patterns of host use by avian malaria lineages across space and time. ROBERT C. FLEISCHER.  
*Smithsonian Conserv. Biol. Inst., Natl. Zool. Park, Washington, DC.*

Avian malaria parasites show wide variation in the level of specificity across hosts, from some lineages that appear specific to particular bird families to ones that span the entire avian phylogeny. Based on phylogenetic trees, some clades contain avian malaria lineages that show low specificity and others high, so phylogenetic relatedness is not the only factor involved. However, most studies to date deal with a snapshot in time and space, and it is instructive to determine whether and how host use by malaria parasites varies temporally and spatially. I present analyses that illustrate the level of variability on both micro and macrogeographic scales, and also differences in host use across time (comparing, for example, lineages from museum specimen and modern samples). Also particularly effective for understanding the variation in host use among lineages is the assessment of patterns of malaria parasite infection in exotic captive avian collections embedded in a native bird matrix. Over all, our currently available data do not suggest that avian malaria lineage host diversity varies substantially over time or space.

## Symposium 8

### Cowbird brood parasitism: a uniquely New World phenomenon

*Conveners B. Strausberger and M. E. Hauber*

#### s8.1 Peer, Hawkins

The effect of egg shape on incubation temperature in the Brown-headed Cowbird. BRIAN D. PEER and LYNDON R. HAWKINS, *Dept. Biol. Sci., Western Illinois Univ., Macomb, IL.*

The Brown-headed Cowbird has one of the shortest incubation periods of any bird. Cowbird eggs and those of other brood parasites are more spherical than eggs of non-parasitic species due to their greater relative width. The traditional explanation for this egg-shape is that it helps resist host puncture-ejection, but wider eggs may also provide more contact with a host's brood patch during incubation, especially in the nests of large hosts. We tested whether greater egg width increased heat acquisition in Brown-headed Cowbirds by inserting temperature probes into cowbird and House Sparrow eggs and placing them into Red-winged Blackbird nests. There was no significant relationship between mean egg temperature and egg shape. Variation in egg temperature was also not related to egg width, however, it was significantly affected by species, with the temperature of Brown-headed Cowbird eggs varying less than House Sparrow eggs. These results suggest that Brown-headed Cowbirds may have short incubation periods in part because the temperatures of their eggs vary less. The spherical shape, which promotes heat retention, in addition to the thicker eggshell, which likely insulates the embryo, may work in concert to promote heat retention. Enhanced heat retention of cowbird eggs may be beneficial in this host generalist brood parasite whose egg encounters a wide variety of host nest microclimates.

#### s8.2 Swan, Zanette, Clinchy

Brown-headed Cowbirds 'farm' their hosts. DAVID SWAN, LIANA ZANETTE and MICHAEL CLINCHY, *Dept. Biol., Univ. Western Ontario, London, ON.*

Brood parasitic Brown-headed Cowbirds lay their eggs in the nests of other species ('hosts') whereupon the host individuals are burdened with providing for the parasitic young. Cowbirds may also act as nest predators, causing complete nest failure by removing all eggs and killing nestlings from nests that are unparasitized. The farming hypothesis suggests that cowbirds will destroy, or 'farm', host nests found too late in the nesting cycle to be suitable for parasitism, thus inducing those hosts to resume a new reproductive cycle prematurely – ultimately creating future opportunities to parasitize the host's re-nesting attempts. Despite much interest and speculation around farming behaviour, there has been little research devoted to testing the predictions of this hypothesis. Through analyses of cowbird parasitism and nest predation on a population of Song Sparrows we have confirmed a fundamental prediction of the farming hypothesis – cowbirds preferentially attack late-stage nests. We also conducted a series of experiments using captive birds to verify that cowbirds preferentially attack nests that are at an unsuitable stage for parasitism – a central prediction of the farming hypothesis. Moreover, we determined the stimuli to which cowbirds attend when selecting a nest to destroy.

#### S8.3 Strausberger, Literacki

Incubation delay-dependent sex ratio skew in a bird: the Brown-headed Cowbird. BILL M. STRAUSBERGER and JOHN LITERACKI, *Pritzker Lab., Field Mus., Chicago, IL.*

Sex ratios have important evolutionary consequences and are often biased by diverse environmental factors. To my knowledge, there is no evidence that the length of delay of incubation onset can affect sex ratios in birds. Here we show that the length of incubation delay affects sex ratios in Brown-headed Cowbirds, an avian brood parasite. We also show that increased delay of incubation to day 5 results in reduced hatching success. In addition, the length of incubation delay negatively affects hatchling mass. However, the length of the incubation period was unaffected by the length of incubation delay. Our data suggests a sex biased incubation delay-dependant embryo mortality because significantly more males hatched at delays beginning at day 3 and continued through day 5, where the only offspring to hatch were males.

#### **s8.4 Rothstein, Peer, Rivers, Fleischer**

New and old directions in the study of brood parasitism: from Herbert Friedman to modern phylogenetics. STEPHEN I. ROTHSTEIN, *Dept. Ecol., Evol. & Marine Biol., Univ. Calif., Santa Barbara, CA*, BRIAN PEER, *Dept. Biol. Sci., Western Illinois Univ., Macomb, IL*, JIM RIVERS *Oregon State Univ., Corvallis, OR*, and ROBERT C. FLEISCHER *Smithson. Inst, Washington, DC.*

Herbert Friedmann was a remarkable scholar who studied every group of parasitic birds. He wrote monographs that established baseline data for these taxa starting with his landmark 1929 opus on cowbirds. His work is still valuable and worth referencing today. Evolutionary theory was less developed during Friedmann's time and some hypotheses advanced then are no longer tenable, such as a progressive loss of reproductive features causing the evolution of brood parasitism in birds whose normal breeding biology became inefficient. The use of DNA data to construct phylogenies now enables us to apply modern evolutionary theory to some of these same issues. As expected, there is no evidence that brood parasitism is related to a non-adaptive deterioration of breeding behavior. In addition, the cowbird phylogeny indicates that current character states of several traits do not reflect ancestral character states. These shifts in character states might be expected in systems involving parasite-host coevolution but contradict the usual practice in phylogenetic studies of inferring past character states from current patterns of occurrence. Some character shifts likely relate to adaptations not yet discovered. Among hosts, however, current defenses against cowbirds appear to be deeply rooted in lineages with only a few host clades showing strong interspecific variation in effective defenses. Friedmann would have been delighted with these new findings, even when they contradict what he believed.

#### **s8.5 Literacki**

Are genetic diversity and effective population size of the host generalist brood parasitic cowbird affected by West Nile Virus? JOHN CHARLES LITERACKI, *Roosevelt Univ. and Pritzker Lab., Field Mus., Chicago, IL.*

Cowbirds are avian brood parasites that demonstrate resistance to West Nile Virus (WNV). However, because cowbirds depend on surrogate bird species to rear their young that are susceptible to the disease, WNV may indirectly reduce cowbird population size. Cowbirds are generalist brood parasites allowing them potential to switch to more abundant host species, provided WNV does not affect all hosts equally. We tested for a reduction in the effective population size of cowbirds in an area near Chicago, IL, where WNV caused high bird mortality during 2002 and 2003. Using genetic and host nest census data collected before and after the spread of WNV into the area, we assessed cowbird genetic diversity and host species abundance to understand how this host brood generalist parasite responded to WNV, a disease that causes high mortality in many bird species. Our genetic analysis suggests that the cowbird population size remained stable throughout the spread of WNV into the area. Host abundance analysis also suggests that certain host species disappeared from the breeding area after the introduction of WNV but others increased in abundance, providing evidence for the potential of host switching. Understanding how cowbirds responded to WNV host infections will improve our ability to control declining bird populations in the US where habitats are shrinking and host extinctions are more likely.

#### **s8.6 Rivers, Blundell, Rothstein**

Begging displays of Brown-headed Cowbird nestlings are insufficient to maximize food provisioning by a small host. JAMES W. RIVERS, *Dept. Forest Ecosystems and Society, Corvallis, OR*, MELISSA A. BLUNDELL, *Dudek, Encinitas, CA*, and STEPHEN I. ROTHSTEIN, *Dept. Ecol., Evol. & Marine Biol., Univ.*

California, Santa Barbara, CA.

Assessing whether host parents use the same rules to provision related and parasitic offspring is fundamental for understanding how brood parasites obtain adequate food during development. In this study, we quantified feeding behaviors of Bell's Vireo parents when provisioning broods that contained 1-4 vireo offspring or a single parasitic Brown-headed Cowbird. In unparasitized nests, we found a positive relationship between brood size and the number of feeding visits, and between brood size and the amount of food delivered to the nest. In addition, we found that the number of begging calls given and the gape area displayed by vireo young were both strongly and positively correlated with the amount of food delivered by parents. Despite begging on nearly all feeding visits, however, cowbird offspring were fed less frequently and received significantly less food than broods of 4 vireo nestlings, the modal brood size at our study site. Our results indicate that the visual and/or vocal begging stimuli of cowbirds are insufficient to elicit maximum provisioning rates by vireo parents, and therefore suggest that the Bell's Vireo serves as a sub-optimal host for the cowbird.

### **s8.7 Lock, Strausberger, Hauber**

Dynamic effects of nest-mates on growth and procurement of parental provisions by brood parasitic young. JUSTIN LOCK, *School Biol. Sci., Univ. Auckland, Auckland, New Zealand*, BILL M. STRAUSBERGER, *Pritzker Lab., Field Mus., Chicago, IL*, and MARK E. HAUBER, *Dept. Psychol., Hunter Coll. of City Univ. New York, New York, NY*.

Theory predicts that nestling obligate brood parasites should eliminate all nestmates to reduce levels of interbrood competition with unrelated young. The offspring of some brood parasitic bird species, however, routinely develop alongside host young. Based on comparative data, Kilner (2003, *Anim. Behav.* 66: 569-576) predicted, and using experimental manipulations Kilner et al. (2004, *Science* 305: 877-879) supported, the hypothesis that brood parasitic Brown-headed Cowbirds may, in fact, gain a fitness benefit in the form of additional parental feedings when in the presence of host young; brood parasitic young can exploit the collective begging display of larger broods to secure and monopolize higher parental provisioning rates. We support further predictions of this hypothesis experimentally by showing a positive relationship between nestling cowbird body mass and brood sizes across 2 common cowbird hosts, the Red-winged Blackbird and the Song Sparrow. We then describe a general mathematical model to characterize the social context, including brood size and competitive asymmetry, in which a brood parasite or otherwise competitively superior nestling will benefit from the presence of additional nest-mates. This model based on complex family dynamics predicts that a parasitic nestling will benefit from the presence of nestmates whenever that nestling has a competitive advantage, through hatching asynchrony, larger body mass or other mechanisms, in securing parental provisions.

### **s8.8 Strausberger, Maddox**

Host choice of individual cowbirds across years: trade-offs among host range, parasitism efficiency, and offspring number? BILL M. STRAUSBERGER and J. DILON MADDOX, *Pritzker Lab., Field Mus., Chicago, IL*.

Trade-offs between the number of host species utilized and parasitism efficiency is often invoked to explain parasitism strategies. Despite the importance of host choice on cowbird fitness and parasite-host dynamics, virtually nothing is known about host use by individual Brown-headed Cowbirds across breeding seasons. Limited evidence suggests that some female cowbirds are host specific whereas others are not. Intraspecific variation in host-use strategies offers a unique opportunity for studying correlates of fitness that result from varying parasitism strategies. Here we use microsatellite genotyping to characterize the host-use of individual female cowbirds. 868 offspring were sampled at a single site in ne. Illinois across 17 yr. We identified 136 full-sibling groups ranging in size from 2 to 23 (mean = 3.34) individual offspring. Full-sib offspring were identified across up to 5 yr. Most (58.1%; n = 79) females were host generalists parasitizing from 2 to 6 host species. A significant proportion (41.9%; n = 57) of females, however, were host specific, with some females parasitizing up to 10 nests from a single host species. Host generalists and host specific females produced a mean of 2.98 eggs (range = 2 - 10, sd = 1.78) and 3.5 offspring (range = 2 - 10, sd = 1.76); the difference is not significant (P = 0.099). We present the first evidence for trade-offs between brood parasites' host range and both parasitism efficiency and number of offspring produced.

**Symposium 9**  
**Ecology and conservation of insectivores of the tropical rainforest understory**  
*Convener L. L. Powell*

**s9.1 Sekercioglu**

Bird functional diversity and ecosystem services in tropical forests, agroforests and agricultural areas. CAGAN H. SEKERCIOGLU, *Dept. Biol., Univ. Utah, Salt Lake City, UT.*

Although most bird species avoid agricultural areas, nearly a third of all birds regularly to occasionally use such habitats, often providing important ecosystem services like pest control, pollination, and seed dispersal. Combining literature review with large-scale analyses of the ecological characteristics of the world's birds, I compared tropical bird species that prefer forests, agricultural areas or both, with respect to body mass, diet, range and population size, frequency, conservation status, habitat and resource specialization. Compared to primary forests, species richness of large frugivorous and insectivorous birds (especially terrestrial and understorey species) often declines in agroforests. In contrast, nectarivores, small-to-medium insectivores (especially migrants and canopy species), omnivores, and sometimes granivores and small frugivores do better, frequently by tracking seasonal resources. However, changes in guild species numbers do not necessarily translate to changes in relative abundance, biomass or function, and more studies are needed to quantify these important measures. These findings indicate that the replacement of forests and agroforests with simplified agricultural systems can result in shifts towards less specialized bird communities with altered proportions of functional groups. These shifts can reduce avian ecosystem function and affect the ecosystem services provided by birds in agroforests and other agricultural landscapes.

**s9.2 Dauphine, Kolani**

Understory bird community responses to logging in Upper Guinea forests of West Africa. N. SUZANNE DAUPHINE and ZEBIGOU KOLANI, *Zool. Soc. London and Dept. Marine & Wildl. Res., American Samoa Government, Pago Pago, AS.*

We compared forest understory bird communities in Ghana's Upper Guinea rain forests at different stages of post-logging succession and in unlogged forests. Currently less than 1% of the land area of these forests remains inside formal Protected Areas, while ~75% is in logging concessions. Based on previous research (Holbech 2005, **Bird Conserv. Internatl.** 15: 27-52), we expected understory bird species richness to decline following logging but then recover after ~20 yr to resemble understory bird communities in unlogged forest. Using constant-effort mist netting, we sampled understory birds at 27 forest sites representing 3 or more replicates of 4 treatments (unlogged forest, forest ~3 yr post-logging, forest ~10 yr post-logging, and forest ~20 yr post-logging) in 2 forest types (evergreen and semi-deciduous). Using a sample effort of ~ 5400 mist net hr, we made 962 individual captures of 43 bird species, the majority of which were understory insectivores. In contrast to previous research, we found that bird species richness and abundance exhibited a steady decline post-logging, and showed no sign or recovery within 20 yr. We will discuss species and guilds particularly vulnerable to forest degradation, address potential mechanisms and propose hypotheses to test these mechanisms. Understory birds in West Africa are threatened not only by widespread industrial logging but also a high level of disturbance caused by frequent human intrusions into forests to conduct activities such as poaching and illegal logging. Protecting birds in these forests should be an international priority, as this area is a priority global "biodiversity hotspot" and home to a number of priority global Endemic Bird Areas.

**s9.3 Cordeiro**

Forest fragmentation in an eastern arc forest impacts key understory species in mixed species foraging flocks. NORBERT J. CORDEIRO, *Dept. Bot. and Dept. Zool., Field Mus., Chicago, IL.*

Forest fragmentation, the process by which extensive forest is broken down into smaller patches by adverse human activities, is a well known agent of bird species loss and declining abundances in the tropics. The question on whether this process affects mixed species foraging bird flocks has been poorly explored, particularly in African forests. To address this question, I evaluated the consequences of forest fragmentation on mixed species foraging flocks by censusing birds in mixed species flocks in 5 small, isolated fragments and 5 widely spaced continuous forest sites in the East Usambara Mountains. Results showed that small forest fragments had significantly fewer species and reduced bird abundance compared to continuous forest. Furthermore, most understory insectivorous and omnivorous species



differed significantly between the 2 habitat types, but abundance of both guilds showed a similar trend to decline in small fragments compared to continuous forest. Playback experiments using vocalizations of nuclear species, the species that are responsible for drawing in other species, demonstrated that their loss in small, isolated fragments may be one factor that affects the smaller and less diverse composition of mixed species flocks in fragments. This is particularly apparent in understory insectivorous species, the guild of birds that is most impacted by forest fragmentation globally. Implications of these results are discussed in terms of ecological interactions and conservation of understory insectivores.

#### **s9.4 Zakaria, Raipar, Moradi**

Effects of edge on understory insectivorous birds in a fragmented tropical rainforest in peninsular Malaysia. MUHAMED H. ZAKARIA, M. N. RAIPAR and H. V. MORADI, *Dept. Park & Ecotourism, Faculty of Forestry, Universiti Putra Malaysia, Selangor, Malaysia.*

Understory insectivorous birds are found to be one of the most sensitive groups to the changes in environmental condition in tropical rainforest. Therefore, edge effect may have great impacts on the persistence of these species in a fragmented forest. We examined the abundance insectivorous birds along the edge-interior gradient in an isolated lowland tropical rainforest in Peninsular Malaysia. The study was conducted between May 2007 and Apr 2008 using Distance Sampling Point Count method. Results showed that the most striking changes on the understory bird community (i.e., relative abundance, density, diversity, and composition) occurred within 25 m to 400 m of the forest edge to the interior. The association between the birds and the micro-environmental factors separated 2 completely different groups of birds: 1) forest interior-specialist species such as the short-tailed babbler and black-caped babbler which used the forest interior habitats discriminately and tended to avoid the microclimatic fluctuations close to the edge; and 2) forest edge-specialist species such as the yellow-vented bulbul and cream-vented bulbul which preferentially used the edge. In terms of feeding guilds, interior-specialist guilds such as terrestrial insectivores and sallying insectivores and the edge-specialist guilds such as arboreal foliage gleaning insectivores and terrestrial insectivores-frugivores were separated based on their sensitivity to the edge effects. The environmental conditions, vegetation structure and composition along the edge-interior gradient resulted in different responses of the understory birds. The forest edge-specialist species were associated with the high light intensity and shrub cover, and they could be the best indicators of the edge habitat condition. The forest interior-specialist species were associated with high relative humidity and leaf litter cover and thus, could be the best indicators of the forest interior habitat condition.

#### **s9.5 Pavlacky, Possingham, Goldizen**

Integrating life history traits and forest structure to evaluate the vulnerability of rainforest birds along gradients of landscape change. DAVID C. PAVLACKY, Jr., HUGH P. POSSINGHAM and ANNE W. GOLDIZEN, *School Biol. Sci., Univ. Queensland, St. Lucia, Queensland, Australia.*

Determining which species are vulnerable to landscape change within species-rich assemblages is essential for the conservation of rainforest ecosystems. Our objectives were to investigate 1) the importance of life history traits on avian occurrence, 2) the effects of stand, landscape and patch structure on species richness, and 3) species vulnerability along gradients of landscape change in subtropical rainforests of se. Queensland, Australia. We used a multi-species occupancy model to simultaneously evaluate life-history hypotheses for species occurrence and forest structure hypotheses for species richness. Species occurrence increased with population density and clutch size, and declined with increasing body mass. The occurrence of sedentary species was 30% lower than nomadic species. The occupancy rate of understory species was 24% lower than generalists, not different than terrestrial species and 23% greater than canopy species. The occurrence of insectivores was 33% lower than frugivores. At the stand scale, species richness increased with stand basal area in rainforests infested by an invasive shrub. At the landscape scale, species richness increased with rainforest and open Eucalypt forest cover. At the patch scale, species richness increased with rainforest patch size. Along gradients of landscape change, deforestation had a greater influence on species richness than rainforest fragmentation. We discovered that sedentary, insectivores with low population density, low clutch size and high body mass, such as the ground-dwelling Albert's Lyrebird (*Menura alberti*) and canopy-dwelling Paradise Riflebird (*Ptiloris paradiseus*), were the most vulnerable to landscape change. The findings may be used to inform forest and landscape conservation and ensure the integrity of the rainforest bird community.

### **s9.6 Powell, Stouffer**

How maturation of secondary growth affects movement and dispersal of understory insectivores through a heterogeneous Amazonian landscape. LUKE L. POWELL and PHILIP C STOUFFER, *School Renew. Nat. Res., Louisiana State Univ., Baton Rouge, LA.*

Amazonia now contains vast areas of secondary forest due to widespread regeneration following clearcutting, yet the value of secondary forest to wildlife remains poorly understood – particularly with respect to how animals disperse through secondary forest. Understory rainforest birds are diverse, easily captured, considered poor dispersers and often sensitive to habitat change, making them relatively convenient organisms with which to study dispersal in human modified landscapes. To quantify dispersal of understory Amazonian birds in a spatiotemporally dynamic landscape, we analyzed patterns in the distribution of bird recapture distances at the Biological Dynamics of Forest Fragments Project (BDFFP), near Manaus, Brazil. From 1970 - 2012, we caught >50,000 birds (>15,000 recaptures). We calculated capture probabilities and adjusted movement distributions to account for spatiotemporal heterogeneity in capture effort. We used radiotelemetry to quantify day-to-day (i.e., non-dispersal scale) movements for dozens of species, then calculated the probability that each movement from the capture database represented dispersal. To isolate dispersal-scale movements, we weighted movement frequency distributions by probability that they represented dispersal. Pasture and young secondary forest reduced the ability of rainforest birds to disperse across the landscape; however, recovery of secondary forest allowed for animals to disperse across previously impenetrable barriers. Differences among species were considerable, thus we hypothesize that species with the smallest wing aspect ratio will be least able to disperse across anthropogenic barriers. If we can determine which characteristics make species capable dispersers in human-modified landscapes, we will be in a strong position to make meaningful management decisions.

### **s9.7 Kelley, Tarwater**

Using fine-scale age estimation to explore the influence of landscape on demography and sexual selection of a Neotropical bird. J. PATRICK KELLEY, *Dept. Biol. Sci., Florida State Univ., Tallahassee, FL,* and COREY E. TARWATER, *Dept. For. & Conserv. Sci., Univ. British Columbia, Vancouver, BC.*

Demography is an important emergent property of individuals in a population and is essential for understanding long-term persistence of populations. Demography is often considered at relatively large spatial scales, for instance, by comparing demographic traits of multiple, spatially distinct populations. Yet, individual behaviors such as dispersal or mating may be influenced by the demography of local environments (e.g., neighborhoods). We examined spatial variation in individual age, a fundamental trait for the quantification of demography, of Western Slaty Antshrikes (*Thamnophilus atrinucha*) residing in a large fragmented forest, Barro Colorado Island (BCI) in Panama. BCI was isolated from the mainland by the creation of the Panama Canal and since its isolation, has lost a large percentage of its bird species. We conducted a large-scale survey of antshrikes to assess how variation in individual age, relative abundance, and intra-pair age skew were influenced by topography, island edge, and forest age. To accomplish this, we built upon previous work that demonstrated a novel relationship between song characteristics and age, allowing us to estimate individual age, and then demographic traits, such as survival. We found that adult survival declined with increasing forest age and in all but the youngest forests, females paired with older males. This suggests that forest age may influence sexual selection. Song-based age estimation may be possible for a large number of suboscines and can allow examination of fine-scale processes (e.g., sexual selection) that may impact populations. Thus, we advocate for the inclusion of bioacoustics into long-term demographic studies in the Neotropics.

### **s9.8 Woltmann**

Understanding dispersal in understory tropical forest invertivores: the role of genetic data. STEFAN WOLTMANN, *Dept. Biol., Austin Peay State Univ., Clarksville, TN.*

Regular and successful dispersal between forest fragments is one of the primary mechanisms thought to explain the persistence of forest understory invertivores in fragmented landscapes; populations that behave as metapopulations are more likely to persist than populations not connected via dispersal. Assessing whether metapopulation dynamics are in play is difficult, but population genetic data have great potential to provide insight when sampling in fragmented contexts with discrete habitat patches. Importantly, understanding dispersal behavior in unfragmented contexts is critical to understanding how individuals and populations will respond in increasingly fragmented landscapes. Using *Myrmeciza exsul*

(Chestnut-backed Antbird) as a focal species, I explore some of the practical issues related to understanding dispersal in various contexts.

### **s9.9 Visco**

Nest predation patterns suggest that it is a key mechanism explaining an understory insectivore's demographic responses to forest fragmentation. DEBORAH M. VISCO, *Dept. Ecol. & Evol. Biol., Tulane Univ., New Orleans, LA.*

Investigating mechanisms is essential for understanding the causes of understory insectivorous birds' drastic demographic responses to rainforest fragmentation. To assess nest predation mechanisms, I took advantage of Chestnut-backed Antbird (*Myrmeciza exsul*) population persistence in small, isolated fragments, a mid-sized connected reserve (La Selva Biological Station), and expansive contiguous forest within the Sarapiquí lowlands of Costa Rica. I quantified population densities, nest survival and success rates, and identified nest predators with digital video recording systems. I hypothesized that populations in small fragments would be reproductively disadvantaged because they could not effectively compensate for the associated increases in nest predation risk. Contrary to typical understory insectivore responses, I found that *M. exsul* is not declining and in fact persists at much higher densities in small fragments than in mid-sized or expansive forest. Nest survival was significantly better in fragments compared to other sites, with overall nest success probabilities highest in fragments, lower in contiguous forest, and extremely low in the connected reserve. Nest predator types (snakes and mammals) differed between isolated and connected/contiguous forest ( $X^2 = 5.3$ ,  $df = 1$ ,  $p = 0.021$ ), with mammalian predators only affecting fragments. Responsible for 81% of nest depredations, the bird-eating snake *Pseustes poecilonotus* emerged as the dominant nest predator. This identification helps explain *M. exsul*'s nest success patterns. High adult survival and persistent reneating tendencies suggest that demographic flexibility may compensate for low reproductive output. To further explain their remarkable persistence, study of adult and juvenile survival rates plus season-long productivity across sites is underway.

### **s9.10 Stratford, Stouffer**

Habitat associations of terrestrial insectivorous birds compared to second growth, forest fragments, and a continuous forest site in central Amazonas, Brazil. JEFFREY A. STRATFORD, *Dept. Biol. & Health Sci., Wilkes Univ., PA*, and PHILIP C. STOUFFER, *School Renew. Res., Louisiana State Univ., Baton Rouge, LA.*

Neotropical terrestrial insectivorous birds are purported to be particularly sensitive to forest fragmentation and other forms of anthropogenic disturbance. Sensitivity to habitat modification might be a consequence of habitat requirements that are not found where vegetation has been altered as a consequence of forest clearing or edge effects in forest fragments. To evaluate this hypothesis, we compared vegetation characteristics of terrestrial insectivores to vegetation in second growth, forest fragments, and a reference forest. We used principal component analysis to remove redundant variables from the 21 original variables and used MCMC to estimate means and standard deviations of the remaining habitat variables. The habitat associated with terrestrial insectivores was not available in either of the 2 major types of second growth. Vegetation characteristics of 100-ha fragments were similar to most of the terrestrial insectivores; however, the vegetation in 10- and 1-ha forest fragments was less similar. Our results support the vegetation hypothesis in small forest fragments and second growth areas.

### **s9.11 Fernandez-Juricic**

Visual sensory constraints in avian species exploiting micro-habitats with different ambient light conditions. ESTEBAN FERNANDEZ-JURICIC, *Dept. Biol. Sci., Purdue Univ., West Lafayette, IN.*

Variations in habitat structure due to habitat fragmentation can cause changes in the intensity and spectral properties of ambient light at the micro-habitat level. These variations can influence the behavioral performance of visually-guided organisms, like understory birds. A recent hypothesis (Stratford & Robinson 2005, *Frontiers Ecol. & Environ.* 3: 91-98) proposed that bird species inhabiting forested areas with intact canopies (gap sensitive species) may be more sensitive to altered ambient light regimes than species inhabiting edges or gaps of forests (gap specialists). I will discuss some of the mechanisms that may be involved in the light sensitivity hypotheses and review the scant empirical evidence. First, individuals may become more visible to predators in sunlit compared to shaded patches, which may reduce the use of forest gaps (predation risk hypothesis). Second, the extra sunlight of sunlit patches may cause glare effects that may reduce the performance of the visual system in detecting predators/food

(disability glare hypothesis). Third, the different spectral properties of the ambient light in sunlit patches may reduce the chromatic and achromatic contrast in the visual system of gap sensitive species, reducing their ability to find food (visual contrast reduction hypothesis). The limited tests conducted so far partially support the first and second mechanisms. I will propose conceptual and empirical frameworks for future tests of these mechanisms taking into account the sensory system of species inhabiting different forest micro-habitats.

#### **s9.12 Patten, Smith-Patten**

Microclimate matters: occupancy patterns of resident and migrant birds in the northern Neotropics. MICHAEL A. PATTEN and BRENDA D. SMITH-PATTEN, *Oklahoma Biol. Surv. and Dept. Biol., Univ. Oklahoma, Norman, OK.*

Species vary in their vulnerability to extirpation in response to habitat loss. We posit that vulnerability is determined chiefly by fine-scale consequences of habitat selection, whether by resident species that must survive in areas fragmented by deforestation or migrant species whose choices on their breeding or wintering grounds affect fitness in the other area ("carry over effects"). Hence, we explored ramifications of the "microclimate hypothesis" – the idea that cues at a fine spatial scale are used to select habitat – under the premise that selection at this scale affects occupancy patterns and thus provides insight into vulnerability. At 2 sites in Central America, microclimate varied in a predictable manner from a forested edge, with the extent of light penetration being the best predictor of occupancy across a suite of forest residents that occur below the subcanopy. Crucially, those species that occupy low-light environments are those most vulnerable to extirpation. We also compared microclimate of occupied sites on wintering and breeding grounds of boreal migrants and found that extent of light penetration provides a key link in habitat selection and thus likely exerts strong carry over effects, although the mechanisms by which this is accomplished remain to be elucidated. Together these studies support the microclimate hypothesis, specifically how it relates to sensitivity to light as a limiting factor.

#### **s9.13 Pollock, Brawn, Cheviron**

The role of microclimates and light environments in the habitat selection of tropical and temperate-zone birds. HENRY S. POLLOCK, JEFFREY D. BRAUN, *Dept. Nat. Res., Univ. Illinois at Urbana-Champaign, Champaign, IL,* and ZACHARY A. CHEVIRON, *Dept. Animal Biol., Univ. Illinois at Urbana-Champaign.*

Tropical understory insectivorous birds are particularly sensitive to forest fragmentation. This guild of birds has also been shown to be sensitive to changes in humidity, and it has been suggested that forest fragmentation may change microclimates, rendering disturbed habitats physiologically unsuitable for understory insectivores and potentially explaining the declines of understory insectivore populations in forest fragments. In contrast, temperate-zone birds are predicted to have broader physiological tolerances to cope with the higher levels of environmental variation that they experience daily and seasonally. If tropical birds are more sensitive to environmental variation, they should exhibit greater microclimatic selectivity than temperate-zone birds. To test this prediction, we investigated microclimate selection (temperature and humidity) and light microhabitats in suites of tropical (n = 9) and temperate-zone (n = 6) species and used null models to determine whether or not birds were selecting microclimates significantly different from random. None of the tropical or temperate-zone species exhibited non-random selection of microclimates with respect to temperature and humidity. Five of 9 tropical species (all forest interior insectivores), however, exhibited avoidance of microhabitats with high light levels (i.e., gaps) and selected microclimates with significantly lower temperature and higher humidity than gap microclimates. None of the temperate-zone species exhibited evidence of microclimate/microhabitat selectivity. Avoidance of microclimates with high light levels in tropical forest insectivores could be due to reduced food resources, predator avoidance, or physiological sensitivity to high temperatures/low humidities.

### **Symposium 10**

#### **The extended specimen: emerging frontiers in collections-based ornithological research**

*Convener M. Webster*

#### **s10.1 Webster**

Ornithological Specimens in the 21st Century. MIKE WEBSTER, *Dept. Neurobiol. and Lab. Ornithol.,*

Cornell Univ., Ithaca, NY.

Biological collections have long been the backbone of basic research in ornithology, providing the raw material for studies uncovering the diversity, distribution, abundance, evolution, and life histories of birds. Recent new developments are making our research collections even more versatile and useful than ever before. First, emerging new technologies in genetics, chemistry, and computer imaging now make it possible for researchers to use “traditional” museum specimens to address new types of questions and at new levels of detail. Second, it is now possible to collect new types of specimens and ancillary materials (e.g., media recordings, new tissue preparations) that open doors to whole new areas of inquiry, such as animal behavior, disease, or gene expression, that in the past have been mostly “off limits” to collections-based research. Finally, advances in information technologies are now making it possible for researchers to amass and analyze huge datasets from biological specimens, making it possible to answer questions at unprecedented scales. As a consequence of these various advances, museums and their research collections are being used in ways unimaginable just a decade ago. These new opportunities also bring with them considerable challenges with respect to the collection, curation, and accessibility of specimens. This talk will provide an overview of these opportunities and challenges, and will serve as an introduction to the other talks in this symposium, which will illustrate these issues in more detail.

### **s10.2 Thomas, James, McGraw**

Non-destructive, *in-situ* analysis of avian plumage pigments using Raman spectroscopy. DANIEL B. THOMAS, HELEN F. JAMES, *Smithsonian Inst., Washington, DC*, and KEVIN J. MCGRAW, *Arizona State Univ., Tempe, AZ*.

Chemical analyses of feather pigments have mostly required the consumption of whole feathers, which is not always appropriate for museum collections. In contrast, Raman spectroscopy can identify pigments from individual feather barbs, and can ideally be performed without damaging study skins. Raman spectroscopy uses a low-powered laser to describe functional groups within molecules. Specific combinations of peaks in a Raman spectrum form a ‘fingerprint’ for differentiating chemical compounds. We have used Raman spectroscopy to broaden the taxonomic distribution of carotenoid feather pigmentation. Carotenoids have been identified in 132 species from 93 families and 11 orders using Raman spectroscopy, including new identifications from Anseriformes, Galliformes and Pelecaniformes. Furthermore, Raman spectra from plumage with different carotenoid compositions have been referenced against data obtained with high-performance liquid chromatography. Using this referenced approach, we have non-destructively described the major carotenoid in the plumage of study skins without plucking feathers. Similar analyses could be performed for other pigment systems in birds. Indeed, ornithology collections are rich chemical storehouses replete with research questions that could be investigated with non-destructive Raman spectroscopy.

### **s10.3 Harvey, Scholes, Bostwick, Laman, Marschner**

From microscopic feather structure to whole-organism display behavior: using multiple specimen types to uncover the private courtship signals of *Parotia wahnesi* (Paradiseidae). TODD A. HARVEY, *Dept. Ecol. Evol. Biol., Yale Univ., New Haven, CT*, EDWIN SCHOLES, KIMBERLY S. BOSTWICK, *Lab. Ornithol. and Mus. Vert., Cornell Univ., Ithaca, NY*, TIMOTHY G. LAMAN, *Mus. Comp. Zool., Harvard Univ., Cambridge, MA*, and STEVE MARSCHNER, *Dept. Computer Sci., Cornell Univ*

Characterizing the appearance and signaling performance of the courtship display of *Parotia wahnesi* is challenging due to its directional and temporal attributes. We used vouchered behavioral specimens in the form of field-generated video-recordings, in combination with reflectance measurements from a museum specimen in the lab to reconstruct the “anatomy” of the extended courtship phenotype of the male *Parotia wahnesi*. We investigated 3 fundamental components of its directional signaling: (1) the direction of light illuminating the male in his court, (2) the direction of the reflectance from the male’s iridescent ornamental plumage, and (3) the position and orientation of the ornaments with respect to the female during display. We show how plumages are tightly aligned at multiple structural scales to maximize the effectiveness of visual signals. In a highly choreographed performance, ornamental plumages entice females through contrasting shape, intensity, and color, while ancillary plumages construct a backdrop framing those ornaments. We present evidence that the male leverages the geometry of his court and lighting environment to gain additional directional advantages. Every attribute, whether intrinsic or extrinsic to the male himself, hones signal production to generate spectacular but private displays intended for visiting female birds, unobservable from other vantage points.

#### **s10.4 Bostwick**

The integrated evolution of behavioral and morphological novelties in manakins (Pipridae) as revealed by digital and physical natural history specimens. KIMBERLY S. BOSTWICK, *Mus. Vert., Cornell Univ., Ithaca, NY.*

When viewed in a phylogenetic context, the rich morphological and behavioral data captured in physical and media specimens offer incredible opportunities for studying macroevolutionary patterns of inter-trait diversification. Here I present a manakin example: using a new phylogenetic hypothesis of the manakins (Pipridae), and data obtained from physical museum specimens as well as audio and video specimens, I present a specific historical hypothesis for the evolution of feather, bone, muscular, acoustic and behavioral traits in *Pipra/Machaeropterus* as they lead to the evolution of several novelties that have been described previously in the Club-winged Manakin. My results indicate that several basic behaviors are basal to the study group, persisting through many speciation events in recognizable form, that behavioral diversification has been greater than morphological, and that morphological modifications have lagged behind behavioral ones. In addition, behavioral modularity and specific trends towards incremental increasing complexity of both display and morphological traits are observed.

#### **s10.5 Mason, K J Burns, Shultz**

Combining museum and media collections to study multimodal sexual signaling and acoustic adaptations in tanagers (Thraupidae). NICHOLAS A. MASON, KEVIN J. BURNS, *Dept. Biol., San Diego State Univ., San Diego, CA*, and ALLISON J. SHULTZ, *Dept. Organ. Evol. Biol., Harvard Univ., Cambridge, MA.*

The elaborate plumages and complex songs of birds have provided some of biology's most celebrated examples of sexual selection. However, the relationship between these secondary sexual signals remains largely unexplored. Furthermore, the degree and directionality of the signaling environment's influence on bird song appears inconsistent. Here, we analyzed thousands of recordings and vouchered specimens from media and museum collections to examine correlations between song complexity, plumage elaboration and acoustic environments in tanagers. Tanagers are the largest family of Neotropical passerines and are remarkably diverse in terms of habitat preferences, plumage, and song. After collecting song and plumage data from 311 species of tanagers, we used Phylogenetic Generalized Least Squares (PGLS) across a posterior distribution of phylogenies and found variation among subfamilies with respect to correlations between song and plumage complexity. Assuming the best-fit evolutionary model, song and plumage elaboration are uncorrelated across all tanagers. However, 3 subfamilies demonstrated an inverse correlation between song and plumage complexity, following the predictions of the Transfer Hypothesis. These 3 subfamilies also exhibit fewer transitions between open and closed habitats compared to other thraupid subfamilies. Closed habitats with denser vegetation are predicted to favor lower frequencies, increased inter-note intervals, and decreased trill rates due to selective pressures for long-distance transmission. Using Ornstein-Uhlenbeck Comparative Hypothesis testing (OUCH), we found greater support for "acoustic adaptations" among temporal and structural components of song rather than frequency-based characters. Our study also suggests that acoustic adaptations may be more prevalent in lineages that have, on average, less complex songs.

#### **s10.6 Derryberry, Seddon, Claramunt, Brumfield, Tobias**

Of songs and specimens: using vouchered behaviors to examine song evolution in avian radiations. E. P. DERRYBERRY, *Dept. Ecol. Evol. Biol., Tulane Univ., New Orleans, LA*, N. SEDDON, *Dept. Zool., Oxford Univ., Oxford, UK*, S. CLARAMUNT, *Am. Mus. Nat. Hist., New York, NY*, R. T. BRUMFIELD, *Mus. Nat. Sci. and Dept. Biol. Sci., Louisiana State Univ., Baton Rouge, LA*, and J. A. TOBIAS, *Dept. Zool., Oxford Univ.*

Diversification of mating signals, such as song, can have important functional consequences for mate choice and species recognition in birds. Testing hypotheses about song diversification in a phylogenetic context is becoming more feasible with the advent of robust, species-level molecular phylogenies and new phylogenetic models of trait evolution. This opportunity highlights the value of behavioral data explicitly linked with ecological, genotypic and morphological data from extended specimens. Here, we explore the interplay between morphological, ecological and vocal evolution in an avian radiation characterized by dramatic ecological and morphological variation, the Neotropical ovenbirds and woodcreepers (Aves: Furnariidae). We also discuss the value of using behavioral data from extended specimens in such phylogenetic analyses.

### **s10.7 Wiley, James, Ostrom**

Museum-based stable isotope studies: guiding principles, sampling strategies, and the past, present, and future of foraging ecology in the endangered Hawaiian Petrel (*Pterodroma sandwichensis*). ANNE E. WILEY, HELEN F. JAMES, *Dept. Vert. Zool., Natl. Mus. Nat. Hist., Smithsonian Inst., Washington, DC*, and PEGGY H. OSTROM, *Dept. Zool., Michigan State Univ., East Lansing, MI*.

In their isotopic composition, museum specimens preserve an abundance of information on the diet, foraging locations, and physiology of modern and historic bird populations. We summarize guiding principles and sample requirements for isotope-based studies that involve museum collections. For example, multiple tissues and feather types can be taken from museum specimens, but isotope studies require an understanding of the period of the annual cycle represented by these tissues and the potential of preservation techniques to alter their chemistry. While some treatments, such as addition of borax drying, and the simple passage of time can leave isotope values unaffected, preservation using alcohol and factors such as melanin concentration may alter isotope results. As a case study, we present isotope-based inferences about the modern and ancient foraging ecology of the endangered Hawaiian Petrel (*Pterodroma sandwichensis*). A 4,000-yr isotope chronology from the Hawaiian Petrel shows a recent, species-wide decline in  $\delta^{15}\text{N}$  values, the timing of which was established using historically preserved museum study skins. The shift in  $\delta^{15}\text{N}$  most likely reflects a fishery-related decline in trophic level. Isotope data were also used to contrast the level of foraging specialization present among modern petrel populations. Minimally-destructive isotope sampling protocols were designed for flight feathers of museum study skins, and by analyzing the isotopic composition of flight feathers grown in a sequence, foraging habits were described for individuals at multiple, discrete points in time. Varying levels of foraging specialization among populations suggest they may respond differently to future changes in prey availability.

### **s10.8 McCormack, Tsai, Faircloth**

Prospects for using target enrichment and next-generation sequencing to collect thousands of DNA loci from museum specimens. JOHN MCCORMACK, WHITNEY TSAI, *Moore Lab. Zool., Occidental Coll., Los Angeles, CA*, and BRANT FAIRCLOTH, *Dept. Ecol. & Evol. Biol., Univ. California Los Angeles, Los Angeles, CA*.

Next-generation sequencing (NGS) has dramatically altered the scope of many biological research questions, but applications of these new DNA sequencing technologies have been slow to arrive to avian phylogenetics. Colleagues and I developed a method where ultraconserved stretches of DNA are used as baits to “catch” DNA loci and their variable flanking sequence (i.e., target enrichment), allowing for simultaneous NGS of thousands of loci from species throughout the bird tree of life (and beyond). If this method could be adapted to historical DNA from museum specimens, this would allow specimens collected prior to frozen tissue preservation (pre-DNA), many of which include locations and sample sizes impossible to recollect, to be included in modern phylogeography and population genetic studies, potentially revitalizing older natural history collections that have witnessed declining fortunes in recent years. We report results from a test using target enrichment of 5,000 ultraconserved elements (UCE) on a time series of historical DNA extracted from Western Scrub-Jay specimens dating from the recent back to the late 1800s. Based on these results, we assess prospects for using UCE target enrichment on the 62,000 pre-DNA bird specimens in the Moore Laboratory of Zoology, the largest Mexican bird collection in the world, to enhance studies on the origin of Mexico’s biodiversity.

### **s10.9 Wright, Gregory, Witt**

Flight ability drives genome size reduction in birds. NATALIE A. WRIGHT, *Mus. Southwest. Biol. and Dept. Biol., Univ. New Mexico, Albuquerque, NM*, T. RYAN GREGORY, *Dept. Integrative Biol., Univ. Guelph, Guelph, ON*, and CHRISTOPHER C. WITT, *Mus. Southwest. Biol. and Dept. Biol., Univ. New Mexico*.

The evolution of powered flight is thought to induce genome size reduction, but this hypothesis needs to be tested using high-resolution comparative data for species with variable flight abilities. We use museum specimens and associated data to test the hypothesis that the metabolic demands of flight constrain avian genome size. We estimated genome sizes of 422 species of birds from eighteen orders, creating the largest single genome size dataset for birds to date. We used relative flight muscle size, relative heart size, and wing shape and size parameters as quantitative indicators of flight ability. In both phylogenetic and non-phylogenetic models, relative flight muscle size, relative heart size, and wing

pointedness were negatively correlated with genome size, while body mass was positively correlated with genome size. The best-supported models included relative heart and flight muscle sizes as predictor variables. These metabolic engines of powered flight predict genome size better than mass alone, implicating selection rather than neutral demographic processes as the cause of genome size evolution. Higher-level clades differed notably in the mean and degree of variability of genome size. Hummingbird genome sizes were small with very little variation, suggesting that they have evolved under strong constraints. Piciform genomes were large and evolutionarily labile. The link between genome size and lability implicates repeat expansion and contraction as the mechanism of genome size change within birds. All of the specimens used in this study and additional ancillary data are archived in museum collections, allowing for indefinite extension of this study to additional taxa, genome comparisons, or unanticipated future hypotheses.

#### **s10.10 Claramunt**

Using research specimens for comparative studies of dispersal in birds. SANTIAGO CLARAMUNT. *Dept. Ornithol., Am. Mus. Nat. Hist., New York, NY.*

Dispersal ability in birds depends on behavior, physiology, and the morphology of the flying apparatus. While behavioral and physiological factors are difficult to quantify for most bird species, the morphology of the flying apparatus can be measured using research specimens. Aerodynamic models of avian flight indicate that high aspect-ratio wings are the most efficient for long distance flight. Therefore, actual estimates of the aspect ratio or appropriate surrogates can be used as proxies for long distance flight performance. I show examples of the use of a simple index of wing shape in a comparative study of dispersal and its macroevolutionary effects. In addition, I show that direct estimates of aspect ratio are better predictors of dispersal distance. For that reason, I encourage research collections to increase efforts to preserve 'aerodynamic' specimens, i.e., specimens with an extended wing preparation, and measurements of wingspan and weight. Traditional study skins and 'aerodynamic' specimens are promising tools for large-scale studies of bird dispersal in ecology and evolution.

#### **s10.11 Lutz, Jiang, Skeen, Hackett, Weckstein**

The evolution of scientific collecting: comprehensive biodiversity surveys of avian parasites and pathogens can produce important baseline data and lead to novel eco-evolutionary insights. HOLLY L. LUTZ, *Dept. Ecol. Evol. Biol., Dept. Pop. Med. & Diag. Sci., Cornell Univ., Ithaca, NY, and Field Mus., Chicago, IL*, ZIFENG JIANG, *Inst. Genomics and Systems Biology, Univ. Chicago, Chicago, IL, and Field Mus.*, HEATHER R. SKEEN, SHANNON J. HACKETT, and JASON D. WECKSTEIN, *Field Mus.*

Scientific collections have long provided a significant source of primary data for taxonomic and evolutionary studies. Vouchered specimens, often considered the "gold standard" in systematic biology, play a critical role in species identification, delineation, and as morphological and genetic references. While bird specimens themselves have historically been the focus of collections-based research, additional data for parasites have also been recorded sporadically in the past. Yet, parasites which comprise 30 - 70% of life on earth are important elements in the lives of birds and can impact their health, demography, behavior, and evolutionary history. Furthermore, in the face of rapid environmental change, scientific collecting now has the potential to play a key role in monitoring pathogens and parasites of avian hosts. We will discuss the importance of comprehensive sampling, and demonstrate how thorough sampling approaches for a broad range of parasites and pathogens have led to novel opportunities for studying the ecology and evolution of avian parasites and pathogens.

#### **s10.12 Winkler, Orzechowski, Pegan, Chalkowski, Stager, Kapoor, Hruska, Greg, Hite**

Collecting the total specimen package: research and educational opportunities for museum expeditions. DAVID WINKLER, S. ORZECOWSKI, T. PEGAN, K. CHALKOWSKI, MARIA STAGER, JULIAN KAPOOR, J. HRUSKA, EMMA GREIG and JEREMY HITE, *Mus. Vert., Cornell Univ., Ithaca, NY.*

Recent years have seen the development of technologies that make high-definition videography and sonography available to all institutions, and digital content on the phenotypes/natural histories of wild birds is burgeoning on the internet, and, potentially, in museum collections. Meanwhile, biomedical imaging of ever-increasing acuity and capacity is opening up entirely new vistas in the field of comparative morphology through non-destructive sampling, which is bringing new value to museum specimens and a ready conduit for communication to communities formerly unaware of, or insensitive to, museum science. These developments provide new opportunities and challenges for field expeditions: a new generation of



“digital ornithologists” is being trained with a modern tool-kit that complements the foundation of traditional collecting techniques and practices. Students trained in the phylogenetic and natural history literature for poorly-known target taxa are able to conduct comparative biological work in the field where their discoveries have immediate relevance and perspective and key distinctions are most likely to be pursued and definitively documented.

**s10.13 Cicero, Spencer, Koo, Bloom, Steele, Wieczorek, Guralnick, Otegui, Russell, Vieglais, Bart, Rios**

VertNet and Big Data: visualizing birds in the cloud. CARLA CICERO, CAROL SPENCER, MICHELLE KOO, DAVID BLOOM, AARON STEELE, JOHN WIECZOREK, *Mus. Vert. Zool., Univ. California, Berkeley, CA*, ROB GURALNICK, JAVIER OTEGUI, *Univ. Colorado, Boulder, CO*, LAURA RUSSELL, DAVID VIEGLAIS, *Univ. Kansas, Lawrence, KS*, HANK BART and NELSON RIOS, *Tulane Univ., New Orleans, LA*.

VertNet is pushing the frontiers of biodiversity informatics by creating search and visualization tools to explore large and complex data sets (Big Data) that reflect global and temporal distributions of species. Currently, VertNet is working with 164 institutions and 375 collections containing over 150 million data-rich records on birds and other vertebrates. This tremendous growth has fueled the development of innovative, cloud-based ways for processing, harvesting, and publishing these data which would otherwise be impossible using traditional applications. We will present a new VertNet data portal (beta version) and demonstrate how access to these Big Data enable novel collections-based ornithological research. The new portal aggregates and synthesizes records that were formerly searchable in limited ways through separate networks (FishNet, MaNIS, HerpNet, and ORNIS). Powered by CartoDB and using Big Data technologies, it enables rapid and easy searching and mapping of records across hundreds of data resources. Summary statistics of the holdings within VertNet are also easily generated. The inclusion of paleontological data provides a new temporal dimension that was lacking in the previous networks. Likewise, integrations with partners such as Map of Life, as well as links to media associated with collection records, provide new ways of exploring and visualizing biodiversity represented by natural history museums.

**s10.14 Webster**

Open Discussion: The use of ornithological specimens and collections in the 21st Century. MIKE WEBSTER, *Lab. Ornithol., Cornell Univ., Ithaca, NY*.

No abstract.

## GENERAL PAPER SESSIONS

**1 vacant**

**2 Sari, Ellis, Rois, Parker**

Disentangling parasite-specific immune responses in *Myiarchus tyrannulus*. ELOISA H. R. SARI, VINCENZO A. ELLIS, LISA ROIS and PATRICIA G. PARKER, *Univ. Missouri, St. Louis, MO*.

Parasites are often detrimental for their hosts' health condition and fitness, eliciting a variety of immune and physiological responses, but the extent of these responses to specific parasites is widely unknown in wild birds. In this work we analyzed the health condition and immune responses of *Myiarchus tyrannulus* (Passeriformes: Tyrannidae) to different parasites. We captured 74 birds in Costa Rica, from which we collected blood samples and ectoparasites. Haemosporidian parasites were identified through molecular analyses and ectoparasites were identified according to their morphology. We quantified the proportions of 4 white blood cell types in the peripheral blood of each host as measures of immune function. To better understand the effects of these parasites on the overall health condition of hosts, we calculated a body condition index (BCI) and measured packed cell volume (PCV, the proportion of red blood cells) for each host. We created several sets of general linear models with each white blood cell type, BCI, and PCV as the response variables and each parasite (*Plasmodium*, feather mites, chiggers, and lice - *Menacanthus*, *Ricinus*, *Philoaterus*), host sex, and site captured as explanatory variables. We

found that immune function (white blood cell proportions) vary according to host sex and is best explained by presence of chiggers, *Plasmodium*, and/or *Ricinus* lice. Host health condition (BCI and PCV) also vary with host sex, but is mostly explained by presence of chiggers. Our results demonstrate the complex relationships between parasite pressure and immune function and host condition in the wild.

### **3 Smiley, Williams, Wright, Witt**

Assessing hypoxic stress in high-Andean birds using right ventricular morphology. A. SMILEY, G. WILLIAMS, N. A. WRIGHT and C. C. WITT. *Dept. Biol. and Mus. Southwestern Biol., Univ. New Mexico, Albuquerque, NM.*

Birds whose ranges span the entire elevational gradient of the Andes defy ideas about niche limitations: they experience huge ranges in abiotic factors including differential partial pressures of oxygen, temperature and precipitation. How do these environmental factors affect avian physiology? The House Wren (*Troglodytes aedon*) and the Pied-Crested Tit-Tyrant (*Anairetes reguloides*) are 2 passerine songbirds that occur from sea level to over 4,000 m elevation in the Peruvian Andes. Exposure to hypoxia has led to pulmonary hypertension in low-altitude mammals followed by right-ventricular hypertrophy. However, it is unknown whether birds employ the same compensatory response. We tested whether high-altitude populations of widespread Andean bird species exhibit the enlarged right ventricles suggestive of chronic pulmonary hypertension. The right ventricles of high-altitude House Wrens were significantly enlarged, indicating that House Wren populations in the high Andes are not optimally adapted to hypoxia. Right ventricular enlargement represents a plastic developmental response to hypoxic stress, as opposed to a genetic adaptation to hypoxic environments. Inter-family relative heart mass comparisons in Andean birds indicate species-specific patterns of high-altitude adaptation that likely reflect unique biogeographic histories.

### **4 Terrill**

Feather growth and the biogeography of stress in Neotropical birds. RYAN S. TERRILL, *Mus. Nat. Sci., Louisiana State Univ., Baton Rouge, LA.*

How environmental conditions affect physiology and distribution of animals has been a pervasive topic in both ecology and evolution because spatial distribution guides the interactions of organisms, and so is thought to be the primary driver of both speciation and community composition. Physiological response to environment can limit distribution through variation in ability to cope with variation in factors such as temperature, oxygen, photoperiod, and primary productivity. Furthermore, environmental gradients can affect life-history traits through trade-offs in energetic decisions. According to Ashmole's Hypothesis, time invested in breeding increases with increased latitude. Because of this and the fact that most birds molt immediately after breeding and protract molt when they fail to breed or abandon breeding early, I hypothesized that birds in higher latitudes will show higher rates of feather growth. Furthermore, because stress effects the amount of energy a bird invests in parental care compared to individual survival and molt is an essential investment in survival, duration of molt should respond differentially to environmental factors such as elevation and precipitation depending on habitat preferences. I analyzed feather growth rates in 968 individuals of 5 widespread Neotropical birds. I found significant latitudinal gradients in accordance with my hypothesis, and differential responses to elevation and precipitation. These results suggest feather growth may be useful in studying how environment and physiology interact to affect distribution and energetic decisions. Further work will combine these datasets with phylogeography to investigate the relative roles of geographic features as biogeographic barriers on Neotropical birds.

### **5 Zhang, Swanson**

Cold and exercise training produce similar increases in maximal metabolic output in House Sparrows YUFENG ZHANG and DAVID L. SWANSON, *Dept. Biol., Univ. South Dakota, Vermillion, SD.*

Maximal metabolic outputs for both exercise and thermogenesis in birds presumably influence fitness through effects on flight and shivering performance. Because both summit ( $M_{sum}$  = maximum thermoregulatory metabolic rate) and maximum (MMR = maximum exercise metabolic rate) metabolic rates are largely functions of skeletal muscle metabolism, correlations between these measures of maximal metabolic output might be expected to occur, but this has been little studied in birds. In this study,

we measured effects of 3-wk experimental cold and exercise training protocols on body, muscle and heart masses, basal metabolic rate (BMR),  $M_{sum}$ , and MMR in House Sparrows. Cold-training resulted in significantly higher  $M_{sum}$ , MMR, body mass, and flight muscle (pectoralis + supracoracoideus) masses than in control birds and non-significant trends toward higher BMR ( $P = 0.087$ ) and heart masses ( $P = 0.076$ ). Exercise-training also significantly increased  $M_{sum}$  and MMR, as well as body mass and pectoralis muscle and heart masses relative to controls. However, BMR was significantly reduced in the exercise-trained group compared to controls. These data indicate that both cold and exercise training modified the phenotype of house sparrows to similarly increase maximal metabolic outputs for exercise and thermogenesis. These increases are associated with elevated body, pectoralis and heart masses in both groups, suggesting that such changes are prominent drivers of metabolic flexibility for both exercise and shivering. However, BMR varied differently for exercise and cold training, suggesting that other factors (e.g., changes in digestive organs) account for flexibility in BMR.

## **6 S J Cooper, Cousineau.**

Seasonal and geographic variation in metabolism and ventilation in Downy Woodpeckers. SHELDON J. COOPER and CHRISTOPHER J. COUSINEAU, *Dept. Biol., Univ. Wisconsin Oshkosh, Oshkosh, WI.*

Small birds that are year-round residents in temperate climates undergo seasonal acclimatization which facilitates maintenance of thermoregulatory homeostasis. These changes in thermoregulatory metabolism should be supported by equivalent changes in  $O_2$  transport. How the avian ventilatory system accommodates the large changes in rates of oxygen consumption ( $VO_2$ ) between basal (BMR) and summit metabolism ( $M_{sum}$ ) is not well understood. We measured ventilation and  $VO_2$  under thermoneutral conditions and cold stress in seasonally acclimatized Downy Woodpeckers from Wisconsin. Cold stress tests were conducted using a gas mixture of 79% helium and 21% oxygen (helox). In addition, we compared the BMR and  $M_{sum}$  of Wisconsin woodpeckers with published values from South Dakota. Wisconsin woodpeckers had significantly higher BMR and  $M_{sum}$  in winter relative to summer. BMR increased 22.4% and  $M_{sum}$  increased 30.7% in winter birds. BMR did not vary significantly between woodpeckers from Wisconsin and South Dakota in either summer or winter.  $M_{sum}$  was significantly higher in South Dakota woodpeckers compared to Wisconsin woodpeckers in both summer and winter. The increase in  $VO_2$  under cold stress for both summer and winter Wisconsin woodpeckers was accommodated by significant increases in tidal volume (VT), breathing frequency, and minute volume. Oxygen extraction efficiency (EO2%) was significantly higher under thermoneutral conditions for winter woodpeckers (45.3%) compared to summer woodpeckers (33.0%).

## **7 Hudon, Shustack, Driver, Rice**

Diet, not introgression, explains red flight feathers in Yellow-shafted Flickers in eastern North America. JOCELYN HUDON, *Royal Alberta Mus., Edmonton, AB*, DANIEL P. SHUSTACK, *Massachusetts Coll. Liberal Arts, North Adams, MA*, ROBERT J. DRIVER, and NATHAN H. RICE, *Acad. Nat. Sci. and Drexel Univ., Philadelphia, PA.*

Yellow-shafted Flickers in e. North America and the American Midwest far from the hybrid zone with Red-shafted Flicker occasionally display red flight feathers. The red feathers tend to show bilateral symmetry and may differ from one year to the next. Short (1965, *Bull. Am. Mus. Nat. Hist.* 129: 307-428) believed that the variation was the result of past introgression with the Red-shafted Flicker, also possibly local selection for the red color. Ingold and Weise (1985, *J. Field Ornithol.* 56: 403-405) hypothesized some fairly complex, but largely unproven, physiological mechanisms to explain the variation. We evaluated a simpler, dietary, explanation for the unusual color in 2 Yellow-shafted Flickers with aberrant red feathers: that rhodoxanthin acquired exogenously at the time of feather molt come to rest alongside the carotenoids normally found in these feathers. An exogenous source of rhodoxanthin exists in the berries of 2 bush honeysuckles actively propagated as wildlife habitat in e. North America and the American Midwest, notably in the 1960s. The honeysuckles were recently implicated in the appearance of orange-colored variants of several species of songbirds. As predicted, rhodoxanthin rather than the 4-keto-carotenoids found in the Red-shafted Flicker are present in the aberrantly-colored flickers. A dietary origin explains many of the unusual features of red-feathered Yellow-shafted Flickers.

## **8 Kleist, Cruz, Francis**

The costs of noise pollution in high desert secondary cavity nesting species. NATHAN J. KLEIST, ALEX CRUZ, *Univ. Colorado-Boulder, Boulder, CO*, and CLINTON D. FRANCIS, *Natl. Evol. Synthesis Center, Durham, NC*.

Health experts report that exposure to noise pollution has negative physiological effects in humans, but whether free-living animals experience similar effects is unclear. Because of their reliance on acoustic communication, birds are viewed as especially sensitive to noise, potentially raising stress hormones (e.g., glucocorticoids or “cort”) to levels that may compromise growth, reproduction, and even territory defense and parental behaviors. We used a unique system where the influences of noise are isolated from factors that complicate studies in urban habitats to determine whether continuous noise pollution acts as a long-term source of stress in several passerine birds. Blood samples, nest success and morphometric parameters were recorded to isolate species and age-specific responses to a potential negative chronic stressor—extreme noise pollution from natural gas extraction activity. Two species of interest, Western Bluebirds and Ash-throated Flycatchers, displayed hormonal responses to noise as nestlings, with cort levels ten minutes after capture positively related to noise levels in Ash-throated Flycatchers and negatively related to noise levels in Western Bluebirds. In Western Bluebirds adult female tarsus length was negatively related to noise levels and nestling wing chord length was negatively related to cort levels. In Ash-throated Flycatchers we found wing chord length was positively related to both baseline and stress-induced levels in adults and nestling weight was negatively related to noise levels. The effects of noise on cort levels and the subsequent effects of those hormones on reproductive success metrics, as suggested by this study, vary by species and age group. Uncovering how these stress responses differ within and across species and life stage will be an important step towards untangling the complexities of how physiological stress is related to reproductive success.

## **9 Kellam**

Exogenous testosterone has a negative effect on calling behavior of male and female Downy Woodpeckers in the non-breeding period. JAMES S. KELLAM, *Dept. Biol., St. Vincent Coll., Latrobe, PA*.

Numerous studies have shown that testosterone (T) increases singing rates of passerine birds, but much less is known about the influence of T on non-song vocalizations, particularly in non-passerine species. Downy Woodpeckers give several non-song vocalizations in a variety of social contexts throughout the year, including whinny and *pik* calls. I gave free-living male woodpeckers subcutaneous T implants during the non-breeding period to determine whether the incidences of these calls were greater among the experimental males and their female partners compared to control males and females. I also tested whether calls were given more or less often when pair members were spatially proximate, and whether T treatment affected this pattern. Both call types were more likely given when pair members were nearby (<40 m), and this was true regardless of T treatment. Surprisingly, both males with T-implants and their female partners showed significantly lower incidences of vocalization than control birds. I attributed this to the possible effect of T on non-vocal behaviors that influenced the social relationship between members of a pair.

## **10 Beck, Hopkins, Jackson, Hallagan, Hawle**

The effects of dietary exposure to trace element contamination on the stress and immune responses of Tree Swallows following remediation of a coal fly ash spill. MICHELLE L. BECK, WILLIAM A. HOPKINS, JOHN J. HALLAGAN, *Dept. Fish & Wildl. Conserv., Virginia Tech. Univ., Blacksburg, VA*, DANA M. HAWLEY, *Dept. Biol., Virginia Tech. Univ.*, and BRIAN P. JACKSON, *Dept. Earth Sci., Dartmouth Coll., Hanover, NH*.

Coal fly ash contains elevated concentrations of numerous trace elements that pose health risks to humans and wildlife. Exposure to even low concentrations of trace elements could have subtle effects on wildlife because these elements normally facilitate a number of physiological processes. We examined the effects of dietary exposure to low trace element concentrations on Tree Swallows following remediation of a coal fly ash spill that occurred in 2008 in Kingston, TN. Nestling Tree Swallows are exposed to elevated concentrations of trace elements through the consumption of emerging aquatic insects, particularly through the consumption of midges. While trace element levels in insects and nestlings near the spill are elevated above those in reference areas, trace element concentrations near the spill are below levels typically associated with serious reproductive effects. However, some trace elements are related to aspects of nestling physiology. Nestlings with greater exposure to trace elements

such as Fe, Cu, and Zn have lower basal corticosterone concentrations and we detected a trend for nestlings with high blood Se levels to have greater stress-induced corticosterone concentrations. We found that elevated concentrations of Se and Fe are associated with a reduced cell-mediated immune response in nestlings. However, exposure to trace elements did not affect the bactericidal capacity of nestling blood. Our results indicate that Tree Swallows are exposed to slightly elevated concentrations of trace elements following remediation of the fly ash spill, and that trace element concentrations are related to some aspects of their physiology.

## **11 Kaiser, Sillett, Webster**

Habitat-specific reproductive strategies in response to food supplementation increase male fitness in a songbird. SARA A. KAISER, *Lab. Ornithol., Cornell Univ., Ithaca, NY*, T. SCOTT SILLETT, *Migratory Bird Center, Smithsonian Conserv. Biol. Inst., Washington, DC*, and MICHAEL S. WEBSTER, *Lab. Ornithol., Cornell Univ.*

Environmental constraints are hypothesized to affect the fitness costs and benefits associated with investment in extra-pair mating. Habitat quality, such as food availability, might influence male investment in competing behaviors that affect whether males lose or gain paternity, contributing to the variability in extra-pair paternity and fitness among individuals within populations. We experimentally examined the fitness consequences of individual variation in paternity patterns in low and high quality habitats in the migratory Black-throated Blue Warbler. We found that male reproductive strategies differed between low and high quality habitats in response to food supplementation, which resulted in fed males having higher reproductive fitness than control males. In low quality habitat, food supplementation reduced the probability of males gaining extra-pair paternity and increased double-brooding. In high quality habitat, fed and control males did not differ in their probability of gaining extra-pair paternity or double-brooding. In both habitats, however, food supplementation and high natural food availability reduced the probability of males losing within-pair paternity. Additionally, older males suffered less fitness costs and had higher reproductive fitness than yearling males. Our results provide support for the hypothesis that environmental constraints can strongly affect male reproductive fitness by influencing trade-offs between mate guarding and pursuing extra-pair matings that affect individual variation in paternity patterns within populations.

## **12 Baillie, Kelemen, Ferretti, R L Curry**

The bold and the bashful: anti-predator behavior in Carolina Chickadees. SARAH K. BAILLIE, EVAN P. KELEMEN, VALENTINA FERRETTI and ROBERT L. CURRY, *Biol. Dept., Villanova Univ., Villanova, PA*.

Personality is defined as consistency in behavior across time and contexts. This is an active area of study, with many researchers finding that personalities can account for much behavioral variation among individuals. Experiments simulating predation threat can be used to study boldness and risk-taking – as key components of personality – in passerines. We investigated boldness in response to predatory threat through field experiments involving Carolina Chickadees, a species that has exhibited consistency in some other behaviors across different social contexts. Among responses to threat that can be quantified in chickadees is vocal behavior: call rate and number of *dee* elements in the *chick-a-dee* call increase linearly with degree of threat. We presented predator (squirrel and owl) and control models to breeding pairs during the 2-wk nestling stage and then recorded chickadee vocal and spatial responses. Principal components analysis (PCA) yielded composite measures representing mainly call content (PC1) and spatial response (PC2). PC1 varied among individuals regardless of stimulus type, whereas PC2 varied among stimuli. Brood size and nestling age did not affect responses, suggesting that intrinsic more than external factors constrain responses to perceived threat. Our results support the hypothesis that anti-predatory behavior is a component of personality in Carolina Chickadees. Boldness is likely to be important for nest defense and for males protecting mates from extra-pair copulations, both of which can be expected to impact reproductive success.

## **13 Kelemen, Baillie, R L Curry**

Does sing behavior reveal personality in Carolina Chickadees. EVAN P. KELEMEN, SARAH K. BAILLIE and ROBERT L. CURRY, *Dept. Biol., Villanova Univ., Villanova, PA*.

Animal personality is consistent behavioral variations exhibited by individuals, which influences how an animal interacts with the environment and conspecifics. Singing behavior as a component of

personality has received relatively little attention, even though it is important for mate attraction and territory defense. Our study addressed if singing behavior during the dawn chorus is consistent with personality by correlating it with boldness in Carolina Chickadees. We measured boldness by recording male responses to 3 stimuli (nestling predator decoy, adult predatory model, and control) 1 m from the nest. We assessed correlation using Principal Component Analysis (PCA) to calculate scores for each male in each context. PC1 scores for dawn chorus participation reflected the intensity of each male's performance. PC1 scores for boldness reflected each male's alarm call rate and length. Dawn chorus PC1 scores were negative correlated ( $r^2 = 0.85$ ) with boldness PC1 scores in response to the nestling predator decoy. The PC1 scores in response to adult predator model and control did not correlate with dawn chorus PC1 scores. The results from this study suggest that singing behavior is a component of personality because singing behavior correlates with boldness. The negative correlation between dawn chorus performance and boldness indicates that males that sing more intensely have a weaker vocal response to threats than individuals that sing less intensely. Males that sing less intensely may be more cautious, responding stronger to potential nest threats. This study suggests that males may be able to broadcast their personality to potential mates or rivals via singing.

#### **14 Fowler, Rolland**

Winter nest box use and roost composition in Eastern Bluebirds in northeastern Arkansas.

JESSICA FOWLER, VIRGINIE ROLLAND, *Dept. Biol. Sci., Arkansas State Univ., State University, AR.*

Despite a history of population decline caused by severe winter weather, little is known about Eastern Bluebird winter behavior. Group roosting has been previously documented in Eastern Bluebirds, but the criteria regarding the decision to use a nest box during the winter and the social composition of roosting groups remain unknown. We checked 69 boxes in ne. Arkansas every 4 d from Nov 2012 - Feb 2013. All birds found were banded and a blood sample was taken to determine social and genetic relationships found within groups. Using a block random design for nest treatment and recorded weather data, we also clarified the effects of temperature, wind-chill and nest presence on nest box use by Eastern Bluebirds. Not only did box occupancy (i.e., probability of being used) increase as the "felt" temperature (which includes wind-chill) at sunset decreased, but Eastern Bluebirds also used nest boxes at higher temperatures than previously reported. Boxes that had either a natural or artificial nest were chosen preferentially over empty boxes. Genetic analysis of roosting groups shows that Eastern Bluebirds do not form family-based roosting groups to the same extent as Western Bluebirds, though at least one pair began breeding in the following spring suggesting that roosting groups may help form early mate bonds. Two other species (Downy Woodpeckers and Carolina Wrens) were also found using nest boxes for roosting during the winter, although the relationships with temperature differed from those for Eastern Bluebirds.

#### **15 Harris, Siefferman**

Intensity of interspecific competition differentially affects avian personality and reproductive success. MORGAN R. HARRIS and LYNN M. SIEFFERMAN, *Appalachian State Univ., Boone, NC.*

Predictable personality (or consistent and predictable behavioral responses of individuals) in animals is thought to influence monogamous relationships by better allowing mates to coordinate territory defense and parental care behaviors. Aggressive territorial defense behavior is often an important and ecologically relevant measure of animal personality. However, recent invasions can increase interspecific competition for limited breeding resources and may interfere with otherwise adaptive personality traits. Eastern Bluebirds are secondary cavity nesting birds that have been shown to exhibit personality (or repeatable aggressive behaviors toward simulated territorial intrusions). Tree Swallows have recently expanded their breeding range southward and have been breeding near our field site in the mountains of North Carolina for < 30 yr. Here we examine the effects of interspecific competition on 1) consistency of aggressive behavior within individual bluebirds, 2) the degree to which bluebird pairs exhibit similar aggressive behavior, and 3) on the relationship between within pair behavioral similarity and fitness. We found that at locations with little or no interspecific competition bluebirds showed consistent aggressive behaviors, within pair behavioral similarity did not have an affect on reproductive success, and nestling mass was higher. In areas with high levels of interspecific competition we found that bluebirds do not display consistent aggressive behavior, but pairs that behaved similarly achieved the highest reproductive success. Our research demonstrates that interspecific competition can disrupt otherwise consistent and predictable aspects of personality and this disruption reduces reproductive success.

## **16 B C Jones, Bebus, Bateman, Schoech**

They remember: long-term memory and the link between stress physiology and anti-predator behavior in free-living Florida Scrub-Jays. B. C. JONES, S. BEBUS, *Univ. Memphis, Memphis, TN*, P. W. BATEMAN, *Curtin Univ., Perth, Western Australia, Australia*, and S. J. SCHOECH, *Univ. Memphis*.

For many avian species, anti-predator behavior is not an innate characteristic, but rather, appropriate responses to predators must be learned. However, few studies have explored the underlying mechanisms that mediate the acquisition and retention of anti-predator behaviors. Perception of a known predator is a stressful stimulus that releases corticosterone (CORT) in a number of different taxa, including some species of birds. This hormone facilitates physiological and behavioral changes that can enhance survival, but also can affect memory. Given this link, CORT is a likely candidate to mediate the memory of past experience with predators, and thus facilitate subsequent learned anti-predator behaviors. Florida Scrub-Jays (FSJ) exhibit intraspecific variation of stress induced plasma CORT levels, which are repeatable within individuals. We used the FSJ as a model to test 2 hypotheses: 1) FSJs have the capacity to learn anti-predator behavior and 2) CORT responsiveness is predictive of anti-predator behavior. We developed a model, using a novel "predator", to test the link between CORT responsiveness and learned anti-predator behavior in free-living FSJs. Compared to control birds, individuals previously threatened by our novel "predator" displayed greater flight initiation distances (FID), and retained this memory for approximately one year (i.e., exhibited similar FIDs when later challenged with this "predator"). Further, CORT responsiveness was positively correlated with FID. Combined, these data indicate FSJs can learn to associate a novel "predator" as a threat with a single exposure, retain this memory for at least one year, and that stress physiology is related to this cognitive process.

## **17 M L Grunst, Rotenberry**

Phenotypic plasticity in nest departure calls: weighing costs and benefits. MELISSA L. GRUNST, *Univ. California-Riverside, Riverside, CA*, and JOHN C. ROTENBERRY, *Univ. Minnesota, Twin Cities, MN*.

In birds male song has been extensively studied, but female vocalizations have received little attention. One unique female vocalization, found in several North American species, is the nest departure call (NDC). NDCs are given upon departure from nests and have acoustical properties that make nests easy to locate. Thus, calls must have an adaptive function that outweighs costs, and call frequency may be adaptively adjusted as the balance between costs and benefits change. Our work explored the hypothesis that NDCs in Song Sparrows function to recruit male vigilance for nest defense, and that call frequency is plastically modulated to reflect differential costs and benefits of calling induced by mate quality (measured by body condition and song complexity), nest predator presence, and nest height. Results indicate that females do, indeed, display adaptive plasticity in call production. Calling increased in the male's presence, and males were more likely to recruit to nest-guard following a NDC. Additionally, NDC production decreased given nest predator presence, perhaps because costs of predator attraction outweigh benefits of male recruitment in this context. Moreover, although male song complexity failed to predict calling rate, females called more if their mate was in good body condition. Males in good condition may provide superior nest-guarding services, thus elevating benefits of calling. Finally, there was counter-intuitive positive interaction between nest height and predator presence in predicting call production. Plasticity in calling likely exists because context-appropriate communication elevates fitness, whereas contextual mistakes in the decision to communicate results in fitness declines.

## **18 Bowman, Pruett, Aldredge, Albrecht-Malinger, Slowinski**

Fire isn't scary, lack of fire is: behavioral responses to changes in predation risk. REED BOWMAN, M. SHANE PRUETT, *Archbold Biol. Sta., Venus, FL*, JILL ALDREDGE, *Durham, NC*, DAN ALBRECHT-MALINGER, *Virginia Commonwealth Univ., Richmond, VA*, and SAM SLOWINSKI, *Indiana Univ., Bloomington, IN*.

Optimal habitat for Florida Scrub-Jays is open oak scrub, typically 5 - 20 yr post fire. In long unburned scrub, habitat structure succeeds into forest and demographic performance of jays declines. Scrub-jays are cooperative breeders with a coordinated sentinel system that relies on early detection of predators. As habitat becomes more structurally complex, this system is less reliable because predators are harder to detect. Eventually populations are extirpated unless the habitat subsequently burns. We assessed the behavioral patterns of jays in optimal habitat or riskier overgrown habitat. Typically, jays

trade off foraging for vigilance. We compared the relative amount of time breeding males invested in foraging versus vigilance in open and overgrown habitats, during 2 periods when the cost of foregoing foraging differed - incubation and nestling rearing. In open habitat, males shifted from more vigilance to more foraging; however, in overgrown habitats, males maintained high rates of vigilance, even when the demand for additional foraging increased. We also assessed the effect of habitat structure on foraging decisions using Giving-Up Density experiments. Males in overgrown habitat abandoned artificial foraging patches at higher food densities than males in open habitat. These results suggest that in risky habitat long-lived birds, like the Florida Scrub-Jay, may sacrifice investment in current reproduction to maximize their own survival.

## **19 Chutter, Redmond, Dolan, Murphy**

Paternity and paternal care by Eastern Kingbirds. CHRISTOPHER M. CHUTTER, LUCAS J. REDMOND *Dept. Biol., Portland State Univ., Portland, OR*, AMY C. DOLAN, *Dept. Biol., Northern State Univ., Aberdeen, SD*, and MICHAEL T. MURPHY, *Dept. Biol., Portland State Univ.*

Biparental care is the norm for birds. However, the many studies that have shown that males frequently lose paternity suggest that male and female investment should not necessarily be equal. Over evolutionary time, males are expected to downscale their parental care as the frequency of extrapair paternity increases, but a major question is whether males can, in ecological/behavioral time, perceive losses of paternity and respond appropriately. We report the results of an analysis of variation in paternal care by Eastern Kingbirds breeding at Malheur National Wildlife Refuge, OR, between 2003 and 2010. Losses of paternity in this population occur in ~60% of kingbird nests every year, and complete loss of paternity is common (25 - 33% annually). We filmed parental behavior at 50 kingbird nests, determined the proportion of young sired by the male, and measured other variables that are predicted theoretically to potentially influence male investment, including availability of fertile females, density of surrounding males, number and age of young, date within the year, and quality of the male and female. A quarter of the males in our sample lost all paternity at their nest while 39% sired all young. Despite these disparities, paternal care (measured as proportion of feeding trips by the male) did not vary with paternity. In addition, we found no evidence that paternal care varied with the availability of fertile females, or any other variable, except that males showed a weak, but significant, tendency to reduce their feeding effort when pair density was high.

## **20 Dale, Dickinson, Akcay, Kyser, Nocera, Ratcliffe**

Personality differences between migrants and residents in a partially migratory population of Western Bluebirds. CATHERINE A. DALE, *Dept. Biol., Queen's Univ., Kingston, ON*, JANIS L. DICKINSON, *CAGLAR AKCAY, Lab. Ornithol., Cornell Univ., Ithaca, NY*, T. KURT KYSER, *Dept. Geol., Queen's Univ.*, JOSEPH J. NOCERA, *Ontario Min. Nat. Res. and Trent Univ., Peterborough, ON*, and LAURENE M. RATCLIFFE, *Dept. Biol., Queen's Univ.*

Recent studies have demonstrated personality differences between closely related resident and migrant bird species, suggesting that adaptive responses to the challenges of migration or residency are mediated by cognitive mechanisms. However, relatively few studies have examined personality differences between migrant and resident individuals in partially migratory species. In this study, we compared aggressive behaviour of migrant and resident Western Bluebirds in a partially migratory population in the Okanagan Valley, BC, test the prediction that migrant individuals would be more aggressive than residents. We also compared the BC population with a fully resident Western Bluebird population from Hastings Natural History Reserve in California. We used stable hydrogen isotope signatures to determine BC individuals' migratory strategy and measured their aggressive response to a model of a competing cavity nester (the House Wren). For each individual tested, we calculated an aggression rank based on the number and type of aggressive actions performed. The relationship between aggression rank and migratory strategy was examined separately for males and females. Contrary to our predictions, we found that male BC residents were more aggressive than BC migrants or California residents. However, in females, aggression did not differ with migratory strategy. To our knowledge, this study is the first to examine the relationship between aggression and migratory strategy in a partially migratory population. Our results suggest that personality may play a role in determining migratory strategy in Western Bluebirds.

## **21 Contina, Bridge, Kelly**



Birds, borders, and the black market: genetic insight into the Painted Bunting trade. A CONTINA, E. S. BRIDGE and J. F. KELLY, *Oklahoma Biol. Surv., Norman, OK.*

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is a worldwide effort among governments to monitor and safeguard international trade of wild animals and plants with the ultimate goal of preventing their extinction. However, from 2005 to 2009, CITES documented more than 317,000 live birds sold annually within an industry estimated to be worth billions of US dollars per year. In this context, migratory species can be particularly difficult to protect because any management effort would necessarily involve cooperation among different countries with distinct laws and regulations. A case in point is the Painted Bunting, which breeds primarily in the United States and winters in Mexico, Central America, Florida, and the Caribbean. Male Painted Buntings are brightly colored, which makes them highly sought after as pets, particularly in Europe. Although linking migrant songbirds legally or illegally captured outside the US boundaries to breeding populations is often a challenge that remains unresolved, there are genetic tools that can support these investigations. Here we describe our use of an extensive microsatellite DNA library to determine the population of origin of Painted Buntings sold in the European pet market. Although Painted Buntings are abundant throughout most of their range, the small, isolated east-coast breeding population might be vulnerable to overexploitation. We hope that our findings draw attention to the need for international collaboration and cooperation in combating illegal pet-trade activity.

## **22 Bateson, Dunn, Hull, Henschen, J A Johnson, Whittingham**

Genetic restoration of a threatened population of Greater Prairie-chickens in Wisconsin. ZACHARY W. BATESON, PETER O. DUNN, Dept. *Biol. Sci., Univ. Wisconsin-Milwaukee, Milwaukee WI*, SCOTT D. HULL, *Wisconsin Dept. Nat. Res., Madison, WI*, AMBERLEIGH E. HENSCHEN, *Univ. Wisconsin-Milwaukee*, JEFF A. JOHNSON, *Univ. North Texas, Denton, TX*, and LINDA A. WHITTINGHAM, *Univ. Wisconsin-Milwaukee.*

Many species that once inhabited large contiguous grassland prairies in North America now occupy a fragmented landscape, and are forced to exist in small isolated populations where long-term persistence is uncertain. The future of these populations depends on management strategies that attempt to limit the loss of genetic diversity from the eroding effects of genetic drift. Translocations, the movement of individuals from one population to another, have been used for decades to supplement small populations. However, relatively few studies have determined the efficacy of translocations in terms of increasing genetic diversity. We studied a small, isolated and genetically depauperate population of Greater Prairie-chickens (*Tympanuchus cupido pinnatus*) in Wisconsin both before and after translocations of females from a larger more genetically diverse population in Minnesota. We examined genetic diversity of the pre- and post-translocation Wisconsin populations, and the Minnesota females at neutral (microsatellite, mtDNA) and functional (MHC) markers. Overall, the translocation resulted in successful introgression that increased genetic diversity, thus offsetting the adverse effects of genetic drift.

## **23 Alexandrino, Ferraz, Couto, Silva**

Bird communities of small Atlantic Forest patches in an agricultural landscape of Brazil: The analytical approach is the challenge. EDUARDO R. ALEXANDRINO, KATIA M. P. M. B. FERRAZ, HILTON T. Z. COUTO, Dept. *For. Sci., "Luiz de Queiroz" Coll. Agri., Univ. São Paulo, São Paulo State, Brazil*, and WESLEY R. SILVA, *Biol. Inst., Dept. Animal Biol., Univ. Campinas, São Paulo State, Brazil.*

Birds communities are often considered good indicators of the general condition of the habitat. In this study, we compared 3 analytical approaches to bird community in order to identify habitat quality of 8 Atlantic Forest patches (3 to 64 ha) in an agricultural landscape in se. Brazil (Corumbataí River Basin). After 1-yr sampling (448 h), we made use of (1) classical approaches as species richness, Shannon diversity and quantification of species in trophic guilds; (2) Index of Biotic Integrity (IBI) with sensitivity to disturbance (high, medium or low) as a response metric, based on the classification for Neotropical birds (Stotz et al. 1996, **Neotropical Birds**); (3) IBI using sensitivity for regional level supported by Indicator Species Analysis. The classical approach showed significant difference only for the smaller fragment, but not among others, indicating that they have the same habitat quality, which is not consistent with previous phytosociological, historical, and landscape studies. The IBI proved useful, once the metric chosen represents the species response to the anthropogenic disturbance. However, IBI values by Stotz's sensitivity returned less difference among the patches ( $x = 0.57$ ;  $SD = 0.19$ ;  $var = 0.03$ ) when compared

with IBI using regional levels of sensitivity ( $x = 0.57$ ;  $SD = 0.05$ ;  $var = 0.002$ ). In conclusion, when the highly and small disturbed patches are the focus of the study, the attempting to identify differences on the habitat quality could be null if a weak analysis of the bird communities is chosen. Thus, our results challenges ornithologists that intend to compare bird communities of small Atlantic Forest patches.

## **24 Dornak, Conway, Aycrigg**

Does the protected areas network in the US contribute to bird conservation? L. L. DORNAK, C. J. CONWAY, and J. AYCRIGG, *Idaho Coop. Fish & Wildl. Res. Unit, Dept. Fish & Wildl. Sci., Univ. Idaho, Moscow, ID.*

Protected areas are considered important tools for conservation of biodiversity and natural systems. Efforts to evaluate the extent to which these areas are curbing population declines and maintaining species diversity are rare, but such efforts can help inform policy-makers regarding priorities for future conservation efforts. We evaluated the effectiveness of the US protected areas network at curbing population declines of birds. We used data from the North American Breeding Bird Survey to examine whether long-term trends were influenced by proportion of protected areas surrounding BBS routes. We examined whether differences in management emphasis, areas managed for biodiversity and areas managed for multiple uses, were associated with population trend. Of 50 species of highest conservation concern in the US, 48% have BBS trends that are more positive in protected areas managed for biodiversity than areas managed for multiple uses. Of these 24 species, 19 (38% overall) have higher population trends in areas with a higher proportion of protection in the surrounding area. Of 91 species that are not considered species of conservation concern, 43% have BBS trends that are more positive in areas managed for biodiversity compared to their trends in areas managed for multiple uses. Of these 39 species, 23 species (25% overall) show a benefit from proportion of area in protected areas. Our results suggest that while the relative number of species that benefit from the US protected areas network may be low, a substantial proportion of species of greatest conservation concern benefit from protection afforded by these areas.

## **25 Boyle, Sigel**

New changes in the avifauna of La Selva Biological Station: insights based on twenty-three years of Christmas bird counts. W ALICE BOYLE, *Div. Biol., Kansas State Univ., Manhattan, KS*, and BRYAN J. SIGEL, *Nevada State Coll., Henderson, NV.*

Tropical forest fragmentation influences community composition via differential effects on species differing in ecological attributes. In lowland tropical forests, the birds most negatively affected by fragmentation appear to be insectivores depending on intact understory vegetation. Studies of avian community change at La Selva Biological Station have been important in shaping our understanding of how fragmentation affects Neotropical birds. However, previous studies analyzed time periods corresponding to high rates of deforestation. Since the 1990s, the protected land within and surrounding La Selva and Braulio Carrillo National Park has increased, and much previously deforested land has reverted to tall secondary forest providing an opportunity to test hypotheses regarding the drivers of ongoing avifaunal change. We estimated population trends using Christmas Bird Count data from 1989 - 2011 for 202 resident species counted within the La Selva property. After accounting for observer effort and count day weather, we found that >50% of the species have either increased or declined over the 23 yr period – more than twice the proportion of species previously shown to have changed. Declining species are declining rapidly with 18% of species declining by = -10%/yr. By contrast, increasing species are doing so more slowly. As in previous studies, habitat association was an important predictor of population trends, and understory specialists continue to decline. However, birds preferring open habitats that were previously increasing are now declining consistent with recent forest regeneration. Associations between diet and population trends were variable in ways suggesting that important dietary differences are obscured by the necessarily blunt categorizations employed in community-level studies. Importantly, previous trend classifications do not predict current trends suggesting that reversals in tropical avifaunal changes are possible over short time scales. Long-term data from standardized censuses such as Christmas Bird Counts are invaluable resources in tropical locales where such datasets are rare.

## **26 W A Cox, Wolfenbarger, McCarty**

The influence of land-use and conservation practices on grassland songbird densities. W. ANDREW COX, L. LAREESA WOLFENBARGER, JOHN P. McCARTY, *Dept. Bio., Univ.*

*Nebraska-Omaha, Omaha, NE.*

Recent spikes in commodity prices have incentivized the conversion of grasslands to row-crop fields, with >500,000 ha of grasslands lost in the US Western Corn Belt during 2006 - 2011. To establish the potential impacts that land conversion of this scale may have on grassland passerine communities, it is critical to first understand the relative value of different grassland types for native bird species. We used a hierarchical model that allows for the joint estimation of factors influencing both detectability and abundance to evaluate how land-use and conservation practices affected the abundance of grassland birds in tallgrass prairies and farmlands of eastern Nebraska. Of 4 species with counts sufficient for analyses (Sedge Wren, Common Yellowthroat, Dickcissel, Grasshopper Sparrow), all but the Grasshopper Sparrow exhibited substantially higher densities in conservation grasslands versus agricultural fields embedded within a conservation matrix. All but the Common Yellowthroat had higher densities in warm- versus cool-season dominated conservation grasslands, and the diversity of forb plantings within warm-season grasslands exhibited species-specific effects on abundances. Sedge Wrens were absent in marginal grasslands in agricultural landscapes and the remaining 3 species were present in substantially lower densities. Nevertheless, Dickcissel and Grasshopper Sparrow densities were high enough to suggest the loss of marginal grasslands through land conversion will have substantial negative impacts on regional populations.

## **27 Girard, Duro, King, Fahrig, Lindsay, Mitchell**

Effects of farmland heterogeneity on bird abundance varies among habitat guilds. JUDITH GIRARD, DENNIS DURO, DOUG KING, LENORE FAHRIG, SCOTT MITCHELL, GLEEL, *Carleton Univ., Ottawa, ON*, and KATHRYN LINDSAY, *Environment Canada*.

Landscape heterogeneity has been proposed as an important predictor of biodiversity in agricultural regions. However, heterogeneity is frequently positively correlated with amount of natural habitat so the independent effects of heterogeneity remain unclear. If heterogeneity alone predicts biodiversity in farmland, then farmland biodiversity could be increased without taking land out of agricultural production. We surveyed birds in 93, 1-km<sup>2</sup> landscapes in eastern Ontario in 2011 and 2012. We used multinomial mixture models to predict abundance of individual species, grouped a priori into 3 habitat guilds; farmland generalists, grassland specialists and row crop specialists. Predictor variables were habitat amount (% cover of agriculture, grassland and row crops respectively), compositional heterogeneity (crop diversity) and configurational heterogeneity (mean field size) all at a 3 km extent. We predicted that habitat amount and crop diversity would have a positive effect on bird abundance and mean field size would have a negative effect (landscapes with small field sizes have the highest heterogeneity). Preliminary results show that farmland generalist species show a weak positive effect of agricultural cover and tend to be more abundant in landscapes with smaller fields. Grassland specialists are more abundant in landscapes with higher cover of grassland and higher crop diversity, and row crop specialists are more abundant in landscapes with higher cover of crops and larger fields. Varying habitat requirements and varying effects of farmland heterogeneity among habitat guilds suggest that recommending an increase of semi-natural habitat or farmland heterogeneity alone would be inadequate to conserve all farmland birds.

## **28 Thomas, McNew, Sandercock**

Occupancy of grassland birds in State Acres for Wildlife Enhancement program enrollment fields in Kansas. ALAINA D. THOMAS, *Div. Biol., Kansas State Univ., Manhattan, KS*, LANCE B. McNEW, *US Geol. Surv., Anchorage, AK*, and BRETT K. SANDERCOCK, *Div. Biol., Kansas State Univ.*

Grassland bird populations have experienced significant declines worldwide as habitat has decreased due to urbanization and conversion to agriculture. Several components of the Conservation Reserve Program (CRP) specifically target wildlife enhancement and aim to mitigate the current decline in grassland bird populations. The newest CRP program, State Acres for Wildlife Enhancement (SAFE), was designed to restore vital habitat for high priority wildlife throughout the US. Our objective was to assess the effects of the SAFE program on grassland bird occupancy in Kansas. We monitored tracts of land enrolled in the SAFE program to estimate abundance, diversity, and relative use by sensitive species of grassland birds. Our study was conducted in 7 counties in the Smoky and Flint Hills ecoregions. We surveyed 68 SAFE fields and 29 fields enrolled in other types of CRP. We modeled occupancy for 8 grassland bird species of interest in Kansas. We modeled the effects of field size and habitat type (enrolled in SAFE or other CRP type) on probability of occupancy for each species. For Northern Bobwhite, Ring-necked Pheasant, Eastern Meadowlark, Western Meadowlark, and Grasshopper Sparrow,

patch size was the best predictor of occupancy based on  $\Delta AICc$  and model weights. Probability of occupancy increased as patch size increased. Since field size is positively related to probability of occupancy for several species of conservation concern, we recommend a contiguous enrollment of SAFE fields whenever possible.

## **29 Brandt, Wood, Pidgeon, Han, Fang, Radeloff**

Sacred forests are keystone structures for forest bird conservation in southwest China's Himalayan Mountains. JODI S. BRANDT, *Univ. Michigan, Ann Arbor, MI*, ERIC M. WOOD, ANNA M. PIDGEON, VOLKER C. RADELOFF, *Univ. Wisconsin, Madison, WI*, LIAN-XIAN HAN and ZHENDONG FANG, *Yunnan, China*.

Identifying and protecting "keystone structures" is essential to maintain biodiversity in an increasingly human-dominated world. Sacred forests, i.e., natural areas protected by local people for cultural or religious regions, may be keystone structures for forest birds in the Greater Himalayas, but there is limited understanding of their use by bird communities. We surveyed birds and their habitat in and adjacent to 6 Tibetan sacred forests in nw. Yunnan, China, a biodiversity hotspot. Our goal was to understand the ecological and conservation role of these remnant forest patches for forest birds. We found that sacred forests supported a different bird community than the surrounding matrix, and had higher bird species richness at plot, patch, and landscape scales. While we encountered a homogeneous matrix bird community outside the sacred forests, the sacred forests themselves exhibited high heterogeneity, and supported at least 2 distinct bird communities. While bird community composition was primarily driven by the vegetation vertical structure, plots with the largest-diameter trees and native bamboo groves had the highest bird diversity, indicating that protecting forest ecosystems with old-growth characteristics is important for Himalayan forest birds. Finally, we found an increased bird use of the sacred forests and their edges during 2010, a severe drought year in Yunnan, indicating that sacred forests may serve as refuges during extreme weather years. Our results strongly indicate that sacred forests represent an important opportunity for Himalayan bird conservation because they protect a variety of habitat niches and increase bird diversity at multiple spatial scales.

## **30 Kirchman**

Historic decline of genetic diversity in an imperiled population of Spruce Grouse (*Falcapennis canadensis*). JEREMY J. KIRCHMAN, *New York State Mus., Albany, NY*.

Spruce Grouse are relatively common in the boreal forests of Canada and Alaska but are considered rare at the southeastern extent of their range, where they occur in isolated patches of spruce and tamarack forest in New York, Vermont, New Hampshire and Maine. The species was once relatively abundant in these peripheral populations, but has experienced a gradual decline since the late 1800s. Peripheral Spruce Grouse populations continue to decline, and over the past 20 yr have experienced greater than 50% reduction in geographic range. I report preliminary results of a genetic study of mitochondrial DNA variation in the New York (Adirondacks) population, including information regarding the genetic structure within and between New York subpopulations and genetic relatedness of the New York population and neighboring populations. Blood samples were obtained from 22 birds captured in nearly all extant New York populations and 6 samples from birds in Algonquin Park, ON. Complete mitochondrial Control Region sequences (1150 bp) obtained from these samples indicate that New York's Spruce Grouse population has very low genetic diversity even relative to the much smaller sample from Ontario. Two polymorphic nucleotide sites define only 3 haplotypes, with 19 of 22 New York Spruce Grouse identical at all nucleotides. Shorter Control Region sequences were obtained from 11 historic museum specimens collected in New York over the past 150 yr. These data indicate that much genetic variation has been lost from New York Spruce Grouse in the last century.

## **31 Becker, Wood, Strager**

Impacts of mountaintop mining on terrestrial ecosystem Integrity: identifying landscape thresholds for avian species. DOUGLAS A. BECKER, *West Virginia Coop. Fish & Wildl. Res. Unit, Div. Forestry & Nat. Res., West Virginia Univ., Morgantown, WV*, and Dept. Biol., *Kutztown Univ., Kutztown, PA*, PETRA B. WOOD, *US Geol. Sur., West Virginia Coop. Fish & Wildl. Res. Unit, West Virginia Univ.*, and MICHAEL P. STRAGER, *Div. Resource Manage., West Virginia Univ.*

Mountaintop mining dramatically changes forested landscapes, creating the need to quantify effects on terrestrial species which is often lacking in environmental assessments. We examined avian

community abundance in response to landcover and landscape metrics in the mountaintop removal/valley fill region of sw. West Virginia and ne. Kentucky. We used 50-m fixed radius point count data collected in mature forest habitats adjacent to mines during 2008 - 2012 (n = 1086 points; 5,167 detections from 75 different bird species). We created landcover layers using feature extraction from aerial photography flown within 1-yr of avian data collection, and measured forest edge density, % core mature forest, % mature forest, % non-forest mineland, % total barren, and % total grassland/shrubland within a 1-km radius of each point. Survey locations represented a large range of conditions for each metric [i.e., mean % mature forest = 84% (1 - 100%); mean % core mature forest = 55% (0 - 90%); mean % total non-forest mineland = 10% (0 - 83%)]. We completed community-level Threshold Indicator Taxa Analyses for each metric to identify thresholds in the landcover and landscape metrics where avian community abundance increased and decreased. Thresholds for a negative-response by the avian community occurred at <98% mature forest, <79% core mature forest, >1% non-forest mineland, >28 m/ha edge density, >0.3% barren, and >0.2% grassland/shrubland. Thresholds at which a positive community response occurred were at <49%, <16%, >75%, >118 m/ha, >21%, and >47% respectively. Thresholds for individual species varied depending on each species ecology. Data collected during 2013 will be added to the analyses to quantify final individual species and community thresholds.

### **32 Bonisoli-Alquati Møller, Tedeschi, Milinevsky, Mousseau**

Variation across bird species in exposure to radioactive contamination in the Chernobyl region. ANDREA BONISOLI-ALQUATI, *Univ. South Carolina, Columbia, SC*, ANDERS P. MØLLER, *Laboratoire d'Ecologie, Systématique et Evolution, Université Paris-Sud, Orsay, France*, DAVID J. TEDESCHI, *Univ. South Carolina*, GENNADI MILINEVSKY, *National Taras Shevchenko University of Kyiv, Kyiv, Ukraine*, and TIMOTHY A. MOUSSEAU, *Univ. South Carolina*.

Previous studies of the ecological consequences of the Chernobyl accident have shown that birds living in radioactively contaminated areas have increased genetic damage and oxidative stress, reduced brain size and increased aberrations and tumors, among other deleterious consequences. Likely as a result, many populations of birds are declining in areas contaminated by the fallout. These findings, however, are based on environmental measurements of radiation, rather than on direct measures of radioactivity and dose. Here, we describe the results of a large-scale sampling of the understory avifauna aimed at assessing the exposure of different species to radioactive contamination. During Jun 2012, we mist-netted birds across forest plots that differed for radiation levels by 4 orders of magnitude (range: 0.01 - 96.5  $\mu\text{Sv/h}$ ). We captured 376 birds belonging to 38 species (range: 1 - 116 birds per species). To estimate radiation exposure, we conducted gamma spectrometry of 293 of these birds, and converted gamma counts per seconds to radioactivity measurements. In the overall sample of birds, environmental radiation levels significantly positively predicted radioactivity. To further analyze variation across species in exposure to radiation, for each species we regressed radioactivity measurements obtained from gamma spectrometry on the corresponding environmental measurement of radiation in the spot where each bird was captured. The slope of this relationship significantly varied across species. The strength of the relationship also significantly varied across species [range of effect sizes ( $R^2$ ) = 0.01 - 0.78]. These results highlight that bird species vary in their exposure to radioactive contamination. Future analyses will be directed toward analyzing the ecological traits that predict species-specific radiation exposure and sensitivity.

### **33 Hethcoat, Chalfoun**

Nest predation and energy development; what's coming down the pipe for sagebrush obligate songbirds? MATTHEW G. HETHCOAT and ANNA D. CHALFOUN, *Wyoming Coop. Fish & Wildl. Res. Unit, Univ. Wyoming, Laramie, WY*.

Avian eggs and nestlings are vulnerable to a remarkable suite of potential nest predators. Increasingly, human activities alter habitats and hence the context within which predator-prey dynamics historically occurred, further complicating our understanding of nest predation risk. A growing source of anthropogenic disturbance within North America is the result of road networks, pipelines, and drill pads associated with energy development activities. We examined songbird daily nest survival rates across a gradient of well density (wells/km<sup>2</sup>) and tested the hypothesis that energy development activities influenced local nest predation rates via increases in predator abundance. During 2008 - 2009 and 2011 - 2012 we monitored 887 nests of 3 sagebrush species breeding at 12 sites in w. Wyoming. In 2011 and 2012, we identified predators using infrared cameras and assessed predator abundance via point counts,

scent stations, and live-trapping. Daily nest survival rates decreased with well density for Brewer's Sparrows and Sage Thrashers during 3 of 4 yr, while the null model of constant nest survival was most supported for Sage Sparrows. Diurnal and nocturnal rodents comprised 70% of predation events. Concordant with decreased nest survival, rodent detections increased with energy development intensity; suggesting energy development activities modified local predator assemblages. Given increasing demands for both domestic and cleaner sources of energy, understanding why certain predators increase in areas with increased energy development intensity is an important next step. This work is one of a handful of studies which have attempted to identify mechanisms underlying increased nest predation rates, linking predation patterns, nest predators, and human induced habitat alteration.

### **34 McClure, Ware, Carlisle, Barber**

An experimental investigation into effects of traffic noise on distributions of birds: Avoiding the phantom road. CHRISTOPHER JW McCLURE, *Biol. Dept., Boise State Univ., Boise, ID*, HEIDI WARE, JAY CARLISLE, *Biol. Dept., Boise State Univ., and Idaho Bird Observ., Boise, ID*, and JESSE R. BARBER, *Biol. Dept., Boise State Univ.*

The majority of past studies of the effects of road noise on wildlife have suggested that the negative effects of roads on animals are primarily due to traffic noise. However, these past studies were all conducted in the presence of the other confounding effects of roads such as chemical pollution, collisions, and visual disturbance among others. This is the first study to experimentally apply road noise to a road-less area – thereby avoiding the other confounding effects of roads present in past studies. We developed a 0.5-km array of speakers within a migratory stopover site in the Boise Foothills of s. Idaho to produce a noise source which mimicked the traffic noise of an actual road. We surveyed for birds daily using point counts along our “Phantom Road” and in a nearby control site. We alternated between turning our speakers on or off in 4-d intervals from 19 Aug through 9 Oct 2012. Bird abundance along the phantom road declined by over one quarter and some species were nearly extirpated from the phantom road during noise-on periods. This study therefore experimentally corroborates past correlative studies demonstrating negative effects of traffic noise on abundances of animals – suggesting traffic noise is a major driver of the effects of roads on populations of animals. This study also provides the first demonstration of negative effects of anthropogenic noise on migrating birds – i.e., noise can cause migrating birds to avoid otherwise suitable stopover habitat. Managers should therefore consider traffic noise when preserving and managing habitat for migratory birds as well as other taxa.

### **35 McKelvy, Nott, Manne**

The influence of landscape composition on age structure of bird populations and implications for conservation: an example using Yellow Warblers. ASHLEY O. McKELVY, *Dept. Biol., City Univ. New York, Staten Island, NY*, M. PHILIP NOTT, *Institute for Bird Populations*, and LISA L. MANNE, *Dept. Biol., Coll. Staten Island, Staten Island, NY*.

Current methods used to determine whether bird populations are persisting versus declining often use proxies such as abundance or long term occupancy. In migratory birds, these approaches alone may be problematic since a) population size may be heavily influenced outside breeding season; b) suitability of patches may vary despite persistent occupancy, with dominant individuals occupying the best territories; and c) source-sink dynamics may confound observations of persistence when patches are sustained by repeated colonization due to unequal reproductive success between patches. Since annual reproductive success has been shown for many species to be greater for older individuals, age structure may be useful for predicting true population persistence. We tested whether landscape characteristics could predict age structure using age ratios of 21 populations of Yellow Warblers provided by the Monitoring Avian Productivity and Survivorship (MAPS) program. Binomial regressions of the land cover principle components yielded significant results for 2 of the 3 components tested, suggesting that age structure is influenced by landscape context. We also noted that the average number of Yellow Warblers captured per year at a site was not correlated with the proportion of older (after second year) individuals ( $p = 0.973$ ). This has important implications for source-sink dynamics and metapopulation conservation and persistence, as populations with the highest number of individuals may not produce the most offspring per individual.

### **36 Noel, Winn, Keyes**

Can annual surveys on the Georgia barrier coast provide insight into long-term trends for wintering

shorebird populations? BRANDON L. NOEL, *Bethune-Cookman Univ., Daytona Beach, FL*, BRAD WINN, *Manomet Center for Conserv. Sci., Manomet, MA*, and TIM KEYES, *Georgia Dept. Nat. Res., Brunswick, GA*.

Most North American shorebird species spend approximately 70% of their lifetime at migration stopover and wintering sites. The coasts of the se. US provide important wintering habitat for shorebirds. In 1997, a year after the second International Piping Plover Census, we began conducting an annual survey of all shorebird species on all Georgia's barrier beaches. This was a 1-d survey, usually in late Jan, covering approximately 156 km of beach with 70 or more observers. While hypotheses have been proposed that shorebirds will re-distribute in response to local changes, the Georgia coast is one of the most undeveloped coastlines remaining in the se. US. Therefore, we present findings from a subset of 7 remote islands that we believe had reliable and consistent survey effort for the period 1997 - 2013. Fully aware our findings are limited by bias, they still highlight possible trends at a regional scale for wintering species, with minimal human disturbance. We highlight 4 species exhibiting declines (3 that are or high concern: Piping Plover, Marbled Godwit, Sanderling; and Willets) and 6 species exhibiting growth (Semipalmated Plover, Black-bellied Plover, American Oystercatcher, Dunlin, and dowitcher sp.).

### **37     Ambardar, Grindstaff**

Testosterone production in parental and aggressive contexts in Eastern Bluebirds: physiological or behavioral constraint? MEDHAVI AMBARDAR and JENNIFER L. GRINDSTAFF *Zool. Dept., Oklahoma State Univ., Stillwater, OK*.

In birds, testosterone (T) generally promotes territorial aggression while reducing parental care. This is not always the case, however, and in those circumstances, the physiological mechanisms that mediate these relationships are poorly understood. For example, males of some species elevate T following a territorial challenge, while males of other species do not. Species that do not elevate T might be physiologically constrained; their T levels might already be circulating at maximum levels. Alternatively, males might be behaviorally constrained. If males provide care to young, they may incur a cost of elevating T because of the suppressive effects of T on parental care. We investigated how male Eastern Bluebirds elevated T in response to gonadotropin-releasing hormone (GnRH) in parental and aggressive contexts. We videotaped feeding behavior by adult bluebirds when nestlings were 5 - 7 d old. We quantified aggressive behaviors during a simulated territorial intrusion (STI) using a live House Sparrow when nestlings were 7 - 9 d old. Following parental care and STI trials, we collected an initial blood sample to determine circulating levels of T. We then administered GnRH and took a second blood sample to determine if male bluebirds could further increase T levels. We found that males significantly increased T following parental care observations ( $P = 0.03$ ), but they did not increase T following STIs ( $P = 0.69$ ). These data suggest that T production in male bluebirds was not constrained in parental contexts. In aggressive contexts, males did not increase T because they were likely already at maximum levels.

### **38     Barron, Webster, Schwabl**

Body condition influences sexual signal expression independent of circulating androgens in male Red-backed Fairy-Wrens. D. G. BARRON, *School Biol. Sci., Washington State Univ., Pullman, WA*, M. S. WEBSTER, *Lab. Ornithol. and Dept. Neurobiol. & Behav., Cornell Univ., Ithaca, NY*, and H. SCHWABL, *Washington State Univ.*

Androgens play a major role in the regulation of sexual signal expression of male vertebrates. In this study we assessed the prevalent, yet largely untested, assumption that signal honesty is maintained through condition-dependent androgen regulation by experimentally manipulating body condition of male Red-backed Fairy-Wrens (*Malurus melanocephalus*) through trimming several flight feathers before the prenuptial molt. In their first reproductive season males of this species exhibit androgen-regulated plasticity in plumage coloration, ranging from red/black (high androgens) to brown (low androgens). Red/black plumage is preferred by females and might be constrained by a negative relationship between body condition and androgen levels. We also evaluated whether corticosterone changes to altered conditional state mediate the relationship between condition and androgens. While we predicted that males with trimmed feathers would expend greater energy and thus be in poorer condition at the time of molt, they were counter-intuitively in better condition compared to control birds, likely as a consequence of subtle behavioral changes. These birds in better condition molted a greater proportion of red/black plumage, as predicted, and also molted more heavily. However, experimental and control birds did not differ in their androgen or corticosterone concentrations. Furthermore, analysis of long-term data from the

same population revealed no correlation between condition and androgen levels. Collectively, these results challenge the notion that condition-dependent androgen regulation alone is responsible for maintaining the honesty of sexual signals and highlights the necessity of considering alternate explanations.

### **39 Elderbrock, Small, Schoech**

Corticosterone regulation of nestling begging behavior in Florida Scrub-Jays. EMILY K. ELDERBROCK, THOMAS, W. SMALL and STEPHAN J. SCHOECH, *Univ. Memphis, Memphis, TN.*

Altricial young depend upon adults for food during their early life. In birds, nestling begging elicits parental feeding. Begging is hypothesized to communicate an honest signal of a nestling's nutritional needs. Corticosterone (CORT), the avian glucocorticoid, has been identified as a potential regulator of begging. During periods of nutritional deficiency, nestling CORT levels often increase and this may in turn stimulate begging as the nutritionally stressed nestling attempt to gain additional food from adults. In this study we manipulated 2 factors that may influence begging rate: a nestling's CORT levels and food availability. We increased CORT in Florida Scrub-Jay nestlings by administering exogenous CORT on days 8-11 post-hatch. We studied the role of food availability by indirectly supplementing all nestlings within a brood via their parents. Individual nestlings were marked at hatch and monitored until fledging. Nestling mass was measured at hatch and at several points during development, and blood samples were taken on day 11 post-hatch to determine baseline and stress-induced CORT levels. On days 5, 8, 11, and 13 post-hatch we monitored nestling and adult behavior using high-definition videos. Food supplementation did not alter begging rates compared to non-supplemented nestlings. No difference was detected between CORT-treated nestlings and non-treated nestlings within the same nest, however, nestlings within a nest containing a CORT-treated nestlings begged more overall compared to nestlings without a CORT-treated nest mate. These findings suggest that CORT may alter the behavior of the CORT-treated individual and that nest mates are competing with that individual by also increasing begging rates.

### **40 Swanson, Zhang, King**

Relative roles of temperature and photoperiod as drivers of metabolic flexibility in Dark-eyed Juncos. DAVID SWANSON, YUFENG ZHANG and MARISA KING, *Dept. Biol., Univ. South Dakota, Vermillion, SD.*

Seasonal phenotypic flexibility in small birds produces a winter phenotype with elevated maximum cold-induced metabolic rates (= summit metabolism,  $M_{sum}$ ) and cold tolerance relative to summer. Temperature and photoperiod are candidates for drivers of seasonal phenotypes, but their relative impacts on metabolic variation are unknown. We examined photoperiod and temperature effects on  $M_{sum}$  and body composition in winter Dark-eyed Juncos. We randomly assigned birds to 4 treatment groups varying in temperature (Cold = 3° C and Warm = 24° C) and photoperiod (Short Day (SD) = 8L:16D and Long Day (LD) = 16L:8D) in a 2-by-2 design. We measured body mass ( $M_b$ ) and  $M_{sum}$  before and after 6-wk treatments and, at the completion of treatments, removed flight muscles and heart for analyses of body composition. LD birds were significantly larger and gained more  $M_b$  over the treatment period than SD birds, irrespective of temperature treatments.  $M_{sum}$  and the change in  $M_{sum}$  during treatments were higher in cold-exposed than in warm-exposed birds. Flight muscle masses did not differ significantly among groups, but heart mass was significantly larger in cold-exposed than in warm-exposed birds. The cold-induced changes in  $M_{sum}$  and heart mass parallel winter changes for a number of small birds, but the larger  $M_b$  in LD birds and the stable flight muscle masses among groups contrast with typical winter adjustments. Temperature appears to be a primary driver of flexibility in  $M_{sum}$  and heart mass in juncos, but photoperiod appears to induce changes in  $M_b$  and body composition that interact with temperature to contribute to seasonal phenotypes.

### **41 Stager, Swanson, Cheviron**

Molecular mechanisms of metabolic flexibility induced by synthetic, environmental cues in the Dark-eyed Junco. MARIA STAGER, *Dept. Animal Biol., Univ. Illinois at Urbana-Champaign, Urbana, IL,* DAVID L. SWANSON, *Dept. Biol., Univ. South Dakota, Vermillion, SD,* and ZACHARY A. CHEVIRON, *Dept. Animal Biol., Univ. Illinois at Urbana-Champaign.*

Phenotypic plasticity is considered a driving force in evolution; environmental variation can induce



transcriptional responses that enable an organism to adapt by flexibly altering its phenotype. Avian biology is replete with examples of profound phenotypic plasticity (e.g., seasonal changes in plumage, mass, phenology, and diet), including traits that have critical implications for organismal fitness, such as flexibility in metabolic performance. However, very little is known about the mechanisms responsible for these changes in wild birds. In order to gain insight into the fundamental mechanisms of avian metabolic flexibility, we evaluated the effects of 2 environmental cues (photoperiod and temperature) on seasonal variation in metabolic performance and correlated differences in underlying gene expression profiles in Dark-eyed Juncos. We exposed overwintering juncos ( $n = 20$ ) to a 6-wk acclimation trial using a two-by-two experimental design with (a) short or long day lengths and (b) cold ( $3^{\circ}\text{C}$ ) or warm ( $24^{\circ}\text{C}$ ) temperatures. We quantified aerobic capacity (summit metabolic rate;  $M_{\text{sum}}$ ) using open-flow respirometry and collected samples of pectoralis tissue for genomic gene expression profiling. We tested for genes that exhibited differential expression among the experimental treatments, and performed functional enrichment analyses to identify specific biochemical pathways that respond to changes in temperature and day length. Cold-induced enhancement in  $M_{\text{sum}}$  was associated with upregulation of genes involved in oxidative phosphorylation, myogenesis, and hematopoiesis ( $n = 305$  transcripts). Conversely, exposure to warm temperatures was associated with upregulation of genes in apoptotic and immunological pathways ( $n = 284$  transcripts). Photoperiod also induced changes in gene expression, but these differences were not associated with changes in metabolic performance. These findings suggest increased metabolic performance is due to simultaneous changes in genetically independent, but interacting hierarchical pathways.

#### **42 Fairhurst, Marchant, Soos, Machin, Clark**

Experimental relationships between plasma- and feather-levels of corticosterone in a free-living bird. GRAHAM D. FAIRHURST, *Dept. Biol., Univ. Saskatchewan, Saskatoon, SK, and Environment Canada, Saskatoon, SK*, TRACY A. MARCHANT, *Dept. Biol., Univ. Saskatchewan*, CATHERINE SOOS, *Environment Canada, Saskatoon, SK, and Dept. Vet. Pathol., Univ. Saskatchewan*, KAREN L. MACHIN, *Dept. Vet. Biomed. Sci., Univ. Saskatchewan*, and ROBERT G. CLARK, *Environment Canada, Saskatoon, SK, and Dept. Biol., Univ. Saskatchewan*.

Integrated measures of corticosterone (CORT), such as from feathers ( $\text{CORT}_f$ ), have intuitive appeal because they incorporate the duration, as well as the amplitude, of glucocorticoid secretion. However,  $\text{CORT}_f$  is a fundamentally different measure of physiology than an instantaneous sample of CORT from plasma, so it is unclear as to when and if these measures should be correlated. We hypothesized that  $\text{CORT}_f$  should correlate with instantaneous measurements of plasma CORT when the latter reflect sustained changes in the activity of the hypothalamic-pituitary-adrenal (HPA) axis. To test this, we experimentally manipulated levels of plasma CORT in wild nestling Tree Swallows using 5-d time-release CORT pellets, and measured plasma CORT and growth parameters before, during, and at the end of hormone manipulation (days 7, 9, and 11 post-hatch, respectively).  $\text{CORT}_f$  and plasma CORT were significantly positively related only when the latter was at its highest and most variable (day 9). Our results demonstrate that  $\text{CORT}_f$  from free-living birds reflects plasma CORT, but correlations may not always be expected, especially if elevations in plasma CORT are relatively modest and of short duration.

#### **43 Hahn, Oyler-McCance, Pepe-Ranney, Hall**

Microbiota of avian brood parasites shaped by foster parent species: a role in enhanced immunity? CALDWELL HAHN, *US Geol. Surv., Patuxent Wildl. Res. Center, Laurel, MD*, SARA OYLER-McCANCE, *US Geol. Surv., Ft Collins Sci. Center, Ft Collins, CO*, C. P. PEPE-RANNEY, *Dept. Plant & Soil Sci., Cornell Univ., Ithaca, NY*, and E. K. HALL, *Nat. Res. Ecol. Lab., Colorado State Univ., Ft Collins, CO*.

More effective immune responses characterize avian brood parasites like the New World cowbirds that exploit many species. Given the symbiotic role of the gut microbiome in vertebrate immunity, we hypothesized that microbial inoculations from foster parent species contribute to greater diversity of cowbird microbiome and this underlies the cowbird's enhanced immunity. We used next generation sequencing to examine gut and cloacal microbe communities of the cowbird and a non-parasitic relative. We found that cowbird cloacal beta diversity (among individuals) is higher than beta diversity of the closely-related, Red-winged Blackbird, and cloacal diversity is the best predictor of gut diversity.

#### **44 Lombardo, Andrews, Thorpe**

Factors associated with local recruitment in Tree Swallows. MICHAEL P. LOMBARDO, DANIELLE M ANDREWS, and PATRICK A. THORPE, *Dept. Biol., Grand Valley State Univ., Allendale, MI.*

The reproductive fitness of parents is best estimated by the number of offspring they produce that become reproductives. We monitored the breeding biology of Tree Swallows nesting in boxes on the GVSU campus in west Michigan from 1992 - 2006. During that time, 2446 nestlings fledged from 603/780 (77.3%) nests and 166/3463 (4.8%) nestlings and 14.7% fledglings returned to breed at GVSU. While most nests produced fledglings, only 136/780 (17.4%) nests produced one or more recruits; 115 nests produced 1 recruit, 15 nests produced 2 recruits, 5 nests produced 3 recruits, and 1 nest produced 4 recruits. The distribution of recruits coming from broods of different sizes (1 - 3, 4, 5, 6, 7 - 8) was not random; broods of 7 were the most likely to produce recruits. However, the likelihood of producing a recruit did not differ across the most common brood sizes of 4 - 6. The sex ratio of recruits (79 male:70 female: 17 unknown sex) did not significantly differ from 50:50. Neither mother's age category (second year or after second year) nor the physical characteristics of adults were associated with the production of recruits. Recruits were more likely to be reared in nests where egg laying began earlier in the season than those where egg laying started later. We suggest this is an example of the "relative age effect"; swallows that fledge earlier in the season have more time to prepare for migration than those that fledge later.

#### **45 Macias-Duarte, Alvarado-Castro, Gutierrez-Ruacho, Villarruel-Sahagun**

Association of nest success and nesting phenology of the Rufous-winged Sparrow to climate, vegetation, and land use in the Sonoran Desert of Mexico. ALBERTO MACIAS-DUARTE, J. ANDRES ALVARADO-CASTRO, O. G. GUTIERREZ-RUACHO, and L. VILLARRUEL-SAHAGUN, *Universidad Estatal de Sonora, Hermosillo, Sonora, Mexico.*

Global circulation models predict an increase in aridity over northern Mexico. Species specialized in arid ecosystems are then potential indicators of climate change in the region, such as the Rufous-winged Sparrow (*Peucaea carpalis*). In this context, we aimed to determine the effect of the seasonal distribution of summer rainfall and the associated seasonal changes in vegetation on the timing of reproduction and nest success of *P. carpalis* in central Sonora, as well as the effect of the exotic buffelgrass. We monitored 59 nests from 01 Jun to 04 Oct 2012. We analyzed nest survival data implementing logistic-exposure models in program WinBUGS using accumulated summer rainfall, the normalized difference vegetation index (NDVI) and whether the nest was located in a buffelgrass prairie or not as explanatory variables. We found explanatory variables BUFFELGRASS, ndvi, and rainfall among nests did not explain nest daily survival probability. The intercept-only model yielded a mean nest daily survival probability of 97.01%. Given that projected fledgling dates in this population are distributed about the dates of maximum NDVI values at the nest level, the timing of Rufous-winged Sparrow reproduction may have been selected to maximize the concealment of the fledglings. Therefore, we suggest to monitor fledgling survival of the species as a indicator of the effects of climate change on Sonora Desert ecosystems. Given that nest survival seemed unaffected by the habitat alteration in buffelgrass prairies, we conclude that the Rufous-winged Sparrow may be resilient to habitat transformation in the center of its distribution.

#### **46 Stanback, Mercadante, Millican, McGovern**

The cost of breeding (again): Eastern Bluebird replacement nests, clutches, eggs not smaller. MARK T. STANBACK, AUSTIN N. MERCADANTE, DAVID M. MILLICAN, and PATRICK G. MCGOVERN, *Dept. Biol., Davidson Coll., Davidson, NC.*

Recent research suggests that egg production can be extremely costly for free-living birds. To assess the energetic burden of clutch formation for female Eastern Bluebirds, we removed freshly laid clutches and forced females to renest in an adjacent nest box. We performed this experiment in both Apr and Jun of 2010 and 2011. In Apr we removed only clutches of 5 eggs (Apr mode); in Jun we removed only clutches of 4 eggs (Jun mode). We compared nest height, nest thickness, clutch size, egg mass, egg volume, and egg color for original and replacement nests. We found no indication that building a new nest and producing a new clutch presents a substantial energetic challenge to female bluebirds. For Apr nests, the only significant difference (egg volume) was contrary to our prediction that replacement nests would have smaller eggs. For Jun nests, the only significant difference (nest size) was contrary to our prediction that replacement nests would be shorter and thinner. Our results suggest that nest size and egg production in Eastern Bluebirds are not constrained by proximate energy availability.

#### **47     Ruskin, Etersson, B J Olsen**

Characterization of the nest site preferences of Saltmarsh and Nelson's Sparrows, and hybrids. KATHARINE J. RUSKIN, *Ecol. & Environ. Sci., Univ. Maine, Orono, ME*, MATTHEW A. ETTERSON, *Mid-Continent Ecol. Div., US Environ. Protect. Agency, Duluth, MN*, and BRIAN J. OLSEN, *Ecol. & Environ. Sci., Univ. Maine*.

Saltmarsh Sparrows (hereafter SALS) are named on the National Audubon Society's current WatchList as a species of global conservation concern (National Audubon Society 2007). Anthropogenic climate change is perhaps the largest threat to SALS populations because sea level rise is predicted to result in a loss of high marsh habitat, where SALS breed exclusively (Greenberg et al. 2006, **BioScience** 56: 675-685). Marsh conservation and restoration offer hope for mitigating threats to the persistence of SALS by increasing available breeding habitat. However, previous attempts to characterize SALS nesting preference have provided mixed results and there is little evidence for habitat associations that distinguish successful from unsuccessful nests (Gjerdrum et al. 2005, **Condor** 107: 849-862; Shriver et al. 2007, **Auk** 124: 552-560). In this study, we characterized nest preference of SALS, the closely related Nelson's Sparrow (hereafter NESP), and their apparent hybrids in a breeding population in Scarborough Marsh, Maine. We compared nest preference traits to nest success rates to test whether habitat choices are driving differential nest success observed among species. In both years of study, nest success rates were significantly different among species; NESP nests experienced higher rates of failure than SALS and hybrid nests. We found a tendency toward spatial clustering of nest sites at the scale of study plot (approximately 10 ha), but this pattern was not distinguishable from complete spatial randomness. We found significant differences between nest sites and randomly-selected points for various attributes, for example that nest sites were associated with more *Spartina patens*, a thicker thatch layer, and taller vegetation than randomly-selected points. These results indicate that female sparrows are exhibiting a nest site preference based on habitat characteristics at a small spatial scale.

#### **48     Aldredge**

House Sparrows optimize survival of well-fed offspring. ROBERT A. ALDREDGE, *Dept. Biol., Univ. North Carolina at Chapel Hill, Chapel Hill, NC*.

Organisms that provide extensive parental care often produce young that experience high mortality rates prior to reaching independence. Parents can maximize fitness by increasing reproductive investment, including increasing the amount of parental care or increasing the number of offspring produced. Songbirds are an important group of organisms for understanding the factors influencing reproductive investment because young remain sedentary for most of the early life history stages that experience increased mortality. Temperate breeding birds are thought to maximize the number of offspring produced by laying as many eggs as parents can raise in optimal conditions and setting up a developmental size hierarchy to eliminate nestlings when resources are poor. I determined how egg and nestling mortality and growth were associated with natural variation in clutch size in the House Sparrow. The House Sparrow provides an appropriate organism for studying how reproductive investment influences fitness because several reproductive traits, including clutch size, have changed rapidly as House Sparrows expanded across North and Central America over the last 160 yr. 5- and 6-egg clutches produced the greatest number of young that left the nest. Hatching failure occurred frequently and was independent of clutch size. Nestling mortality was high in broods of 6, and growth was reduced in late-hatched nestlings in broods of 5 and all nestlings in broods of 6. Taken together, these data suggest that the optimal clutch size is 5 eggs, which produce the most offspring with maximal growth. Five eggs is the modal clutch size in this population.

#### **49     vacant**

#### **50     Piacentini, Silveira**

Rivers are not barriers: a taxonomic review of the *Phaethornis ruber-stuarti* group (Apodiformes: Trochilidae) suggest alternative promoters of speciation. VITOR Q. PIACENTINI and LUIS FABIO SILVEIRA, *Seção de Aves, Mus. Zool., Univ. Sao Paulo, Brazil*.

The *Phaethornis ruber-stuarti* group comprises up to 6 taxa of South American hummingbirds inhabiting cis-Andean tropical forests and whose taxonomy, distribution and nomenclature has been debated for over 2 centuries. We aimed to review the taxonomy of the group and compare the distribution

of its taxa to biogeographic patterns described for South America. We analyzed 755 skins housed in 28 collections worldwide. Based on color of the tail and the back, width of the pectoral band, and morphometric data we found 5 fully diagnosable taxa that deserve species status: *P. nigrincinctus* (Colombia, sw. Venezuela, Peru and nw. Brazil), *P. ruber* (se. Venezuela, Guiana, w.W Suriname and n. Brazil), *P. pygmaeus* (e. Surinam, French Guiana, e and central Brazil, and Bolivia), *P. longipennis* (s. Peru), and *P. stuarti* (n. Bolivia). The name *ruber* Linnaeus, traditionally applied to the populations of French Guiana and e. Brazil, instead apply to the taxon of Venezuela, British Guiana, Surinam and n. Brazil. Each species is in contact with at least one other species of the group, with the contact zones qualifying as sympatry without hybridization (*nigrincinctus* x *ruber*), sympatry with restricted hybridization (*ruber* x *pygmaeus*, *pygmaeus* x *stuarti*) or parapatry with restricted hybridization (*stuarti* x *longipennis*). Large rivers such as the Amazon, Negro, Marañon, Madeira, Tapajós, Tocantins-Araguaia and São Francisco – which commonly separate related fauna, including other *Phaethornis* species – do not act as barriers to the *ruber-stuarti* group. This suggests that ecological factors and/or sexual selection may have important roles in the speciation and range delimitation of the species within the *Phaethornis ruber-stuarti* group.

## 51 Vaidya, Lepage, Lapp, Guralnick

Quantifying taxonomic redescription: patterns of lumping and splitting in the last 127 years of the **Check-List of North American Birds**. GAURAV VAIDYA, *Univ. Colorado Boulder, CO, DENIS LEPAGE, Bird Studies Canada, Port Rowan, ON, HILMAR LAPP, Natl. Evol. Synthesis Center, Durham, NC, and ROBERT P. GURALNICK, Univ. Colorado Boulder.*

Species discovery curves are essential in quantifying how much of current biodiversity has been documented, but such curves only represent one part of the taxonomic enterprise - adding newly named units of diversity into the pool of existing names. Another process, taxonomic redescription, may be as or more important, especially in well studied groups such as birds. Unfortunately, tracking those 2 processes at the same time is very challenging and requires a significant compilation effort. The AOU's **Check-List of North American Birds** provides a detailed history of taxonomic changes in North American bird taxa between 1886 and 2012. We present our analysis of these changes, including a detailed examination of the criteria used to lump or split species, as recorded in the **Supplements** to the **Check-List** and in cited materials. Our preliminary data show a striking increase in the numbers of splits relative to lumps in the recent past, as well as a net increase in the number of species split or lumped. By August, we will have finished a comprehensive analysis of all lump and split events catalogued by these **Check-Lists**. Preliminary results suggest that redescrptions are the key process by which diversity is increasing in North American birds.

## 52 A E Johnson, Price, Pruett-Jones

Different modes of evolution in males and females generate dichromatism in fairy-wrens (Maluridae). ALLISON E. JOHNSON, *Dept. Ecol. & Evol., Univ. Chicago, Chicago, IL, J. JORDAN PRICE, Dept. Biol., St. Mary's College of Maryland, St. Mary's City, MD, and STEPHEN PRUETT-JONES, Dept. Ecol. & Evol., Univ. Chicago.*

Sexual dichromatism in birds is often attributed to selection for elaboration in males. Yet, evolutionary changes in either sex can result in plumage differences, and such changes can result in either gains or losses of dimorphism. We reconstructed the evolution of plumage colors in both males and females of species in Maluridae, a small family showing wide variation in plumage dichromatism. The family contains monochromatic species in which both sexes are dull (*Stipiturus*, *Amytornis*) or bright (New Guinea *Malurus* sp.), dichromatic species in which males are brighter than females (Australian *Malurus* sp.), as well as variation in dichromatism within species (i.e., *M. alboscapulatus*). We found that, across species, males and females differ in their patterns of evolution. Male plumage colors have diverged at relatively steady rates, whereas female colors have changed dramatically in some lineages and little in others. Accordingly, in comparisons against evolutionary models, plumage changes in males fit a Brownian motion (BM) model, whereas plumage changes in females fit an Ornstein Uhlenbeck (OU) multi-peak model indicating natural selection, with different adaptive peaks corresponding to Australia and New Guinea. Levels of dichromatism are significantly associated with latitude, with greater dichromatism in more southerly taxa. Our results suggest that current patterns of plumage diversity in malurids are a product of evolutionary changes in both sexes. In particular, while sexual selection represents a significant selective force in male malurids, sexual selection is not solely responsible for the observed

patterns of dichromatism.

### **53 Price, Eaton**

Evolution of female traits drives sexual dimorphism in New World blackbirds. J. JORDAN PRICE, *St. Mary's Coll. of Maryland, St. Mary's City, MD*, and MUIR D. EATON, *Drake Univ., Des Moines, IA*.

Males of sexually dimorphic species often appear more divergent among taxa than do females. As a consequence, it is often assumed that male traits have changed more dramatically in the evolutionary past. Yet, phylogenetic studies show that dimorphism can be a product of historical changes in either or both of the sexes. Here we describe the evolution of male and female songs and plumage colors in members of the New World blackbird family, a group with diverse mating systems. Although both songs and colors are clearly influenced by sexual selection, levels of dimorphism in these traits are not related to mating system. Furthermore, although male plumages generally represent greater differences in coloration between species, female plumages represent more frequent and rapid color divergence in the evolutionary past. These findings suggest that the influences of natural and sexual selection in the evolution of sexual dimorphisms in species are more complicated than we often assume.

### **54 Shultz, Baker, Hill, Nolan, Edwards**

Phylogeography and signatures of pathogen-mediated selection using genome-wide diachronic comparisons in the House Finch (*Haemorhous mexicanus*). ALLISON J. SHULTZ, *Dept. Organ. Evol. Biol., Mus. Comp. Zool., Harvard Univ., Cambridge, MA*, ALLAN J. BAKER, *Dept. Nat. Hist, Royal Ontario Mus., Dept. Ecol. Evol. Biol., Univ. Toronto, Toronto, ON*, GEOFF E. HILL, *Dept. Biol. Sci., Auburn Univ., Auburn, AL*, PAUL M. NOLAN, *Dept. Biol., The Citadel, Charleston, SC*, and SCOTT V. EDWARDS, *Dept. Organ. Evol. Biol., Mus. Comp. Zool., Harvard Univ.*

Despite its importance in evolutionary and behavioral research, the phylogeographic history of the House Finch has been a subject of contention. This species is native to the w. US and Mexico, but was introduced into the Hawaiian Islands and the eastern US in 1870 and 1940 respectively. In addition to these recent introductions, a well-documented epizootic caused by the poultry-associated *Mycoplasma gallisepticum* (MG) has been a strong selective force, particularly in the eastern population (Bonneaud et al. 2012, **Proc. Nat. Acad. Sci.** 180:7866-7871). We use double-digest RADseq to sequence thousands of SNPs across the genome in individuals throughout the range, collected before and after exposure to MG. We find population differentiation, but significantly lower genetic variation in both the introduced eastern and Hawaii populations compared to the native western population, consistent with a founder effect. However, we find no change in genetic variation in populations collected before and 9 yr after exposure to MG. By locating  $F_{ST}$  outliers found in all 3 eastern diachronic population comparisons but not in our western diachronic control, we detected 12 loci with signatures of positive selection associated with MG exposure. These loci are found in intergenic, intronic, and exonic regions of the genome, and associated genes code for proteins important in cell signaling. These candidate loci show that populations might adapt to emerging diseases through regulation of existing pathways.

### **55 Lituma, Buehler**

Effects of conservation practices on grassland birds. CHRISTOPHER M. LITUMA, DAVID A. BUEHLER, *Dept. For., Wildl. & Fish., Univ. Tennessee, Knoxville, TN*.

Conservation and management of rare and declining species usually focuses at the practice level scale of research. Grassland and other early successional birds are declining more than any other avian group in North America. The North American Breeding Bird Survey (BBS) is inadequate for modeling species conservation and management associations at multiple spatial scales. Our objective was to determine whether Natural Resources Conservation Service (NRCS) conservation programs and associated practices are effective in positively impacting populations of high-priority grassland and early successional bird species for the Central Hardwoods Bird Conservation Region (CHBCR). We implemented a spatially-balanced roadside monitoring protocol by randomly locating 5 15-km roadside-based routes with 5-min point counts (30 counts/route), along secondary roads within grassland, agricultural, and scrub-shrub cover types in conservation priority counties (n = 37) in the CHBCR from May - Jul, 2008 - 2011. We listened for and recorded 11 high priority grassland songbird species. We acquired spatial locations of conservation programs and their associated practices through NRCS. We used Arc GIS to plot point locations for all programs in the CHBCR. We extracted the program points

located within a 500 m buffer. We used a Chi-squared analysis to compare the observed proportion of conservation programs on points from overall survey routes to the proportion of programs on species specific points. Proportion of conservation programs on Northern Bobwhite points was >19% greater than the proportion on overall surveys, and the proportion of conservation program area on northern bobwhite points was >30% greater than the proportion on overall surveys for all years ( $P < 0.05$ ). Northern Bobwhite are either selecting areas with conservation practices disproportionately to the surrounding area, or state and federal agencies are effectively targeting areas with a greater proportion of Northern Bobwhite population for conservation programs.

## **56 McDermott, Rodewald**

Conservation value of silvopasture and shade agroforestry to Andean forest birds. MOLLY E. McDERMOTT, *School Environ. & Nat. Res., Ohio State Univ., Columbus, OH*, and AMANDA D. RODEWALD, *Dept. Nat. Res., Cornell Univ., Ithaca, NY*.

In the face of continued habitat loss and fragmentation in the Andes, shade agroforestry provides habitat for a diverse assemblage of birds, including several migratory species of concern. Unfortunately, shade coffee continues to be converted to sun coffee and pastures which provide fewer ecosystem services, reduce habitat complexity, and thus, support less biodiversity. Silvopastures are an agroforestry system that combines grazing pastures and trees. In an effort to evaluate the conservation value of little-studied silvopastures to Andean birds, we compared bird communities associated with different types of agroforestry systems, with emphasis on mixed-species flocks and declining species of Neotropical migrants. In Jan - Feb of 2011 - 2013, we recorded species composition, flock size, and individual foraging heights for 446 flocks at 9 sites in the Antioquia province of Colombia. We sampled shade-coffee, shade-cardamom, secondary forest, and silvopasture at ~1,150 - 1,850 m. Silvopastures supported smaller, less diverse flocks with proportionally fewer migrant species and more generalist residents than other habitats. Although silvopasture is preferable to conventional pasture without trees, our findings suggest that silvopastoral systems provide less suitable habitat for flocking birds than other agroforestry types. Further analyses indicate that vegetative complexity and tree density across habitats may be driving patterns in bird habitat use, indicating that conserving and planting trees would be highly beneficial to the maintenance and conservation of Andean bird flocks.

## **57 Stanton, Kesler, Thompson**

Cost-sensitive fine-scale resource selection in a cooperatively-breeding resident bird. RICHARD A. STANTON Jr., DYLAN C. KESLER, *Dept. Fish. & Wildl. Sci., Univ. Missouri-Columbia, Columbia, MO*, and FRANK R. THOMPSON III, *US Forest Serv., Northern Res. Station, Columbia, MO*.

Activities associated with acquiring and maintaining access to critical resources drive movement and space use in birds. The spatial configuration of resources within home ranges should therefore influence bird movements, and resource values should be relative to their locations. We radio-tracked 22 Brown-headed Nuthatches and related their space use and home range sizes to available resources, after accounting for the relative spatial distribution of resources and nests. We developed utilization distributions (UDs) from nuthatch relocations, treating the area of each 95% isopleth as home range size and the height of the UD as relative probability of use. We fit models relating home range size to mean resource measures within home ranges using lognormal regression and related intensity of use to resource metrics at random points by ranking linear mixed models. Areas of high use within nuthatch home ranges were mainly associated with density of recently-killed snags (a likely foraging resource) and recent prescribed fire. Home ranges were generally large (median 7.1 ha, range 0.3 - 47.6 ha) and smaller home range sizes were associated with pine dominance and nest snag density. Predicted home range size decreased by 77% and 71% respectively when percent pine and nest snag density in home ranges were maximized with other covariates held constant. Our results illustrate that territory-scale movement decisions are driven by both the availability and spatial distribution of resources.

## **58 Cunningham, Kesler, Lanctot**

Habitat and social factors influence nest site selection in Arctic-breeding shorebirds. J. A. CUNNINGHAM, D. C. KESLER, *Univ. Missouri Columbia, Columbia, MO*, and R. B. LANCTOT, *US Fish & Wildl. Serv., Anchorage, AK*.

Shorebirds select nest sites at Arctic breeding grounds based on proximate and ultimate factors that may be altered by a changing climate and shifting population demographics. We investigated how

habitat and social features influence nest site selection to better anticipate how shorebirds may be affected by these changes. Shorebird nests ( $n = 1,617$ ) were located on fixed study-plots in Barrow, Alaska between 2005 and 2012. We used satellite-derived land cover imagery and conducted ground surveys of study-plots to attribute habitat information to nests. We also measured distances from nests to nearest nesting shorebird neighbors. To predict nest site selection, we developed candidate sets of mixed models comprised of explanatory variables of relevant habitat and social features. We ranked model sets for 6 species using AICc. We found that nest site selection was not random for any species. Tundra moisture regime within 3 m of the nest was associated with selection for all species, with most selecting drier habitat than randomly available. Increasing tundra microrelief increased probability of nest site selection for American Golden Plovers, Pectoral Sandpipers, and Semipalmated Sandpipers. Distance to nearest conspecific nest was associated with selection for American Golden Plovers, Dunlin, Pectoral Sandpipers, and Semipalmated Sandpipers, which nested farther apart than random distributions predicted. Long-billed Dowitchers selected nest sites that were closer to other non-territorial shorebirds. Our analysis found that shorebirds select nest sites based on habitat features and proximity to other nesting shorebirds, and provides insights into how they may be affected by a changing Arctic landscape.

## **59 Kendrick, Porneluzi, Morris, Haslerig, Thompson, Faaborg**

Stand-level breeding bird density response to experimental forest management in the Missouri Ozarks. SARAH W. KENDRICK, *Dept. Biol. Sci., Univ. Missouri, Columbia, MO*, P. A. PORNELUZI, D. L. MORRIS, *Div. Sci., Math. & Computer Sci., Central Methodist Univ., Fayette, MO*, J. M. HASLERIG, *Missouri Dept. Conserv., Jefferson City, MO*, F. R. THOMPSON III, *US Dept. Agri., Forest Service, Northern Res. Sta., Columbia, MO*, and J. FAABORG, *Dept. Biol. Sci., Univ. Missouri*.

Long-term landscape-scale experiments allow for the detection of trends in bird abundance in different forest management treatments. Landscape experiments focus on large site-scale changes in breeding bird abundance, but analyses of long-term experiments at a finer scale can identify potential drivers of these changes. We studied stand-level bird territory density of 15 species across 19 years of the Missouri Ozark Forest Ecosystem Project (MOFEP) on 9 study sites (3 even-age, 3 uneven-age, and 3 no-harvest sites; 312 - 514 ha in size) in southeast Missouri. We spot-mapped territories on each site during 10 visits for 3-4 h a day. We counted the number of territories per stand (22 - 59 stands per site averaging 4.4 ha) and used generalized linear mixed models with a Poisson distribution, an offset term to account for stand area, and a random site effect to test effects of year, stand treatment type (even-age, intermediate, uneven-age, or no-harvest), and an interaction on the number of territories in a stand. We mapped 30,176 territories of 15 species in 228 stands for 5 yr pre-harvest and 10 yr post-harvest. Treatment and treatment $\times$ year had significant effects on most species and year had a highly significant effect ( $P < 0.0001$ ) on all species. Densities of forest-interior species generally declined post-harvest in all treatment types, and densities of early-successional species increased dramatically post-harvest, especially in clearcut stands. A stand-level scale allowed a finer focus on changes in abundance within sites in harvested stands and in surrounding no-harvest stands and advanced our knowledge of breeding bird response to forest management.

## **60 vacant**

## **61 N W Cooper, Marra, Sherry**

Analyzing movement and tracking data in birds via utilization distributions: now in 3D! NATHAN W. COOPER, *Tulane Univ. New Orleans, LA*, PETER P. MARRA, *Smithsonian Migratory Bird Center, Washington, DC*, and THOMAS W. SHERRY, *Tulane Univ.*

Many animals, including birds, use their environment in all 3 spatial dimensions. However, until recently methods to analyze tracking and movement data in 3 dimensions (3D) did not exist. We describe how to create 3D utilization distributions using a kernel density estimator. We also adapt 2 measures of joint space use, the Volume of Overlap Index (VI) and the Utilization Distribution Overlap Index (UDOI). Using 3D movement data collected on wintering American Redstarts in Jamaica, we then compare and contrast 2D and 3D methods in terms of spatial overlap of territories and adequate sample size. We found a high degree of territorial overlap using both 2D and 3D methods. However, our analysis revealed that using 2D data significantly overestimated overlap, suggesting that wintering redstarts may partition their space in 3D to reduce competition over space and resources. Sample size analysis confirmed previous studies of 2D data in terms of minimum sample size, but also suggested larger sample sizes are

needed for 3D data. This extension of a common method for assessing animal movements provides behavioral ecologists with a powerful new tool to investigate ecologically interesting questions involving territoriality, intra- and inter-species competition, predator-prey relationships, niche partitioning, and foraging ecology.

## **62 Cohen, Hostetler, Royle, Marra**

Estimating migratory connectivity of birds when encounter probabilities are heterogeneous. E. B. COHEN, J. A. HOSTETLER, P. P. MARRA, *Migratory Bird Center, Smithsonian Cons. Biol. Inst., Natl. Zool. Park, Washington, DC*, and J. A. ROYLE, *Geol. Surv., Patuxent Wildl. Res. Center, Laurel, MD*.

Understanding the biology and doing effective conservation of migratory species requires an understanding of the geographic linkages of populations between stages of the annual cycle – the migratory connectivity. Unfortunately, for most species we are lacking such information. The North American Bird Banding Laboratory (BBL) houses an extensive database of marking, recaptures and recoveries of most Nearctic-Neotropical migratory bird species that have yet to be comprehensively analyzed for migratory connectivity. However, heterogeneous encounter probability makes interpretation problematic. Here, we explore the utility of using effort maps across the overlapping non-breeding ranges of species as site-specific covariates to account for the regional variation in encounter and reporting probabilities. The effort covariates are derived from the number of birds recaptured and recovered (exclusive of the species modeled) in the combined non-breeding ranges of the modeled species. We incorporate the values from the effort maps as a recapture and recovery covariate in a multistate model with live and dead encounters. Here we present the geographic linkages from breeding areas to non-breeding regions for several species of intercontinental migrants breeding in North America. The dataset uses records of from 1955 to 2011 that were banded in North America during breeding (May - Aug) and encountered in their winter ranges during winter (Nov - Feb) to build capture histories. We modeled the effect of effort on recapture and recovery probabilities irrespective of the species modeled. Understanding the connectivity of migratory birds is fundamental to our knowledge of population dynamics and has important consequences for conservation and management of migratory species. Our results emphasize the importance of the BBL database for understanding the migratory connectivity of North American birds.

## **63 Pope**

Occupancy of riparian birds in Utah. THERESA L. POPE, *Utah Div. Wildl. Res., Salt Lake City, UT*.

Riparian systems make up <1% of land area in Utah, but riparian systems are arguably the habitat in greatest conservation need. Over 70% of Utah's birds use riparian habitat, yet little was known about population status and trends of these species when Utah DWR initiated a 20-yr riparian monitoring project. To get baseline data and evaluate trends, Utah DWR conducted point counts at 37 riparian sites across Utah from 1992 to 2011. I converted count data to presence-absence data and used the multi-season analysis function in PRESENCE to model occupancy for 48 avian species with data neither too sparse for modeling (e.g., Yellow-billed Cuckoo), nor saturated (e.g., Yellow Warbler), using covariates to identify factors influencing probability of occupancy, colonization, extinction, and probability of detection. For example, probability of occupancy for Broad-tailed Hummingbird was greatest at high elevations and in the Utah Mountains ecoregion (range:  $\psi = 0.49 - 0.99$ ). Song Sparrow and Plumbeous Vireo had the greatest probability of occupying each site, range:  $\psi = 0.81 - 0.98$  and  $\psi = 0.74 - 0.92$ , respectively; whereas Bewick's Wren had the least probability, range:  $\psi = 0.14 - 0.59$ . There were no trends in occupancy for these relatively common species; most species were in equilibrium. Although occupying sites continuously during this study, these species could be declining numerically. Through ongoing analyses, I will also investigate trends in abundance and species-habitat relationships to develop habitat guidelines that will assist managers in assessing and restoring riparian systems throughout Utah.

## **64 Stenger**

The effects of bison on bird diversity in early American forests. JACK M. STENGER, *Dept. Biol. Sci., Univ. Cincinnati, Cincinnati, OH*.

In e. North America, 128 species of birds depend on habitats created by ecological disturbance. Thus, understanding historic patterns and drivers of ecological disturbance is crucial to managing habitat for these species. Previous studies have considered the impact of abiotic and human-induced disturbance in early American forests, yet the role of extirpated herbivores, such as the American Bison



(*Bison bison*), remains largely unexplored. Bison occurred throughout much of e. North America prior to European expansion. They were abundant in forested landscapes in the Central Hardwoods ecoregion. Herds of bison, often numbering in the thousands, wore great roads into the earth, created wetlands with their wallowing, killed woody vegetation by rubbing, horning, and bark-stripping, and maintained grassland and shrubland by grazing and trampling. When we consider the impact of extirpated herbivores, our understanding of the historic patterns of disturbance-created habitats changes. They were not always ephemeral, isolated, and patchily distributed as has been suggested. Bison created and maintained successional habitats in predictable locations. Furthermore, bison roads connected successional habitats on a local and regional scale. The impact of bison on historic forests raises questions relevant to modern conservation. For example, were bison a keystone species in some eastern forests? Are bison a potential management tool for disturbance-dependent wildlife?

## **65 James, Spitzer**

How many species of Hawaiian birds? HELEN F. JAMES and MEGAN D. SPITZER. *Natl. Mus. Nat. Hist., Smithsonian Inst., Washington, DC.*

The richness and diversity of native birds in the Hawaiian Islands have been obscured by recent extinctions caused by human-induced ecological changes. Forty extinct species of Holocene fossil birds have been described, and approximately another 23 extinctions are documented by museum skin specimens. Before we can confidently analyze biogeographic patterns in the Hawaiian avifauna, we need estimates of how many human-caused extinctions of species and populations have not yet been discovered. Estimates are needed for each major island as well as archipelago-wide. We have compiled a nearly-comprehensive inventory of the Hawaiian fossil record of birds, enabling us to approach this question using several methods: 1) a mark-recapture approach, 2) analysis of biogeographic gaps in the distribution of widespread taxa, 3) analysis of species-abundance curves for fossil assemblages, 4) consideration of taphonomic biases in fossil sampling. We use our estimates of species richness before the human era, per island, to ask whether the Hawaiian avifauna exhibits an evolutionary species-area relationship.

## **66 Kelley, DuVal**

Quantifying predator-driven natural selection on nest phenotypes in the Lance-tailed Manakin: a 10-year study. J. PATRICK KELLEY and EMILY H. DuVAL, *Dept. Biol. Sci., Florida State Univ., Tallahassee, FL.*

Quantifying the form of natural selection acting on reproductive traits is important for understanding how birds may respond to changing environments. Ornithologists have amassed huge data sets on the factors that influence nest survival, such as nest site selection or parental behavior. Yet, such patterns have not been placed within the context of natural selection through the estimation of selection gradients or estimation and visualization of complex fitness surfaces that would allow comparisons to other studies of other populations or species. Using 10 yr of data from Lance-tailed Manakins (*Chiroxiphia lanceolata*) on Isla Boca Brava in w. Panama, we quantified patterns of predator-driven natural selection acting on nest phenotype. Using a semiparametric nonlinear modeling and visualization approach, we examined 786 nests (13,047 exposure days) and estimated the mode and magnitude of selection acting on timing of breeding, nest height, and nest age. The mode of natural selection varied between and within years. In half the years, natural selection appeared random with respect to nest phenotype. In 3 years, we observed strong selection against nests higher than 1-m and also against older offspring (nestlings). We discovered 3 years where correlational selection was prevalent, whereby the pattern of selection on both nest height and nest age varied across the breeding season. This study highlights how basic nesting data may be used to address fundamental questions related to offspring viability selection and also underscores the utility of semiparametric modeling and model selection determining the strength and form of natural selection acting on nests.

## **67 Greig, Baldassarre, Webster**

Subspecies discriminate against foreign song but not plumage: Red-backed Fairy-Wrens attack feathered mounts of many colors. EMMA I. GREIG, DANIEL T. BALDASSARRE and MICHAEL S. WEBSTER, *Lab. Ornithol., and Dept. Neurobiol. & Behav., Cornell Univ., Ithaca, NY.*

Socially selected signals, such as plumage and song in birds, may diverge in allopatry or parapatry. Understanding how such traits interact when divergent populations come together is important

because some signals may hinder gene flow while others facilitate hybridization and introgression. Here, we investigated the relative effectiveness of divergent song and plumage as isolating mechanisms in 2 subspecies of the Red-backed Fairy-Wren (*Malurus melanocephalus*). In this system, song shows geographic patterns of variation that correspond to genetic divergence across a historical geographic boundary, but plumage shows geographic patterns of variation that suggest asymmetrical introgression of the trait has occurred from one subspecies (*M. m. cruentatus*: red) to the other (*M. m. melanocephalus*: orange). Using playbacks, artificially feathered mounts and a reciprocal experimental design that included presentations of mismatched song and plumage, we tested the hypothesis that divergent signals resistant to introgression (here, song) exhibit greater behavioral isolating potential than signals that introgress (here, plumage). Additionally, we tested the hypothesis that unidirectional plumage introgression in this system is caused by a behavioral asymmetry in territorial interactions between red- and orange-plumaged males. We found that both subspecies discriminated against foreign song irrespective of mount plumage, but neither discriminated against foreign plumage when combined with local song. Our results complement other work indicating that song is often an important behavioral isolating mechanism. We do not detect asymmetrical behavioral tendencies in territorial responses to plumage, so other factors such as mating preferences may explain the unidirectional introgression of plumage in this system.

## **68 Baldassarre, Webster**

Experimental evidence of asymmetrical introgression of a sexual trait via extra-pair mating. DANIEL T. BALDASSARRE and MICHAEL S. WEBSTER, *Dept. Neurobiol. & Behav. and Lab. Ornithol., Cornell Univ., Ithaca, NY.*

Sexual selection is thought to be a main factor promoting reproductive isolation during speciation, but it may also facilitate hybridization and thus restrict speciation. When 2 recently diverged taxa meet at a zone of secondary contact, and reproductive isolation is incomplete, sexually selected traits may introgress asymmetrically from one taxon to the other. The Red-backed Fairy-Wren is a small Australian passerine classified as 2 subspecies that differ primarily in male plumage color (red vs. orange). There is evidence of asymmetrical introgression of plumage color from the red subspecies into the genetic background of the orange subspecies. We hypothesized that this asymmetrical introgression may be facilitated by sexual selection if red males have a mating advantage over orange males. To test this idea, we experimentally manipulated the plumage of a subset of wild males in a population of the orange subspecies. The birds were manipulated at the beginning of the breeding season and then released into the population, where we could monitor their reproductive success. Experimentally reddened males sired the same amount of within-pair young as control and sham treatment males, but sired significantly more extra-pair offspring. This extra-pair mating advantage translated to a significant difference in total reproductive success. Thus we conclude that sexual selection via extra-pair mating is a likely mechanism responsible for the asymmetrical introgression of plumage color in this system.

## **69 C M Curry, Patten**

Sexual and natural selection on song across the temporally complex hybrid zone of Tufted and Black-crested Titmice (Paridae). C. M. CURRY and M. A. PATTEN, *Dept. Biol. and Oklahoma Biol. Surv., Univ. Oklahoma, Norman, OK.*

Hybrid zones, where distinct populations interbreed, are excellent systems to study selection across gradients (Arnold 1997, **Natural hybridization and evolution**). We ask how natural and sexual selection on song affects reproductive isolation across a temporally complex hybrid zone between 2 passerine sister species, Tufted (*Baeolophus bicolor*) and Black-crested (*B. atricristatus*) titmice. They interbreed in 2 contact zones of differing age (Patten and Smith-Patten 2008, **BNA**, no. 717). We also ask which hybrid zone models (tension zone, tension zone with reinforcement, or bounded hybrid superiority; Arnold 1997) best explain observed zone stability (Dixon 1990, **Auk** 107:184-188). To test natural selection, we looked for evidence of the acoustic adaptation hypothesis (Morton 1975, **Am. Nat.** 109:17-34) and morphological constraints (Podos 2001, **Nature** 409:185-188). To test for sexual selection, we conducted male playback and female mate choice experiments. To compare hybrid zone models, we estimated reproductive fitness. Vegetation was not correlated with interspecific song differences, but was correlated with characteristics predicted by the acoustic adaptation hypothesis. Beak dimensions correlate with characteristics predicted to be constrained, but not across species. For male responses to song, in the older zone each species responds most strongly to conspecific song; in the younger zone, the parental species show no preference. These data suggest that reproductive isolation is

stronger in the older zone and that a tension zone model may best explain the stability of this system. Ongoing analysis with mate choice and fitness data should determine if differences are due to pre-zygotic or post-zygotic isolation.

## **70 Carling, Parchman**

Introgression on a genomic scale: using next-generation sequencing to investigate hybridization between *Passerina amoena* and *Passerina cyanea*. MATTHEW D. CARLING and THOMAS L. PARCHMAN, *Univ. Wyoming, Laramie, WY*.

Speciation is a critical component of biodiversity generation and understanding this dynamic phenomenon requires a thorough investigation of the genetic basis for the evolution of reproductive isolation. While previous investigations of the hybrid zone between *Passerina amoena* (Lazuli Bunting) and *Passerina cyanea* (Indigo Bunting) have demonstrated that introgression patterns differ among different classes of loci (mitochondrial, autosomal, sex-linked) and that hybridization patterns are influenced by patterns of environmental heterogeneity, these studies have analyzed relatively few loci. Here we expand on prior work by analyzing tens of thousands of loci collected using next-generation sequencing technologies. Ongoing analyses suggest the underlying genetic architecture of reproductive isolation between these species is complex and involves many genetic regions. We will discuss how these data can be used to identify the genetic basis of reproductive isolation as well as how these data can elucidate the influence of environmental heterogeneity on the continued maintenance of reproductive isolation between these species.

## **71 R L Curry, Low, McKenna**

Variation in achromatic plumage brightness associated with hybridization between Black-capped and Carolina chickadees. ROBERT L. CURRY, KELSEY A. LOW and AMANDA L. MCKENNA, *Dept. Biol., Villanova Univ., Villanova, PA*.

Achromatic plumage brightness, including variation in UV wavelengths, correlates positively with dominance and reproductive success in Black-capped Chickadees (BCCH), but patterns in Carolina Chickadees (CACH) and hybrids have not been examined previously. As a prelude to determining whether plumage variation influences female mate choice during hybridization, we used field spectrometry to investigate variation among breeding BCCH and in 2011 and 2012, and among hybrid-zone chickadees (HYCH) in 2012, CACH in southeastern Pennsylvania. Breeders from all populations exhibited achromatic sexual dimorphism, with males averaging brighter than females. Discriminant Function Analysis distinguished brighter BCCH from duller CACH in both sexes. Plumage brightness in HYCH of both sexes was intermediate on average and more variable relative than that of BCCH and CACH. Overlapping brightness distributions for the sexes could reduce the utility of plumage characteristics as signals of rank and attractiveness among hybridizing chickadees. Determining whether variation in plumage brightness within the HYCH population is associated with genotype variation (hybrid index) revealed by single nucleotide polymorphism (SNP) markers is a component of ongoing study.

## **72 Jiménez, Ornelas, Cicero**

Molecular analysis and ecological niche modeling reveal that Blue-tailed Hummingbird might be the result of hybrid speciation. ROSA A. JIMÉNEZ, FRANCISCO ORNELAS, *Instituto de Ecología, A.C., Xalapa, Veracruz, México*, and CARLA CICERO, *Mus. Vert. Zool., Univ. California, Berkeley, CA*.

Hybridization between Berylline (*Amazilia beryllina*) and Blue-tailed (*A. cyanura*) hummingbirds has been proposed since 1911. Based on morphology, these 2 species could be hybridizing in Guatemala and El Salvador. However, it has never been suggested that Blue-tailed hummingbird might be the result of hybridization between Berylline and Steely-vented (*A. saucerrottei*) hummingbirds, which might explain the wide phenotypic variation in the area. Analysis of 12 microsatellite loci shows that Blue-tailed and Berylline hummingbirds from central Mesoamerica (between Isthmus of Tehuantepec and the Nicaragua Depression) carry a mixture of alleles found in one or the other of their putative parental species, forming a third group. Central Mesoamerican individuals also carry unique mitochondrial DNA haplotypes related to either one parental species or the other. Ecological niche modeling indicates that Berylline Hummingbird is distributed mostly in the highlands, Steely-vented Hummingbird inhabits mainly lowlands, and hummingbirds from the contact zone are found at intermediate elevations. Our results indicate that Blue-tailed Hummingbird might be the result of hybridization between 2 diverged forms, and it may have remained in isolation due to the geomorphology of central Mesoamerica.

### **73 Megna, Moncrieff, Hayward, Henson**

Equal reproductive success of phenotypes in the *Larus glaucescens-occidentalis* complex. LIBBY C. MEGNA, ANDRE E. MONCRIEFF, JAMES L. HAYWARD, *Dept. Biol., Andrews Univ., Berrien Springs, MI* and SHANDELLE M. HENSON, *Dept. Mathematics, Andrews Univ.*

Glaucous-winged Gulls (*Larus glaucescens*) and Western Gulls (*L. occidentalis*) hybridize extensively where their ranges overlap along the coasts of Washington and Oregon, producing a continuum of phenotypic intergrades between the 2 parental species. This zone often is considered an example of bounded hybrid superiority, but studies of relative fitness among parental types and hybrids have not consistently supported this model. We tested the predictions of the dynamic-equilibrium and bounded hybrid superiority hypotheses by studying mate choice and reproductive success among gulls on Protection Island, Washington, the largest breeding colony of Glaucous-winged/Western Gulls within the hybrid zone. Additionally, we investigated whether phenotype, hatching success, and nest site choice are correlated for Protection Island gulls. We assigned a hybrid index to each sample bird by examining plumage melanism and bare part coloration in the field. Sheltered nests contained larger clutches and exhibited increased hatching success, but choice of nest habitat was not associated with hybrid index. Western Gull-like pairs produced smaller third eggs; however, hybrid index was not correlated with clutch size or hatching success. The most abundant phenotypes on the colony were not significantly more or less successful than other phenotypes. Additionally, we found significant evidence of assortative mating. Thus, we did not find strong support for either bounded hybrid superiority or the dynamic-equilibrium hypothesis.

### **74 Cheviron, Taylor, J Jones, Lovette, Carling**

Comparative transcriptomics and environmental adaptation in *Poecile* chickadees. ZACHARY A. CHEVIRON, SCOTT TAYLOR, *Lab. Ornithol., Cornell Univ., Ithaca, NY*, JENNIFER JONES, *Dept. Animal Biol., Univ. Illinois, Urbana-Champaign, IL*, IRBY J. LOVETTE, *Lab. Ornithol.*, and MATT D. CARLING, *Dept. Zool. & Physiol., Univ. Wyoming, Laramie, WY.*

Theory suggests that local adaptation should often involve coordinated changes in the structure and expression of hundreds of proteins that participate in hierarchical biochemical pathways, and pleiotropic constraints that arise from the architectures of these pathways can influence the adaptive potential of specific proteins. Chickadees (genus *Poecile*) collectively occupy one of the broadest altitudinal and latitudinal winter ranges of any passerine genus, and metabolic performance influences species-level range limits, making them an excellent model to study the mechanistic underpinning of environmental adaptation. We used massively-parallel sequencing of skeletal muscle transcriptomes (RNA-seq) to simultaneously examine the expression and sequence variation of over 15,000 genes in 3 chickadee species, *Poecile atricapillus*, *P. carolinensis*, and *P. gambeli*. Using a pathway-level population genomic approach, we examined 1.) whether interspecific levels of genetic divergence were randomly distributed among biochemical pathways, 2.) whether gene expression divergence was correlated with sequence divergence both within and among pathways, and 3.) whether regulatory network structure influences levels of genetic diversity both within and among species. We found that levels of genetic divergence were not randomly distributed among pathways. Instead, genes that participate in oxygen transport, aerobic metabolism, and oxidative stress response were significantly over-represented among those exhibiting levels of divergence that deviated from neutral expectations. We also found a weak positive correlation between sequence divergence and gene expression divergence, but the strength and direction of this relationship varied among pathways. Finally, highly connected genes that occupy central positions of regulatory networks exhibited reduced intraspecific diversity and interspecific divergence compared to genes in peripheral network positions.

### **75 A S Cox, W A Cox, Thompson, Faaborg**

Factors affecting post-fledging survival in passerine birds and the value of post-fledging studies to conservation efforts. ALLISON S. COX, *Omaha, NE*, W. ANDREW COX, *Univ. Missouri, Columbia, MO*, FRANK R. THOMPSON III, *USDA Forest Service Northern Res. Sta., Columbia, MO*, and JOHN FAABORG, *Univ. Missouri, Columbia, MO.*

The post-fledging period remains an understudied life stage in passerine birds, which reduces the utility of demographic models and hinders conservation efforts. We reviewed the literature for studies examining survival of passerine birds during the post-fledging period to synthesize the current state of

knowledge of factors that influence survivorship. We also examined how post-fledging survival studies may inform population trends by estimating best-case first year survival rates based on post-fledging survival rates. Fledging age was a strong predictor of survivorship, with the highest mortality during the first 3 wk post-fledging. Post-fledging survivorship among species increased with adult body mass and nestling period duration. The relatively high proportion (12 of 19; 63%) of studies that detected at least one habitat effect on survivorship suggests that management focused on post-fledging habitat can improve survival. Best-case first year survival rates indicated that post-fledging survival may be lower than needed to maintain a stable population in 6 of 17 cases (35%), but the lack of knowledge regarding differential survival between first-year and adult birds during migration and/or the winter limits the utility of post-fledging survival estimates in population models. Much remains unknown about the first year of life in passerines, but post-fledging survivorship is a useful metric because it provides a ceiling on overall first-year survival, it may respond to habitat management, and it is required knowledge that brings us one step closer to building comprehensive demographic models for songbirds.

## **76 Dillon, Conway**

Does nest predation or food limitation explain the elevational gradient in clutch size in Red-faced Warblers? KRISTEN G. DILLON, *Idaho Coop. Fish & Wildl. Res. Unit, Dept. Fish & Wildl. Sci., Univ. Idaho, Moscow, ID*, and COURTNEY J. CONWAY, *US Geol. Surv., Idaho Coop. Fish & Wildl. Res. Unit, Dept. Fish & Wildl. Sci., Univ. Idaho*.

Birds typically lay smaller clutches at higher elevations. For example, Red-faced Warblers (*Cardellina rubrifrons*) breeding at higher elevations lay a 20% smaller clutch than individuals breeding at lower elevations within the same mountain range. Nest predation and food limitation are the 2 most-commonly invoked hypotheses to explain variation in avian life history traits, but the influence of these 2 processes to explain elevational gradients in clutch size have not been tested. We tested a suite of both experimental and correlative predictions of the Food Limitation and Nest Predation Hypotheses to explain elevational variation in clutch size in Red-faced Warblers in se. Arizona. We also tested whether the pattern merely reflects elevational gradients in breeding season length or breeding phenology. Although Red-faced Warblers initiated nests later in the season at higher elevations (8 May vs. 20 May), variation in breeding phenology by itself cannot explain the pattern and the length of the breeding season (23 d) was similar across breeding elevations. Females provided supplemental food did not increase their clutch size, and ambient arthropod abundance increased (not decreased) with elevation. Females exposed to an increased perception of nest predation risk decreased their clutch size slightly (as predicted by the Nest Predation Hypothesis), but ambient nest predation rates were not correlated with breeding elevation. Elevational patterns in breeding density of warblers mirrored the elevational pattern in abundance of arthropod prey, suggesting that elevational variation in female condition or female age may be responsible for the elevational gradient in clutch size. Moreover, nestling growth rates were positively correlated with breeding elevation. Hence, smaller clutches at higher elevations may reflect strong selection on timing of fledging.

## **77 Chiavacci, Benson, Ward**

Not all predators are created equal: patterns in nest predation differ based on the type of predator involved. SCOTT J. CHIAVACCI, THOMAS J. BENSON and MICHAEL P. WARD, *Illinois Nat. Hist. Surv. and Univ. Illinois, Champaign, IL*.

It is well established that nest predation is the primary cause of nest failure in birds, yet we know relatively little of what influences the probability of nests being depredated by certain predators. While cameras have enabled identification of nest predators, attempts to elucidate patterns in predation when predators are known may be obscured if predators are combined into a single or several general groups for analyses. Our objective was to identify factors useful for explaining predator-specific patterns in nest predation. Using cameras, we documented shrubland bird nest predators and grouped predators into species-specific or ecologically relevant categories. We analyzed how habitat, temporal, and biological factors influenced the probability of predation by certain predators using multinomial logistic regression. We monitored over 340 nests with cameras and documented over 130 predation events involving 24 predator species. We found that factors useful for predicting the probability of nest predation differed among nest predators. The probability of nests being depredated by either snakes or raccoons was influenced by nest height and day of year. Also, whereas the probability of long-tailed weasel predation was influenced by vegetation density around nest sites, the probability of predation by corvids and raptors

was influenced by nest stage and the amount of vegetation concealing nests. These findings demonstrate that factors influencing nest predation vary among predator species, illustrating the utility of predator-specific analyses. As camera systems continue to be used for nest predator identification, such analyses may prove more definitive when attempting to explain nest predation probability.

## **78 Buxton, Benson**

Making the most of what remains: determining urban grassland quality in Illinois. VALERIE L. BUXTON, Dept. Nat. Res. & Environ. Sci., Univ. Illinois, Urbana-Champaign, IL, and THOMAS J. BENSON, *Illinois Nat. Hist. Sur., Champaign, IL.*

As urban and suburban development continues to spread, natural environments are invariably converted into areas that are unsuitable for many native wildlife species. In these landscapes, most of the areas that once provided habitat for many bird species have been lost, fragmented, and surrounded by unsuitable habitat. This is especially relevant for grassland birds which are the most consistently declining group of species in North America, with at least 48% of conservation concern. In developed landscapes, which are largely unsuitable for grassland birds, suitable grassland fragments are needed if these species are to persist. In the greater metropolitan Chicago region there are >12,000 ha of grassland that may provide valuable habitat for grassland birds. However, little is known about the value of grasslands located in an urban matrix. We examined grassland bird habitat use and reproductive success in a range of patch sizes across an urban to rural gradient to determine the quality of this available habitat. Although occupancy and densities varied depending on numerous factors including habitat structure and landscape context, grasslands in the Chicago region provided habitat for several species of conservation concern, including Henslow's Sparrow, Dickcissel, Grasshopper Sparrow, and Bobolink. Overall, our results suggest that grasslands embedded in urban landscapes can contribute to grassland bird conservation and this research contributes to an ongoing effort to determine the factors important for designing grassland bird conservation areas in these landscapes.

## **79 Marini, Heming**

Southward increase in variation and egg volume of New World flycatchers. MIGUEL Â. MARINI and NEANDER M HEMING, *Zool. Dept., Univ. Brasília, Brasília, DF, Brazil.*

To understand reproductive investment, geographical variation in egg size and its relationship with ecological and environmental variables are well documented for several taxa. However, it remains insufficiently described for birds in spite of relatively well-known clutch size latitudinal gradient. Clutch size varies little throughout the Neotropical region, a pattern that has been challenging researchers. Egg volume, on the other hand, might be influenced by several factors, which makes its investigation an interesting alternative to understand bird reproductive investment. Here, we evaluate geographical variation in egg volume of Fluvicolinae Flycatchers thorough the New World. We made a comprehensive literature review, tested for spatial autocorrelation using Moran's I, and examined the relative support for the ecological and environmental variables in explaining egg volume using linear models and multi-model inference. Egg volume was larger in South than in North America and tended to increase southward even after controlling for species body mass. Long-distance migrants have smaller eggs than resident species, and cavity and enclosed nesters have larger eggs than open nesters. Neither species clutch size nor seasonality influence egg mass. The increase in egg volume and variability in the Southern hemisphere is striking because it shows an opposite pattern relative to clutch size. In addition, seasonality, a classical variable to explain clutch size gradient, does not explain the variation in egg volume. The milder climate in Austral and Neotropical America may increase the importance of individual birds' condition and environmental variability across years, permitting higher variability in egg volume.

## **80 Ruiz-Sánchez, Rojas-Soto, Renton**

Subspecies and seasonal ecological niche variations of Wilson's Warbler. ANGELINA RUIZ-SÁNCHEZ, *Universidad Nacional Autónoma de México, Coyoacán, Distrito Federal, México,* OCTAVIO ROJAS-SOTO, *Instituto de Ecología, Xalapa, Veracruz, México,* and KATHERINE RENTON, *Instituto de Biología, Universidad Nacional Autónoma de México, Jalisco, México*

Wilson's Warbler (*Cardellina pusilla*) is a Neotropical migrant considered in 3 subspecies: *C. p. pusilla* that breeds in eastern North America and *C. p. pileolata* and *C. p. chryseola* that breed in western North America. Previous genetic analyses suggest that these 2 allopatric subspecies groups may be cryptic species. In the present study we evaluate whether the ecological niches of the 2 geographic

groups differ more than expected by chance, using a background ENMtools test and a novel analysis of the distances of the species records to its ecological niche centroid. We also analyzed seasonal variation of the ecological niche for summer and winter distributions. We found that *C. p. pusilla* and the *C. p. pileolata/chryseola* group present niche switching, meaning that they utilize different climatic regimens in summer and winter distributions. The seasonal analysis also enabled us to determine 2 potential geographic and ecological routes that the 2 subspecies groups follow during the months of spring and autumn migration. Our findings demonstrate that there are ecological niche differences between *C. p. pusilla* and *C. p. pileolata/chryseola*, supporting the cryptic species theory. These differences in ecological niche may provide insights to the geographically differentiated population decline shown by the species in the past 4 decades.

## **81 Rushing, Dudash, Marra**

Climate drives long-distance dispersal in a migratory bird. CLARK S. RUSHING, MICHELE R. DUDASH, *Dept. Biol., Univ. Maryland, College Park, MD*, and PETER P. MARRA, *Smithsonian Conserv. Biol. Inst., Migratory Bird Center, Washington, DC*.

Global climate change represents a major threat to the planet's biodiversity. Long-distance migratory birds are believed to be particularly vulnerable to climate change if they cannot adjust the timing of spring migration in response to advances in temperate phenology. Flexible dispersal strategies could buffer individuals from the effects of climate change by ensuring that reproductive effort coincides with optimal resource levels. However, at present there is no direct evidence that long-distance dispersal in migratory species is influenced by large-scale climate conditions. We studied American Redstarts breeding at the Patuxent Research Refuge in Laurel, MD, and used stable hydrogen isotopes to quantify the effects of individual-level traits and climate conditions on long-distance dispersal. We found no evidence that individual-level traits (sex, size, body condition, or winter habitat quality) were significant drivers of dispersal but both spring phenology and winter conditions in the Caribbean were significant predictors of immigration into our population. In years with early phenology, both yearling and older individuals were more likely to immigrate from the south of our study site while in years with later phenology individuals were more likely to originate to the north. Furthermore, dispersal in yearling individuals was influenced by climate conditions in the Caribbean, with individuals more likely to disperse north following winters with poor conditions. Our results suggest that long-distance dispersal in migratory birds is driven primarily by climate conditions experienced throughout the entire annual cycle and these results have important implications for understanding how migratory species will respond to climate change.

## **82 Filadelfo, Silveira, Marini**

Cowbird experimental brood parasitism in a neotropical savanna, Brazil. THIAGO FILADELFO, MARIANA B. SILVEIRA and MIGUEL A. MARINI, *Dept. Zool., Brasilia Univ., Brasilia, DF, Brazil*.

We experimentally parasitized clutches with model eggs mimicking Shiny Cowbird eggs and followed hosts' behavioral response. The study was conducted in the interior of a well preserved reserve in the Cerrado (savanna-like habitat) and in small rural fragments in the surrounds of that same reserve in central Brazil. We tested the Evolutionary Lag Hypothesis (Rothstein 1975, *Condor* 77: 250-271) in 33 species from 13 families (n = 168 nests; 1 - 20 nests each species) to determine which species have developed defences against brood parasitism. We found that 25 species accepted eggs, 5 rejected and 3 could not be classified yet. Overall, egg acceptance was higher than egg ejection suggesting that hosts have not been exposed to parasitism long enough to evolve egg discrimination and rejection behaviors. Since only *Turdus rufiventris*, *Cyclarhis gujanensis*, *Tyrannus savana*, *Tyrannus melancholicus* and *Pitangus sulphuratus* rejected parasite model eggs, it is possible that this ability have evolved only recently in these host populations. Egg rejection behavior was also present and absent in species from 7 families: Psittacidae, Picidae, Tyrannidae, Mimidae, Vireonidae, Turdidae and Thraupidae, suggesting a probable species-specific response. An evolutionary lag may persist if mutations that affect egg discrimination and ejection do not evolve or do not become widespread in their populations.

## **83 Duckworth**

Maternal effects produce adaptive shifts in behavior during population colonization. RENEE A. DUCKWORTH, *Ecol. & Evol. Biol., Univ. Arizona, Tucson, AZ*.

Identifying the mechanisms that enable species to successfully colonize new habitat is crucial for predicting species invasions and range expansions. Previous work established that, in Western Bluebirds, a species that has undergone a recent range expansion and historically depended on postfire habitat, breeding females influenced son's competitive ability by producing sex-bias in egg laying order in response to changes in resource abundance. Using long-term data from multiple populations of known colonization stages, I show that within and across populations, sex-biased egg laying order closely tracks changes in hetero- and conspecific density occurring during colonization. Such modifications fine-tune son's competitive ability during different stages of colonization. These results establish maternal effects as an important, albeit frequently overlooked, mechanism for adaptive shifts in traits during species range expansion. Further, they show that integrating a species historical colonization history with current patterns of range expansion is crucial to understanding colonization dynamics.

#### **84 Wang, C E Cooper, Ardia, Winkler**

Patterns and timing of nest attendance in New World swallows. JENNIFER M. WANG, *Univ. Central Arkansas, Conway, AR*, CAREN E. COOPER, *Lab. Ornithol., Cornell Univ., Ithaca, NY*, DANIEL R. ARDIA, *Franklin & Marshall Coll., Lancaster, PA*, and DAVID W. WINKLER, *Lab. Ornithol.*

The onset of incubation mechanistically links clutch size with hatching asynchrony, 2 life history traits with well documented latitudinal patterns. Although there has been mixed empirical support for adaptive hypotheses of hatching asynchrony, a recent shift to those addressing physiological or environmental constraints has begun to explain intraspecific patterns in clutch size and hatching asynchrony. Using nest temperatures from the laying period to hatching, we tested the egg viability and energetic constraints hypotheses for the onset of incubation in 4 *Tachycineta* species at 7 sites along a latitudinal gradient. We predicted that ambient temperatures above physiological zero lead to earlier onset, while poorer body condition and suboptimal foraging conditions delay onset. Individual and environmental variables were also predicted to correlate with patterns of onset that range from optimal to suboptimal. The patterns of onset were classified according to a published typology (Wang & Beissinger 2009, *Anim. Beh.* 78: 601-613), with diurnal patterns being assigned to the Rising and Irregular Rising groups. Nocturnal patterns were assigned to all possible groups: Rising, Irregular Rising, Not Rising, and Flat. The effects of onset pattern and timing on outcomes such as incubation period and hatching success were explored.

#### **85 Sofaer, Sillett, Power, Ghalambor**

Latitudinal differences in nestling provisioning rates, growth rates, and food quality: revisiting Lack's hypothesis. HELEN R. SOFAER, *Dept. Fish, Wildl. & Conserv. Biol., Colorado State Univ., Ft Collins, CO*, T. SCOTT SILLETT, MICHAEL L. POWER, *Smithsonian Conservation Biol. Inst.*, and CAMERON K. GHALAMBOR, *Colorado State Univ.*

Variation in food availability has long been thought to be a major factor driving the evolution of the latitudinal gradient in avian clutch sizes. Nevertheless, few studies have quantified how provisioning rates vary with latitude or tested if the relationship between provisioning and nestling growth rates differs between populations. Here, we exploit life history variation between Orange-crowned Warbler populations breeding in Alaska and California to test whether variation in food delivery could explain larger clutch and brood sizes and faster growth rates in Alaska. Using 24-h recordings of parental behavior at nests, we show that total provisioning rates increased with brood size in Alaska but not California, and that per-nestling provisioning rates were highest in small broods in California. In addition, we weighed nestlings before and after each 24-h video to show that per-nestling food delivery was correlated with faster growth only in Alaska, suggesting that nestlings in these populations may allocate energy and nutrients differently. Finally, we found that insects collected in Alaska and California differed in their caloric and nutritional content, rejecting the assumption that food quality is consistent between populations. Our study shows that the relationships between brood sizes, provisioning rates, and growth rates within and between populations are more complex than has been suggested by traditional views focused on the role of food availability, and our work highlights the need to understand the divergent selective pressures that underlie variation in patterns of parental investment and nestling development.

#### **86 Westneat, Bókony, Burke, Chastel, Jensen, Kvalnes, Lendvai, Liker, Mock, Schroeder, Schwagmeyer, Sorci, Stewart**



Plasticity in fecundity varies among populations of a globally-distributed songbird. DAVID F. WESTNEAT, *Dept. Biol., Univ. Kentucky, Lexington, KY*, VERONIKA BÓKONY, *Dept. Limnology, Univ. Pannonia, Veszprém, Hungary*, TERRY BURKE, *Dept. Anim. & Plant Sci., Univ. Sheffield, UK*, OLIVIER CHASTEL, *Centre d'Etudes Biologiques de Chizé, CNRS, Beauvoir sur Niort, France*, HENRIK JENSEN, THOMAS KVALNES, *Centre Cons Biol, NTNU, Trondheim, Norway*, ÁDÁM Z. LENDVAI, *Dept. Biol., Virginia Tech. Univ., Blacksburg, VA*, ANDRÁS LIKER, *Centre d'Etudes Biologiques de Chizé, CNRS*, DOUGLAS MOCK, P. L. SCHWAGMEYER, *Dept. Biol., Univ. Oklahoma, Norman, OK*, JULIA SCHROEDER, *Evol. Biol., Max Planck Inst. Ornithol., Seewiesen, Germany*, GABRIELLE SORCI, *Laboratoire BioGéo Sciences, CNRS, Université de Bourgogne, Dijon, France*, and IAN R. K. STEWART, *Dept. Biol., Univ. Delaware, Newark, DE*.

Plasticity in life history characteristics can influence multiple ecological and evolutionary phenomena, including how invading organisms interact with novel conditions in new locations or how environmental change affects organisms in native locations. We amassed data on clutch size from marked females in 8 populations of House Sparrows from North America and Europe. We exploited repeated measures of clutch size to assess the extent of within-individual phenotypic plasticity and among-individual variation in clutch size and to test predictions arising from a model of optimal clutch size reaction norms. Worldwide, females of this multi-brooded species altered their clutch size with respect to date, attempt order, and the interaction of date and order. However, we found significant differences between populations in the response to date and the date by attempt order interaction. We tested the prediction that the relationship with date should be increasingly negative as breeding season becomes shorter and found steeper declines in clutch size with date in populations with longer seasons, contrary to the prediction. Populations also differed in the level of among-individual variation in reaction norm intercept, but we found no evidence of among-individual variation in reaction norm slope. We show that complex reaction norms in life history characters exhibit within and among population variance. The nature of this variance is only partially consistent with current life history theory and stimulates expansions of such theory to accommodate complexities in adaptive life history.

## **87 Arnold**

Count-free estimates of population dynamics in American Black Ducks. TODD W. ARNOLD, *Dept. Fish., Wildl. & Cons Biol, Univ. Minnesota, St. Paul, MN*.

Population size, recruitment rate (young/adult), and annual survival are key components of avian population dynamics. Since 1990, population size of breeding American Black Ducks has been estimated using dedicated aerial or ground-based surveys, however survey costs are high and precision of these surveys is relatively low. Alisauskas et al. (2009, *Environ. Ecol. Stat.* 3: 463-489) recently revived and refined Lincoln's method for estimating population size in arctic-breeding geese using only harvest and band recovery data:  $N_{(i)} = H_{(i)}/h_{(i)}$ , where  $H_{(i)}$  is an estimate of total harvest for year  $i$ , and  $h_{(i)}$  is an estimate of direct harvest rate obtained from banding data. During 1969 - 2010, Lincoln estimates of fall population size (1.5 – 3.3 million) had an annual coefficient of variation of 18%, vs. 12% for the May breeding survey. In addition to population size, Lincoln estimators also provided measures of annual productivity (fall age ratios; 0.7 – 1.9) and population sex ratio. With careful matching of harvest and banding data, regional estimates of population size can be obtained, and by banding in different seasons, seasonal estimates of population size are possible. When combined with survival data, a complete integrated population model can be developed without ever counting birds.

## **88 Corrêa, Heming, Marini**

The state of the art in Fluvicolinae (Tyrannidae) breeding in South America. GABRIELA D. CORRÊA, NEANDER M. HEMING, MIGUEL Â. MARINI, *Universidade de Brasília, DF-Brasília, Brazil*

Exclusive to the New World, the Fluvicolinae subfamily of Flycatchers (Tyrannidae) have 132 species, of which 100 occur in South America (SA). These species have broad range distribution and a high variety of breeding strategies. Therefore, this study aims to review existing data on breeding biology of Fluvicolinae species, specifically to highlight lack or scarcity of knowledge on these subjects and how these information are available within species geographic range. Data were collected from the largest existing dataset on Fluvicolinae breeding biology (Heming et al., unpubl.). Breeding parameters of every species were compiled in a table and, then, used to build a knowledge map. Breeding biology of 17% of species is totally unknown. Conversely, 73% have known clutch size, and nest height is known for 58%. There are data on egg dimensions and weight for, respectively, 64% and 41% of species. Incubation and

nestling period are known for only 22% and 21% of the species, out of which only 80% have any information on breeding period. The maps produced reveal all available data are clustered in few regions of SA, and a total lack of data in areas where Fluvicolinae richness is strikingly high. In addition to evidencing absence of breeding biology knowledge for a considerable number of Fluvicolinae species, results from this study should stimulate future research focus on the lesser studied species and regions of SA. Broadening the existing knowledge on Fluvicolinae breeding biology along SA is vital not only for a better understanding on Fluvicolinae biology, but also for improving and refining phylogenetic models and species conservation efforts.

## **89 Thompson, W A Cox, Reidy**

The effects of temperature on nest predation by mammals, birds, and snakes. FRANK R. THOMPSON III, *USDA. Forest Ser. Northern Res. Sta., Columbia, MO*, and ANDREW COX, J.L. REIDY, *Dept. Fish. & Wildl. Sci., Univ. Missouri, Columbia, MO*.

Understanding how weather influences survival and reproduction is an important component of forecasting how climate change will influence wildlife population viability. Nest predation is the primary source of reproductive failure for passerine birds and can change in response to temperature; however, it is unclear which predator species are responsible for such patterns because predation events are rarely observed. We investigated whether temperature influenced predator-specific rates of nest predation by analyzing data from 6 studies during 1997 - 2010 in Texas, Illinois, and Missouri that used constant surveillance video systems to identify predators at the nests of Golden-cheeked Warblers, Black-capped Vireos, Indigo Buntings, and Acadian Flycatchers. Rates of nest predation by snakes and birds increased as daily maximum temperatures increased, whereas predation by mammals was essentially invariant in response to temperature. The relative role of physiological versus community-level (e.g., abundance or behavior of predators and/or alternative prey) mechanisms driving the patterns we observed remain unclear, but our data point to the need to consider important biological interactions when forecasting the effects of climate change on songbird populations.

## **90 Wood, Pidgeon, Radeloff, Culbert, Keuler, Flather**

Housing development erodes protected area avian community structure. ERIC M. WOOD, ANNA M. PIDGEON, VOLKER C. RADELOFF, PATRICK D. CULBERT, *Dept. Forest & Wildl. Ecol., Univ. Wisconsin-Madison, Madison, WI*, NICHOLAS S. KEULER, *Dept. Stat., Univ. Wisconsin-Madison*, and CURTIS H. FLATHER, *Rocky Mt. Res. Sta., USDA For. Serv., Ft. Collins, CO*.

Biodiversity conservation is a primary goal of protected areas. However, both private inholdings and adjacent lands are attractive for housing development. In the US, housing growth on inholdings and along the boundaries of protected areas has boomed since the 1970s. Our goal here was to examine the effect of housing development, within and outside of protected areas, over the past 40 yr on avian communities of adjacent protected areas. Focusing on 4 ecoregions across the US, we explored associations between the proportional abundance of species of greatest conservation need (SGCN), land cover affiliates, and synanthropes within protected areas, versus housing density within- and outside-protected areas from 1970 to 2010. In 3 ecoregions, the proportional abundance of SGCN and land cover affiliates showed a strong negative association with housing density within protected areas, whereas synanthropes showed a strong positive association with housing density within protected areas. In eastern forests, the most densely developed region in our study, the proportional abundance of SGCN and land cover affiliates steadily declined with increasing housing density, whereas native synanthropes and exotic species steadily increased. In the less densely populated West, we found similar trends in desert shrublands, as well as interior and Pacific valleys and mountains, though the effect was not as great for the latter regions. Housing density outside protected area boundaries was also negatively associated with either the proportional abundance of SGCN or land cover affiliates, and positively associated with synanthropes in eastern forests and desert shrublands. Our results raise concern that as housing development continues in and near protected areas the conservation benefit of these lands will likely diminish.

## **91 Garcia, Walters**

Long-term changes in Red-cockaded Woodpecker life history traits. V. GARCIA and J. R. WALTERS, *Dept. Biol. Sci., Virginia Tech. Univ., Blacksburg, VA*.

Many species have shifted their ranges in response to changing environmental factors such as

climate change. Further environmental change is caused by changes in land management practices over time. In the case of the endangered Red-cockaded Woodpecker, a resident habitat specialist strongly tied to longleaf pine forest, the potential for the bird to shift range in response to environmental changes is restricted. Hence the fate of the Red-cockaded Woodpecker and similar species will depend on their ability to adapt to changing conditions at the locations where they currently exist, such as by shifting demographic traits. Recent data indicate that Red-cockaded Woodpeckers are indeed being affected by climate change: egg-laying dates from 1980 - 1998 advanced significantly (Schiegg et al 2002, **Proc. R. Soc. B** 269: 1153-1159). In this study, we examined how Red-cockaded Woodpecker life history traits have changed over time. We used existing data collected at 2 sites in North Carolina from 1980-2011, and more than 1,000 individuals and >30,000 observations were analyzed. Results indicate that laying date continues to advance over time and clutch size is increasing as predicted from earlier laying dates. Despite larger clutch sizes, within-brood hatching asynchrony is decreasing over time. However, as predicted, larger clutches are associated with smaller nestlings. Annual fecundity is increasing over time, perhaps due to larger clutch sizes. Management of longleaf pine forests has greatly improved over the last 30 yr, and improved habitat quality has likely affected demographic traits. Additionally, many of the traits that are changing are changing in a direction predicted by climate change.

## **92 Chavez, Galen, Projecto-Garcia, Storz, Witt**

Evidence for high altitude adaptation in Andean House Wrens. ANDREA N. CHAVEZ, SPENCER C. GALEN, *Dept. Biol. and Mus. Southwestern Biol., Univ. New Mexico, Albuquerque NM*, JOANA PROJECTO-GARCIA, JAY STORZ, *Dept. Biol., Univ. Nebraska, Lincoln NE*, and CHRISTOPHER C WITT, *Dept. Biol. and Mus. Southwestern Biol., Univ. New Mexico*.

The House Wren, *Troglodytes aedon*, encompasses a broad geographic range in the Peruvian Andes, and is common from sea level to ~4700 m. This species comprises 7 phylogeographically distinct populations within the Peruvian Andes. These populations are characterized by 2 - 3% divergence in their mitochondrial DNA. This makes the House Wren an ideal taxon on which to search for evidence of local adaptation to environmental conditions. Beta-globin is an ideal candidate gene for adaptation to high altitude because a small number of substitutions can shift oxygen binding affinity, with corresponding effects on oxygen uptake under variable ambient pressure. In the House Wrens, we found 2 variant beta-globin alleles that are associated with altitude, at positions 55 and 80, respectively. Purified hemoglobin from House Wrens bearing each of the beta-globin genotypes demonstrated that the alleles that predominated at high altitude were associated with increased oxygen affinity. We sequenced beta-globin genomic DNA for 140 House Wrens representing all 7 mtDNA clades across the Peruvian Andes. Beta-globin was highly structured among mtDNA clades. Within and among clades, beta-globin variants at positions 55 and 80 were structured with respect to altitude. In both the Andean west slope and *puna* subspecies of House Wren, there is beta-globin structure with altitude even in the absence of mtDNA structure. In combination with the hemoglobin oxygen binding performance data, these results comprise powerful evidence of local molecular adaptation across a complex landscape.

## **93 Gawin, Sheldon**

Divergence among selected populations of Mountain Blackeye (*Chlorocharis emiliae*) in Borneo: estimating divergence times and substitution rates from mitochondrial genes. DECNY F. GAWIN and F. H. SHELDON, *Mus. Nat. Sci., Louisiana State Univ., Baton Rouge, LA*.

On Borneo, populations of montane birds are often subdivided by intervening regions of lower elevation forest and this led to changes in the birds morphological and genetic characteristics, causing some of them to attain sub-specific or even full species status. The degree of isolation of montane populations is influenced by climatic fluctuation associated with global glacial cycles which occurred during the Quaternary and caused the periodic connection and disconnection of montane forest habitat. Hence, past climatic events appear to have contributed to the frequent changes of montane species distributions and subsequently promoted genetic diversity. The Mountain Blackeye (*Chlorocharis emiliae*) occurs only in montane forests that are at least 1,600 m in elevation and presents an excellent opportunity to study historical processes influencing montane endemism on the island. Currently, Blackeye populations on the various Bornean peaks are strongly isolated after LGM, explains the relatively large number of morphologically distinct subspecies on different mountain peaks: *emiliae*, *trinitae*, *fusciceps*, and *moultoni*. These recent dynamics in Blackeye population distribution have created an opportunity to estimate the timing of divergence from molecular data. The divergence times can be used to test whether divergence

events of several populations of Blackeyes coincided with the contraction of montane forests before or after LGM. In this study, I employ non-coding control region and 3 protein-coding genes which are the complete cytochrome b (CYTb), NADH dehydrogenase 2 and 3 genes. The results from this study contribute additional knowledge in estimating the relative ages and substitution rates of bird species from Borneo Island.

#### **94 Savit, Bates**

Nuclear and mitochondrial data illustrate the influence of habitat on intraspecific diversification in *Tangara* tanagers. AARON SAVIT and JOHN M. BATES, *Field Mus., Chicago, IL*.

Allopatric speciation through the fragmentation of formerly contiguous habitat is considered to be the primary mode of diversification at the species level in birds and many other organisms. We study how intraspecific genetic structure differs between major South American biomes across a large monophyletic radiation of neotropical birds, tanagers in the genus *Tangara*. Using mitochondrial DNA sequences and nuclear-encoded microsatellite data, we study the demographic and phylogeographic background of broadly sympatric congeners in each of several biomes and compare and contrast the evolutionary processes that formed the observed patterns of variation. We test the hypothesis that different habitats contain species with predictably different patterns of intraspecific diversity, and examine how orientation and regional stability of biomes through time influences divergence and diversification. Our results show strikingly different patterns of diversity, divergence, and geographical structure between congeners occupying different biomes. Andean foothill and tropical savanna species showed greatest levels of divergence and geographic structure. Upper Andean species showed intermediate levels of divergence in mtDNA sequence and sometimes weak geographic structure among microsatellite groups. Geographic structure is almost entirely absent in the mtDNA of Amazonian lowland and human commensal species, though lowland species share patterns of geographic structure in microsatellites. This includes distinct groups in the central Amazon, a group spanning the 'Amazonian headwaters' to the north, south and west, and a group associated with the Atlantic forest in e. Brazil.

#### **95 Seeholzer, Claramunt, Brumfield**

Testing alternative models for the evolution of the climatic niche in a South American radiation, the Furnariidae. G. F. SEEHOLZER, *Mus. Nat. Sci., Louisiana State Univ., Baton Rouge, LA, S.* CLARAMUNT, *Am. Mus. Nat. Hist., New York City, NY*, and R. T. BRUMFIELD, *Mus. Nat. Sci.*

The ecological niche is a fundamental concept in ecology and evolution. Despite widespread interest in the characterization of the niche using climatic data and species distribution modeling, the evolutionary dynamics of the climatic niche are seldom examined. Understanding the tempo and mode of climatic niche evolution has important implications for understanding diversification. The ecological theory of adaptive radiation predicts various evolutionary patterns for the climatic niche which are testable using phylogenetic comparative methods. For instance, a niche-filling model would be supported by rapid climatic niche evolution early in a radiation that slows down as the clade diversifies and climatic niche space must be divided more finely. Ecological speciation across environmental gradients is also thought to drive adaptive radiations. The predicted pattern would be climatic niche evolution concentrated at speciation events rather than accumulating gradually over time. This speciation model has never been examined for the climatic niche. We gathered a large locality dataset for the all Furnariidae species (18,915 records, mean 63.5 records/species) and extracted elevational and climatic variables. Species means and standard errors for these variables were plotted on a well resolved phylogeny to test alternative macroevolutionary models of niche evolution. We found no support for a niche-filling model. We found that a speciation model of climatic niche evolution was strongly supported over a gradual model for most climatic variables. This result is seldom observed in comparative data and suggests a role for environmental gradients in driving the diversification of Furnariidae.

#### **96 Venkatraman, McCormack**

Allopatric speciation in an endemic cloud forest bird, the Unicolored Jay. MADHVI X. VENKATRAMAN and JOHN E. MCCORMACK, *Moore Lab. Zool., Occidental Coll., Los Angeles, CA*.

Delimiting species and understanding divergence mechanisms when species are in allopatry is difficult because common determinants of speciation like reproductive isolation and assortative mating are not useful. In this study we produce a portrait of speciation in the Unicolored Jay (*Aphelocoma unicolor*), an endemic Middle American cloud forest bird with 5 distinct subspecies, by studying multiple dimensions

of divergence in phenotype, genetics, and the niche. Through multivariate trait analyses we determined that Unicolored Jay subspecies are diagnosable units in both morphological traits and plumage characteristics. Guided by pre-existing genetic data, we tested for ecological niche divergence and conservatism and found a trend of increasing niche divergence deeper in the phylogeny, with monophyletic lineages on either side of the Isthmus of Tehuantepec showing strong niche divergence. This suggests that vicariant speciation played a predominant role in incipient speciation, whereas ecological niches diverged later, after geographical separation. We found significant correlations between some phenotypic traits and niche characteristics: wing to tail ratio, adjusted bill size and bill shape were all correlated to percent tree cover. This suggests an ecological basis for morphological divergence, although causation cannot be rigorously tested without experimental studies. Based on our findings of phenotypic and niche divergence, and prior work showing genetic divergence, we suggest splitting the lineages north and south of the Isthmus of Tehuantepec into separate species. By delimiting a new Mexican endemic species with a modest and fragmented range, our results highlight the importance of conserving Middle American's threatened cloud forest habitat.

### **97 Brennan, A W Jones**

Song variation in the Veery in the Appalachian Mountains. COURTNEY L. BRENNAN, *Cleveland State Univ., and Cleveland Mus. Nat. Hist., Cleveland OH*, and ANDREW W. JONES, *Cleveland Mus. Nat. Hist.*

Disagreement exists in the current literature describing the songs and repertoire size of the Veery, a common thrush who breeds in s. Canada and the ne. US, continuing south through the higher elevations of the Appalachian Mountains. Here we describe the song structure, repertoire size, and geographic variation in the song of the Veery along the Appalachian Mountains. To investigate geographic variation, a total of 1,558 typical songs from 95 individuals recorded in May - Jun 2012 were analyzed for the following measurements: song length (sec), highest frequency (Hz), lowest frequency (Hz), and delta frequency (Hz). ANOVA results show significant differences ( $p < 0.05$ ) in 8 out of 12 Veery song components measured across the sampled states. Visual analysis of spectrograms of at least 30 consecutive songs from 53 individuals revealed that Veeries' repertoire ranges from 1 to 6 different song types, which is larger than what was previously described in the literature. We found no geographic variation in repertoire size, which is normally distributed in each sample state. Spectrogram analysis also shows that Veeries present each song type in a predictable pattern, and patterns change depending on repertoire size. We found that Veeries also present their songs in an oscillating frequency pattern regardless of repertoire size, a previously undocumented feature of Veery singing behavior.

### **98 Francis**

Evaluating the strength of ecological selection on acoustic communication using metabolic theory of ecology. CLINTON D. FRANCIS, *Natl. Evol. Synthesis Center, Durham, NC*.

Diverse taxa use acoustic communication to defend resources, attract mates and identify kin or competitors, yet the environments within which animals dispatch their acoustic signals vary markedly in their influence on signal transmission. As such, researchers have long sought to understand how acoustic signals evolve in response to variation in habitat structure (acoustic adaptation hypothesis, AAH), and most notably with birds. Yet comparative studies have not often evaluated the role of phylogeny and the influence of metabolic costs of signaling when testing AAH. Here, I use first-order predictions from the metabolic theory of ecology (MTE) in a phylogenetic comparative framework to weigh evidence for the evolution of signal frequency in response to habitat structure. For a large avian dataset, MTE estimates based on body size consistently predict the central tendency of vocal frequency distributions across families and deviations from MTE predictions are consistent with AAH. For example, birds in forested and open habitats signal at lower and higher frequencies than expected based on MTE respectively; however, the opportunity for acoustic adaptation appears to have a strong link to body size with more variation in vocal frequency at larger sizes. This work not only clarifies the strength of acoustic adaptation through comparisons to first-order predictions, but also provides a needed framework for incorporating the metabolic costs of sound production and identifying how signal features tradeoff through energetic compromises.

### **99 Masco, Pruett-Jones**

Song overlapping: distinguishing between intention and chance. CHRISTINA MASCO and

STEPHEN PRUETT-JONES, *Dept. Ecol. & Evol., Univ. Chicago, Chicago, IL.*

Song overlapping, a behavior in which a bird begins singing while its counterpart is in mid-song, has been the subject of a recent debate. While it has been hypothesized to function as an aggressive signal in songbirds, no study has yet demonstrated that birds consistently overlap songs at above chance levels. As a result, it remains unclear whether song overlapping is a signal or simply a chance occurrence. In part, the difficulty of discriminating between these hypotheses is due to the fact that there is no widely accepted method for determining chance levels of song overlap. We propose a suite of null models, which use the song durations and inter-song intervals in natural singing interactions to build randomized recitals. Calculating the amount of overlap in these randomized recitals generates a probability distribution for the expected overlap due to chance alone. Comparing the observed amount of overlap to this distribution allows us to test whether the observed differs from this expectation. While each of our null models has this same underlying method, they differ in the constraints they impose on the randomization procedure; in this way, we can vary the assumptions we make about the importance of preserving natural song order, interval order, and interval duration. These models represent an important step toward understanding the signal value of temporal patterning in vocal interactions, not only in birds but in other taxa as well.

### **100 Sosa-Lopez, Mennill**

Song divergence in island and mainland House Wrens populations. J. ROBERTO SOSA-LOPEZ and DANIEL J. MENNILL, *Dept. Biol. Sci., Univ. Windsor, ON.*

By understanding patterns of variation in bird song, it is possible to assess differences between populations and gain insight into groups whose taxonomic status is poorly understood. The House Wren complex (genus: *Troglodytes*) is one such group that presents extensive taxonomic controversy. Based on morphological traits and geographic distributions, research suggests that many independent evolutionary units comprise this species complex. Although House Wren songs are also known to vary extensively, no study has been undertaken to explore the vocal differences between populations. In the first part of this study, we assessed the variation in the fine structural characteristics of the songs of the House Wren complex at 3 different spatial scales. We compared songs among the 5 principal forms (*aedon*, *musculus*, *brunneicollis*, *beani*, and *martinicensis*); among the 4 recognized North American subspecies (*T. a. aedon*, *T. a. parkmanii*, *T. a. cahonii*, and *T. a. brunneicollis*); and among the 2 Caribbean forms and their 2 closest mainland counterparts (*beani*, *martinicensis*, *T. a. intermedius*, and *T. a. albicans*). In the second part, we assessed the vocal divergence between taxonomically conflicting populations and compared them with currently recognized *Troglodytes* species (*T. hiemalis*, *T. pacificus*, *T. tanneri*, *T. sissonii*, and *T. rufociliatus*). After widely sampling House Wren songs from throughout the Americas (n = 758), we carried out a series of discriminant function analyses. Our results showed that all groups examined have significantly divergent songs. Our vocal divergence analysis showed that the divergence between at least 4 differentiated acoustic forms were similar to, and in some instances stronger than, the divergence shown between pairs of currently recognized species. Our study identifies several differentiated vocal groups that may result in new species-level upon further taxonomic analysis. The high degree of divergence between groups in a sexually selected trait suggests that such differentiation may arise due to independent historical processes and probably maintained by isolation, drift and/or selection.

### **101 Hale, Nelson, Augustine**

The role of male vocal signals during male-male competition and female mate choice in Greater Prairie-Chickens. JENNIFER A. HALE, DOUGLAS A. NELSON, *Dept. Evol., Ecol. & Organ. Biol., Ohio State Univ., Columbus, OH,* and JACQUELINE K. AUGUSTINE, *Ohio State Univ., Lima, OH.*

In many taxa, vocal communication plays an integral role in aggression, territorial defense, and female choice. The acoustic structure of vocalizations is influenced by physical constraints on the vocalizer, suggesting a potential for discrimination among individuals. In the lek-mating Greater Prairie-Chicken, male vocalizations are an integral part of the ritualized display. We investigated whether variation among vocal characteristics of individual male Greater Prairie-Chickens plays a role during female choice and male-male competition. Vocal characteristics varied among males but were fairly consistent for each male, suggesting that vocalizations might be used by prairie-chickens to identify individuals. Female choice was evaluated by comparing characteristics of vocalizations produced by reproductively successful and unsuccessful males, and successful males were found to vocalize at a relatively lower mean frequency. Playbacks of familiar and unfamiliar males were conducted on the lek to

assess the role of vocalizations during male-male competition. Males responded to the prairie-chicken treatments by vocalizing at a faster rate and approaching the playback speaker, but they did not respond more strongly to the vocalizations of unfamiliar males than familiar males. Our results suggest that variation is present among the vocalizations of individual male Greater Prairie-Chickens and that this variation could be used by females during mate choice, but signal variation does not appear to be used by males to discriminate among familiar individuals and strangers. However, vocalization elicits an aggressive response in males that hear it, regardless of the individual that has produced it. Vocalization likely functions as a way of announcing that a territory is occupied and defended, but it may also serve as a way of advertising to male or female conspecifics or as a signal that is secondary to other forms of communication.

### **102 Moore, Schmidt, S A MacDougall-Shackleton, E A MacDougall-Shackleton**

Measuring vocal performance in Song Sparrows, and its relationship to age, morphology and song complexity. S. DREW MOORE, KIM L. SCHMIDT, *Dept. Biol., Western Univ., London, ON*, SCOTT A. MacDOUGALL-SHACKLETON, *Dept. Psych., Western Univ.*, and ELIZABETH A. MacDOUGALL-SHACKLETON, *Dept. Biol., Western Univ.*

Birdsong, like many mating signals, comprises multiple aspects to which receivers may attend. One such aspect is vocal performance, defined as the ability to perform physically demanding song such as rapid broadband trills. Unlike more permanent aspects of song such as repertoire size, vocal performance may respond dynamically to variation in the singer's age or condition. Conversely, performance may be constrained by morphological characters such as bill or body size. We measured maximum vocal performance of free-living male Song Sparrows. Vocal performance did not vary with age, nor did it appear constrained by bill or body size. Instead, vocal performance was correlated with song complexity, such that better-performing males also had larger song repertoires. Moreover, paternal repertoire size predicted subsequent vocal performance of their sons, even when offspring were raised and tutored under standardized conditions. This suggests that the developmental timing of cognitive ability necessary for song learning may overlap with that of sensi-motor ability required to produce high-performance songs. If so, vocal performance and song complexity may provide redundant information as to male quality. Moreover, the relationship between paternal song repertoire size and offspring vocal performance suggests that heritable developmental stability may influence multiple aspects of song learning.

### **103 Abolins-Abols, Ketterson**

Shift in a life history trade-off linked with change in hormonal cross-talk. MIKUS ABOLINS-ABOLS and ELLEN KETTERSON, *Indiana Univ., Bloomington, IN*.

Perhaps the most fundamental life history trade-off is that between reproduction and self-maintenance. This trade-off is mediated by cross-talk between 2 major endocrine systems, the hypothalamic-pituitary-gonadal (HPG) axis, which regulates reproduction, and the hypothalamic-pituitary-adrenal (HPA) axis, which regulates metabolism and the stress response. Environmental change may alter optimal allocation of resources to reproduction and self-maintenance, shifting the trade-off and giving rise to selection for change in the interaction of the HPA and HPG axes. A recent colonization of an urban environment by the typically mountain-breeding Dark-eyed Junco in California has dramatically affected timing of breeding and stress ecology, resulting in increased allocation to reproduction and reduced response to stressors. We compared the direction and strength of the interaction between the HPA and HPG axes in individuals from both city and mountain populations by injecting wild birds with corticotropin releasing hormone (CRH), a major activator of the HPA axis, and measuring corticosterone, followed by an injection of gonadotropin releasing hormone (GnRH), a major activator of the HPG axis, and measuring testosterone. Unexpectedly, CRH did not have a significant effect on corticosterone levels, and the ability to secrete corticosterone and testosterone was correlated positively in both populations. Importantly, however, CRH negatively affected the ability of the birds to release testosterone in the mountains but not in the city, suggesting greater sensitivity of reproduction to stressors in the mountain population. We conclude that hormonal interactions are not only plastic and complex, but can be molded by environmentally induced changes in trade-offs between life history characters.

### **104 M R Jones, Cheviron, Carling**

Spatial variation in avian malaria prevalence and associations with major histocompatibility complex in Rufous-collared Sparrows. MATTHEW R. JONES, *Dept. Zool. & Physiol., Univ. Wyoming, Laramie, WY*, ZACHARY A. CHEVIRON, *Dept. Animal Biol., Univ. Illinois Urbana-Champaign, Urbana, IL*, and MATTHEW D. CARLING, *Dept. Zool. & Physiol., Univ. Wyoming*.

Host-parasite interactions are often highly context-dependent. For example, parasite virulence or abundance and host resistance to pathogens can vary substantially by environment. The major histocompatibility complex (MHC) is an essential component of the vertebrate immune system, involved in pathogen recognition and immune response initiation. MHC genotypes in many species are associated with resistance and susceptibility to pathogens or disease. Investigating associations between parasite infection and MHC across heterogeneous landscapes may provide insight into how host-parasite interactions are altered by environment. Avian malaria blood parasites occupy a wide range of environments and can infect birds at high rates. Rufous-collared Sparrows (*Zonotrichia capensis*) are common Neotropical residents, which inhabit a wide variety of habitats from sea level to 5000 m. We investigated: 1) spatial patterns in avian malaria infection prevalence and the environmental factors correlated with prevalence and 2) associations between avian malaria infection and *Z. capensis* MHC loci across environmental gradients. A PCR screening assay for avian malaria infection revealed mid-altitude peaks in infection prevalence for a single *Haemoproteus* lineage. Infection prevalence was strongly associated with temperature and precipitation variables related to seasonality. We employed next-generation 454 sequencing to investigate variation at *Z. capensis* MHC and found specific MHC alleles and functional 'supertypes' were strongly associated with infection or lack of infection. The effects and frequency of these alleles and supertypes varied substantially across altitudinal and latitudinal gradients. These results are consistent with predictions of fluctuating selection, in which environmental variation governs spatial or temporal change in parasite abundance or virulence, creating a dynamic selection landscape on hosts. Our research highlights the importance of considering host-parasite systems in the context of their external environment.

### **105 A S Grunst, Salgado-Ortiz, Rotenberry**

Does sexual coloration differentially predict oxidative stress in Northern Yellow Warblers versus Mangrove Warblers? Effects of life history, environment, and sex. ANDREA S. GRUNST, *Univ. California-Riverside, Riverside, CA*, JAVIER SALGADO-ORTIZ, *Universidad Michoacana, Morelia, Michoacana, Mexico*, and JOHN T. ROTENBERRY, *Univ. Minnesota, Twin Cities, MN*.

Viability costs of oxidative stress (OS) may mediate tradeoffs between survival and reproduction, and enforce reliable condition-dependent expression of sexual signals. However, life history may influence how sexual ornamentation varies with viability and OS. In longer-lived species, high quality individuals may out-survive rather than out-signal lower quality competitors, such that signaling of condition and OS is less reliable in longer-lived species. On the other hand, if faced with reduced condition, individuals from shorter-lived species may be more likely to terminally invest in sexual signaling, making signaling of condition less reliable in shorter-lived species. We explored the hypothesis that closely related species with divergent life histories show differences in OS, and also the above alternative hypotheses regarding how life history affects signaling of OS. To do so, we collected pre-nesting data on carotenoid and phaeomelanin pigmentation and OS in Northern Yellow Warblers (*Setophaga petechia brewsteri*) and in the Mangrove Warbler subspecies of *S. petechia* (*S. p. bryanti*), which displays a slower life history. As predicted, Yellow Warblers displayed higher OS than Mangrove Warblers. However, results did not suggest consistent subspecies-level differences in sexual signaling of OS. Melanin saturation negatively predicted OS in male Mangrove Warblers and Yellow Warblers captured in 2011, but not in male Yellow Warblers captured in 2012, while carotenoid saturation negatively correlated with OS in females only, regardless of subspecies. These results suggest that sexual signaling dynamics vary with year-to-year environmental changes, and that signaling strategies may be more different between the sexes than between the subspecies.

### **106 Schmitt, McNew, Montaña, Vargas Campos, Valqui, Witt.**

Color polymorphism and adaptation in the Vermilion Flycatcher. C. JONATHAN SCHMITT, *Dept. Biol. and Mus. Southwestern Biol., Univ. New Mexico, Albuquerque, NM*, ENRIQUE L. MONTAÑO, *Dept. Geograph. Sci., Univ. Maryland, College Park, MD*, WALTER VARGAS CAMPOS, *Centro de Ornitología y Biodiversidad, Lima, Peru*, SABRINA M. McNEW, *Dept. Biol. and Mus. Southwestern Biol., Univ. New Mexico*, THOMAS VALQUI, *Centro de Ornitología y Biodiversidad*, and CHRISTOPHER C.



WITT, *Dept. Biol. and Mus. Southwestern Biology, Univ. New Mexico.*

Vermilion Flycatchers (*Pyrocephalus rubinus*) are strikingly bright red and sexually dimorphic throughout their range, from the sw. US to Argentina; however, in the heavily polluted city of Lima, Peru, over half of *P. rubinus* individuals of both sexes have sooty brown plumage. We found that plumage morph is perfectly predicted by a single nucleotide polymorphism in the MC1R gene and determined by a 2-allele system. The dominant allele confers a solid sooty brown plumage and homozygotes lack any red. Homozygous recessive individuals have red plumage typical of the species, while heterozygotes have intermediate phenotypes. Using this new understanding of the genetic basis of the dark plumaged morph, we conducted surveys to quantify genotype and allele frequencies in and around Lima. Genotype frequencies depart significantly from Hardy-Weinberg expectations in 8 subpopulations. An observed deficit of heterozygotes and preliminary surveys of mated pairs suggest assortative mating among color morphs. A drop in the melanic allele frequency from ~ 60% to ~ 5% across the ~10 km urban-rural interface in Lima strongly suggests divergent selection on plumage color across this gradient. We found that spatial models with coastal cloudiness as an independent variable best predict melanic allele frequency across this gradient. Sequences of the mitochondrial gene ND2 show no structure among MC1R genotypes, suggesting either ample gene flow among genotypes or divergences too recent to detect with mtDNA sequences. Collectively, our results suggest that assortative mating and divergent selection both act to maintain the melanic allele in this population of *P. rubinus*.

### 107 Hill, J D Johnson

The mitonuclear compatibility hypothesis of sexual selection. GEOFFREY E. HILL and JAMES D. JOHNSON, *Dept. Biol. Sci., Auburn Univ., Auburn, AL.*

Why females assess ornaments when choosing mates remains a central question in evolutionary biology. We hypothesize that ornaments signal the efficiency of oxidative phosphorylation (OXPHOS) thus enabling females to select mates with nuclear genes that are compatible with maternal mitochondrial genes in formation of OXPHOS complexes. Species-typical pattern of ornamentation is proposed to serve as a marker of mitochondrial type insuring that females assess prospective mates with shared mitochondrial background. Ornament quality is proposed to signal OXPHOS function and compatibility. The mitonuclear compatibility hypothesis predicts that production of ornaments will be closely linked to OXPHOS pathways and that sexual selection for compatible mates will be strongest when genes for nuclear components of OXPHOS complexes are located on sex chromosomes in species in which males are the homogametic sex (ZZ). The implications of this hypothesis are that female mate choice may serve as a driver in mitonuclear co-adaptation and co-evolution.

### 108 Nocedal

*Dendroica's* cry for help: should grade be considered to name a clade or is cladogenesis enough? JORGE NOCEDAL. *Facultad de Ciencias Forestales, Universidad Juárez del estado de Durango, Durango, Mexico.*

Phylogenomics analyzes nuclear and mitochondrial DNA of related taxa to elucidate evolutionary paths and the more genes used as markers the more parsimonious and less noise will result in phylogenetic studies. It is a promising path to solve controversial evolutionary relationships among taxa and to reconstruct their evolutionary processes when they occur in short periods. A phylogenetic tree is a bi-dimensional way to show taxa relationships based on evolutionary relatedness. If a phylogenetic tree is characterized by short branches it is possible that deep branches can confound concatenated analyses. It may be a general problem for the application of species-tree methods to rapid radiations, even with large phylogenomic data sets (Townsend et al. 2011, **Molec. Phylogenet. Evol.** 61: 363-380). The AOU Committee voted in favor of merging *Dendroica* into *Setophaga* owing to the rule of priority and stated that ... "is the state of the art, and unlikely to be revised for some time" ... Not surprisingly, the committee voted 8 in favor and 2 against the merging and new naming. They also stated that the ... "proposed generic limits are consistent with the nodes with strong support, and actually make lots of "sense" in terms of warbler biology", a statement I will address with the question: Should nomenclature be more stable so changes needed should try to keep at minimum as much as possible? I will rely on Figure 5 of Lovette et al. (2010, **Molec. Phylogenet. Evol.** 57: 753-770) as it is the foundation for the new nomenclature of the Parulidae and some differences in the approach of several clades is remarked.

### **109 Adams, B J Olsen**

Using a hierarchical modeling framework to estimate detection probability of bird migration banding censuses. EVAN M ADAMS and BRIAN J OLSEN, *School Biol. & Ecol., Climate Change Inst., Univ. Maine, Orono, ME.*

Migration banding station capture data are often used as indices of abundance, yet there have been no attempts to quantify bias in these surveys and improve their accuracy. Using hierarchical modeling methods we analyzed migration banding station data to determine the probability of detecting Black-throated Blue Warblers during migratory stopover at Bill Baggs Cape Florida State Park on Key Biscayne, FL. We employed the recently developed Dail-Madsen model in a novel formulation to estimate daily changes in population size, detectability and the environmental covariates that affect those estimates. We found that daily changes in weather affected detectability. The most important factors affecting detectability included evening weather conditions likely to cause migratory fallouts along with precipitation, wind speed and wind direction during the banding session. We hypothesize that fallout conditions increase detectability due to increases in foraging behavior frequency. Annual abundance estimates from the hierarchical model were only moderately correlated with other common data analysis techniques. Taken together, we believe that observation bias was significant for this species and changed at the daily time scale, which indicates that efforts such as this are valuable for inferring population size and increasing the accuracy of population trend estimates from migration banding stations.

### **110 Beatty, Kesler, Webb, Raedeke, Naylor, Humburg**

Quantitative and qualitative approaches to identifying migration chronology in a continental migrant. WILLIAM S. BEATTY, DYLAN C. KESLER, *Dept. Fish. & Wildl., Univ. Missouri, Columbia, MO*, ELISABETH B. WEBB, *US Geol. Surv., Missouri Coop. Fish & Wildl. Res. Unit, Univ. Missouri*, ANDREW H. RAEDEKE, *Missouri Dept. Conserv.*, LUKE W. NAYLOR, *Arkansas Game & Fish Comm.*, DALE D. HUMBURG, *Ducks Unlimited.*

The degree to which extrinsic factors influence migration chronology in North American waterfowl has not been quantified and rigorous approaches to defining avian migration chronology are limited. We used movement data from 40 female adult Mallards equipped with solar power global positioning system satellite transmitters to evaluate 2 approaches to quantify migration chronology. The first approach defined migration based on individual movements among geopolitical boundaries, whereas the second method modeled net displacement as a function of time using nonlinear models. Differences in migration chronologies identified by each of the approaches were examined with analysis of variance. The geopolitical method identified mean fall migration midpoints at 15 Nov 2010 and 13 Nov 2011, whereas the net displacement method identified midpoints at 15 Nov 2010 and 14 Nov 2011. The mean midpoints for spring migration were 3 Apr 2011 and 20 Mar 2012 using the geopolitical method, and 31 Mar 2011 and 22 Mar 2012 using the net displacement method. The duration, initiation date, midpoint, and termination date for both fall and spring migration did not differ between the 2 individual-level approaches. Although we did not detect differences in migration parameters between the different approaches, the net displacement metric offers broad potential to address questions in movement ecology for migrating species. Ultimately, an objective definition of migration chronology will allow researchers to obtain a comprehensive understanding of the extrinsic factors that drive migration and assist in the monitoring of populations to document long-term climate effects.

### **111 Bowlin, Enstrom, Murphy, Jurich, Purdy, Cochran, Cochran**

Between-individual variation in the flight altitudes of Swainson's Thrushes. MELISSA S. BOWLIN, *Univ. Michigan-Dearborn, Dearborn, MI*, DAVID A. ENSTROM, *Illinois Nat. Hist. Surv., Urbana, IL*, BRIAN J. MURPHY, PETER JURICH, CHRISTINE PURDY, *Univ. Michigan-Dearborn, Dearborn, MI*, WILLIAM W. COCHRAN, *Illinois Nat. Hist. Surv.*, JAMES COCHRAN, *JDJC Corp., Fisher, IL.*

Radar can track individual migratory birds at night for tens of minutes and in some cases even longer, but in most cases little if anything is known about the individual being studied. Here, we present continuous flight altitude data from 5 Swainson's Thrushes making 6 full (6 - 8 h) migratory flights over the Midwestern US. We used new ~1 g altitude radiotransmitters and a radiotracking vehicle to collect our data. To our surprise, the data we have analyzed so far suggests that passerines do not select a consistent altitude for the majority of their flight; instead, some repeatedly gained and lost over 60% of their maximum altitude throughout the flights. In this talk, we will present our data and discuss some potential explanations for this seemingly maladaptive behavior.

### 112 Paxton, Moore

Migratory connectivity and en route migration strategies. KRISTINA L. PAXTON and FRANK R. MOORE, *Univ. Southern Mississippi, Hattiesburg, MS.*

We utilized stable isotopes to geographically link black-and-white warblers (*Mniotilta varia*) captured during spring migration with their breeding area destinations (measured via stable hydrogen isotopes) and over-winter habitat quality (measured via stable carbon isotopes,  $\delta^{13}\text{C}$ ). In doing so, we assessed (1) how far migrants must travel from the stopover site to their breeding area (2) whether migrants are early or late relative to other birds migrating to the same breeding area and (3) how conditions prior to the onset of migration influence migration success. Warblers arriving late to the stopover site had significantly enriched  $\delta^{13}\text{C}$  values compared to conspecifics migrating to the same breeding area, indicating birds arriving late to the stopover site over-wintered in lower quality habitat. In addition, individuals arriving late to the stopover site were in the poorer condition compared to conspecifics migrating to the same breeding area. These patterns were the same for breeding populations in the se. US and boreal forest. However, males arriving early to the stopover site also had reduced energy reserves for both breeding populations, which stopover at different time periods, suggesting that the pattern is not a function of the time of season, but the timing of migration compared to conspecifics migrating to the same breeding area. While early migrants from high quality over-winter habitat are predicted to have larger energy stores, the strong selection pressures for males to arrive early to breeding sites to secure high quality breeding territories may drive males to maximize time at the expense of energy.

### 113 Covino, Jawor, Morris, Moore

Testosterone production in a songbird during spring migration. KRISTEN M. COVINO, JODIE M. JAWOR, *Biol. Sci., Univ. Southern Mississippi, Hattiesburg, MS*, SARA R. MORRIS, *Biol. Dept., Canisius Coll., Buffalo, NY*, and FRANK R. MOORE, *Biol. Sci., Univ. Southern Mississippi.*

The connection and interaction among phases of the annual cycle in migratory species are poorly understood. Testosterone may be an important signal for the onset of vernal migration: Elevated testosterone induces migratory activity, testosterone levels increase throughout spring migration in some species and early arriving males on breeding grounds generally have higher circulating levels. Presumably, migrants must have sufficient levels of testosterone in circulation soon after arrival on the breeding grounds to facilitate necessary breeding behaviors. We investigate whether testosterone production may be modulated during migration to take advantage of beneficial effects while avoiding negative consequences of elevated testosterone en route. To do so, we determined both circulating testosterone levels as well as testosterone production capability in a boreal breeding migrant. Male and female Swainson's Thrushes were sampled at 2 stopover sites representing different distances remaining to the breeding grounds. Males at both locations were capable of producing more testosterone than naturally circulating levels, and capability was higher in males sampled closer to their breeding grounds. Females showed conflicting results: testosterone production capability was not different from naturally circulating levels in individuals sampled closer to the breeding grounds, whereas those sampled farther from the breeding grounds were capable of producing more testosterone than naturally circulating levels. We are currently exploring the possibility that the proportion of testosterone that is converted to estradiol may change throughout migration.

### 114 Caton, Owen

Migratory behavior of captive Blue-winged Teals. JESSICA L. CATON and JENNIFER C. OWEN, *Dept. Fish. & Wildl., Michigan State Univ., East Lansing, MI.*

Migratory behavior of birds can be studied under controlled conditions. Migratory disposition, including migratory activity [*Zugunruhe*] and hyperphagia, can be experimentally induced in captive birds. This activity corresponds to the daily and annual pattern of migration of free-ranging conspecifics. Most of the research on migratory restlessness has been conducted with landbirds with few studies on migratory behavior of waterfowl. We hypothesized that Blue-winged Teals would exhibit migratory restlessness in captivity during both fall and spring migration. Here we will present our spring migration results. Employing video surveillance cameras, infrared motion sensors, and audio recorders, we investigated whether teals would (1) enter migratory disposition, as shown by mass gain, (2) demonstrate migratory restlessness in captivity, and (3) exhibit quantifiable behavior. We found that teals, when photoadvanced, exhibit behavior consistent with migratory disposition, including hyperphagia and increased nighttime activity. Based on initial analysis of video recordings, the nighttime activity is consistent with *Zugunruhe*

as behaviors include increased flight, looking up, and restless flapping. To our knowledge, this is the first study to successfully demonstrate that under controlled conditions waterfowl exhibit migratory disposition and restlessness. Future analysis includes correlating video footage with motion sensors and audio recordings.

### **115 Taff**

Female ornamentation, incubation rhythms, and offspring quality in a warbler. C. C. TAFF, *Dept. Evol. & Ecol., Univ. California, Davis, CA.*

Studies of sexual selection often focus on the fitness costs and benefits of signaling in males. In many species, however, both males and females possess elaborate signals and a complete understanding of sexual selection should explain these traits in both sexes. Female ornaments could arise as nonfunctional byproducts of sexual selection in males, but could also serve as signals of female quality that function in mate choice and that are maintained by sexual or natural selection. One problem with studying sexual selection in female songbirds is that the most commonly measured fitness proxy – number of offspring fledged – is constrained by clutch size and often shows little variability between females. Indeed, the quality of offspring produced – and therefore the likelihood of offspring recruitment and mating success – may be a more important determinant of female fitness than simple counts of offspring. Offspring quality may be influenced by many factors, but the thermal environment during early development is an especially critical component in nestling development that may alter life history trajectories through the carryover effects associated with early thermal stress. Thus, variable female incubation behavior may be both signaled by ornamentation and may influence offspring quality. Here, we quantify individual variation in female incubation behavior in Common Yellowthroats using thermal sensors to log over 6,000 on and off bouts from 38 females on 69 nests. The total length of incubation bouts was highly variable between females, ranging from 34 to 93 min, but individual females followed repeatable incubation patterns. Further, individual variation in the length of incubation bouts and the percent of time spent on the nest was correlated with carotenoid based female plumage coloration and with female hematocrit scores. Finally, nestlings with high incubating mothers were larger (both wing and mass) on day 5 after hatching than nestlings from low incubating mothers. Taken together, these data suggest that female ornamentation is a reliable indicator of incubation behavior and may be a target of sexual selection.

### **116 Deaner, Chandler**

Sex roles in breeding Wilson's plovers and their consequences to foraging success. LAUREN M. DEANER and C. RAY CHANDLER, *Dept. Biol., Georgia Southern Univ., Statesboro, GA.*

Sex differences in parental care may differentially constrain the ability for each sex to meet its energy demands. For example, Wilson's Plovers partition incubation duties; females incubate during the day and males incubate at night. Thus, each sex has different foraging opportunities, which may lead to differences in habitat use and foraging success. From Apr - Jun 2012 we observed the foraging of adult Wilson's Plovers in beach and marsh habitat during daylight hours. Male plovers were 150% more abundant foraging in both habitats during the day ( $p = 0.0032$ ,  $df = 44$ ,  $U = 116$ ). All plovers foraging on the beach were more than 3 times likely to use pecking rather than the typical plover 'stalk-and-run' foraging strategy ( $p < 0.0001$ ,  $df = 118$ ,  $U = 908.5$ ). Pecking rates did not differ between males and females in either habitat ( $p = 0.6686$ ,  $df = 23$ ,  $U = 72$ ). Within marsh habitats, where fiddler crabs are the primary prey, plovers use the 'stalk-and-run' method nearly 8 times more frequently than pecking ( $p = 0.0484$ ,  $df = 118$ ,  $U = 2258.5$ ). While there were no differences in prey capture attempts ( $p = 0.0768$ ,  $df = 75$ ,  $U = 819$ ), males were more than 3 times more successful than females ( $p = 0.0371$ ,  $df = 25$ ,  $U = 116.5$ ). During 2013 we conducted foraging observations during nighttime hours; however preliminary results suggest neither male or female Wilson's Plovers forage at night in beach or marsh habitat. Thus, males forage in both marsh and beach habitat during the day when they are largely free of incubation duties. However, neither males or females have been located foraging in these habitats at night when females are free of incubation duties. Nocturnal observations are ongoing.

### **117 Grace, Anderson**

Personality, stress, and fitness in Nazca Boobies. JACQUELYN K. GRACE and DAVID J. ANDERSON, *Wake Forest Univ., Winston-Salem, NC.*

The relationship between the stress response, fitness, and personality has recently become

controversial. General “rules” of personality developed in laboratories appear to be less applicable in the wild or across species. Here, we test the hypothesis that shy individuals mount a greater corticosterone (CORT) stress response than bold individuals in free-living Nazca Boobies. Incubating adults were tested in the field for personality, and CORT stress response. We compared structural equation models of personality and stress response using corrected Akaike Information Criterion values. Nazca Boobies have a domain-specific personality syndrome (aggression, agitation, and anxiety), including reaction to a novel object, human intruder, and simulated conspecific (mirror), which is repeatable across years. Plasticity between tests was not correlated with any personality domain. Maximum CORT, area under the CORT curve, and baseline CORT during a capture-restraint test were repeatable across years. All CORT parameters predicted personality traits, with stress induced CORT being positively correlated with anxiety-like behaviors, and negatively correlated with aggression, supporting our hypothesis. In many cases, personality can affect mate choice and fitness. In Nazcas, aggressiveness of males and females were generally correlated within pair. However, assortative and disassortative mating had no impact on fledgling production, within a year. The only personality trait associated with fledgling production was male aggression toward an intimidating novel object. Because this trait was repeatable across years ( $r = 0.31$ ), this relationship is probably not due to changing behavior based on chick viability, but rather is a fitness consequence of a personality trait.

### **118 Novy**

Habitat utilization, foraging and prey restraint of the Solitary Eagle in Belize. STACIA A. NOVY, *Southern Illinois Univ. Edwardsville, Edwardsville, IL.*

The first documented active nest of a Solitary Eagle (*Buteogallus solitarius solitarius*) in Belize was discovered on 30 Jun 2011 in the Mountain Pine Ridge, Cayo District (17.0254 N, 88.8217 W). The nest was located in a Nicaraguan Pine (*Pinus oocarpa*) at the transitional edge of submontane pine forest and submontane broadleaf moist forest, overlooking steep riparian valleys. Sighting reports of solitary eagles have occasionally originated from lower elevations and diverse habitat types, to include humid broadleaf and dry pine-oak forest, and remain a source of contention among researchers, wildlife biologists and birdwatchers. The nest site in Belize was located with archaic wildlife tracking techniques that did not rely upon radio-telemetry or GPS technology. Applied methods required the determination of routine flight trajectories and establishment of surveillance points to visually intercept the prey-carrying male eagle at strategic locations in the field. Ten observations made at 4 designated surveillance points from 7 - 30 Jun 2011 yielded further insights on the habitat utilization, flight dynamics, prey preference and prey restraint of this poorly known neotropical raptor species.

### **119 Román, Jiménez, Vergara, Rozzi**

Developing sustainable ecotourism with the Magellanic Woodpecker (*Campephilus magellanicus*) as a charismatic species in the Cape Horn Biosphere Reserve. IRÁN ROMÁN, *Dept. Biol. Sci., Univ. North Texas, Denton, TX*, JAIME E. JIMÉNEZ, *Dept. Biol. Sci., and Dept. Philos. & Religion Stud., Univ. North Texas, and Inst. Ecol. & Biodiversity, Universidad de Magallanes*, PABLO VERGARA, *Universidad de Santiago, Chile*, and RICARDO ROZZI, *Dept. Philos. & Religion Stud., Univ. North Texas, and Inst. Ecol. & Biodiversity, Universidad de Magallanes*

Watching Magellanic woodpeckers (*Campephilus magellanicus*) is an increasingly popular ecotourism activity in the Cape Horn Biosphere Reserve (CHBR), southern Chile. Unfortunately, watching woodpeckers lacks a standardized protocol trading off the economic benefits of providing tourists with a close experience with these birds against the conservation costs associated with ecotourism. Here, we determined critical distances for woodpecker watching that do not affect the behavior of this charismatic species. We experimentally assessed the impact of bird watching by testing the response of free-living woodpeckers to the simulated presence of a visitor. We monitored the number of: trees used, pecking, calls uttered, prey extracted, as well as the foraging height on trees, distance moved between trees, and the rate of movement toward the observer of focal birds. We recorded these variables by approaching 7 different male woodpeckers: first from a moderate distance (30-40 m) and then by constantly approaching the birds as a tourist would do. To test for habituation to tourists, this methodology was repeated 5 times on 5 individuals. Results showed that only the pecking rate decreased significantly when the visitor approached. Although not significantly, the number of calls and visited trees increased, as well as the distance traveled between trees. Additionally, the rate of movement toward the observer decreased when the woodpeckers were disturbed. These findings suggest that a distance beyond 30m is ecologically

acceptable for watching Magellanic woodpeckers in the CHBR.

### **120 Kamioki, Ueda, Kawaji**

Two's company, but three's no crowd: why do male Asian stubtails visit their neighbors and why are they tolerated? MASAYOSHI KAMIOKI, KEISUKE UEDA, *Dept. Life Sci., Rikkyo Univ., Tokyo, Japan*, and NORITOMO KAWAJI, *Hokkaido Res Center, Forestry & Forest Products Res. Inst., Sapporo, Japan*.

The Asian Stubtail is a small (ca. 10 cm) ground-nesting species of warbler, which breeds around Japan and over-winters in Southeast Asia. Although this species is socially monogamous, up to 2 extra-pair males are frequently seen at nests during the nestling stage. The extra-pair males rarely help the pair, but they spend their time at the nest looking at nestlings, singing, and resting all day. They are also often seen following the parents around the nest when they leave the nest to forage. Both members of the pair tolerate the male and he does not behave aggressively towards the parents. Moreover, there was a very low rate of extra-pair young in this population suggesting that the male is not cooperatively breeding. Females are solely responsible for building the nest, incubating eggs, and brooding young in this species while males provision the young with food meaning the division of labor is not equally shared between sexes in this species. Therefore, males may have a lot of spare time when his own mate is incubating allowing him to visit other territories. A possibility is that males are visiting females in order to increase their probabilities of pairing with the social female in subsequent breeding attempts in the event of her nest failure or if she breeds for a second time. Further studies are needed to elucidate the adaptive significance of this behavior.

### **121 Li, Wang, Zhang, Lv, Liu**

Mate choice of a small passerine bird is related to phenotypic, but not genetic characteristics. JIANQIANG LI, YONG WANG, *Dept. Biol. & Environm. Sci., School Agri., Life & Nat. Sci., Alabama A&M Univ., Normal, AL*, and ZHENGWANG ZHANG, LEI LV, YINGYING LIU, *Ministry Edu. Key Lab. for Biodivers. Sci. & Ecol. Engineer., Coll. Life Sci., Beijing Normal Univ., Beijing, China*.

Mate choice is a process through which individuals can maximise fitness by selecting the best or compatible partner. Both phenotypic and genetic traits can play a role in mate choice. We investigated the roles of phenotypic and genotypic traits in the mate choices of the Silver-throated Tit, *Aegithalos glaucogularis*. For the former, we tested whether they assortatively chose mates based on 7 morphological measurements. For the later, we tested for assortative mating based on genetic heterozygosity (heterozygosity hypothesis) and whether birds mated with genetically dissimilar individuals (compatible genes hypothesis). We found significant correlations for bill length and body length between paired individuals, indicating possible assortative mating based on these 2 traits in Silver-throated Tits. Moreover, the body measurements were related to individual dominance status, and the clutch size was affected by female body length, which suggested that the mate choice process might directly affect individual fitness. In contrast, genetic heterozygosity was not correlated between paired individuals, and the relatedness of the mates was not significantly different from that of randomly mated individuals, suggesting that Silver-throated Tits might not actively choose heterozygous individuals, or genetically more dissimilar individuals, as mates. Also, individual heterozygosity was not reflected in the measured morphological traits, as no correlation was detected. Furthermore, neither the individual heterozygosity nor the relatedness between mates affected clutch size. Our results suggest that while the current data did not support the "heterozygosity" and "compatible genes" hypotheses, phenotypic traits might have played a role in the mate choice of Silver-throated Tits.

### **122 DuVal**

Variation in mate choice behavior among female Lance-tailed Manakins: the role of choosiness. EMILY H. DuVAL, *Dept. Biol. Sci., Florida State Univ., Tallahassee, FL*.

Mate choice can dramatically influence the rate and direction of evolution by sexual selection. Success of lekking male Lance-tailed Manakins (*Chiroxiphia lanceolata*) is determined primarily by female mate choice, but paternity reveals much variation in which males females choose. I investigated how variation in mate choice behavior contributes to this overall pattern using an automated telemetry system, and here specifically address variation in female choosiness. Receivers under male display perches detected visits of tagged females within 5 m of the perch, and manual tracking to nest sites linked genetic

paternity with search behavior. Choosiness was quantified as number of display areas visited, visits per area, and time per visit. I examined whether choosiness varied in relation to female age, body condition, morphology, or experience. Older females and those with longer tails (an age-linked trait) visited areas more often before mating. Substantial mate fidelity in this system did not decrease choosiness, as females mating with the same male as a prior year still searched extensively among potential mates. These results suggest female age is an important factor in mate choice.

### **123 Grunzel, B J Olsen**

A test for multiple antipredation strategies in songbirds during migration using phylogenetic contrasts. DAVID P. GRUNZEL and BRIAN J. OLSEN, *Climate Change Inst., School Biol. & Ecol., Univ. Maine, Orono, ME.*

Predation is an important factor driving migratory decisions made by songbirds. Behavioral tradeoffs between acquiring energy to fuel their journey and avoiding predators are critical to maximize survival. Birds may be trading in different currencies, however, depending on how far they have left to migrate. Here we used a field experiment to examine whether individuals optimizing time or energy during fall migration respond differently to predation risk. Long-distance migrants optimize time spent on migration, while short-distance migrants optimize energy. We conducted an aviary experiment at 3 sites along the coast of Maine to observe the tradeoff between foraging and vigilance behaviors of long and short-distance migrant songbirds during a simulated Merlin encounter.

### **124 Leighton**

Behavior and genetics suggest indirect benefits are important for the maintenance of cooperative nest construction in Sociable Weavers. G. M. LEIGHTON, *Dept. Biol., Univ. Miami, Coral Gables, FL.*

The evolutionary maintenance of large-scale cooperative behaviors presents a conundrum for biologists: individuals are expected to exploit the cooperative efforts of others, yet cooperative behaviors persist in nature. Especially susceptible forms of cooperative behavior are those behaviors that maintain communal goods. I investigated a behavior that maintains a communal good in a little-studied system, the cooperative nest construction behavior of Sociable Weavers (*Philetairus socius*). The goal of the study was to elucidate the selective mechanisms that stabilize this behavior in the wild. Behavioral observations, RAD-tag sequencing data, and other lines of evidence suggest the importance of kin selection in maintaining cooperative nest construction behavior in wild populations of sociable weavers. These results provide useful inter-species comparisons that test the generality of evolutionary mechanisms argued to be important for maintaining cooperation in natural systems.

### **125 Grundel, Frohnapple, Zaya, Glowacki, Weiskerger, Patterson, Pavlovic**

Geographic coincidence of avian conservation value measures. RALPH GRUNDEL, KRYSTALYNN J. FROHNAPPLE, *US Geol. Surv., Potter, IN*, DAVID N. ZAYA, *Univ. Illinois, Chicago, IL*, GARY A. GLOWACKI, *Lake Co. Forest Preserves, Grayslake, IL*, CHELSEA J. WEISKERGER, TAMATHA A. PATTERSON, *Univ. Notre Dame, Notre Dame, IN*, and NOEL B. PAVLOVIC, *US Geol. Survey, Porter, IN.*

Distributional patterns across the US of 5 avian community breeding season characteristics – community biomass, richness, constituent species' vulnerability to extirpation, percentage of constituent species' global abundance present in the community (Conservation Index, CI), and community's position along the ecological gradient underlying species composition - were described, their co-variation analyzed, and projected effects of climate change on the characteristics and their co-variation modeled. Higher values of biomass, richness, and CI are generally preferred from a conservation perspective. However, higher values of these characteristics often did not coincide geographically so regions of the US would differ in their value for conservation depending on which characteristic was chosen for setting conservation priorities. Among the 5 characteristics, community richness and the ecological gradient that underlies community composition had the highest correlations with longitude. The ecological gradient underlying composition exhibited a demarcation near the 100th meridian, separating the lower US grossly into 2 similar sized avian ecological provinces. The Combined Score, a measure of species' threat of decline or extirpation, exhibited the strongest latitudinal pattern, declining from south to north. Over approximately 75% of the lower US, projected changes in Jun temperature and precipitation to year 2080 were associated with decreased averaged values of richness, biomass, and CI, implying decreased conservation value for birds.

## 126 English, Green, Nocera

Flying down the food web: museum specimen isotopes suggest long-term change in diet of a nocturnal aerial insectivore. PHILINA A. ENGLISH, DAVID J. GREEN, *Dept. Biol. Sci., Simon Fraser Univ., Vancouver, BC*, and JOSEPH J. NOCERA, *Ontario Min. Nat. Res. and Trent Univ., Peterborough, ON*.

Aerial insectivores, dietary specialists that rely on flying insects, are exhibiting some of the steepest population declines of any group of birds in North America. One hypothesis for the decline is a change in food availability; however, long-term data on insect abundance and avian diet are generally lacking for both breeding and wintering grounds. We look for evidence of changing diets in Ontario's Eastern Whip-poor-wills using museum specimens collected between 1880 and 2000, and samples from whip-poor-wills breeding at 3 distinct sites in 2012. We use nitrogen isotope ratios ( $\delta^{15}\text{N}$ ), which are known to increase with trophic level and diet quality, to assess changes in diet using tissues grown on the wintering grounds (claw) and breeding grounds (feathers). Eastern Whip-poor-wills are nocturnal aerial insectivores that eat primarily lepidopterans (moths) and coleopterans (beetles) of variable trophic levels. We do find significant declines in  $\delta^{15}\text{N}$  in both winter and summer tissues of adults and in nestlings over the past 100 yr. Nitrogen isotopes of both winter-grown claws and summer-molted feathers did not differ between sexes or breeding sites; but nestlings have lower feather  $\delta^{15}\text{N}$  levels than adults, which is consistent with both lower fractionation due to high growth rates and a lower proportion of high trophic level coleopterans in the nestling diet. These results support the hypothesis that aerial insectivore populations may be declining due to changes in prey abundance or quality.

## 127 Eттerson

Hidden Markov models for estimating animal mortality from anthropogenic hazards. MATTHEW A. EттERSON, *Natl. Health & Environ. Effects Res. Lab., US Environ. Prot. Agency, Duluth, MN*.

Carcass searches are a common method for studying the risk of anthropogenic hazards to wildlife, including non-target poisoning and collisions with anthropogenic structures. Typically, numbers of carcasses found must be corrected for scavenging rates and imperfect detection. Parameters for these processes (scavenging and detection) are often estimated using carcass-distribution trials in which researchers place carcasses in the field at known times and locations. In this manuscript I develop a variety of estimators based on multievent or hidden Markov models for use under different experimental conditions. I apply the estimators to 2 case studies of avian mortality, one from pesticide exposure and another at wind turbines. The proposed framework for mortality estimation points to a unified framework for estimation of scavenging rates and searcher efficiency in a single trial and also allows estimation based only on accidental kills, obviating the need for carcass distribution trials. Results of the case studies show wide variation in the performance of different estimators, but even wider confidence intervals around estimates of the numbers of animals killed, which are the direct result of small sample size in the carcass distribution trials employed. These results also highlight the importance of a well formed hypothesis about the temporal nature of mortality at the focal hazard under study.

## 128 Gehring

Bird collisions with communications towers: progressing from research to policy change and bird conservation. JOELLE GEHRING, *Fed. Communications Comm., Washington, DC*.

Each year millions of birds, primarily Nearctic-Neotropical migrants, collide with communications towers during migration. Our research determined that tower height, tower support system, and tower lighting influence the numbers of avian collisions. Collaboration with the communications tower industry and the Federal Aviation Administration resulted in new tower lighting recommendations that include lighting systems to reduce avian collisions by as much as 70%. Lighting changes can be accomplished at almost no cost to the tower owner and they reduce maintenance and energy costs long term, resulting in the most effective and economically feasible means of achieving a significant reduction in avian fatalities at communications towers. The Federal Communications Commission, one of the regulatory agencies of communications towers, has now changed their policies on the environmental review process and tower lighting requirements on new towers. Education of the tower industry and bird conservation groups is ongoing and successful. This case study emphasizes the value of rigorous scientific research and collaboration with all stakeholders when working to resolve long term conservation issues.



### **129 Helton, Risch**

Use of fish farms and Wetland Reserve Program properties by Interior Least Terns in eastern Arkansas. LAUREN W. HELTON AND THOMAS S. RISCH, *Dept. Biol., Arkansas State Univ., State University, AR.*

Extensive losses of wetlands in the central US have resulted in a reduction of foraging sites for migrating and breeding Interior Least Terns (*Sternula antillarum athalassos*), which were listed as federally endangered in 1985 in response to population declines and loss of colony sites. One means of restoring wetland habitat is the Wetland Reserve Program (WRP) operated by the US Department of Agriculture. It is currently unknown if WRP properties in Arkansas are able to support foraging Least Terns. Similarly unknown is whether aquaculture in Arkansas can provide foraging habitat. In 2012, we surveyed 32 fish farms and 25 WRPs for Least Terns, and measured habitat variables including vegetative cover, vegetation height, and percent water cover of individual ponds. We observed Least Terns more frequently at fish farms than at WRPs. Terns were observed foraging and loafing on both WRPs and fish farms, but pre-migratory staging in early fall only occurred at one fish farm site in particular and was not observed on any WRPs. On average, fish farms had less vegetative cover, shorter vegetation, and more water than did WRPs. Current WRP management schemes in Arkansas are based on maintaining habitat for waterfowl and restoring bottomland hardwood forest. In order to manage wetland habitat for Least Terns, we recommend annual clearing of vegetation, and when possible, flooding of natural or artificial pond basins through late summer.

### **130 Herkert, Herkert**

An assessment of potential surrogate species for the Eastern Tallgrass Prairie Bird Conservation Region (BCR 22). JAMES R. HERKERT, *Illinois Dept. Nat. Res., Springfield, IL.*

There is much interest in identifying Surrogate/Focal Species (SFS). SFS approaches are used because it is generally impractical to consider requirements for all species present in a given geography in biological planning and conservation design. As a result, SFS are used to identify where to target conservation efforts, what actions to take, and determine how much effort is needed. By addressing the needs of SFS, other species within the guild are assumed to also benefit. However, this assumption needs evaluation. I used data from the Breeding Bird Survey and a long-term study of breeding birds in Illinois to evaluate the ability of species within the grassland bird guild to represent other species in terms of their presence, absence and abundance at both the landscape and local scales within the Eastern Tallgrass Prairie Bird Conservation Region (BCR 22). Although species associations clearly existed with the data set, power to predict presence, absence, or abundance for one species based on another was limited. At the landscape level, no species pair had better than 40% accuracy in predicting presence and absence and half of the species had no other species capable of predicting presence and absence with greater than 20% accuracy. As a result, SFS approaches may be best focused on selecting species due to conservation interest in the selected species rather than its ability to represent the broader needs of the guild.

### **131 McGowan, Catlin, Shaffer, Gratto-Trevor, Aron**

A meta-population model for evaluating recovery criteria for Piping Plovers in the Great Plains. CONOR P. MCGOWAN, *US Geol. Surv., Alabama Coop. Fish & Wildl. Res. Unit, Auburn, AL*, DANIEL H. CATLIN, *Dept. Fish & Wildl. Conserv., Virginia Polytechnic Inst. & State Univ., Blacksburg, VA*, TERRY L. SHAFFER, *US Geol. Surv., Northern Prairie Wildl. Res. Center, Jamestown, ND*, CHERI L. GRATTO-TREVOR, *Environment Canada, Sci. & Tech., Delta, BC*, and CAROL ARON, *US Fish & Wildl. Serv., North Dakota Field Office, Bismark, ND.*

Listing a species under the Endangered Species Act (ESA) requires USFWS to establish specific and measurable criteria for delisting. Generally, species are listed because they face (or are perceived to face) elevated risk of extinction due to issues such as habitat loss, invasive species, or other factors. Recovery plans and endangered species management efforts are focused on the central question "How do we identify recovery criteria that reduce extinction risk to an acceptable level?" It logically follows that recovery criteria, the defined conditions for removing a species from ESA protections, should be, at least in part, directly related to extinction risk. Extinction probability is a model-derived population parameter estimated by using current demographic information to project the population into the future over a number of replicates, calculating the proportion of replicated populations that go extinct. Using Piping Plovers in the Great Plains, we simulated extinction probabilities and estimated the relationship between

extinction probability and various demographic parameters. We tested the fit of regression models linking initial abundance, productivity, or population growth rate to extinction risk, and then, using the regression parameter estimates, calculated the conditions required to reduce extinction probability to some pre-defined acceptable threshold. Model selection suggested that linear regression models with mean population growth rate and the natural log of initial abundance were the best predictors of extinction probability 50 yr into the future. For example, based on our regression models, an initial abundance of approximately 6,515 females with an expected mean population growth rate of 1.0 will limit extinction risk for Piping Plovers in the Great Plains to less than 0.01. Our method provides a straightforward way of developing specific and measurable recovery criteria linked directly to the core issue of extinction risk.

### **132 Pinney, Gutzwiller**

Species site occupancy is underestimated when temporal dependencies in detections are not considered: implications for avian conservation. TRACY A. PINNEY and KEVIN J. GUTZWILLER, *Dept. Biol., Baylor Univ., Waco, TX.*

Site-occupancy modeling is increasingly used to assess the distribution and population status of bird species of conservation concern, but this method assumes that species detections are independent among temporal replicates for a site. We compared estimates of the probability of site occupancy from 2 modeling approaches: one that addresses temporal correlation in detections (Markov method), and one that does not address this correlation (non-temporal method). Using 5 back-to-back point counts at each of 282 sites, we collected occurrence data for 14 bird species in the Oaks and Prairies Bird Conservation Region. Five principal components that reflected landscape conditions were used as candidate explanatory variables, and we used AIC statistics to identify the best model for each modeling approach and species. Compared to the Markov method, which enabled a better fit of the data for all species, the non-temporal method systematically underestimated site occupancy for all species (range of underestimates = 0.05 - 0.51, mean = 0.21). Failure to model temporal dependencies in detections may lead to poor conservation decisions. For example, if site occupancy is underestimated by 0.20 or more, decisions regarding habitat conservation, restoration and acquisition may exclude significant areas of suitable habitat. Models of occupancy-landscape relationships derived from underestimated occupancy will not be accurate, especially when occupancy underestimates vary with landscape conditions, and will result in faulty projections of species distributions in response to land-use change or climate change. These and similar situations will lead to suboptimal application of limited conservation resources.

### **133 Rigby, D H Johnson**

Detection zones of simulated grassland birds: implications for bird surveys. ELIZABETH A. RIGBY, *Univ. Minnesota, St Paul, MN,* and DOUGLAS H. JOHNSON, *Northern Prairie Wildl. Res. Center, Jamestown, ND.*

Detectability of birds during surveys is affected by many factors, but previous assessments of these factors have been limited to forested habitats. We extended this investigation to grasslands using a portable speaker apparatus to broadcast songs of 10 grassland bird species and documenting song detections by 4 observers. We used logistic regression analyses with mixed models to evaluate covariates of detection, using correct detection of a broadcast song as the binary response variable. Distance from the sound source and wind speed and direction were the major factors affecting detection. Density of vegetation had a lesser effect, a contrast to the strong effect seen for forested sites. The greatest probability of detection occurred close to and downwind from the sound source, which resulted in roughly teardrop-shaped zones where songs were most likely to be detected. Detection zones were constricted at higher wind speeds. When wind speed exceeded 4 m/s, detection upwind of the sound source was = 25% for distances = 60 m. At low wind speed (= 1 m/s), upwind detection exceeded 40% for distances = 120 m. The asymmetry of detection zones suggests there may be substantial differences in perceptibility of birds depending on their orientation relative to observer and the wind, even if they are equidistant from the observer and have equal availability. Wind effects should be considered in bird survey design and survey points should be placed so as to avoid drastic differences in land cover type surveyed under differing wind conditions.

### **134 Novak, Kronenberg, Yandell, Brady, Puiu, Salzberg, Fonseca, Gilbert, Fulton, Green, Shapiro**

From so small of beginnings: genome-wide sequence data of the extinct Passenger Pigeon. BEN J. NOVAK, *Revive & Restore, Long Now Found., Santa Cruz, CA*, ZEV KRONENBERG, MARK YANDELL, *Univ. Utah, Salt Lake City, UT*, DANIELLA PUIU, *Johns Hopkins Univ., Baltimore, MD*, ARTHUR BRADY, *Univ. Maryland, College Park, MD*, STEVEN L. SALZBERG, *Johns Hopkins Univ.,* RUTE DA FONSECA, M. THOMAS GILBERT, *Univ. Copenhagen, Copenhagen, Denmark*, TARA L. FULTON, RICHARD E. GREEN and BETH SHAPIRO, *Univ. California Santa Cruz, Santa Cruz, CA*.

DNA persists in museum samples for decades or even centuries. The latest high-throughput sequencing technologies make it possible to sequence this DNA with increasing speed and at declining cost. Here we demonstrate that very small toe pad samples extracted from 160 - 110 yr-old, conventionally preserved specimens of extinct Passenger Pigeons, *Ectopistes migratorius*, contain sufficient DNA to reconstruct, in principle, the entire nuclear genome. Full mitochondrial genomes are easily obtained from multiple specimens, providing the preliminary basis to begin understanding the species' population biology. The extraction process was minimally invasive leaving the samples fit for displays and further research without future sub-sampling. Our results demonstrate the potential for obtaining genomic data from large numbers of individuals using only minimally-invasive sampling techniques, moving museum genetic studies forward from having to choose between limiting samples or DNA sequence targets and into a wider application of biological study in the age of genomics.

### 135 Galla, J A Johnson

Acknowledging life history strategy in the choice of molecular marker for resolving phylogenetic relationships among recently divergent taxa. STEPHANIE GALLA and JEFF A. JOHNSON, *Dept. Biol. Sci., Univ. North Texas, Denton, TX*.

Life history strategies can influence the effective population size ( $N_e$ ) of loci that differ based on their mode of inheritance. For example, a polygynous and polyandrous breeding behavior can further increase or decrease the  $N_e$  of sex-linked markers compared to neutral expectations depending on the heterogametic sex. Recognizing how this affects the rate of lineage sorting among marker types is important for studies focused on resolving phylogenetic relationships among recently divergent taxa. In this study, we explore how marker type (mitochondrial, Z-linked, and autosomal) influences our ability to identify phylogenetic relationships using both traditional gene tree and coalescent-based species tree analyses with a highly polygynous taxonomic group, the North American prairie grouse (genus: *Tympanuchus*). We found that Z-linked loci outperformed autosomal and mtDNA loci in both species and gene tree analyses; however, differences existed among methods for resolving species-level relationships with the species tree approach outperforming those for constructing gene trees. Further, given that prairie grouse diversification is fairly recent (i.e., late Pleistocene), results suggest that additional factors, such as strong sexual selection and postzygotic behavioral isolation, are further decreasing the  $N_e$  of Z-linked loci relative to both mtDNA and autosomal loci. Overall, this study demonstrates how life history strategy, specifically mating behavior, can be an important factor for identifying the most appropriate markers for resolving species relationships in phylogenetic analyses among recently divergent taxa.

### 136 Benz

Deciphering the evolutionary history of the montane New Guinea avifauna: comparative phylogeography and insights from paleodistributional modeling in a dynamic landscape. B. W. BENZ, *Am. Mus. Nat. Hist., New York, NY*.

New Guinea's extensive montane landscape supports an avifauna of high species richness, strong elevational specialization, and fine-scale endemism among disjunct sky-island communities. The underlying evolutionary processes driving these patterns of diversification remain poorly understood, as lack of genetic sampling has precluded modern phylogeographic analyses for most taxonomic groups. Herein, I reconcile spatial analyses of genetic diversity with contemporary and paleoecological niche reconstructions in 8 co-distributed montane passerines to examine how Pleistocene climate change and topographic relief have influenced avian diversification across the New Guinea highlands. Phylogeographic analyses revealed substantial disparity in the degree and distribution of genetic diversity among taxa, with several taxa exhibiting deep species-level divergences across well-known biogeographic boundaries whereas other taxa displayed little or no genetic structure across these putative barriers. Shallow genetic divergences observed throughout the Eastern Highlands and Papuan Peninsula are consistent with low-level gene flow and recurrent population connectivity predicted by Last Glacial Maximum paleoecological niche reconstructions, whereas deeper genetic splits in the Bird's Neck region,

Strickland Gorge, North Coast Ranges, and Huon Peninsula indicate retention of genetic diversity across multiple climatic cycles. Although Pleistocene climatic oscillations have clearly influenced the demographic and evolutionary history of New Guinea's montane avifauna, variation in dispersal capacity and ecology has also likely contributed to the disparity in phylogeographic structure among taxa, as significant Mantel tests indicate an isolation-by-distance effect has impacted the distribution of genetic diversity in several species.

### **137 Barrowclough, Groth, Lai, Tsang**

Phylogenetic relationships of the endemic genera of Australo-Papuan hawks. GEORGE F. BARROWCLOUGH, JEFF G. GROTH, JONAS E. LAI and SUSAN M. TSANG, *Am. Mus. Nat. Hist., New York, NY*.

Six genera of accipitrids (*Erythrotriorchis*, *Hamirostra*, *Harpyopsis*, *Henicopernis*, *Lophoictinia*, and *Megatriorchis*), composed of a total of 8 species, are endemic to the Papua-Australian region. Traditionally, these were assigned to 4 diverse tribes in the Accipitridae; however, a recent hypothesis suggested they together comprise an endemic radiation of closely related genera and species. We investigated these alternatives using phylogenetic analysis of DNA sequences of the slowly evolving nuclear RAG-1 exon. Bootstrapped maximum likelihood trees and a permutation likelihood ratio test provide robust evidence that these genera represent 4 clades placed in 3 tribes: 1.) *Hamirostra*, *Henicopernis*, and *Lophoictinia* comprise a monophyletic clade of pernine kites, 2.) *Harpyopsis* is a harpy eagle, and 3.) *Erythrotriorchis* and *Megatriorchis* represent 2 divergent clades of accipiters. The hypothesis that they are all monophyletic is strongly rejected. The data are consistent with a southeast Asian or Papua-Australian origin for each of the 4 clades.

### **138 Braun, Burleigh, Kimball**

"Big Bird" – inferences based upon analyses of a large-scale supermatrix of avian genetic data. EDWARD L. BRAUN, J. GORDON BURLEIGH and REBECCA T. KIMBALL, *Dept. Biol., Univ. Florida, Gainesville, FL*.

Advances in DNA algorithms for phylogenetic analyses, high performance computing, and sequencing technology have made it possible to generate comprehensive phylogenies that can be used to examine patterns of evolution across the tree of life. However, the need to synthesize heterogeneous phylogenetic datasets presents many analytical challenges for evolutionary biologists, who would like to extend the taxonomic sampling of past phylogenies without sacrificing the accuracy or quality of the estimated phylogenetic trees. We use available molecular data and the latest computational methods to estimate an empirically-derived taxon-rich avian phylogeny, compare this phylogeny to other recent studies, and assess the implications of topological and branch length uncertainty on views on evolutionary inference and diversification. Mean support for internal nodes in the 7000-taxon ML tree was surprisingly high. More than ¾ had =50% bootstrap support, and the backbone relationships were largely consistent with those from Hackett et al. (2008, *Science* 320:1763-1768). Nonetheless, despite the support for monophyly of most families and genera, many of these clades had no support. Our analysis illustrates how the tremendous abundance of sequence data and advances in phylogenetic methods and tools can be effectively exploited for large-scale phylogenetic synthesis of birds, but we also caution that topological and branch-length uncertainty may affect some evolutionary inferences.

### **139 K J Burns, Shultz, Title, Mason**

Diversification of tanagers (Thraupidae), the largest radiation of Neotropical songbirds. KEVIN J. BURNS, ALLISON J. SHULTZ, PASCAL O. TITLE and NICHOLAS A. MASON, *Dept. Biol., San Diego State Univ., San Diego, CA*.

The tanagers represent a major continental radiation, making up an important component of the Neotropical fauna. Traditionally, the group was considered to contain 242 species of mostly colorful, fruit-eating or omnivorous birds. In this study, we show that the tanagers are a clade of 370 species spanning a diversity of feeding morphologies, plumage variation, vocal abilities, and habitat preferences. We reconstructed a phylogeny for tanagers using 2 mtDNA and 4 nuclear genes using a combination of maximum likelihood and Bayesian methods. Within tanagers, we identified 13 major clades that diverged at roughly the same time, but vary in size from 2 to over 100 species. These clades provide independent tests concerning character variation and species diversification. Compared to related groups of birds, the

tanagers are significantly species-rich relative to background expectations, with a diversification rate comparable to Hawaiian silverswords. The phylogenetic tree of tanagers shows a pattern of lineage diversification expected under a scenario of adaptive radiation. Testing the fit of different diversification process models on an ultrametric tree identified an exponential density-dependent decline model as the most appropriate for tanagers. However, testing diversification models for each of the major clades of tanagers indicates that 2 of the major clades fit a pure birth model (the Darwin's finch clade and the *Sporophila* clade). Using the phylogeny of tanagers, we also compare patterns of evolution in characters typically associated with natural selection (ecological niche, morphology) and those associated with sexual selection (plumage, song) and evaluate their relationship to diversification rates.

#### **140 Catanach, K P Johnson**

Insights into the phylogeny of diurnal raptors from their feather lice. THERESE A. CATANACH, *Prog. Ecol., Evol. & Conserv., Univ. Illinois, Urbana, IL and Dept. Wildl. & Fish. Sci., Texas A&M Univ., College Station, TX*, and KEVIN P. JOHNSON, *Illinois Nat. Hist. Surv., Prairie Res. Inst., Univ. Illinois, Champaign, IL*.

The majority of bird species host feather lice, which are permanent parasites, spending their entire lifecycle on the host. While many lice are incredibly host specific, others, including those found on Falconiformes, are less so. Although they lack strong host specificity, falconiform lice can still be used to provide insights into higher level relationships in diurnal raptors. Additionally, the fact that some louse species can occur on multiple host species mean that spatial (i.e. migration pathways) rather than phylogenetic factors may drive more fine scale louse relationships. Lice in the genus *Degeeriella* were collected from approximately 10 genera (33 species) of diurnal birds of prey, including representatives of both Falconidae and Accipitridae. One mitochondrial and 3 nuclear genes were sequenced for these louse specimens and included in a phylogenetic dataset of 9 additional louse genera from a variety of unrelated hosts, with which *Degeeriella* forms a generic complex. Phylogenetic analyses revealed that *Degeeriella* is polyphyletic, with falcon lice forming a clade sister to a genus of woodpecker louse, while the lice from rollers (Coraciidae) were nested within lice from Accipitridae. At a finer scale, lice from Red-tailed Hawks in the western United States were found to be more closely related to Rough-legged Hawk lice from the same region than to lice from other Red-tailed Hawks east of the Mississippi River.

#### **141 Chesser, Isler, Martin, Naka, Bravo, Aleixo, Bergner, Whitney**

Phylogeography of the Amazonian antwren *Myrmotherula brachyura*, with comparisons to co-distributed understory antwrens. R. TERRY CHESSER, *US Geol. Surv./Natl. Mus. Nat. Hist., Washington, DC*, MORTON L. ISLER, *Natl. Mus. Nat. Hist., Washington, DC*, ADAM MARTIN, *Oregon State Univ., Corvallis, OR*, LUCIANO N. NAKA, GUSTAVO A. BRAVO, *Mus. Nat. Sci., Louisiana State Univ., Baton Rouge, LA*, ALEXANDRE ALEIXO, *Mus. Paraense Emilio Goeldi, Belem, Brazil, L.* BERGNER, *Natl. Zool. Park, Washington, DC*, and BRET M. WHITNEY, *Mus. Nat. Sci., Louisiana State Univ*

We studied the phylogeography of the Pygmy Antwren *Myrmotherula brachyura*, a monotypic pan-Amazonian species that inhabits rainforest canopy and subcanopy, using samples of 70 individuals collected throughout its distribution. Despite the lack of morphological variation, analysis of sequences of 2 mtDNA genes (ND2 and cytochrome-b) revealed 6 geographically coherent clades separated by at least 1.5% sequence divergence. Range limits of clades were consistent with river-delimitation, although divergence across most major rivers (e.g., Amazon, Tapajós, Madeira) was lower in *M. brachyura* than in congeneric and co-distributed understory species *M. longipennis* and *M. menetriesii*. Preliminary analysis of vocalizations identified vocal groups corresponding to most of the genetic clades, and suggests that there are multiple biological species, as well as phylogenetic species, within *M. brachyura*.

#### **142 Andersen, Moyle**

Phylogenomics and hybridization in an oceanic archipelago: high-throughput sequencing resolves patterns of diversification in the Fiji Whistler (*Pachycephala vitiensis*). MICHAEL J. ANDERSEN and R. G. MOYLE, *Biodiv. Inst., Univ. Kansas, Lawrence, KS*.

We used the Fiji Golden Whistler, *Pachycephala vitiensis*, as a model to study patterns and processes of differentiation in an oceanic island archipelago. Ten subspecies are distributed across the archipelago, including all 3 plumage types that are present in the entire *P. pectoralis* species complex.

The occurrence of all 3 plumage types led Ernst Mayr to infer 3 independent colonizations of this remote archipelago, which provides the opportunity to study the relationship between plumage pattern, isolation, and phylogenetic relationships. Furthermore, Mayr noticed a zone of intergradation between populations with 2 distinct plumage types on the island of Vanua Levu, and he hypothesized secondary contact between 2 previously isolated taxa. The rarity of interactions between recently derived taxa is one drawback of working in island systems, so this putative hybrid zone provides a rare opportunity to investigate the results of divergence on islands. We used high-throughput sequencing on the Illumina platform to obtain thousands of SNPs from 20,450 loci (RAD-tags). Data were analyzed to test hypotheses across multiple spatial scales. We examined phylogeographic patterns in the archipelago and found evidence for multiple independent colonizations of Fiji. Our phylogeographic results provided unprecedented resolution when compared to a previous study of this group based on Sanger sequence data. We also took advantage of genome-wide SNP data to examine the putative hybrid zone. Based on low  $F_{st}$  values and estimates of gene flow, we found evidence for divergence in the presence of gene flow across the island of Vanua Levu.

### **143 Harvey, Smith, Faircloth, Glenn, McCormack, Brumfield**

Information content of genomic ultraconserved elements for avian phylogenetics and phylogeography. MICHAEL G. HARVEY, *Dept. Biol. Sci. and Mus. Nat. Sci., Louisiana State Univ., Baton Rouge, LA*, BRIAN TILSTON SMITH, *Mus. Nat. Sci., Louisiana State Univ.*, BRANT C. FAIRCLOTH, *Dept. Ecol. & Evol. Biol., Univ. California, Los Angeles, CA*, TRAVIS C. GLENN, *Dept. Environ. Health Sci., Univ., Athens, GA*, JOHN E. McCORMACK, *Moore Lab. Zool., Occidental Coll., Los Angeles, CA*, and ROBB T. BRUMFIELD, *Dept. Biol. Sci. and Mus. Nat. Sci., Louisiana State Univ.*

Ultraconserved elements (UCEs) are short regions of the genome that are nearly identical across distantly related organisms. Their conserved sequences allow for probe-based capture and massively parallel sequencing (MPS) and subsequent alignment of sequencing reads, and variation in their flanks provides informative characters for systematics. We compare the utility and information content of UCEs to traditional markers by analyzing datasets from the different markers constructed from the same samples or species. At deep, phylogenetic timescales we use samples from 29 birds across Neoaves to compare UCEs to nuclear genes. At shallow, phylogeographic timescales we use samples from multiple populations of 5 Neotropical bird species to compare UCEs to mitochondrial sequences. Using phylogeographic samples, we also compare UCEs to SNPs generated by Genotyping by Sequencing, a restriction enzyme-based approach to generating reduced-representation genomic data with MPS.

### **144 Edwards, Lowe, Clarke, Baker**

Comparative genomics suggests regulatory, not coding, innovation underlies the origin of feathers. SCOTT V. EDWARDS, *Mus. Comp. Zool., Harvard Univ., Cambridge, MA*, CRAIG B. LOWE, *Dept. Dev. Biol., Stanford Univ. School of Medicine, Stanford, CA*, JULIA A. CLARKE, *Jackson School Geosci., Univ. Texas, Austin, TX*, ALLAN J. BAKER, *Dept. Nat. Hist., Royal Ontario Mus., Toronto, ON*, and DAVID HAUSSLER, *Center for Biomol. Sci. & Engineering, Univ. California, Santa Cruz, CA*.

The molecular basis of major innovations that have facilitated adaptive radiation have long intrigued biologists, and recent work suggests that comparative genomics is a powerful tool for identifying the molecular underpinnings of such innovation. Feathers are an obvious key innovation in the diversification of birds and constitute a trait that evolved just once across the Tree of Life, achieving its most diverse expression in extant birds. To better understand the molecular basis of feather evolution, we first surveyed the developmental biology literature and found over 200 genes that have been implicated in feather development. We then used computational tools involving whole-genome alignments of 14 amniotes and a Hidden Markov model to measure patterns of constraint in coding and regulatory regions of feather-related genes (FRGs) as compared to genome-wide neutral patterns. Our analysis suggests that, except for the dramatic expansion of beta-keratins in birds, the genic (coding sequence) toolkit for feather development, which shares at least 30 genes involved in development of hair in mammals, is old and has experienced little innovation during vertebrate evolution. By contrast, conserved non-exonic elements (CNEEs) of FRGs have evolved dynamically throughout vertebrate evolution and experienced a spike in origination rates in the common ancestor of birds and also of amniotes. We develop a ranked list of FRGs with exceptional CNEE evolution in birds that might be used to target genes with special roles specifically in feather development. Our results suggest that, quantitatively, genomic innovations associated with feather evolution have been largely noncoding.

#### **145 Rueda-Hernandez, Renton**

Cavity availability in cloud forest in southern Mexico. RAFAEL RUEDA-HERNANDEZ and KATHERINE RENTON, *Instituto de Biología, Universidad Nacional Autónoma de México, Coyoacán, Distrito Federal, México*

Habitat loss in the Neotropics is a threat for many bird species, particularly for bird species with specific habitat requirements (Sodhi et al. 2008, *Auk* 125:511-519), such as cavity nesters. Cloud forests in Mexico host a rich community of cavity nesting birds (Monterrubio-Rico and Escalante-Pliego 2006, *Biol. Conserv.* 128:67-78), which may be threatened by increasing deforestation rates. We assessed cavity availability and characteristics in 3 forest fragments in central Veracruz, Mexico 1) a 125.9 ha forest with federal protection since 1975, 2) a 17.8 ha forest fragment with federal protection since 2003, and 3) a 21.4 ha unprotected forest fragment. We found a higher cavity density in the larger forest area that is under protection since the mid 1970s (35 cavities/ha), and this was the only site where we found woodpecker cavities, all in standing dead trees. The smaller protected forest fragment had fewer cavities (24.4 cavities/ha), while only 11.9 cavities/ha were found in the unprotected forest. Those cavities excavated by woodpeckers were significantly higher from the ground and had a significantly wider entrance diameter compared to natural cavities. Hence, cavity characteristics and availability in cloud forest fragments may have been limited by past management activities at our sites. The restoration of natural decay processes may take over 10 yr of active protection thus greater efforts are needed to maintain adequate cavity nesting resources in cloud forest remnants.

#### **146 Sandler, Atkins, McLarty, McCormick, Henson, Hayward**

Features of copulation and the copulation call in Glaucous-winged Gulls. AMANDA SANDLER, GORDON ATKINS, MINDY McLARTY, MELISSA McCORMICK, SHANDELLE HENSON and JAMES HAYWARD, *Dept. Biol. and Dept. Math., Andrews Univ., Berrien Springs, MI.*

Glaucous-winged Gulls breed in colonies along the Pacific Northwest coast where they perform a highly stereotypical set of courtship displays. Like most larids, Glaucous-winged Gulls vocalize during copulation and these vocalizations are thought to help maintain pair bonds. Recent studies, however, have challenged the notion that this is the only function of vocalization during copulation. Certain vocalizations have been shown to induce courtship within pairs of Ring-billed Gulls, but only playback of the copulation call stimulated increased rates of copulation (Fetterolf and Dunham 1985, *Can. J. Zool.* 63: 1017-1019). We describe the temporal and spectral features of the copulation call in Glaucous-winged Gulls. Preliminary data indicate this call to be highly variable in harmonic structure and syllable duration. Additionally, changes in mount duration, start-to-start mount interval, and the number of cloacal contacts attempted by the male are associated with environmental variables. Results of a test designed to test the influence of the copulation call on copulation behavior and egg-laying synchrony in neighboring pairs of Glaucous-winged Gulls in spring 2013 will be reported.

#### **147 Bubac, Spellman**

How habitat connectivity shapes genetic structure during range expansion: insights from Virginia's Warbler in the Black Hills. CHRISTINE M. BUBAC, GARTH M. SPELLMAN, *Black Hills State Univ., Spearfish, SD.*

Species range expansions facilitated through global climate change has been documented across the spectrum of life. Consequently, the ecological and evolutionary costs of range expansion in response to climate change are beginning to be teased apart and have the potential to be strikingly different among taxa experiencing different types of range expansion across highly variable landscapes. Contiguous range expansion with recurring gene flow could curtail the loss of genetic diversity in newly colonized areas. Alternatively, range expansion across inhabitable regions to habitat islands could produce founder events and without recurring gene flow substantially decrease genetic variation in newly colonized areas. We aim to investigate how landscape and habitat connectivity impact genetic diversity in Virginia's Warbler which has recently colonized (within the last 10 - 15 yr) the Black Hills of South Dakota. To investigate population connectivity, we have sampled Virginia's Warblers from throughout their breeding range. The mtDNA NADH dehydrogenase subunit 2 (ND2) gene was amplified to look at population structure. Twelve microsatellite loci were used to characterize genetic structure within and among populations and investigate genetic variability associated with landscape features and the recent founder event in the Black Hills.

**148 Franco, Enríquez, Castillo-Guerrero, Fernández**

Low genetic relatedness between breeding pairs could explain lack of extra-pair paternity in the Blue-footed Booby of Isla el Rancho, Mexican Pacific. C. FRANCO, *UAM-ICML Univ. Nac. Aut. Mex., Mazatlán, México*, L. M. ENRÍQUEZ, *Univ. Aut. Baja California, Ensenada, Mexico*, J. A. CASTILLO-GUERRERO, *Cent. Inv. Alim. y Des., Mazatlán, México*, and G. FERNÁNDEZ, *UAM-ICML Univ. Nac. Aut. Mex., Mazatlan, Mexico*.

Promiscuity is common in socially monogamous bird species. One of the main hypotheses suggests that female promiscuity is an insurance mechanism against the potential detrimental effects of inbreeding. According to this, females should preferably mate with less related males in multiple mating to enhance offspring heterozygosity. Extra-pair copulations have been reported in the Blue-footed Booby, *Sula nebouxii*, but paternity assessment has not been conducted so far. In this study, molecular data were used to determine if mean heterozygosity in males and chicks, paternity and relatedness between mates provide evidence supporting the enhanced heterozygosity hypothesis in the Blue-footed Booby. Multilocus genotyping (12 microsatellite) was performed in 24 broods (42 chicks) sampled at El Rancho Island, Sinaloa, during the 2011 - 2012 breeding season. Individual heterozygosity (number of heterozygous loci/total number of typed loci) in male adults and chicks was high (67%), 8 out of 12 loci were heterozygous; paternity of all chicks was unambiguously assigned to their broods (parent-offspring relatedness 0.48 - 0.63). Most social pairs were not related (mean mate relatedness 0.0 - 0.34), the low overall relatedness among breeding adults and between mates indicates that most males have on average the same quality in terms of heterozygosity, females are not involved in additional matings (no EP copulations observed) in order to avoid the negative effects of mating with a relative. These results indicates that there's no sign of inbreeding in the offspring of the Blue-footed Booby in El Rancho and apparently females can choose their social pair randomly according to genetic similarity.

**149 Hane, Kroll, J R Johnson, Rochelle, Arnett**

Nest survival in experimentally created snags on a managed forest landscape. MATTHEW E. HANE, ANDREW J. KROLL, JOSH R. JOHNSON, MIKE ROCHELLE, *Weyerhaeuser NR*, and EDWARD B. ARNETT, *Theodore Roosevelt Conservation Partnership*.

Intensive forest management may threaten individual species or communities if practices degrade or remove habitat types or structural features (e.g., snags or downed logs) required to fulfill life history requirements. However, demographic responses of species to alternative practices have received little research attention. We evaluated responses of cavity-dependent birds to structural enrichment on 28 experimental plots. From 2008 - 2010, we monitored 506 nests built by 10 species. Chestnut-backed Chickadee, House Wren, Northern Flicker and Purple Martin nests composed >95% of the nest totals. Period survival rates were equivalent to survival rates reported for these species in unmanaged forests.

**150 Hayward, Henson, Megna**

Ovulation synchrony in gulls. JAMES L. HAYWARD, SHANDELLE M. HENSON, and LIBBY C. MEGNA, *Dept. Biol. and Math., Andrews Univ., Berrien Springs, MI*.

The menstrual cycles of women and estrous cycles of Norway rats (*Rattus norvegicus*) living in close proximity can synchronize. We reported ovulation synchrony among densely nesting Glaucous-winged Gulls (Henson et al. 2010, *Auk* 127: 571–580), and recently we detected the same phenomenon among Ring-billed Gulls. In both species, the degree of synchrony was proportional to nest density. The synchronizing mechanism has yet to be identified, but synchrony may be common among female larids nesting at sufficient nest densities and in sufficient numbers. Weather-delayed reproduction compresses the breeding season and destroys synchrony. A preliminary mathematical model suggests the possibility that ovulation synchrony confers a selective advantage on synchronous females by reducing the probability their eggs will be cannibalized. The degree to which ovulation synchrony exists among non-larids remains an open question, but the occurrence of this phenomenon in both mammals and birds suggests the possible existence of a hitherto unrecognized but general reproductive tendency among female vertebrates.

**151 Klicka, K J Burns, Kus**

Phylogeography and conservation genetics in the morphologically variable Bell's Vireo. LUKE B. KLICKA, KEVIN J. BURNS, *Dept. Biol., San Diego State Univ., San Diego, CA*, and BARBARA E.



KUS, *US Geol. Surv., Western Ecol. Res. Center, San Diego, CA.*

The Bell's Vireo (*Vireo bellii*) is a widespread species of North American bird consisting of 4 subspecies (*V. b. pusillus*, *V. b. medius*, *V. b. bellii*, and *V. b. arizonae*) breeding from central Mexico to the central and sw. US. Subspecies were delimited in the late 1800s and early 1900s on the basis of plumage variation. The subspecies *V. b. pusillus* is federally endangered, and the other 3 are listed by Partners in Flight as birds of conservation concern. This is the first study to examine geographic variation in the Bell's Vireo using genetic data. We reconstructed evolutionary relationships within the complex using mitochondrial ND2 and nuclear sex-linked ACO1-I9. We sequenced ND2 for 45 individuals from throughout the breeding range of the Bell's Vireo and ACO1-I9 was sequenced for a subset of those individuals. Bayesian analyses of these data identified 2 major clades within Bell's Vireo. The 2 clades follow an east/west division with a contact zone in Arizona. The eastern clade contains *V. b. bellii* and *V. b. medius*, while the western clade contains *V. b. pusillus* and *V. b. arizonae*. The 4 individual subspecies do not form reciprocally monophyletic units within their respective clades. The east and west clades are approximately 3% divergent in their mitochondrial sequence data, a similar level to that observed between other avian species. Using BEAST and an ND2 divergence rate of 0.0115 per lineage per million years, we estimate the 2 clades diverged from 1.12 - 2.09 million years ago.

### **152 Lee, Patane, Bates, Aleixo, Weckstein**

Comparative phylogeographic history of the Channel-billed and White-throated Toucans. JENNIE LEE, *Univ. Chicago, Chicago, IL*, JOSÉ S. L. PATANÉ, *Instituto Butantan, São Paulo, SP, Brazil*, JOHN M. BATES, *Field Mus., Chicago, IL*, ALEXANDRE ALEIXO, *Museu Paraense Emilio Goeldi, Belém, Brazil*, and JASON D WECKSTEIN, *Field Mus., Chicago, IL*

Throughout Amazonia the Channel-billed Toucan (*Ramphastos vitellinus*) and the White-throated Toucan (*Ramphastos tucanus*) overlap in geographic range, and each of these toucan species complexes includes multiple morphologically differentiated subspecies, which hybridize to produce populations bearing intermediate or novel coloration patterns. The ranges of these subspecies tend to be bounded by the rivers of the Amazon basin, namely, the Amazon River and its tributaries. Our work focused on uncovering the patterns of introgression across these 2 overlapping hybrid zones, with the aim of elucidating the comparative phylogeographic history and population structure of the 2 species given their limited dispersal ability across rivers. We collected sequence data from 2 mitochondrial loci (cytochrome-b and cytochrome oxidase I) and 2 Z-linked nuclear introns (CHD-18 and MUSK-4). Phylogeographic analyses were performed on the resulting nucleotide alignments to compare and contrast patterns of hybridization and introgression in these 2 toucan species. Haplotype networks constructed for each species reveal mtDNA haplotypes with geographic structuring (with *R. vitellinus* exhibiting more structure than *R. tucanus*) but also some haplotype sharing across regions, suggesting either ongoing gene flow or shared ancestral polymorphism between species. Although one nuclear Z-linked locus (MUSK) exhibits generally little structure, the Z-linked CHD locus shows some structure. Taken together these data point towards recent or ongoing gene flow rather than ancestral polymorphisms as the probable basis for haplotype sharing, captured in mtDNA, between geographic regions.

### **153 Manthey, Spellman**

A genomic perspective on the phylogeography of the Brown Creeper. JOSEPH D. MANTHEY, *Univ. Kansas, Lawrence, KS*, and GARTH M. SPELLMAN, *Black Hills State Univ., Spearfish, SD*.

The availability of rapid data generation via next-generation sequencing and new processing tools promotes the use of thousands of loci in phylogenetic and phylogeographic studies. Here, we evaluate the population structure, levels of admixture, and genomic signature of diversification in the Brown Creeper. We sequenced 41 individuals from 8 populations across the previously described diversity of the Brown Creeper across its range. Sequencing identified 10548 single nucleotide polymorphisms present in all localities. Using STRUCTURE, we identified hierarchical genetic structure, separating northern and southern populations. Within each lineage, the south shows strong population structure among regions, while there is evidence for admixture between populations in the north. This pattern is further supported using Treemix, a program that estimates a species tree and associated admixture between populations using maximum likelihood. A species tree analysis in SNAPP, which uses a Bayesian framework, identifies the same hierarchical structure, with strong support for population relationships in the southern lineage, and weak support for relationships among northern populations. Fixed differences between the basal lineages appear to be spread across the genome (based on BLASTs to the Zebra Finch genome),

and are not biased to certain chromosomes, suggesting lineage divergence has occurred across the entire genome.

#### **154 McKay, Mays, Wan, Yao, Nishiumi**

Integrative taxonomy and evolutionary history of the Varied Tit (*Poecile varius*). BAILEY D. MCKAY, *Am. Mus. Nat. Hist., New York, NY*, HERMAN L. MAYS, *Cincinnati Mus. Center, Cincinnati, OH*, DONGMEI WAN, *Liaoning Univ., Shenyang, China*, CHENG-TE YAO, *Endemic Species Res. Inst., Jiji, Taiwan*, and ISAO NISHIUMI, *Natl. Mus. Nature & Science, Tsukuba, Japan*.

We used multiple sources of data to tease apart geographic variation from independent evolutionary lineages (i.e., taxa) in a morphologically variable species complex, appropriately named the Varied Tit (*Poecile varius*). The Varied Tit is an East Asian endemic distributed mainly on islands. Its highly fragmented range has been traditionally divided into 9 subspecies on the basis of plumage and morphometric differences. Using UV digital photography to quantify 9 plumage patches that have been described as differing among subspecies, we evaluated the geographic distribution of color and morphometric measurements. We added sequence data from mitochondrial DNA and 6 nuclear introns to develop an integrative taxonomy with congruent support for 4 independently evolving taxa within the complex. Six subspecies with overlapping clinal variation were condensed into a single, widely distributed and morphologically variable northern taxon. Two narrowly distributed southern taxa were deeply divergent genetically. Another taxon, endemic to the southern Izu Islands, was highly divergent in morphology but did not differ in our DNA markers. A time-calibrated species tree revealed a pectinate phylogenetic history with southern taxa progressively basal to northern taxa, suggesting a northward colonization of the Ryukyu Islands and Japan from southern China. We will discuss the value of incorporating multiple kinds of data for developing taxonomic and biogeographic hypotheses.

#### **155 Saucier, Sánchez, Carling**

Characterizing the morphological and genetic variation in the Plain Wren complex – with insights into biogeographic mechanisms of divergence in southern Central America. JACOB R. SAUCIER, *Dept. Zool. & Physiol., Univ. Wyoming, Laramie, WY*, and *Dept. Vert. Zool., Natl. Mus. Nat. Hist., Smithsonian Inst., Washington, DC*, CÉSAR SÁNCHEZ, *Mus. Nat. Sci., and Dept. Biol. Sci., Louisiana State Univ., Baton Rouge, LA*, and MATTHEW D. CARLING, *Dept. Zool. & Physiol., Univ. Wyoming, Laramie, WY*.

Investigating the evolutionary processes that underlie genetic and morphological variation across the landscape is critical to understanding the mechanisms that promote biodiversity in species-rich regions. The dynamic geophysical history of Central America makes it well-suited for pursuing phylogeographic questions. We focused our study on the Plain Wren (*Cantorchilus modestus*), a ubiquitous lowland tropical bird species of scrub and young second growth habitats which bears the rare distinction of being both restricted to Central America and widespread throughout. Plain Wrens, of which there are 3 recognized subspecies, display substantial, yet cryptic morphological and behavioral variation across this range. We combined existing museum specimens along with samples collected during our own fieldwork in Costa Rica to investigate how landscape features shape patterns of genetic and phenotypic diversity in this species. Our findings indicate substantial levels of genetic divergence bolstered by parallel morphological variation within *C. modestus*. We also explored the relationship between these patterns and major geologic events, as well as patterns of environmental variation across our sampling area. These findings illuminate the shared roles of current and historical biogeography on structuring the present patterns of variation within this species complex and lend insight into how these processes can influence the evolution and maintenance of diversity in sedentary tropical birds. In addition, we addressed the status of monophyly and current range limits within this taxon. These findings could be useful in beginning to identify any unrecognized zones of biological distinctness and/or transition in Central America.

#### **156 Vazquez-Miranda**

The phylogeographic power of sex at the species-level boundary: a multilocus study of wrens and thrashers. HERNAN VAZQUEZ-MIRANDA, *Dept. Ecol., Evol. & Behav. Univ. Minnesota, and Bell Mus. Nat. Hist., St. Paul, MN*.

In recent years it has become possible to obtain hundreds or even thousands of independent loci

for genetic studies employing new technologies to address questions in evolutionary biology. We know that the level of information and polymorphism is higher in loci with smaller times of coalescence. What we ignore is the relative power of resolution of genetic loci at or below the species level relative to their location in the genome. In order to assess the levels of resolution required to estimate population parameters at the species-level boundary, I targeted specific regions of the genome by Sanger-sequencing multiple independent autosomal, sex-linked, and mitochondrial loci from 2 recently-derived lineages of Cactus Wrens (*Campylorhynchus brunneicapillus*) and Leconte's Thrashers (*Toxostoma lecontei*). I quantified levels of polymorphism and confidence intervals of divergence times for each type of locus. In contrast to higher taxonomic phylogenetic studies, levels of variation between sex-linked and autosomal markers were similar at a phylogeographic scale, although some loci from the Z-chromosome showed fixed differences. Such fixed polymorphisms were in several instances not novelties but plesiomorphies when outgroups were added to the analyses. These results highlight the value of looking at broader scales even in "single-species" studies and the contribution of sex chromosomes to phylogeography.

### **157 Buler, Smolinsky, R J Smith, Owen**

Dynamics of nearshore concentrations of spring migrating birds around the Great Lakes. JEFFREY J. BULER, JACLYN A. SMOLINKSY, *Univ. Delaware, Newark, DE*, ROBERT J. SMITH, *Univ. Scranton, Scranton, PA*, and JENNIFER C. OWEN, *Michigan State Univ., East Lansing, MI*.

We assessed broad- and fine-scale distributions of birds during spring migratory stopover throughout the Great Lakes region with a special emphasis on elucidating habitat use near shorelines. We used data from 6 weather surveillance radars to quantify broad-scale bird distributions "on the ground" during 3 springs (1 Apr through 15 Jun 2010 - 2012) as they emerged from stopover sites at the onset of nocturnal migratory flight. Overall, mean relative bird densities were stable between 20 km and 100 km from the shoreline. Within 20 km of the shoreline, bird densities increased nearly 2.5 times with greater proximity to the shoreline. However, nearshore concentrations of migrants were not consistent in all areas. We discuss possible explanations for the dynamics in these patterns. Bird density was also greater within forests, especially forests in landscapes near urban development. We assessed fine-scale bird distribution patterns during spring 2012 through 1,501 ground surveys of birds and arthropods at 270 points split among 2 regions within Muskegon and Emmet counties of Michigan. Sites were located 0.1 to 2.6 km from the shoreline of Lake Michigan within forests. In general, forest migrant bird density among points was positively related to proximity to the shoreline and arthropod abundance, and varied with plant composition. However, these relationships differed among study regions and bird migration distance class (short vs. long). Our results provide a better understanding of the factors intrinsic and extrinsic to habitats that influence where birds stopover within the Great Lakes Basin.

### **158 Davidson, Dodge, Weinzierl, Kays, Wikelski, Bohrer**

New services for archiving, processing, and analyzing avian movement data on Movebank. SARAH C. DAVIDSON, *Dept. Civil, Environ. & Geodetic Eng., Ohio State Univ., Columbus, OH* and Max Planck Inst. Ornithol., *Dept. Migration Immunoecol., Radolfzell, Germany*, SOMAYEH DODGE, *Dept. Civil, Environ. & Geodetic Eng., Ohio State Univ.*, ROLF WEINZIERL, *Seehausen, Germany*, ROLAND KAYS, *North Carolina Mus. Nat. Sci., Raleigh, NC*, MARTIN WIKELSKI, *Max Planck Inst. Ornithol., Dept. Migration Immunoecol.*, and GIL BOHRER, *Dept. Civil, Env., and Geod. Eng., Ohio State Univ.*

Data on movements of individual birds have been collected for over a century, and have been central to our understanding of bird migration. As the volume and accuracy of avian tracking data have increased, so have the opportunities to move beyond descriptive studies to address hypothesis-driven questions, compare across populations, and quantify relationships between animals and their environment. The animal tracking database Movebank ([movebank.org](http://movebank.org)) offers free tools to support such studies while allowing researchers to retain data ownership and access control. Several new features on Movebank provide unique tools for working with avian tracking data. First, new live feeds for incoming GSM data are being added to complement existing features for collecting and filtering data from Argos. Second, Movebank now supports archiving of data from archival geolocators—allowing storage of raw light-level data, derived locations, and documentation of how location estimates were made—and is integrated with TAGS, a new open-source tool for processing light-level data. Third, Movebank's new Env-DATA System allows users to browse and link their tracking data to thousands of variables from

global environmental datasets, including MODIS products, weather models, and human and physical geography datasets. The Env-DATA System annotates tracking data with these environmental variables by accessing and interpolating the source datasets to create value estimates linked to each animal location. Taken together, these tools allow researchers to significantly reduce the time and technical skill required to integrate and reanalyze tracking data, document and improve methods for location estimation using light-level data, and incorporate external environmental data.

### **159 Delmore, Irwin**

Hybrid songbirds employ intermediate routes in a migratory divide. KIRA E. DELMORE and DARREN E. IRWIN, *Dept. Zoology, Univ. British Columbia, Vancouver, BC.*

Seasonal migration may play a significant role in speciation; many divergent populations breed adjacent to one another while using different routes to reach their wintering grounds (i.e., form migratory divides). Migratory orientation is genetically influenced in these populations and often involves navigation around geographic barriers. Accordingly, hybrids have been predicted to employ intermediate routes that are inferior to those of parental forms. We provide the first direct test of this hypothesis here, by attaching light-level geolocators to birds in a narrow hybrid zone between 2 groups of Swainson's Thrushes that form a migratory divide in w. North America. Most of these birds employed intermediate routes, navigating over large geographic barriers. The remainder employed a mixed strategy, using the same route as one parental form on fall migration and the other on spring migration. Narrow hybrid zone width and high levels of linkage disequilibrium in the center of the zone further suggest that hybrids survive at lower rates than parental forms and are selected against. Together, these results provide strong support for the migratory divide hypothesis and represent one of few established examples in which a behavioral trait reduces hybrid fitness, thereby promoting speciation.

### **160 Deppe, Ward, Diehl, Celis-Murillo, Smolinsky, Zenzal, Benson, Moore, Cochran**

Migratory songbirds vary in their stopover behavior along the northern Yucatan Peninsula coast in the fall. JILL L. DEPPE, *Dept. Biol. Sci., Eastern Illinois Univ., Charleston, IL*, MICHAEL P. WARD, *Dept. Nat. Res. & Environ. Sci., Univ. Illinois Urbana-Champaign, Urbana, IL*, ROBERT H. DIEHL, *US Geol. Surv., N. Rocky Mtn. Sci. Center, Bozeman, MT*, ANTONIO CELIS-MURILLO, *Dept. Nat. Res. & Environ. Sci., Univ. Illinois Urbana-Champaign*, JACLYN A. SMOLINSKY, *Dept. Entom. & Wildl. Ecol., Univ. Delaware, Newark, DE*, THEODORE J. ZENZAL, Jr., *Dept. Biol. Sci., Univ. Southern Mississippi, Hattiesburg, MS*, THOMAS J. BENSON, *Illinois Nat. Hist. Surv., Univ. Illinois Urbana-Champaign*, FRANK R. MOORE, *Dept. Biol. Sci., Univ. Southern Mississippi*, and WILLIAM W. COCHRAN, *Illinois Nat. Hist. Surv.*

Migratory flights across geographic features, like the Gulf of Mexico (GOM), are often considered to pose substantial challenges to songbirds, especially species not well-adapted for extended, non-stop flights. We deployed automated radio-tracking systems along the GOM to track Red-eyed Vireo (REVI), Swainson's Thrush (SWTH), Wood Thrush (WOTH) and Gray Catbird (GRCA) between coastal Alabama and the northern Yucatan Peninsula coast in fall 2009 - 2012. We used detection data in Mexico to estimate the percentage of individuals that stopped upon arrival and their stopover durations. Forty percent of radio-tagged SWTH and WOTH, 16% of REVI and 15% of GRCA arrived at the Yucatan Peninsula. Of these birds, 67% of REVI, 60% of GRCA, 20% of SWTH and 0% of WOTH stopped at the coast upon arrival. Only SWTH were detected as they departed the coast and resumed southward migration. Stopover length of SWTH ranged from 4.6 h to 20 d (n = 6), with most birds departing the same day of arrival or staying 1 - 3 d. Species patterns of arrival and stopover did not correspond with expectations based on wing morphology. More efficient fliers, like SWTH and REVI, were expected to have a higher likelihood of arrival but lower likelihood of stopping over than WOTH and GRCA. Banding data collected along the coast suggest that energetic condition alone cannot explain differences in the proportion of each species stopping. Habitat preferences also may contribute to stopover behavior. These data also support the hypothesis that the GOM does not represent a substantial barrier to the migration of most songbirds.

### **161 Horton, Shriver, Buler**

A comparative analysis of migratory passage metrics. KYLE G. HORTON, W. GREG SHRIVER and JEFFREY J. BULER, *Dept. Entomol. & Wildl. Ecol., Univ. Delaware, Newark, DE.*

Many studies have used various methods to document the passage of nocturnal migrants, yet

these techniques are often used individually, rather than comprehensively using multiple methods. With tools readily available for the study of nocturnally migrating birds (radar, acoustics, thermal imaging, etc.), our understanding of how different measures of migrant passage correlate has never been more important. As each method boasts its own strengths, weaknesses, and potential biases, understanding the limitations of these methods is vital to avoid misrepresentation of traffic estimates (Kunz et al. 2007, **J. Wildl. Manage.** 71:2449-2486). We employed 3 primary methods (weather surveillance radar, nocturnal flight calls, and thermal imaging) during the fall of 2012 to quantify migration traffic rates in Lewes, DE. We examined relationships both across nights and within nights, finding that all 3 methods were positively correlated across nights, while showing mixed results within nights. Thermal imaging and weather surveillance showed positive relationships throughout the night, yet nocturnal flight calls showed negative relationships with weather surveillance radar and thermal imaging. Further exploring within night correlations, we found that thermal imaging and weather surveillance radar generally showed moderate positive correlations throughout the night, while nocturnal flight call comparisons with weather surveillance radar and thermal imaging strengthened throughout the night.

## **162 Lundblad, Conway**

Access to food and not intolerance of cold drives altitudinal migration of Yellow-eyed Juncos. CARL G. LUNDBLAD and COURTNEY J. CONWAY, *Idaho Coop. Fish & Wildl. Res. Unit, Univ. Idaho, Moscow, ID.*

Despite the ubiquity and diversity of migratory behaviors, we currently know little about the causes of seasonal movements in most animals. Species exhibiting facultative migration, such as the Yellow-eyed Junco, provide opportunities to test which factors mediate intraspecific variation in migratory decisions within populations. Previous studies have focused often on Body Size hypotheses to explain migration away from the breeding grounds, yet body size could influence migratory decisions through multiple mechanisms. The Physiological Tolerance to Cold Hypothesis suggests that smaller individuals are forced to migrate because they are less able to endure cold temperatures. The Fasting Endurance Hypothesis suggests that smaller individuals are less able to endure fasting during periods of food limitation. We tested predictions of both of these hypotheses in a population of 890 juncos, color-banded on their breeding grounds at 5 sites spanning a 1200-m elevational gradient. The rate of winter residency by juncos on their breeding grounds at a given site was more strongly correlated (negatively) with average snow cover than with minimum temperatures. The duration that individual juncos maintained residency on their breeding grounds was negatively correlated with average snow cover on their breeding territories. Individuals that migrated for the entire winter returned to their breeding grounds in the spring with more stored fat than resident individuals. Our results suggest that the ability of juncos to maintain their territories over the winter is constrained not by their ability to withstand cold temperatures but by their inability to access food resources.

## **163 Brasso, Poltio, Emslie**

*Pygoscelis* penguins as biomonitors of annual trends of mercury availability in the Antarctic Peninsula (2004/2005 - 2011/2012). REBECKA L. BRASSO, MICHAEL J. POLITO and STEVEN D. EMSLIE, *Dept. Biol & Marine Biol., Univ. North Carolina Wilmington, Wilmington, NC.*

Previous research has shown that mercury concentrations in *Pygoscelis* penguins are relatively homogeneous throughout 4 major regions of the Antarctic Peninsula within a single year. However, significant inter-annual differences in mercury availability could arise from variation in ocean circulation patterns, functioning of the biological pump, and emissions of atmospheric mercury. To address these possible inter-annual variations, we determined mercury concentrations in eggshell membranes (2004/2005 - 2011/2012) and chick down (2007/2008 - 2010/2011) from 3 species of *Pygoscelis* penguins breeding at Admiralty Bay, King George Island. While no overall annual trend in mercury was detected in either tissue, there were significant effects of species and year as well as a significant interaction between species and year on mercury concentrations. Chinstrap penguins (*P. antarctica*) had the highest mercury concentrations, while Adélie penguins (*P. adeliae*) had the lowest, among the 3 species. Within each species there was a significant effect of year on mercury concentration in chick down; the highest mercury concentrations in Adélie and Gentoo (*P. papua*) penguins occurred in 2008/2009 while Chinstrap penguins had their highest concentrations in 2010/2011. In the more extensive eggshell membrane dataset, mercury concentrations were highest in 2004/2005 across all species. Stable isotope analyses ( $\delta^{15}\text{N}$ ,  $\delta^{13}\text{C}$ ) will be used to assess whether annual variability in mercury resulted from inter-specific differences in

dietary composition or environmental factors. These analyses provide the most extensive modern timeline to date of mercury availability in the marine food web surrounding the Antarctic Peninsula.

#### **164 Galen, Witt**

Diverse avian malaria in Andean House Wrens: evidence for co-diversification despite lability in host breadth and climatic niche. SPENCER C. GALEN and CHRISTOPHER C. WITT, *Mus. Southwestern Biol. and Dept. Biol., Univ. New Mexico, Albuquerque, NM,*.

Recent research has revealed hundreds of cryptic genetic lineages of avian malaria parasites, but the extent to which this diversity may be associated with host population structure or environment is unclear. We surveyed haemosporidian and host mtDNA in an ecological generalist, the House Wren, across the complex landscape of the Peruvian Andes. We detected deep genetic structure within the House Wren across its range, represented by 7 clades that were between 3.4 - 5.7% divergent. From 140 sampled House Wrens we found an overall parasite prevalence of 0.41, comprising 23 divergent evolutionary lineages of haemosporidian mtDNA, of which 10 were novel. We found no discernable co-phylogenetic structure between haemosporidians and House Wrens, and divergence date estimates revealed that the majority of parasite diversity was present prior to the diversification of House Wren populations. However, a clade of 6 *Haemoproteus* lineages appeared to be host-specific and to have diversified contemporaneously with House Wren populations. Individual haemosporidian lineages varied widely with respect to host specificity, prevalence, and geographic distribution, with the most host-generalist lineages also being the most prevalent and widely distributed. *Haemoproteus* and *Leucocytozoon* included lineages with restricted ranges and high host specificity; however, all *Plasmodium* parasites were host-generalists with broad geographic distributions. Combined and genus-specific haemosporidian prevalence differed significantly across environments and elevation. We also observed spatial stratification of haemosporidians along the west slope of the Andes in central Peru where 5 lineages were restricted to non-overlapping elevational bands.

#### **165 Krebs, Hamer, Newman, Anderson, Ward, Ruiz, Goldberg, Walker, Kitron, Brawn**

Evidence of a selfish roost? Communal roosting decreases vector-borne disease exposure in American Robins. BETHANY L. KREBS, *Prog. Ecol., Evol. & Cons. Biol., Univ. Illinois at Urbana-Champaign, Champaign, IL*, GABRIEL L. HAMER, *Dept. Entomoll, Texas A&M Univ., College Station, TX*, CHRISTINA M. NEWMAN, *Comp. Biomed. Sci. Prog., Univ. Wisconsin-Madison, Madison, WI*, TAVIS K. ANDERSON, MIKE P. WARD, *Dept. Nat. Res. & Environ. Sci., Univ. Illinois at Urbana-Champaign*, MARILYN O'HARA RUIZ, *Dept. Pathobiol., Univ. Illinois at Urbana-Champaign*, TONY L GOLDBERG, *Dept. Pathobiol. Sci., Univ. Wisconsin-Madison*, EDWARD D. WALKER, *Dept. Microbiol., Michigan State Univ., East Lansing, MI*, URIEL D KITRON, *Dept. Environ. Stud., Emory Univ., Atlanta, GA*, JEFFREY D BRAUN, *Dept. Nat. Res. & Environ. Sci., Univ. Illinois at Urbana-Champaign*.

Individual animals participating in groups decrease their risk of predation by 'diluting' risk over a large group. A similar mechanism known as the "encounter-dilution effect" has been proposed in animal groups that experience parasitism from biting insects: increasing group size dilutes the number of insect bites on an individual host. Whether the encounter-dilution effect acts in animal aggregations or whether large groups of hosts simply attract more biting insects per individual host is unclear. Understanding the impact of host aggregation plays on vector behavior is critical to understanding the evolution and maintenance of social behavior. American Robins are an important host species for West Nile virus in the great Chicago area, and they form large communal roosts during the breeding season. We experimentally tested the hypothesis that communal roosts decrease individual risk of contracting a vector-borne disease Using sentinel birds (a common technique of establishing the presence of a vector-borne disease), we found strong evidence for a decrease in West Nile virus transmission within communal robin roosts. Hypotheses for why birds form communal roosts include the transfer of information and safety from predation; our results establish that the transmission and of risk of disease may also be relevant.

#### **166 Kent, Stenger, Burtt**

The microbial ecosystem in avian plumage. CODY M. KENT, JACK M. STENGER and EDWARD H. BURTT, Jr., *Dept. Zool., Ohio Wesleyan Univ., Delaware, OH*.

Burtt and Ichida (1999, *Auk* 116: 364-372) found feather-degrading bacteria on 6.7 to 10.7% of

wild birds. Their analysis included 1,588 individuals of 83 species, mainly from central Ohio. We expand their initial report with data from 1997 to 2013 which include 3,572 individuals of 173 species, representing 29 families. Feather-degrading bacilli occurred on 42.2% of these birds. We found feather-degrading bacilli on all species represented by 4 or more birds ( $n = 87$ ). Feather-degrading bacilli occurred in the plumage of birds at all locations where we sampled more than 4 birds ( $n = 38$ ). This indicates that these bacteria are common in the plumage of birds. We examined both behavioral and environmental trends in the occurrence of feather degrading bacilli. We found that the levels of feather-degrading bacilli varied by foraging guild, and increased with increasing temperature. We also found that the proportion of birds with feather-degrading bacilli increased with an increase in the wear on feathers. The frequent and variable occurrence of feather-degrading bacilli suggests that they may play a significant role in the deterioration of feathers and may act as a selective force on color, maintenance behavior and molt in a wide range of species.

### **167 Walther, Sehgal, Cornel**

Disease dynamics of avian haemosporidia in a California songbird community. E. L. WALTHER, R. N. M. SEHGAL and A. J. CORNEL, *San Francisco State Univ., San Francisco, CA.*

*Plasmodium*, and the malaria-like genera *Haemoproteus* and *Leucocytozoon* - collectively known as haemosporidia - are relatively common in California birds, which have coevolved with the parasites; however, although avian malaria has been shown to affect the health and fitness of birds worldwide, very little information is available on the prevalence and distribution of these blood parasites in California. While many studies have addressed prevalence (% of population infected) and parasitemia (parasite load in individuals) for avian haemosporidia, we know little about seasonal variation in diversity and prevalence within populations. In addition, in many studies, birds are sampled only once during a study, or are sampled multiple times within a short time, e.g., the period during which an adult is caring for nestlings. This provides an indication of infection status and prevalence within a population at a single point in time, but does not increase understanding of the temporal dynamics of chronic infections or the conditions under which recrudescence occurs. The research presented here identifies some of the key players and seasonal dynamics of avian haemosporidia transmission and persistence by resampling avian hosts in a California riparian songbird community, over multiple seasons for 2 yr. Our results confirm a high diversity of haemosporidia in the avian community being studied, strong patterns of seasonal parasite diversity, and a dominant parasite infecting a broad range of hosts. Blood smears are used to confirm infections in these birds where PCR may have failed to do so, and to identify new morphospecies and investigate coinfections.

### **168 Rowse, Rodewald**

Reproductive consequences of low levels of mercury in Acadian Flycatcher. LINNEA M. ROWSE, *Ohio State Univ., Columbus, OH*, and AMANDA D. RODEWALD, *Cornell Univ., Ithaca, NY*.

Mercury in the environment is of particular concern because it is widespread, has the potential to remain in aquatic sediments over a long time period ( $> 50$  yr), and can be redistributed over large areas with flood events (Jackson et al. 2011, **Environ. Pollut.** 159: 3302-3308). Mercury may move from sediments into aquatic emergent insect larvae and be subsequently transferred into terrestrial food webs as adult insects emerge (Cristol et al. 2008, **Science** 320: 335; Menzie 1980, **Water, Air & Soil Poll.** 13: 473-479; Sullivan & Rodewald 2012, **Environ. Tox. & Chem.** 31: 1175-1183). Thus, insectivorous songbirds foraging in riparian habitats can accumulate contaminants at levels comparable to those detected in piscivorous species (Brasso & Cristol 2008, **Ecotoxicology** 17: 133-141; Cristol et al. 2008). We studied the Acadian Flycatcher, a long-distance Neotropical migrant that breeds in mature deciduous and riparian forest. Acadian Flycatcher diets can be heavily comprised of prey from aquatic systems, thereby exposing them to metals from the aquatic system. We hypothesized that mercury would impair reproduction of Acadian Flycatchers, and predicted that the number of young fledged would be negatively related to mercury concentration in blood. Blood samples were collected from flycatchers between the dates of 14 Jun - 13 Aug 2011 and 29 May - 11 Aug 2012, and were analyzed at the Michigan State University Diagnostic Center for Animal and Population Health for total concentrations of mercury. We used a linear mixed-effects model fit by maximum likelihood estimates to evaluate the relationship between contaminant concentration in blood and productivity. Mercury concentration in adult flycatcher blood was negatively related to reproductive success as measured by number of fledglings ( $F_{1,26} = 3.021$ ,  $P = 0.094$ ), despite being below baseline levels determined for other passerine species in the ne. US

(Evers et al. 2012, **Hidden risk**, BRI Report 2012-07).

**169 Sandercock, Winder, McNew, Gregory, Wisely**

Demographic effects of wind power development on Greater Prairie-Chickens. BRETT K. SANDERCOCK, VIRGINIA L. WINDER, LANCE B. MCNEW, ANDREW J. GREGORY and SAMANTHA M. WISELY, *Div. Biol., Kansas State Univ., Manhattan, KS.*

We investigated impacts of wind power development on prairie grouse at the 201MW Meridan Way Wind Power Facility in n.-central Kansas. We used pre/post comparisons and distance to turbines to test for possible impacts of energy development on 5 response variables: lek attendance, nest site selection, reproductive effort, nest survival, and female survival. In a 6-yr period, we monitored 23 lek sites, 251 radio-marked females, and 264 nesting attempts. Wind power had a weak effect on lek attendance: probability of lek persistence increased with distance from turbines, and most abandoned lek sites were located <5 km from turbines. Leks in native grasslands with more than 10 males had the highest probability of persistence. Nest site selection and female reproductive effort were not affected by proximity to development, and the strongest correlate of nest placement and survival was vegetative cover at the nest site. Reproductive output was a key limiting factor for prairie chickens, and was strongly influenced by high rates of nest failure and losses to predation. Unexpectedly, female survival increased after wind power development, and turbines may have disrupted foraging activity of predators. Mortality from collisions or harvest were rare. Overall, Greater Prairie-Chicken demography was not strongly affected by wind power development in Kansas. Future studies should use similar protocols to investigate interactions between wind power and other sensitive species of wildlife in grassland habitats.

**170 Winder, McNew, Gregory, Hunt, Wisely, Sandercock**

Quantifying Greater Prairie-Chicken spatial ecology in response to wind energy development in north-central Kansas. V. L. WINDER, *Div. Biol., Kansas State Univ., Manhattan, KS*, L. B. McNEW, *US Geol. Sur. Alaska Sci. Center, Anchorage, AK*, A. J. GREGORY, *School For., Northern Arizona Univ., Flagstaff, AZ*, L. M. HUNT, *Div. Biol., Kansas State Univ.*, S. M. WISELY, *Dept. Wildl. Ecol. & Conserv., Univ. Florida, Gainesville, FL*, and B. K. SANDERCOCK, *Div. Biol., Kansas State Univ.*

Wind energy development is targeted to meet 20% of US energy demand by 2030. In Kansas, optimal sites for wind energy development often overlap with habitat of Greater Prairie-Chickens. Prairie-chickens are a lek-mating species of prairie grouse with declining populations. Our goal was to use relocation data from radio-marked female prairie-chickens to quantitatively explore drivers of seasonal space use pre- and post-construction of a wind energy facility in n.-central Kansas. We developed individual and population level resource utilization functions (RUFs) for 4 groups of females: breeding season pre-construction (2007 - 2008; n = 28), nonbreeding season pre-construction (n = 14), breeding season post-construction (2009 - 2011; n = 102), and nonbreeding season post-construction (n = 37). RUFs relate non-uniform space use within a home range to landscape metrics in a multiple regression framework. We chose 10 predictor variables that described land cover, habitat patchiness, anthropogenic disturbance, and prairie-chicken social behavior. We documented 2 significant population level responses of female prairie-chickens to wind energy development during the breeding season: (i) distance to turbine was positively correlated with space use, demonstrating population level avoidance of wind turbines, and (ii) 50% volume contour home range size increased ~2-fold. Our primary ecological finding was that distance to lek was consistently the strongest predictor of space use during all treatment periods, with disproportionately high use of areas at short distances from leks in over 79% of home ranges. We present data on female prairie-chicken 50% and 99% volume contour home range size and proximity to lek that can inform decisions about management buffers around leks of various sizes. Our study is the first application of RUF techniques to a prairie grouse population and provides quantitative insight into responses to energy development and seasonal spatial ecology of a species of conservation and recreational concern.

**171 Bohrer, Dodge, Weinzierl, Davidson, Kays, Douglas, Wikelski**

The Environmental-Data Automated Track Annotation (Env-DATA) system – new possibilities in processing and interpretation of movement data. GIL BOHRER, SOMAYEH DODGE, SARAH C. DAVIDSON, *Dept. Civil, Environ. & Geodetic Engineering, Ohio State Univ., Columbus, OH*, ROLF WEINZIERL, *Max Planck Inst. Ornithol., Radolfzell, Germany*, ROLAND KAYS, *North Carolina Mus.*



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Tracking birds and animals with GPS, radio and satellite transmitters is increasing in popularity and availability. Additional information about animal locations can be provided by repeated observations in specific locations, such as bird ringing stations and movement-activated cameras. All these data provide highly valuable information to study habitat use, migration and response to climate change. I will describe the next generation of tools for analysis of movement data. Based on the open and free **movebank.org** database, we have developed Env-DATA - a set of data-access tools that allow users to annotate their movement data or observation locations with remote-sensing-based information about the land-surface, weather, vegetation, topography, sea-surface and human geography at the location and time of the animal observations. Specific datasets that are accessed by the system include MODIS land ocean fire and ice, TRMM-precipitation, 30 m, 90 m and 1 km DEM, NCEP global reanalysis, North American Regional Reanalysis and ECMWF mid-resolution global reanalysis weather datasets, Ocean currents, Ocean productivity, WorldClim, and more. Additional variables that are particularly important for bird movement, such as tail-wind support, and thermal and orographic uplift are calculated by the system by combining data from the track and several environmental datasets. Plotting tools facilitate data exploration and interpretation. Modeling tools enable users to test hypotheses about how and what environmental variables affected the animals' timing and path of movement. Overall, the system assist users to translate data into meaning and support decision making that is dependent on understanding the intricate ways in which animal movement is affected by the changing environment.

### **172 Bonter, MacLean, Shah, Moglia**

Temporal shifts in optimal nesting sites due to storms: a potential effect of climate change. DAVID N. BONTER, *Lab. Ornithol., Cornell Univ., Ithaca, NY*, SARAH A. MacLEAN, *Dept. Nat. Res., Cornell Univ.*, SHAILEE S. SHAH and MICHELLE C. MOGLIA, *Dept. Ecol. & Evol. Biol., Cornell Univ.*

Increases in the frequency and intensity of storm events are a predicted result of climate change and additional research into the ecological effects of extreme events is required. Island-nesting seabirds may be particularly vulnerable to predicted climatic changes because seabirds usually demonstrate high fidelity to natal colonies and nesting areas are often near sea-level where storms can have devastating impacts. We examined the effects of a protracted storm that battered the New England coast of North America in Jun 2012 leading to the destruction of 23% of 146 monitored Herring Gull nests on Appledore Island, Maine. Failed nests were at lower elevations and closer to the high-tide line than nests that survived the storm. Although many pairs from failed nests attempted to re-nest, hatching success from second attempts was lower than from nests that survived the storm. We documented a spatial shift in optimal nesting locations from greater reproductive success in low-elevation, densely populated colonies in previous seasons to relatively high-elevation, isolated nests in 2012. The increased frequency of severe storm events due to climate change could ultimately lead to changes in optimal nesting locations.

### **173 Durkin, Cohen, Zdravkovic**

Impacts of anthropogenic disturbance on Snowy Plover reproductive success and behavior in northwest Florida. MAUREEN M. DURKIN and JONATHAN B. COHEN, *SUNY Coll. Environ. Sci. & Forestry, Syracuse, NY*, and MARGO ZDRAVKOVIC, *Coastal Bird Conservation, Big Pine Key, FL*.

Snowy Plovers, a state-threatened shorebird in Florida, are subject to human-caused disturbance due to the proximity of their habitat to coastal development and recreation. The effects of disturbance on Florida Snowy Plover behavior and reproduction have not been fully evaluated, nor has the efficacy of current measures aimed at disturbance mitigation. Our objective was to examine the correlation between reproductive success, behavior and disturbance through monitoring of individually-marked plovers experiencing a gradient of human impact. Snowy Plovers were monitored at 6 sites across Northwest Florida, and nest success, and chick survival were measured. Activity budgets were conducted to determine time allocation to different behaviors by adult plovers. Snowy Plover responses to different types of disturbance, as well as response distances and durations, were recorded during focal observations of interactions between plovers and potential disturbances. Nest survival was analyzed using logistic exposure, and mark-recapture methods were used to calculate chick survival. Preliminary results indicate that Snowy Plovers respond differently to human and natural disturbances, and that we can identify distance thresholds for responses to different sources of disturbance. Initial findings also

indicate significant site-specific differences in chick survival, but no significant difference in nest success between sites. This may indicate that reduced survival of broods could be the mechanism by which disturbance at the site level directly impacts Snowy Plovers in this system. Further results from this study will shed light on the impacts of anthropogenic disturbance on Snowy Plover, indicating whether reduced chick survival is correlated with changes in parental behavior in the presence of disturbance.

#### **174 Oleiro, Kesler**

Avian ecological responses to anthropogenic and climate changes in an oceanic landscape. PABLO C. OLEIRO and DYLAN C. KESLER, *Dept. Fish. & Wildl., Univ. Missouri, Columbia, MO.*

Anthropogenic habitat changes have greatly influenced avian populations on the Micronesian Islands of Pacific Oceania. For example, some of the last remaining native forests are rapidly being converted to agriculture on the island of Pohnpei, which hosts a diverse avifauna that includes 5 endemic species. Previous studies indicated 67-80% reductions in avian populations, and authors speculated an associated with landscape alterations. We conducted a series of occupancy and abundance surveys across 19 Pohnpei transects and we used the Unmarked package for program R to create detection functions and habitat-associated occupancy models. In contrast to previous surveys, our results did not illustrate definitive island-wide population declines in most species. Habitat-specific density models were then used to evaluate the potential effects of future climate change and anthropogenic habitat alterations. We assessed scenarios representing increased and decreased anthropogenic impacts, and representing various levels of climate-mediated habitat changes. Results indicated that anthropogenization and climate change differentially affected the island's bird communities, with some simulated populations benefitting from changes whereas others declined. Generalist species, like *Zosterops cinereus*, *Myzomela rubratra* and *Halcyon cinnamomina* were among those that benefitted from changes. The most negatively impacted were species associated with the island's mangroves, and those inhabiting upland, palm, dwarf and cloud forest, including *Ducula oceanica* and Pohnpei's endemics *Trichiglossus ribiginosus* and *Rukia longirostra*.

#### **175 Lorenz, Vierling, T R Johnson**

Influence of wood hardness on nest tree selection by a primary cavity excavator: is wood hardness an important but overlooked predictor? TERESA J. LORENZ, KERRI T. VIERLING, *Dept. Fish & Wildl., Univ. Idaho, Moscow, ID*, and TIMOTHY R. JOHNSON, *Dept. Stat., Univ. Idaho*.

Nest site selection by woodpeckers is a keystone ecological process and understanding factors that influence woodpecker nest site selection is important for managing forested ecosystems. Wood mass density, or hardness, may be important in the selection of nest trees but has been studied mostly in Eurasian woodpeckers. We used an information theoretic approach to examine the influence of wood hardness on nest tree selection by a New World species, the White-headed Woodpecker. We tested whether wood hardness was an important predictor compared to previously measured habitat features including canopy cover, shrub cover, and slope. We also estimated the availability of suitably hard wood within home ranges and assessed the accuracy of 3 snag decay classification systems by sampling hardness in 240 unused snags. The top model explaining nest tree selection included a quadratic effect for wood hardness (AICc = 18.11,  $w_i = 0.67$ ,  $k = 4$ ) and far outperformed the top model that did not include wood hardness (AICc = 144.598,  $w_i < 0.0001$ ,  $k = 3$ ). Nests had a distinctive hardness profile in which the cavity sill was harder than the body ( $t(39) = 4.09$ ,  $P = 0.0002$ ) but all excavated wood was softer than wood from unused trees ( $F_{(1,278)} = 124.94$ ,  $P < 0.0001$ ). Wood hardness did not change predictably with decay class and 86% of wood samples from unused trees were unsuitable for White-headed Woodpecker nests. These findings support research in Eurasia that wood hardness may be an important but overlooked factor affecting woodpecker nest site selection.

#### **176 Heins, Smith**

Use of skeletal morphometrics and phylogenetic relationships in predicting body mass in the diverse "waterbird" assemblage. LIAM E. HEINS, *Univ. Chicago, Chicago, IL*, and NATHAN D. SMITH, *Dept. Biol., Howard Univ., Washington, DC*.

Accurate predictive equations for body mass estimates provide a critical tool for understanding the paleobiology of fossil taxa. Generating robust regressions between skeletal measurements and body mass thus has wide-reaching implications for inferences in paleontology. Methods that incorporate information on evolutionary relationships can account for nonindependence between these correlations and

phylogeny. The morphologically and ecologically diverse “waterbird” clade includes groups such as herons, pelicans, and grebes, among others. The evolutionary history of body size in waterbirds is represented by a relatively rich fossil record, which includes several giant forms such as *Gigantornis* and *Archaeopteryx*. We investigated the relationship between skeletal measurements and body mass for a dataset of 42 species and 19 families of waterbirds. Measurements of 9 skeletal traits (femur length, femur circumference, tibiotarsus length, tibiotarsus circumference, humerus length, humerus circumference, skull length, synsacrum length, and synsacrum width) were obtained from a collection ( $n = 191$ ) of museum specimens representative of the morphological diversity of the waterbird clade. Using species-averaged body masses drawn from the literature and three-different phylogenies for this group, regressions were performed using ordinary least squares (OLS), phylogenetic independent contrasts (PIC), and phylogenetic generalized least squares (PGLS) methods. Robust correlations were recovered for each of the morphometric characters considered, with tibiotarsus circumference displaying the strongest correlation with body mass and tibiotarsus length displaying the weakest. Phylogenetic information appears to have a marked effect on the pattern of correlation, indicating that contrasting phylogenetic hypotheses may differentially influence the generation of predictive equations for body mass estimation. These results indicate that robust phylogenetic placement of fossil taxa will be critical to accurate inference of paleobiological attributes such as body mass.

### **177 Kerr, Baker**

Readdressing the phylogeny of the waterbirds using exonic markers. KEVIN C. R. KERR, *Royal Ontario Mus., Toronto, ON*, and ALLAN J. BAKER, *Univ. Toronto, Toronto, ON*.

Tremendous advancements have been made toward resolving the avian Tree of Life, yet many relationships remain contentious because gene tree heterogeneity and incomplete lineage sorting across short internodes result in incongruities between different analyses. Relationships within the waterbirds represent one such problematic area. Molecular and morphological data remain at odds when estimating this group’s phylogeny. We used an augmented molecular dataset to test hypotheses regarding the evolutionary relationships within this group. While there has been strong advocacy for the use of intron sequences when investigating the avian phylogenetic tree, we contend that a suitably large collection of exon sequences should compensate for decreased resolving power while providing the benefit of more accurate multiple sequence alignments. Hence, we developed a genomic pipeline to develop a large suite of novel exonic markers and used these to explore the phylogeny of the waterbirds. We examined 32 waterbird species, representing all extant families (and 2 formerly recognized families) and 10 outgroup taxa. We employed both Bayesian and pseudo-maximum likelihood approaches to tree construction. Using a novel dataset based on 27 exonic markers we recovered a topology that largely mirrors that produced by Hackett et al., with high support for younger relationships. However, we found that gene tree heterogeneity remains problematic in trying to resolve short internodes in the waterbirds tree. Combining our data with that of Hackett et al. (2008, *Science* 320: 1763-1768) resulted in higher support values, but still inadequate resolution for deeper nodes.

### **178 Langin, Sillett, Morrison, Ghalambor**

Linkage between bill morphology and vocalization structure in Island Scrub-Jays: A driver of adaptive divergence in sympatry? KATHRYN M. LANGIN, *Dept. Biol., Colorado State Univ., Ft Collins, CO*, T. SCOTT SILLETT, *Smithsonian Migratory Bird Center, Natl. Zool. Park, Washington, DC*, SCOTT A. MORRISON, *The Nature Conservancy, San Francisco, CA*, and CAMERON K. GHALAMBOR, *Dept. Biol., Colorado State Univ.*

Sympatric divergence is generally considered to be a rare phenomenon, especially in birds. Theory suggests it can be facilitated when a trait under natural selection also influences mate choice (the “magic” trait hypothesis). In birds, it has been suggested that bill morphology may function as a magic trait because of the role it can play in constraining the production of vocalizations. Here we test the magic trait hypothesis in Island Scrub-Jays, a species that is restricted to one island off the coast of s. California. We have previously documented divergence in bill morphology between jays occurring in patches of oak and pine habitat, as well as assortative mating for bill length – which begs the question: is bill morphology linked to vocalization structure? To address that, we recorded vocalizations produced by 137 Island Scrub-Jays across the island. We focused our analyses on the female-specific rattle call, a rapid vocalization that is thought to function in pair bonding. Our data indicate that females with a pine-like bill morphology produce faster rattles than females with an oak-like bill morphology. Transmission

experiments reveal that this pattern cannot be explained by acoustic adaptation to pine and oak habitats; however, if bill morphology plays a proximate role in constraining rattle rapidity, the mechanics of that remain unclear. Regardless of the underlying mechanism, our results indicate that assortative mating may be driven by a linkage between bill morphology and vocalizations in the Island Scrub Jay.

### **179 Maddox, Wootton**

Allen's Rule and bird bills: an intraspecific approach using House Sparrows. J. DYLAN MADDUX and J. TIMOTHY WOOTTON, *Dept. Ecol. & Evol., Univ. Chicago, Chicago, IL.*

We determined whether Allen's Rule, which posits that appendage size decreases in colder climates, could explain geographical variation of bill morphology in House Sparrows. We measured morphological traits of approximately 500 House Sparrow museum specimens collected from 26 states in the US spanning 20° in latitude. Although others have described rapid evolution of numerous morphological traits in House Sparrows since their recent introduction to North America, we found no evidence that bill size (i.e., surface area) conformed to Allen's Rule. We discuss possible reasons why our results are seemingly at odds with several recent studies in which patterns of bill morphology are consistent with Allen's Rule.

### **180 Musser, Wagner, Prum**

Investigating the homology of feathers and scales using high-throughput genomics. JACOB M. MUSSER, GUNTER P. WAGNER and RICHARD O. PRUM, *Dept. Ecol. & Evol. Biol., Yale Sys. Biol. Inst. and Peabody Mus. Nat. Hist., Yale Univ., New Haven, CT.*

Feathers are an important anatomical innovation that evolved in the ancestors of birds and facilitated the evolution of flight, greater thermoregulation, and other facets of modern avian life. However, the molecular basis for the evolution of feathers is poorly understood, and the homology of feathers to other skin derivatives, especially scales, remains contentious. Here, we take a new approach to answering these questions by comparing transcriptomes from different stages of developing feathers, different avian and reptilian scales, and claws. We performed mRNA-seq on different stages of skin appendage development collected from 2 distantly related birds, Chicken (*Gallus gallus*) and Emu (*Dromaius novaehollandiae*), and from American Alligator (*Alligator mississippiensis*), a member of the extant clade most closely related to birds. We found that in early development feathers and scutate scales, a broad asymmetric avian scale, share similar patterns of gene expression compared to other scales and claws. As development progresses, feathers turn off much of this shared gene expression and activate a large number of unique genes. This close relationship between feathers and scutate scales in early development, and subsequent unique expression in later feather development is supported independently by both epidermal and dermal transcriptomes, and by transcriptomes from developing feathers and scales of Emu, a distantly related avian species. Further, to complement our transcriptome data, we used immunohistochemistry to compare spatial patterns of expression and subcellular localization of the transcription cofactor  $\beta$ -catenin, the earliest known molecule expressed in feathers. Our preliminary evidence suggests  $\beta$ -catenin is expressed in similar spatial patterns in early developing feathers and scutate scales. These complementary results suggest feathers share similar molecular pathways to scutate scales in early development, and that feathers may have evolved via elaboration of an asymmetric scutate type scale.

### **181 A M Olsen, Westneat**

Duck, duck, goose: multiple origins of geese from a duck-like ancestor. AARON M OLSEN, *Univ. Chicago, Chicago, IL* and MARK W WESTNEAT, *Field Mus., Chicago, IL.*

How geese originated and what their origin implies for the evolution of anseriforms as a whole are questions that remain largely unexplored. Species commonly referred to as geese are certainly polyphyletic, raising the question of whether the common name even delineates a group of birds that is morphologically or ecologically distinct. The standard grouping of geese into "true geese" and "other geese" only serves to illustrate how little we know of how geese differ both from each other and other anseriforms. We collected 3D morphometric data on skull and beak shape from over 30 genera in Anseriformes and 5 genera in Galliformes. We found that galliforms, geese and ducks have distinct beak shapes as evidenced by the 3D curvature of the tomium and culmen. Further, evolutionary modeling of anseriform beak shape, foraging behaviors and tomial morphology support independent origins of geese from a duck-like ancestor. These results have implications for the evolution of feeding behaviors in

Anseriformes as well as for the origins of Screamers (Anhimidae), a South American family resembling galliforms in beak shape but within the order Anseriformes.

### **182 R J Sardell, Kempenaers, DuVal**

Female mating preferences and offspring survival: testing hypotheses on the genetic basis of mate choice in a wild lekking bird. REBECCA J. SARDELL, *Dept. Biol. Sci., Florida State Univ, Tallahassee, FL.*, BART KEMPENAERS, *Max Planck Inst. Ornithol., Seewiesen, Germany*, EMILY H. DUVAL, *Dept. Biol. Sci., Florida State Univ.*

In lek mating systems, males provide no obvious direct benefits such as resources or offspring care, yet females apparently exert strong mating preferences for particular males. Furthermore, choice is unconstrained by social limitations common in other systems as females are free to choose the same mates. Leks therefore offer an excellent opportunity to test key theories on the evolution of mate choice for indirect genetic benefits. Using 12 yr of data from a population of lekking Lance-tailed Manakins, *Chiroxiphia lanceolata*, we investigated predictions of theories of female mate choice for indirect benefits by testing whether observed patterns of choice correlated with realized benefits via offspring survival. Male annual RS was positively correlated with H, supporting a key prediction of the genetic diversity in mate choice hypothesis. Offspring survival until fledging was positively correlated with father heterozygosity, suggesting females may benefit from the apparent tendency to mate with more heterozygous males. Mates tended to be less related than expected under random mating in only 2 out of 12 yr, indicating weak female choice for less related mates, but there was no evidence for selection on inbreeding avoidance via offspring survival. The potentially inbred nature of the study population may underlie findings of genetic diversity benefits from mate choice.

### **183 Shizuka**

Song discrimination before song learning in Golden-crowned Sparrows. DAIZABURO SHIZUKA, *School Biol. Sci., Univ. Nebraska-Lincoln, Lincoln, NE.*

Species recognition and song are important factors affecting assortative mating in many birds. In passerines, both recognition cues and songs are learned. In sympatry with closely related species, mechanisms that ensure heterospecific cues are not learned are necessary to maintain assortative mating. While such mechanisms for predispositions to learning the species-specific traits have been suggested from captive studies, we do not know how such mechanisms might operate in the field. Here, I use a field playback experiment to show that nestling Golden-crowned Sparrows can recognize conspecific songs prior to the period of song learning. Nestling Golden-crowned Sparrows vocally responded to territorial songs while still in the nest, starting around 7-8 d old, and (b) responded more to songs of their own species than to those of sympatric sister species, White-crowned Sparrows. I suggest that such early song discrimination could be the mechanism for learning predispositions that ensure the proper function of species recognition. The ability to assay early song discrimination in nestling songbirds will open the door to further exploration of how learning predispositions evolve, and how mechanisms of learning predispositions may influence rates of hybridization in the wild.

### **184 Crouch, Ricklefs, Bierregaard**

Multivariate specialism and diversification in birds. N. M. CROUCH, *Biol. Sci., Univ. Illinois, Chicago, IL*, R. RICKLEFS, *Univ. Missouri, St Louis, MO*, and R. BIERREGAARD, *Univ. North Carolina at Charlotte, Charlotte, NC.*

Understanding the causal factors that help explain the patterns of global biodiversity is a principal concern of evolutionary biology and ecology. It is broadly thought that the presence of competitors and inherent genetic trade-offs cause a pattern of niche partitioning – a relatively narrower use of habitats often termed ecological specialization (Futuyma & Moreno 1988, *Ann. Rev. Ecol. Syst.* 19: 207-233; Schluter 1995, *Ecology* 76: 82-90; MacArthur & Levins 1964, *Proc. Nat. Acad. Sci.* 51: 1207-1210). It is also widely held that a progressive increase towards ecological specialization is a hallmark of the evolutionary process (Simpson 1953, *Major features of evolution*, Columbia Univ Press). But the evidence for this asymmetric trend of increasing specialization is at best equivocal (Kelley & Farrell 1998, *Evolution* 52: 1731-1743; Nosil 2002, *Evolution* 56: 1701-1706; Nosil & Mooers 2005, *Evolution* 59: 2256-2263), and it remains very difficult to collect in part because of the inherent complexities in assessing the extent of specialization of a species. For example, while some species may be highly

specialized in their habitat use, living on limited substrate or in limited altitudinal ranges, they may simultaneously be feeding generalists, consuming a wide range of prey items. Furthermore, many widely employed models for estimation of asymmetry of character evolution confound character evolution with diversification rates (Maddison 2006, **Evolution** 60: 1743-1746; FitzJohn 2010, **Syst. Biol.** 59: 619-633), and are unable to accurately estimate directional evolution of characters such as ecological specialization. Here I present a definition of specialism derived from a wide range of ecological data for 1000 species of birds covering passerines, non-passerines and birds of prey and use quantitative state speciation extinction models to examine the effect on net diversification rate.

### **185 Wogan, Voelker, Bowie**

Phylogeography and landscape genetics of the Cape Robin Chat (*Cossypha caffra*). GUINEVERE O. U. WOGAN, *Mus. Vert. Zool., Univ. California, Berkeley, CA*, GARY VOELKER, *Texas A&M Univ., College Station, TX*, and RAURI C.K. BOWIE, *Univ. California, Berkeley, CA*.

The Cape Robin Chat is widely distributed across southern Africa and the Eastern Mountains of Africa. In southern Africa this species is a habitat generalist found in multiple lowland habitats ranging from forest edge, fynbos and karoo biomes to highly modified open habitats such as parks. In the Eastern Mountains this species is found in open highland habitats. The divergence of this species is coincident with a dramatic burst of aridification around 2.8 million years ago suggesting a role for climate and/or habitat mediated dispersal from the north into Southern Africa as has been demonstrated for other arid-land adapted bird, mammal and reptile species. Here we examine the origins of the South African populations relative to the populations from the Mountains of Eastern Africa in a phylogeographic context. We generate predictive models of climate suitability and identify putative areas of climatic stability since the Pliocene. We pair these models with habitat reconstructions then quantify the relationship between climatic and habitat models with genetic structure. We further examine the landscape-level environmental features that structure contemporary patterns of gene flow among southern Africa populations. We find evidence to suggest that gene flow among the southern African populations is essentially panmictic, with little evidence for population differentiation and habitat mediated genetic structure. Further our analyses suggest that the climatic niche of the southern African and Eastern Mountain populations may be conserved and that the current distribution may be reflective of latitudinal and altitudinal climatic gradients.

### **186 Greenberg, Danner**

Climate, ecological release, and bill dimorphism in an island songbird. R GREENBERG and R. M. DANNER, *Smithsonian Migratory Bird Center, Washington, DC*.

Sexual size dimorphism is expected to be more pronounced in vertebrates on islands, particularly in trophic characters, as a response to decreased interspecific competition for food. We found (based on measurements of 1423 museum specimens) that bill size dimorphism was greater in island than mainland populations of Song Sparrows. However, dimorphism varied among islands and was positively correlated with high summer temperature and island size. Island Song Sparrow bills follow the overall positive temperature bill size-relationship for California Song Sparrows, which includes larger bills on large, warmer islands. Large bills dissipate more heat and may be an adaptation to summer heat stress. Dimorphism increases because the slope for males is greater than females. Thus the greater magnitude of bill dimorphism on islands with warmer summers may result from males experiencing greater thermal stress during territorial activity, creating different thermal optima. In contrast, bill dimorphism was unrelated to climate on the mainland. We hypothesize that reduced interspecific competition releases island populations from a constraint so that sex-specific sex-specific physiological optima can be achieved, whereas mainland birds are constrained.

### **187 Tarwater, Arcese**

Not all types of individuals experience trade-offs or the same type of cost: the role of individual heterogeneity in costs of reproduction. COREY E. TARWATER and PETER ARCESE, *Univ. British Columbia, Vancouver, BC*.

The existence of a trade-off between current and future reproduction is fundamental to life history theory and the evolution of reproductive strategies. This trade-off assumes there is a cost to reproduction; an increase in current reproduction will reduce future survival and/or reproduction. Yet, evidence for this trade-off is equivocal. Instead, positive correlations between traits are often observed, potentially because of individual heterogeneity in resource acquisition. Using a 37 yr study of Song Sparrows, we assessed

how individual heterogeneity modified costs. Trade-offs between current reproduction and future survival were observed for average LRS females (lifetime reproductive success relative to one's natal cohort), for females breeding later in the year, and for males and females across all ages. Contrastingly, trade-offs between current reproduction and future number of offspring that survive to independence were observed in higher LRS females and females closer to death, while positive correlations were observed for females farther from death and older in age. Five key points emerged from this analysis: (1) costs of reproduction were context-dependent; individual heterogeneity interacted with current reproductive effort to influence allocation patterns; (2) some females shunted costs of reproduction onto their offspring and others reduced their own survival; (3) only age-independent (years to death) terminal investment was observed; (4) individuals that were older, with higher LRS, and were farther from death are likely able to acquire more resources, compensating for costs of reproduction; and (5) breeding later in the year reduced future survival independent of reproductive effort.

### **188 Clark, Prum**

Courtship, aeroacoustics, and the evolution of non-vocal communication in birds. C. J. CLARK, *Dept. Biol., Univ. California Riverside, Riverside, CA*, and R. O. PRUM, *Peabody Mus. Nat. Hist., Yale, New Haven, CT*.

Bird flight intrinsically produces sound. A familiar example are tonal flight sounds (the so-called "wing whistles") produced by ducks or doves during ordinary flight. We propose a categorization of flight sounds, based in part on inferred aeroacoustic mechanism. Some flight sound mechanisms are inevitable, such as those producing whooshes or rustling sounds. Others mechanisms are not inevitable, such as those producing tonal flight sounds, "wing whirring", and snaps/claps. Wind tunnel experiments on individual feathers of various taxa show that tonal flight sounds are not whistles, rather they are produced by aeroelastic flutter of one or more feathers. Snaps/claps are percussive, while the aeroacoustic origin(s) of "wing whirring" remains unclear. Birds have independently co-opted such incidental flight sounds for communication (i.e., converted them into sonations) at least 61, likely hundreds of times. Clades such as hummingbirds, shorebirds, cotingas, manakins, tyrannid flycatchers, grouse, and nightjars have many independent originations. Sonations evolve most often in courtship displays, or as an analog of vocal song, suggesting this acoustic diversity is driven by sexual selection.

### **189 Feo, Prum**

The theoretical morphology and development of vane asymmetry in flight feathers. TERESA J. FEO and RICHARD O. PRUM, *Dept. Ecol. & Evol. Biol. and Peabody Mus. Nat. Hist., Yale Univ., New Haven, CT*.

Elucidating the developmental processes responsible for morphological variation is key to our understanding of the evolution of morphological diversity. Feathers are a complex branched structure exhibiting a stunning degree of morphological disparity. The flight feathers that form the wings and tails of birds are characterized by an asymmetry in vane width, which contributes to aerodynamic function. Vane asymmetry represents an important novel innovation in the evolution of feathers and flight in birds. Feathers are comprised of a series of branches termed barbs, and it is therefore differences in barb morphology that produce the overall vane asymmetry. Over the past century researches have noted a variety of morphological and developmental modifications present in flight feathers; however, there has been no comprehensive description of how these modifications contribute to overall vane asymmetry. We addressed this question with a combination of theoretical morphology and empirical studies of feather development in 2 species of parrots. First, we constructed a theoretical model that describes vane width in terms of parameters that characterize feather development. Next, we obtained empirical measures of all model parameters from both asymmetric and symmetric feathers in order to identify the developmental and subsequent morphological modifications responsible for creating vane asymmetry. We discovered that vane asymmetry is the result of only 2 of the 3 possible developmental modifications. This study provides the first detailed account of the specific developmental and morphological modifications associated with vane asymmetry.

### **190 L R Jones, DiSciullo**

Seed retention in four toucan species: testing general patterns. LANDON R. JONES, *Dept. Biol., Univ. Louisiana Lafayette, Lafayette, LA*, and RACHAEL A. DISCIULLO, *Dept. Biol., Drexel Univ., Philadelphia, PA*.

Previous studies on seed retention times in avian species indicate important general patterns affecting seed dispersal. Seed retention times tend to increase with (1) defecated versus regurgitated seeds, (2) dry versus fleshy fruits, (3) decreasing seed size, and (4) increasing animal body mass. However, these hypotheses have not been tested comprehensively in the same dataset among closely related species differing in body mass. We conducted seed retention trials with captive toucans in Costa Rica of 4 species ranging in body mass from 180 - 750 g. We fed toucans 10 fruit species with seeds varying in size from 1 - 30 mm. We conducted seed retention trials with multiple fruits from each species, as well as mixed trials with fruits from 2 - 3 different species. On average, toucans retained defecated seeds about twice as long as regurgitated seeds and seeds of dry fruits up to 3 times longer than fleshy fruits. Toucans retained smaller seeds approximately 2 - 4 times longer than larger seeds and the largest toucans retained seeds 2 - 5 times longer than the smallest toucans. Overall our results supported previous studies indicating important patterns in seed dispersal that may be generalized to multiple species and systems.

### **191 Bell, Solomon, Buranek, Boarman, Fesnock, Emmons**

Prairie Falcon home range and habitat use in the Inner Coast Ranges of California, with implications for conservation and land management. D. A. BELL, M. SOLOMON, S. C. BURANEK, W. I. BOARMAN, A. I. FESNOCK and GAVIN EMMONS, *East Bay Regional Park Dist., Oakland, CA.*

The Prairie Falcon is locally distributed throughout the Inner Coast Ranges of California, yet compared to the s. California deserts and the Great Basin, little is known about its home range and habitat use in the region. Obtaining this information is vital for assessing the long-term population sustainability of the prairie falcon in part because the Inner Coast Ranges are being altered by increasing urbanization, renewable energy development and changing agricultural practices. Using radio-telemetry, we compared home range size and habitat use by prairie falcons nesting in 2 areas, the Pinnacles National Monument (PINN) and the San Francisco East Bay Area (SFEBA). Additionally, for falcons nesting at the PINN, we compared falcon use of the following habitat categories: agriculture, chaparral, conifer, floodplain, grassland, oak, scrub, urban and water. With sexes pooled, scrublands and floodplain were used more than expected. With sexes separate, females used grasslands, and males used agricultural and scrub lands, more than expected. Logistic regression revealed that grassland, slope, elevation and distance to nest were important parameters for falcon locations. For falcons nesting at the PINN, the majority of all telemetry locations away from nest sites were west of PINN, in Monterey County, even though apparently suitable habitat exists in San Benito County east of the PINN. Results will be discussed in light of conservation and land management practices.

### **192 Billerman, Murphy, Carling**

Differences in habitat use in the Red-breasted/Red-naped Sapsucker hybrid zone. SHAWN M. BILLERMAN, *Prog. Ecol., Univ. Wyoming, Laramie, WY*, MELANIE A. MURPHY, *Dept. Ecosys. Sci. & Manage., Univ. Wyoming*, and MATTHEW D. CARLING, *Dept. Zool. & Physiol., Univ. Wyoming*.

Hybrid zones offer excellent opportunities to investigate the evolutionary processes that contribute to reproductive isolation between closely related taxa. Red-naped (*Sphyrapicus nuchalis*) and Red-breasted (*S. ruber*) Sapsuckers hybridize along a narrow contact zone that stretches from n. California to British Columbia and are well-suited for investigations of the evolution of reproductive isolation. Substantial differences in habitat and environmental requirements may be extremely informative predictors of change in suture zones such as this, where a variety of other taxa meet and hybridize. Locality data was combined with climate and habitat data to determine habitat preferences for each sapsucker species. Using these climate and habitat data, we employed Random Forest models and found strong evidence for differences in habitat preferences for Red-naped and Red-breasted Sapsuckers. Climate parameters showed that Red-breasted Sapsuckers are found over a wider range of environmental conditions than Red-naped Sapsuckers, suggesting that Red-breasted Sapsuckers are habitat generalists, while Red-naped Sapsuckers are more specialized in habitat preferences. Our results suggest a strong influence of habitat and environment on the sapsucker hybrid zone. Ongoing research is integrating these results with genetic and behavioral data to develop a predictive model of hybrid zone change in the future.

### **193 Dallas, Benson**

Habitat use and demography of Red-headed Woodpeckers in west-central Illinois. TYSON R



DALLAS and THOMAS J BENSON, *Univ. Illinois, and Illinois Nat. Hist. Surv. Champaign, IL.*

The Red-headed Woodpecker (RHWO) was once widespread and common throughout much of eastern North America. Because of several factors, including habitat loss and limited availability of snags for nesting and foraging, RHWO have experienced range-wide declines over the past several decades, including especially steep declines in the Midwestern US. Despite being historically common, detailed knowledge of RHWO habitat use and demography in the Midwest is lacking. Furthermore, most previous research has focused on the RHWO using savannas, which is thought to be high-quality habitat yet is relatively rare in current Midwestern landscapes. We examined habitat and nest-site characteristics and reproductive success of RHWO at 7 sites that represent more commonly available habitats in the Midwest, including open- and closed-canopy upland and bottomland forests. We conducted point-count surveys, searched for and monitored nesting cavities, and quantified habitat structure and composition at used and unused locations as well as nests and randomly selected non-nest points. We monitored > 80 nests, and daily survival rate was greater in bottomland habitat compared to upland. As in past studies of RHWO, our results suggest the importance of habitats with an open understory. Points occupied by RHWO had greater bare ground and less shrub and leaf-litter cover, as well as fewer small trees, than non-occupied points. However, we also found that use of relatively closed canopy forests was greater than expected, suggesting that Midwest forests may support more RHWO habitat than was previously thought.

#### **194 Hovick, Elmore, Fuhlendorf**

Fire and grazing influence winter bird community dynamics. TORRE J. HOVICK, R. DWAYNE ELMORE and SAMUEL D. FUHLENDORF, *Dept. Nat. Res., Ecol. & Manage., Oklahoma State Univ., Stillwater, OK.*

There is a general lack of information on non-breeding habitat use for grassland birds, and understanding how processes such as the fire-grazing interaction impact this imperiled group of species could improve management. Previous research has shown that a shifting-mosaic resulting from patch-burning increases avian diversity during the breeding season and we predicted that a similar response would be found during the winter for non-breeding birds. To evaluate this hypothesis, we used 24 500-m transects in patches ranging from 10 to 46 mo post fire and grazing. Surveys were conducted in Jan and Feb from 2011 - 2013. We observed 13 avian species totaling 344 detections. Many species were detected infrequently and only 5 species had greater than 25 detections. Of the most abundant species, Savannah Sparrow and meadowlarks appeared to be generalists, using all patch types frequently. Conversely, Le Conte's Sparrow and Smith's Longspur were associated with specific patch types. We found that most Smith's Longspurs were detected in patches less than 1 yr post fire-grazing, and in contrast, most Le Conte's Sparrows were detected in patches > 2 yr post fire-grazing. These results support our predictions that non-breeding bird habitat use requires a range of grassland structure and composition, much the same as breeding grassland birds. The use of patch-burning and grazing appears to be an effective means to create structural variation in grassland habitats that allow for use by multiple overwintering avian species.

#### **195 Kocek, Cohen**

Characteristics of salt marshes in New York City preferred by nesting Saltmarsh Sparrows. ALISON R. KOCEK and JONATHAN B. COHEN, *SUNY-ESF, Syracuse, NY.*

Sea level rise and anthropogenic factors have accelerated tidal salt marsh loss along the eastern seaboard of the United States. The Saltmarsh Sparrow (SALS), a tidal marsh obligate species, has mirrored this decline and is considered a species of highest conservation priority, and placed on the 'Vulnerable' list by IUCN in 2004. Habitat characteristics of sites that support SALS reproductive success must be quantified to inform marsh restoration plans that may benefit nesting SALS, and New York City has ongoing salt marsh restoration projects. In 2012, we surveyed 11 marshes in the NYC area for SALS nesting presence. SALS were found breeding at 3 sites, at which twice-weekly systematic nest searches and checks were performed. At all sites, monthly invertebrate sweep-net sampling, monthly vegetation sampling, and regular 10-min disturbance samples were performed. Using ANOVA for regression, we found that SALS nesting presence in NYC cannot be explained based upon machine noise occurrence, prey abundance, or abundance of high elevation within a marsh. Presence of avian nest predators may significantly affect nesting presence of SALS in NYC which contrasts with finding by Gjerdrum et al. (2005, *Condor* 107: 849-862) indicating that marsh elevation has the highest impact on SALS nesting

occurrence. SALS in NYC have also shown a preference towards nesting in tall vegetation (*Spartina alterniflora*) in low elevation areas of marshes leaving nests more exposed to predation than traditional nest locations which are hidden in short grasses at high marsh elevations. Further analysis is pending to provide support for a correlation between nest vegetation preferences and avian predator avoidance.

### **196 J C Ortega, C P Ortega, Wagner, Hathorn, Kraushaar**

Breeding bird population responses to removal of invasive tamarisk and Russian olive in northwest New Mexico. JOSEPH C. ORTEGA, *Dept. Biol., Fort Lewis College, Durango, CO*, CATHERINE P. ORTEGA, *Durango, CO*, SARAH K. WAGNER, *Dept. Ecol. & Evol. Biol., Univ. Colorado, Boulder, CO*, GARY HATHORN, *Farmington, NM*, and BENJAMIN S. KRAUSHAAR, *Dept. Geosci., Fort Lewis College, Durango, CO*.

Tamarisk and Russian olive are 2 prominent non-native invasive trees along riparian areas in the sw. US. In primarily 2008, these 2 species were removed from areas along the San Juan River in Shiprock, NM. From 2008 - 2012, we completed 5-min surveys (using DISTANCE sampling at 20 points) to monitor the responses of breeding birds to this habitat manipulation. Removal of these trees resulted in decreased avian species richness and species diversity. The density of Yellow-breasted Chats and Spotted Towhees both significantly decreased in the years following treatment. The mean distance of first detection was significantly greater from pre- to post-treatment years for a number of avian species. We commonly detected birds in the remaining tamarisk and Russian olive trees outside the treatment area. In addition, avian species richness and species diversity both decreased with increasing distance from the San Juan River or from water. Our study highlights the potential importance of replacement of invasive plants with native plants if birds are to continue to use an area.

### **197 Rand, Burness, Nocera**

Relationships among home range size, habitat selection, and indices of stress in Eastern Whip-poor-wills. GREGORY JAMES RAND, GARY BURNES, *Trent Univ., Peterborough, ON*, and JOSEPH NOCERA, *Trent Univ. and Ontario Min. Nat. Res., Peterborough, ON*.

In Canada, Eastern Whip-poor-will populations have shown dramatic declines, and as a result, the species has been listed as a threatened species within Canada. Despite their broad geographic range, they are one of the most poorly understood species in North America, due largely to their nocturnal habits and cryptic camouflage. Working with a population at the northern edge of their range in nw. Ontario, we radio-tracked adult birds (n = 13) between Jun and Jul 2012, and collected blood samples to evaluate levels of the stress hormone corticosterone. Home range sizes varied considerably among individuals, and were up to 18 times the mean home range reported in previous studies. We will discuss relationships among habitat characteristics (obtained from satellite imagery), home range size and indices of physiological stress.

### **198 Rota, Millsbaugh, Rumble, Lehman, Kesler**

Not all habitats are disturbed equally: Black-backed Woodpecker population dynamics in burned forests and mountain pine beetle infestations. CHRISTOPHER T. ROTA, JOSHUA J. MILLSBAUGH, *Dept. Fish. & Wildl. Sci., Univ. Missouri, Columbia, MO*, MARK A. RUMBLE, *US Forest Service, Rapid City, SD*, CHAD P. LEHMAN, *South Dakota Dept. Game, Fish, & Parks, Custer, SD*, and DYLAN C. KESLER, *Dept. Fisheries & Wildlife Sciences, Univ. Missouri*.

Wildfire and mountain pine beetle infestations are naturally occurring disturbances that benefit numerous wildlife species. Black-backed Woodpeckers are emblematic of the important role these natural disturbances play in creating wildlife habitat since they are almost completely restricted to recently killed forests. Although Black-backed Woodpeckers occupy habitat created by wildfire, prescribed fire, and mountain pine beetle infestations, the relative value of these habitats in maintaining regional populations remains unknown. We studied habitat-specific adult (n = 137 adults) and juvenile (n = 73 juveniles) survival probabilities and reproductive rates (n = 95 nests) between Apr 2008 and Aug 2012 in the Black Hills, SD, which we used to calculate habitat-specific asymptotic population growth rates. We coupled the demographic study with an evaluation of habitat-specific home range size and foraging behavior. Mean population growth rates were positive only in habitat created by summer wildfire, and were negative in fall prescribed fire and mountain pine beetle infestations. Consistent with habitat-specific population growth rates, we found home ranges in mountain pine beetle infestations were nearly 4 times larger than in recently burned forest. We also found Black-backed Woodpeckers captured nearly twice as

many wood-boring beetles, a primary prey item, in summer wildfire relative to fall prescribed fire. The timing of prescribed fire may affect food and predator communities, contributing to lower population growth in this habitat. Our finding that population growth rates were positive only in habitat created by summer wildfire underscores the need to maintain recently burned post-wildfire habitat across the landscape.

### **199 Sousa**

Reproductive success of Dickcissels varies with burn management and average rainfall. B. F. SOUSA, *Univ. Kentucky, Lexington, KY.*

Grassland birds are declining more rapidly than any other group of North American birds. While the effects of habitat destruction on native populations are well studied, the effects of habitat management are less clear. Because management techniques affect the structure and distribution of resources and predators, they may influence the breeding success of birds in complex ways. Furthermore, a population's response to habitat management may vary with climatic conditions. Understanding the factors contributing to variation in breeding success is important in understanding and predicting a population's response to management efforts. I investigated the effects of managed burning used to maintain prairie habitat on the reproductive success of an obligate grassland breeding bird, the Dickcissel. In addition, I investigated the effects of annual variation in spring rainfall on Dickcissel reproductive success. Specifically, I examined nest survival, fledging success, clutch size, hatching success, and breeding phenology across 4 years and in sites with managed burn intervals of 1, 2, 4, and 20 yr. Timing of breeding varied significantly, with nesting occurring earlier in frequently burned sites, and ending later in unburned sites and years with high rainfall. Fledging success increased with both burn frequency and average spring rainfall. Nest survival and hatching success did not vary with either burn frequency or rainfall. Patterns of variation in clutch size and nestling condition did not explain variation in fledging success among years or burn regimes. So while increased management and precipitation had a positive effect on the number of young produced per nest, the mechanisms producing this increase remain unclear. The results of this study suggest that reliance on estimates of nest survival alone may not fully represent the effects of management on breeding success in this species. Further, the effects of management on avian populations may vary depending on climatic conditions.

### **200 Hockman, Buehler**

Occupancy and detectability of grassland birds using habitat and land cover relationships on Fort Campbell, TN/KY. EMILY V. HOCKMAN and D. A. BUEHLER, *Dept. For. Wildli. & Fish., Univ. Tennessee, Knoxville, TN.*

The Department of Defense manages more than 10 million ha of land in the US which have become unintentional refuges for wildlife. Grassland birds, which are experiencing the largest decline of any group, benefit specifically from open vegetation both created and maintained for military training. We used a point-count route around the impact zone on Fort Campbell Military Reservation, TN-KY, to investigate the use of available native warm season grasslands and oak savannas by a suite of declining grassland birds. We asked specific questions regarding the impact of vegetation coverage and arrangement on species' occupancy along the route. Bachman's Sparrows were of particular interest due to the small but persistent and isolated population found on Fort Campbell in the northern-most reaches of the species' range. The most common species recorded were Northern Bobwhite and Prairie Warblers ( $n = 492, 466$ ). Occupancy across both years was lowest for Bachman's Sparrows ( $\psi = 0.08, n = 18$ ), and occupancy did not increase with playback. Bachman's Sparrow and Prairie Warbler occupancy was positively related to grass cover ( $\beta = 12.86, 12.10$ ), while Blue Grosbeak occupancy was best fit by grass cohesion ( $\beta = 0.08$ ). Blue-winged Warbler occupancy was most closely modeled by a negative relationship with shrub cover ( $\beta = 6.52$ ). The remaining species (Dickcissels, Eastern Meadowlarks, Henslow's Sparrows, Northern Bobwhite, and Orchard Orioles) were best modeled by negative relationships with agricultural field cover ( $\beta = -7.45, -7.06, -4.43, -6.23, -19.3$ ). The results describe the interactions between landuse and vegetation for a suite of species while illustrating the importance of man-made disturbance in grassland bird conservation.

### **201 Lightfoot, Taylor, Shutler**

Avian fall migration decisions in the Gulf of Maine region. H. L. LIGHTFOOT, P. D. TAYLOR, and D. SHUTLER, *Dept. Biol., Acadia Univ., Wolfville, NS.*

Research in the Gulf of Maine Region has demonstrated effects of intrinsic and extrinsic factors on avian migration. Although broad patterns of migration have been well described, finer scale movements and decisions have only recently received attention. Using marine radars, we examined effects of weather, time of year, and time of night on migratory decisions of fall songbirds at 4 locations around the Bay of Fundy and Gulf of Maine. In contrast to previous weather radar studies in the 1960s and 1970s, there was high variability in headings used by migrants at the locations in our study. Generally, weather was more important in explaining decisions to forward migrate (move in a seasonally appropriate direction) than in explaining routes used by migrating birds. In addition, larger numbers of migrants were detected with a more westerly heading than in previous studies, which may be a result of the finer resolution of marine radars used in this study or it may indicate that shifts in migratory headings of individuals in this region have occurred in the past 3 decades.

## **202 McKinnon, Stutchbury**

First-time spring migrants: how much does experience improve migratory performance? EMILY A. MCKINNON and BRIDGET J. M. STUTCHBURY, *Dept. Biol., York Univ., Toronto, ON.*

Juvenile migratory birds undertake the amazing feat of naïve migration; they find their way to appropriate wintering and breeding habitat with only an innate map and compass. In contrast, adult birds have both innate orientation abilities and experience, and can exhibit 'true' goal-oriented navigation. There is little information on how juvenile and adult migratory routes and timing differ, owing to the difficulty of following small birds start-to-finish on long-distance migrations. We describe naïve spring migration of 17 juvenile Wood Thrushes tracked using light-level geolocators from 2 wintering sites (Costa Rica and Belize) and compare with adult migrations from the same sites ( $n = 37$ ) to test the hypothesis that adults will take more direct routes and migrate faster owing to memorized geographic cues en route. Spring and fall migrations in Wood Thrushes occur along significantly different routes; therefore, spring migration is truly novel for first-time breeding birds. We also obtained migration data from 4 individuals in 2 consecutive years where birds were naïve migrants in the first year of tracking, allowing a direct comparison of the same bird's naïve and 'experienced' migrations. We predicted that adults would fly more quickly between stopover sites and stopover for fewer days than juveniles, resulting in earlier arrival at breeding sites. Preliminary results indicate that juvenile birds travel at a much slower rate than adults, primarily owing to more frequent and longer stopovers.

## **203 B J Olsen, McCabe, Adams, Grunzel, Miller-Rushing**

An assessment of the potential for phenological mismatch in autumnal migratory stopover. BRIAN J. OLSEN, JENNIFER D. McCABE, EVAN M. ADAMS, DAVID P. GRUNZEL, *Univ. Maine, Orono, ME*, and ABRAHAM J. MILLER-RUSHING, *Natl. Park Serv., Bar Harbor, ME.*

Variation in local phenology across biotic and abiotic ecosystem components can lead to ecological effects from the scale of individuals up to community and ecosystem dynamics. For example, changes in phenological alignment ("mismatch") can cause population-level effects in passerine songbirds during the breeding season. During migration, however, passerine songbirds encounter an even wider range of ecosystems at different stages in local phenology, but there is little understanding of how interactions at these scales may influence songbird ecologies. Mismatches between the resource needs of birds and the availability of resources while birds are present at a locale could influence individual condition, migratory survival, and the viability of migratory populations. We used a hierarchical modeling approach to assess the patterns of habitat use across a system of 4 migratory stopover locations as a function of the local phenology of both habitat structure (i.e., leaf drop) and food resources (i.e., fruit and invertebrates). We compared the ability of these temporally ephemeral resources to explain local bird movements within a site relative to the ability of habitat characteristics that were stable across time (e.g., stem density). The results allowed us to identify bird guilds whose movements are shaped most strongly by locally ephemeral resources, a characteristic that may put them at more risk of phenological mismatch should stopover behaviors misalign with local resource phenology.

## **204 Bellinger, Banks**

Gene-based approaches to identifying magnetite-based magnetic sensory receptors. M. RENEE BELLINGER and MICHAEL A. BANKS. *Dept. Fish. & Wildl., Hatfield Marine Sci. Center, Oregon State Univ., Newport, OR.*

Birds and fish, and other organisms, possess magnetic sense and are hypothesized to use

geomagnetic cues for guidance during migration, but how they are able to perceive magnetic fields is poorly understood. In birds, there is evidence for 2 types of receptor systems: one involving a light-dependent quantum-physic reaction that occurs in the eye, and a second light-independent mechanism that is hypothesized to involve specialized receptor cells containing the highly-magnetic iron-mineral magnetite. Magnetite-based sensory cells have not yet been identified in birds. Salmonids, a type of teleost fish, are capable of light-independent magnetic orientation and they produce magnetite-containing cells in olfactory rosette tissues (the sense of smell organ). The trigeminal nerve responds to magnetic field intensity treatments in birds and fish, and in fish this nerve has been traced to the olfactory rosette. However, the link between magnetite-containing olfactory rosette cells and sensory transduction has not been established because the cells are extremely difficult to find and study. Efforts are underway to identify the genetic basis of iron-mineral formation and function in magnetite-containing cells of fish by comparative analysis of magnetic and non-magnetic olfactory rosette cell transcriptomes using RNA-Sequencing technologies. Preliminary analysis of ~800 million gene transcripts from 6 samples (3 magnetic, 3 non-magnetic) compared against a 67,000 gene contig reference revealed >300 genes differentially expressed in the magnetic cell sample. Based on these findings and continued work, gene-based fluorescent probes will be developed and applied to test whether magnetite-cells of fish respond to magnetic fields. Results can be extended to assessing whether similar systems exist in birds and other vertebrate species.

### **205 J D Ross, Bridge, Rozmarynowycz, Bingman**

Mixed migration strategies in the Eastern Lark Sparrow. JEREMY D. ROSS, ELI S. BRIDGE, *Oklahoma Biol. Surv., Univ. Oklahoma, Norman, OK*, MARK J. ROZMARYNOWYCZ and VERNER P. BINGMAN, *Dept. Biol. Sci./Psychol., Bowling Green State Univ., Bowling Green, OH*.

Neotropical migrants of w. North America are believed to have evolved a partial-molt migration strategy to cope with late-season changes to breeding grounds that may not support molt. One species thought to undergo molt-migrations to the Mexican Monsoon region is the Lark Sparrow. However, this species breeds across a wide area, including areas of the American Midwest that does not experience the degree of late-season drying that would restrain molt. We used light-level geolocators, or geologgers, to interpolate the migratory paths of 3 adult Lark Sparrows from Ohio. Results indicated that one male and one female migrated directly to wintering grounds via the American Southeast, while the other male moved directly westward to Nebraska and lingered there for a month before continuing southward. Our results suggest that molt-migration behavior may be retained in Western Neotropical migrants even in areas where the strategy is apparently unnecessary.

### **206 E J Ross, Zuckerberg, Bonter**

Regional responses in spring migration phenology to climatic cues for short-distance migrants. ERIC J. ROSS, BENJAMIN ZUCKERBERG, *Dept. Forest & Wildl. Ecol., Univ. Wisconsin-Madison, Madison, WI*, and DAVID N. BONTER, *Lab. Ornithol., Cornell Univ., Ithaca, NY*.

The timing of many springtime events throughout the world is shifting due to climate change. Several studies suggest that the arrival of migratory birds to their breeding grounds have followed a similar pattern with first arrivals becoming earlier over the past century. However, the generality of that result between species and populations can sometimes be difficult to detect as many studies focus on data from a limited number of banding stations. Using over twenty years of data from Project FeederWatch, a continental-scale citizen science program focused on wintering and early spring birds, we quantified the timing of spring arrival for 5 species of short-distance migrants to the Upper Midwest. We quantified multiple aspects of migration fronts by 1) linking Project FeederWatch data to a suite of climate variables at both their wintering and breeding grounds, 2) assessing the relationship of first and median arrival date to the breeding region to these climate variables, 3) using generalized additive modeling to characterize how the structure of these fronts varied based on climate conditions, and 4) implementing climate projections to characterize what the future phenological landscape might look like for these species. We found strong support for the importance of mean winter and spring temperatures influencing first and median arrival date. If these relationships between arrival dates and temperature hold firm, future climate projections predict that by 2030 many short-distance migrants will arrive at their breeding grounds nearly a month earlier than they did 40 yr ago.

### **207 Ruiz-Gutierrez, Saracco, Kendall, DeSante.**

Overwintering dynamics of neotropical migratory songbirds. VIVIANA RUIZ-GUTIERREZ, J. F. SARACCO, W. B. KENDALL and D. DeSANTE, *Colorado Coop. Fish & Wild. Res. Unit., Colorado State Univ., Ft Collins, CO.*

The overwintering season between autumn and spring migrations may be the most critical time in the life cycle for many migratory songbirds. However, understanding of the ecology and habitat associations of these species on their overwintering grounds is largely limited to a few intensively studied species and localities. The general model emerging from these studies is one whereby within the constraints of habitat availability, birds attempt to establish and remain on territories through most or all of the overwintering season. The extent to which this model applies to most species, populations, or regions is largely unknown. Here we leverage an extensive capture-mark-recapture data set from bird-banding project in Central America, provide inferences about the dynamics and habitat relationships of 26 migratory songbird species on their tropical, overwintering grounds. We employed a novel analytical approach based on an open robust design multi-state model with state uncertainty. We modeled site persistence for resident birds (i.e., individuals attempting to overwinter), the proportion of resident birds in samples, and monthly probabilities of entry into the population for resident and non-resident (i.e., transient) birds. Mean winter Enhanced Vegetation Index (EVI) or changes in EVI between early and late winter were related to site persistence for 62% (16) of the species. Proportions of residents in samples were generally low and were related to mean EVI for 8 (31%) species. Interestingly, persistence-habitat relationships varied by month for half the species, and some relationships varied widely from one month to another. In addition, entry probability estimates suggested high levels of movement within overwintering seasons for many species. Our results suggest a diversity of overwintering strategies within and among species for Neotropical migrants, and conservation efforts on their wintering grounds may require consideration of habitat mosaics or networks of habitats that could span large spatial extents.

## 208 Guaraldo, Kelly, Marini

Does migration influence birds' ecology? A comparative study. ANDRÉ C. GUARALDO, *Universidade de Brasília, DF, Brazil*, JEFFREY F. KELLY, *Univ. Oklahoma, Norman, OK*, and MIGUEL Â. MARINI, *Universidade de Brasília.*

One of the greatest mysteries behind bird migration is why birds do it. Escaping from harsh weather not always an obvious reason, especially when considering migrants of the South American intratropical migration system. We explore how migration affects the ecology (habitats and diet) of the migrant Lesser Elaenia (*Elaenia chiriquensis*) while using the co-occurring Plain-crested Elaenia (*Elaenia cristata*) as a control. We analyzed the carbon and nitrogen stable isotope values of feather, claw, and blood from females breeding in a seasonal site in Central Brazil. Data analyses followed the information-theoretic approach. Results show that the interaction between period of the year (molting, wintering, and breeding) and species largely explains  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  variations. Migrants and residents use isotopically similar mesic habitats for molting (mean  $\delta^{13}\text{C}_{\text{migr}} = -25.06 \pm 0.72\text{‰}$  and  $\delta^{13}\text{C}_{\text{resid}} = -24.97 \pm 0.80\text{‰}$ ) and wintering ( $\delta^{13}\text{C}_{\text{migr}} = -25.22 \pm 0.61\text{‰}$  and  $\delta^{13}\text{C}_{\text{resid}} = -24.87 \pm 0.21\text{‰}$ ), and only slightly differ in breeding habitat usage ( $\delta^{13}\text{C}_{\text{migr}} = -25.63 \pm 0.52\text{‰}$  and  $\delta^{13}\text{C}_{\text{resid}} = -26.80 \pm 0.49\text{‰}$ ). While molting, migrants and residents have similar trophic levels ( $\delta^{15}\text{N}_{\text{migr}} = 2.84 \pm 0.56\text{‰}$  and  $\delta^{15}\text{N}_{\text{resid}} = 3.38 \pm 1.01\text{‰}$ ), migrants occupy relatively higher levels both while wintering ( $\delta^{15}\text{N}_{\text{migr}} = 1.31 \pm 0.24\text{‰}$  and  $\delta^{15}\text{N}_{\text{resid}} = 0.67 \pm 0.21\text{‰}$ ) and breeding ( $\delta^{15}\text{N}_{\text{migr}} = 3.63 \pm 0.35\text{‰}$  and  $\delta^{15}\text{N}_{\text{resid}} = 2.68 \pm 0.23\text{‰}$ ). Summing up, residents oscillate their trophic level through the year attaining the highest trophic level while molting (rainy season), and the lowest trophic level during winter (dry season). Conversely, it is plausible that behaving as habitat-trackers, migrants can consistently occupy higher trophic levels than residents, especially during breeding (rainy season peak) and at wintering grounds (unknown area). Hence, these data are consistent with the long-standing hypothesis that birds pursue environmental stability through migration. Nevertheless, it also reinforces a need to unravel migrants' wintering ecology to provide full scenario evaluation of trade-offs occurring in this intratropical migration system.

## 209 Leopold, Hess

The role of migration corridors for an intra-tropical altitudinal migrant. CHRISTINA R. LEOPOLD, *Hawai'i Coop. Studies Unit, Univ. Hawai'i at Hilo, Hawai'i Natl. Park, HI*, and STEVEN C. HESS, *U.S. Geol. Surv. Pacific Island Ecosys. Res. Center, Hawai'i Natl. Park, HI.*

The role of movement corridors and stopover sites for intra-tropical altitudinal migrants remains largely unexamined, but may differ dramatically from that of long-distance migrants. We used relatively

new methods of Brownian bridge movement models (BBMMs) and net squared displacement (NSD) in conjunction with high-resolution GPS satellite telemetry data to estimate population level utilization distributions and assess migration patterns and stopover site use of the endangered Hawaiian Goose, or Nene (*Branta sandvicensis*), an intra-tropical altitudinal migrant. We characterized migration and stopover events across the landscape, identified important movement corridors, displacement thresholds, habitat features associated with stopover sites, and the extent of corridor overlap between 2 breeding subpopulations of Nene on Hawai'i Island that were isolated from each another until recently. We obtained a high-resolution spatio-temporal representation of movements across the annual cycle by combining BBMMs and NSD models. We found well-defined common movement corridors over a broad altitudinal gradient within diverse habitats. Stopover sites primarily occurred at the confluence of movement between the 2 subpopulations in native-dominated subalpine shrublands and water features. Migration distance and the number of stopover sites, which were unrelated, multiple individual displacement patterns, and movements which were not unidirectional all suggest that social interactions may be more important than a need for refueling en route. Non-breeding movements coincided with seasonality in important high elevation food resources, but lower-elevation food resource availability was relatively constant, indicating that other factors may influence the timing and duration of return migration.

### **210 Atwell, Rice, Ketterson**

Rapid loss of migratory behavior and physiology associated with recent colonization of an urban habitat. JONATHAN W. ATWELL, R. J. RICE and E. D. KETTERSON, *Univ. Indiana, Bloomington, IN*.

In addition to changing climates, recent studies indicate that urbanization may be contributing to the loss of animal migrations worldwide. Due to the novel resources and/or moderated local temperatures provided by urban habitats, they are predicted to favor shifts towards sedentary behavior. Yet few studies have documented this phenomenon, and fewer still have considered the developmental or evolutionary mechanisms underlying contemporary shifts in migratory biology. Here we describe a range expansion, in which a historically montane-breeding altitudinal migrant songbird, the Dark-eyed Junco (*Junco hyemalis thurberi*), became sedentary (non-migratory) in association with its recent establishment (early 1980s) in an urban habitat in coastal San Diego County, CA. We used a captive common garden study to evaluate whether the observed loss of migratory behavior likely represents a plastic adjustment in response to local conditions or an apparent genetic adaptation. We found reduced levels of migratory restlessness (*Zugunruhe*) as well as reduced seasonal fat deposition in the urban colonist population as compared to a nearby ancestral-range. Although early developmental effects could help to explain these findings, they strongly suggest rapid genetic evolution underlying adaptive loss of migratory behavior and associated physiology. This study provides some of the first experimental evidence from a New World songbird indicating that urbanization may be playing a significant role in the rapid decline of animal migrations.

### **211 Siefferman, Morris, Hood**

Opposites attract: mate choice for personality in Eastern Bluebirds. LYNN SIEFFERMAN, TINA MORRIS, *Biol. Dept., Appalachian State Univ., Boone, NC*, and WENDY HOOD, *Dept. Biol. Sci., Auburn Univ., Auburn, AL, and Biol. Dept., Appalachian State Univ.*

Animals within populations often differ consistently in behavior over time and/or across conditions—referred to as personalities. Sexual selection could influence the evolution of animal personality. Because avian personality is associated with foraging efficiency, territorial defense and offspring provisioning behaviors, personality types likely influence mate quality. Further, optimal mate choice could be influenced by the personality of the male and the female. Here, we present evidence suggesting that sexual selection may act on personality differences in Eastern Bluebirds. We assessed exploratory behavior in captive bluebirds and then allowed females to choose between males of high- and low-exploratory types. Overall, females preferred to mate with low-exploratory males. However, this trend was influenced by the exploratory behavior of females. High-exploratory females showed strong preferences for low-exploratory males while low-exploratory females showed little evidence of preferences. Our results suggest that behavioral compatibility for personality traits might be important for avian mate choice.

### **212 Sutherland**

Nest box philopatry of Tree Swallows in Canadian parkland. JAMES M. SUTHERLAND, *Winnipeg,*

MB.

In 2010, 310 bluebird nest boxes were placed on fenceposts and power/telephone poles at 2 - 3 km intervals between Saskatoon, SK, and Foxwarren, MB. Nest boxes were checked for occupancy in 2011 and 2012. Tree Swallows nested in 40% of the boxes in 2011 and 62% in 2012. Boxes used by Tree Swallows in 2011 were significantly more likely to be used by Tree Swallows in 2012 (Fisher's exact test,  $P < 0.001$ ). The results are discussed in relation to similar studies.

### **213 Augustine, Oxenrider**

Can air sac reflectance be used to determine species identity and individual quality in prairie-chickens (*Tympanuchus* spp.)? JACQUELINE K. AUGUSTINE and KEVIN J. OXENRIDER, *Dept. Evol., Ecol., & Organismal Biol., Ohio State Univ., Columbus, OH.*

Sexual ornaments can signal both species identity and quality of the individual. Morphologically, Greater and Lesser Prairie-Chickens (*Tympanuchus cupido* and *T. pallidicinctus*, respectively) differ in size and the color of their esophageal air sac which they inflate during display. The first goal of this study was to examine the reflectance of the air sac of prairie-chickens to determine how air sac color varies with other morphological characteristics in order to differentiate among the 2 prairie-chicken species and hybrids. Second, we examined how air sac reflectance varies with condition (residuals of a mass by tarsus regression) and territory location to examine whether color may be used to assess inter-individual quality. In lek-mating species, males in the center of the lek are often more successful at attracting females than those at the periphery. We captured prairie-chicken males on leks during the breeding season using drop nets and walk-in funnel traps, and measured UV-visible reflectance of air sacs. This study was conducted in an area where Greater and Lesser Prairie-Chickens are sympatric in western Kansas in the spring of 2013. We found that air sac color can be used to differentiate among the 2 prairie-chicken species and hybrids, but we found only weak relationships between color and male condition or territory location. Future work should manipulate air sac color of males in controlled female choice experiments to determine whether females use air sac color to choose a conspecific mate and to differentiate among individual conspecific males.

### **214 Sarquis-Adamson, MacDougall-Shackleton**

Home-field advantage in a host-parasite system. YANINA SARQUIS-ADAMSON and ELIZABETH MACDOUGALL-SHACKLETON, *Dept. Biol., Western Univ., London, ON.*

The local adaptation hypothesis predicts that local populations of a species are better adapted to their specific home environments than are individuals dispersing from other such populations. In the context of a songbird host-bloodborne parasite system, previous findings that birds of local origin have lower parasite loads are consistent with, but do not definitively support, the local adaptation hypothesis. We hypothesized that host individuals remaining to breed close to where they were born should be better able to defend against the local parasites, relative to hosts immigrating from other populations. To test this, I captured Song Sparrows from 2 geographically separated populations, and conducted reciprocal infectivity trials challenging birds with *Plasmodium* parasites from either the local or non-local site. My results will shed light on how well hosts can cope with parasites from different areas, and ultimately help understand the importance of parasites in restricting host dispersal.

### **215 Skrade, Dinsmore**

Age-specific breeding probabilities for the Mountain Plover. PAUL DANIEL BLOM SKRADE and STEPHEN JAMES DINSMORE, *Dept. Nat. Res. Ecol. & Manage., Iowa State Univ., Ames, IA.*

The age of first reproduction is important in both life-history theory and conservation biology because it can have a large impact on individual fitness, which in turn influences population dynamics. The Mountain Plover is a shorebird of conservation concern that is physically capable of breeding at age one year, but not all individuals are believed to do so. This species has an uncommon parental care system where males and females tend separate nests. We individually color-banded and resighted 850 flightless plover chicks during the breeding seasons of 1995 to 2010 in Phillips County, Montana. Of these, 115 were found in the study area as adults with 38 individuals observed breeding at age one (33%). We developed a set of closed robust design multi-state mark-resighting models in Program MARK to estimate the probability of breeding at age one or delaying breeding to a later age, and how this is influenced by an individual's sex and environmental conditions. The model-averaged probability of a Mountain Plover breeding at age one is 0.20 (SE = 0.05), which was similar to the probability of an older



non-breeding bird breeding in any given year (0.18, SE = 0.04). Both sex and environmental conditions had weak effects on the decision of Mountain Plovers to breed but in general, females were more likely to breed than males and plovers were more likely to breed in drier years than in wetter years. Our study provides needed information about the reproductive biology and population ecology of a species of concern.

## **216 Malpass, Rodewald**

Influence of complex vegetation on nest predator activity in residential yards. JENNIFER S. MALPASS and AMANDA D. RODEWALD, *Ohio State Univ., Columbus, OH*.

Understanding the influence of human development on wildlife is paramount for biological conservation due to the extent and pace of urbanization worldwide. With development often come changes in resource availability that can profoundly affect patterns of diversity, species interactions, and ultimately population viability. Conservation groups concerned about providing resources for urban wildlife often promote using trees and shrubs to improve habitat for birds. However, these same habitat features also may attract predators of birds and their nests. Nest predators often exist at high densities in urban areas, and habitat features that increase their activity may pose a heightened risk to breeding birds. We asked how vegetation characteristics influence activity patterns of nest predators in residential yards. We surveyed nest predator activity and characterized habitat in 7 suburban neighborhoods in Franklin Co., OH, from Apr to Aug in 2011 and 2012. Predator activity varied among individual yards, but contrary to our expectations, the amount of trees and shrubs was not a strong predictor of activity patterns for most predator species. Thus, our study suggests that increasing vegetation complexity, a frequent recommendation of wildlife-friendly gardening programs, does not attract nest predators. Our continuing research investigates what other habitat attributes, such as availability of food resources, may be responsible for spatial variation in activity of nest predators. Identification of these factors influencing nest predator activity is crucial for maximizing the conservation value of residential yards for breeding birds.

## **217 Pavlacky, Blakesley, Hanni**

Hierarchical occupancy estimation to predict bird species distributions. DAVID C. PAVLACKY Jr., JENNIFER A. BLAKESLEY and DAVID J. HANNI. *Rocky Mountain Bird Observ., Brighton, CO*.

Species distribution models are gaining wide use in wildlife ecology and conservation science. Mapped species distributions are often used in conservation planning to prioritize the management of landscapes and to assess conservation responsibility. The scientific value of species distribution models can be improved by using a probabilistic sampling design to account for spatial variation, which allows valid inference to a region. Population estimation approaches that account for incomplete detection and availability are expected to outperform index-based approaches. Our objectives were to 1) illustrate an occupancy approach to predicting distributions of 3 sagebrush birds; Brewer's Sparrow, Sage Sparrow and Sage Thrasher, 2) evaluate the effects of landscape composition on species occurrence and 3) map the large-scale species distributions at the scale of Bird Conservation Regions. We used data from the Integrated Monitoring in Bird Conservation Regions program to parameterize a multi-scale occupancy model. The occupancy distributions accurately depicted differences in the geographic ranges of the species. The land cover effects on species occurrence provided mechanistic explanations for species distributions in the region. The predicted distributions indicated a biodiversity hotspot for sagebrush-dependent songbirds in southwestern Wyoming and northwestern Colorado. We suggest occupancy estimation provides reliable knowledge about bird species distributions to support avian conservation at ecoregional scales.

## **218 Salinas-Melgoza, Wright**

Behavioral plasticity of a Neotropical parrot in human-modified landscapes. ALEJANDRO SALINAS-MELGOZA, *Estación de Biología Chamela, Instituto de Biología, Universidad Nacional Autónoma de México, Mexico*, and TIMOTHY F WRIGHT, *Dept. Biol., New Mexico State Univ., Las Cruces, NM*.

A plastic response in movement and roosting patterns may be expected in individuals living in habitats with fluctuations in resources. Parrots are long-lived and wide-ranging, which could make them likely to face great temporal and spatial variation within their long lifespans. We assessed ranging patterns, habitat usage, and roosting behaviors of the Yellow-naped Amazon (*Amazona auropalliata*) at 2 sites in n. Costa Rica. Each site was characterized by having 2 different degrees of anthropogenic habitat

alteration. Behaviors for residents at the 2 sites and in individuals experimentally translocated between sites were compared to test the hypothesis that individuals would employ behavioral plasticity in response to habitat differences. We found that both the magnitude of ranging movements and the size of communal roosts was larger in the region with dispersed vegetation. In comparison, individuals in the region with concentrated resources moved over a smaller area and roosted in more sites and with fewer individuals. We found translocated individuals showed flexibility in these behaviors and matched the behavioral patterns of resident birds at the release site rather than maintaining behaviors characteristic of their capture site. Our results illustrate the direct response in movements and roosting this parrot species may perform to maximize foraging efficiency in habitats with different land-use strategy. Our results also illustrate a generalized rapid plastic response to human-induced changes in habitat for a number of behavioral traits in the yellow-naped amazon. Such plasticity is directly relevant to reintroduction efforts that are commonly employed as a conservation tool in parrots.

## **219 Sullivan, Greenberg**

Project Passenger Pigeon: message from Martha. S. M. SULLIVAN, *Chicago Acad. Sci. and Peggy Notebaert Nature Mus., Chicago, IL*, and J. GREENBERG, *Peggy Notebaert Nature Mus. and Field Mus., Chicago, IL*.

Anthropocentric activity is the most significant cause of biodiversity loss throughout the world. This phenomenon is spectacularly demonstrated by the Passenger Pigeon, a bird that probably exceeded a billion individuals as late as 1860. But unremitting exploitation for commerce and recreation drove the species to extinction when the last individual died in a zoo on 1 Sep 1914. Project Passenger Pigeon (P3) is an international effort to mark the 2014 centenary of this event. P3 will familiarize people with the story of the Passenger Pigeon and to use that story as a portal into consideration of current issues regarding extinction, the connections between humans and the natural world, and the need to build sustainable relationships with other species. Project Passenger Pigeon presents these messages through a web site and social media, a book, documentary film, and a host of exhibits and programs. Upcoming resources include downloadable exhibit panels, classroom curricula, and a children's play. Individuals and institutions alike are encouraged to use P3 resources to become involved locally; over 160 organizations are currently involved this effort. From species that are imperiled, such as Whooping Cranes and Slender-billed Curlews, to those that have made remarkable recoveries, like Sandhill Cranes, Trumpeter Swans, and Bald Eagles, the story of the Passenger Pigeon is one that can be utilized to unify the conservation efforts of all biologists in 2014.

## **220 Tonra, Marra, Sager-Fradkin**

Tracking responses to marine derived nutrients in American Dippers in the context of the largest dam removal in United States history. CHRISTOPHER M. TONRA, PETER P. MARRA *Smithsonian Conser. Biol. Inst., Washington, DC*, and KIMBERLY SAGER-FRADKIN *Lower Elwha Klallam Tribe, Port Angeles, WA*.

Man-made dams have had many deleterious environmental impacts throughout the world. In western North America, dams obstruct the main vector of nutrient subsidies to freshwater ecosystems from marine environments, salmon (*Oncorhynchus* spp). These subsidies have beneficial effects on recipient food webs. This has led to the removal or proposed removal of many dams, including the removal of 2 dams on the Elwha River, WA. To quantify the impacts of this unprecedented restoration, we are using stable isotopes (C, N) to track marine derived nutrients in a sensitive indicator of aquatic food web quality, the American Dipper. We examined impacts of salmon obstructions on body condition and migratory behavior. Stable-isotope ratios were more enriched in tissues from areas with intact salmon migrations, indicating greater consumption of salmon tissues and potential enrichment of invertebrate prey. Females breeding in areas with salmon migrations were in better condition and both sexes were more likely to occupy territories in fall. Juvenile dippers show the opposite trend in condition suggesting greater investment in reproduction in areas without salmon. Adult condition patterns were more pronounced behind anthropogenic, compared to natural, obstructions. These patterns indicate that dams have sizable, individual level impacts on aquatic consumers and provide a valuable baseline to track the recovery of this watershed following completion of dam removal in 2013.

## **221 Loman, Riffell, Miller**

Effects of switchgrass intercropping in early successional pine plantations on bird communities.

ZACHARY G. LOMAN, SAMUEL K. RIFFELL, *Dept. Wildl., Fish. & Aquaculture, Mississippi State Univ., Mississippi State, MS*, and DARREN A. MILLER, *Weyerhaeuser NR Co., Columbus, MS*.

Increased demand for renewable fuels has led to altered land use regimes. Intercropping native switchgrass (*Panicum virgatum* L) with early seral stage loblolly pine (*Pinus taeda* L.) plantations may generate lignocellulosic biofuel feedstocks. To understand how establishing switchgrass affects bird communities within intercropped plantations, we sampled 6 pine stands in each assigned 4 treatments (~10 ha): traditionally managed pine plots (0, 1, and 2 yr since establishment), young intercropped plots (0, 1 and 2 yr since establishment), older intercropped plots (5, 6, 7 yr since establishment) and switchgrass monocultures (0, 1, and 2 yr since establishment). Treatments were established by Weyerhaeuser Company and Catchlight Energy LLC on land owned and managed by Weyerhaeuser in Kemper County, MS. Bird communities were sampled from May - Jun 2011 - 2013 with 10 min point counts using distance sampling. We determined absolute species densities corrected for imperfect detection. We compared responses to treatment and year for 22 bird species that use early seral pine plantations using non-metric multidimensional scaling. Intercropping resulted in similar bird densities as traditionally managed pine plantations except in the first year of establishment when densities were low. Older intercropping plots had increased densities over younger intercropped plots and younger traditionally managed pine plots. Switchgrass monoculture had very low densities, but increased slightly over time. Intercropping appears to facilitate similar habitat use as traditional pine management with the exception of a lost year during switchgrass establishment that is likely due to reduced vegetation structure from planting related anthropogenic disturbance.

## **222 McKellar, Kesler, Mitchell, Delaney, Walters**

Range-wide variation in foraging habitat quality for the Red-cockaded Woodpecker. ANN E. MCKELLAR, DYLAN C. KESLER, *Fish. & Wildl. Sci., Univ. Missouri-Columbia, Columbia, MO*, ROBERT J. MITCHELL, *Joseph W. Jones Ecol. Res. Center, Newton, GA*, DAVID K. DELANEY, *Engineer Res. & Develop. Center - Const. Engineering Res. Lab., Champaign, IL*, and JEFFREY R. WALTERS, *Virginia Tech, Blacksburg, VA*.

Models are important tools for endangered species management and conservation, but the usefulness of any given model for decision making depends on its accuracy and precision. Few models designed for conservation purposes are ever validated with real-world data. Even rarer are cases where such models are revisited and improved based on these data. We test the performance of a model frequently used and heavily relied-upon for the management of the endangered Red-cockaded Woodpecker (RCW). The RCW Foraging Matrix Application incorporates spatially-explicit forest stand data and RCW territory locations to produce a quantitative assessment of foraging habitat quality. The model is based upon expert opinion and research performed on several key populations. Since the model's inception many RCW populations have been monitored intensely, providing a unique opportunity to evaluate model performance range-wide. We obtained forest stand data and RCW fitness measures from across the species range in the se. US to assess the effectiveness of the Matrix Application in predicting RCW group size and reproduction. We also evaluated foraging habitat quality directly, by relating RCW fitness to foraging habitat metrics through a regression tree analysis. Our results show site-specific variation in the effectiveness of the Matrix Application, and our regression tree analyses identified threshold values for habitat metrics that are likely to further improve foraging habitat quality. Together, our findings suggest that the "one-size-fits-all" range-wide model may not accurately reflect all conditions that are associated with local population productivity, and that additional locally-relevant evaluations of foraging habitat metrics may improve foraging habitat conditions.

## **223 Danner, Greenberg, Walters**

Winter food limits timing of pre-alternate molt in a short-distance migrant. RAYMOND M. DANNER, RUSSELL GREENBERG, *Smithsonian Inst., Washington, DC*, and JEFFREY R. WALTERS, *Virginia Tech, Blacksburg, VA*.

Feather molt in birds is costly and therefore typically does not overlap with migration or reproduction. In spring, the rapid succession of pre-alternate molt, migration (if a migrant), and breeding, suggests that timing of molt could constrain the initiation of breeding. The proximate basis for the timing of pre-alternate molt initiation is not well known, though it typically occurs during a resource poor time of year. Food limitation combined with fitness consequences of molting earlier suggests that plasticity in timing of pre-alternate molt in response to food abundance should be advantageous. We experimentally

tested, for the first time, if food abundance influences the timing of molt in the wild. We conducted a controlled food supplementation experiment on free-living Swamp Sparrows. Supplemented birds began molting the body, face, and crown earlier than control birds (11, 14, and 8 d earlier, respectively) indicating that food abundance limits the initiation of molt. Along with interannual variation, these results indicate that photoperiod is not the sole cue for initiation of molt. Swamp Sparrows molted in sequence, starting with the body, followed by the crown 9 d later, and the face 11 d later. The presence of a sequence further suggests energetic limitation of molt and possibly a strategy to molt the most important regions first or during the optimal time for growth. Food limitation of molt timing could cascade through other life history stages in the annual cycle and ultimately affect reproductive success.

## **224 Harms, Dinsmore**

Co-occurrence of Marsh Wrens and Yellow-headed Blackbirds at wetlands in Iowa. TYLER M. HARMS, STEPHEN J. DINSMORE, *Dept. Nat. Res. Ecol. & Manage., Iowa State Univ., Ames, IA.*

Examining species co-occurrence can provide insight on competitive interactions between 2 species and on how species partition resources in a particular habitat. Marsh Wrens are nest predators and have been found to exclude other species, particularly Yellow-headed Blackbirds, from areas because of their aggressive behavior and territoriality. Our objective was to evaluate co-occurrence of Marsh Wrens and Yellow-headed Blackbirds at wetlands in Iowa. We conducted marsh bird surveys at wetlands throughout Iowa from 16 May - 7 Jul 2009 and 20 Apr - 10 Jul 2010. Prior to each survey, we measured habitat variables at each wetland including water depth, vegetation height, percent cover of open water, and percent cover of various species of emergent vegetation (e.g., *Typha* spp.). Using the 2-species co-occurrence occupancy model in Program MARK, we estimated site occupancy probability of Yellow-headed Blackbirds conditional on the presence ( $\psi_{BA}$ ) and absence ( $\psi_{Ba}$ ) of Marsh Wrens as well as detection probabilities of Marsh Wrens ( $p_A$ ) and Yellow-headed Blackbirds ( $p_B$ ). Models estimated site occupancy of Yellow-headed Blackbirds given presence of Marsh Wrens to be 0.68 ( $\pm$  0.03) and site occupancy of Yellow-headed Blackbirds given absence of Marsh Wrens to be 0.44 ( $\pm$  0.17). Detection probability of Marsh Wrens and Yellow-headed Blackbirds was 0.82 ( $\pm$  0.02) and 0.46 ( $\pm$  0.18), respectively. Based on our results, Yellow-headed Blackbirds are more likely to occupy wetlands with Marsh Wrens than without Marsh Wrens, thus providing little evidence for competitive exclusion of Yellow-headed Blackbirds by Marsh Wrens.

## **225 Hui**

Listening to birds in the twentieth century. ALEXANDRA E. HUI, *Dept. Hist., Mississippi State Univ., Mississippi State, MS.*

Over the course of the twentieth century, changes in ornithologists' descriptions of bird vocalizations co-developed with the rise of bird watching as recreational activity. Many music historians and musicologists have written about the social and cultural policing of listening behavior. I ask how this might be extended to how we have listened to the environment. Specific ways of listening were in service of specific understandings of nature, either separate from or fully integrated into a subjective, individual experience of the world. To chart this development over the last century, publications on bird vocalizations in peer-reviewed journals, various field notebooks held in the Bird Division of the National Museum for Natural History (in Washington, DC), and popular field guides were all analyzed. This examination of the evolving descriptions of bird vocalizations, both by popular writers and ornithologists, illustrates a process by which a certain form of listening is standardized and universalized. As ornithologists standardized nomenclature and taxonomy at the beginning of the twentieth century, field guide authors also developed new and different means of conveying information necessary for species identification. The ability to hear, identify, and mimic these sounds were cultivated as important skills for both the field-ornithologist and the amateur naturalist. By redefining the relevant sounds of the soundscape, these ornithologists and amateur naturalists cultivated new ways of listening and, potentially, heard entirely new sounds.

## **226 Kelly, Bridge, Frick, Chilson**

Energetics of an abundant insectivore: the Purple Martin. JEFFREY F. KELLY, ELI S. BRIDGE, *Oklahoma Biol. Surv., Univ. Oklahoma, Norman, OK*, WINIFRED F. FRICK, *Univ. California, Santa Cruz, CA*, and PHILLIP B. CHILSON, *Adv. Radar Res. Center, Univ. Oklahoma, Norman, OK.*

The atmospheric boundary layer and lower free atmosphere, or aerosphere, is increasingly

important for human transportation, communication, environmental monitoring, and energy production. Anthropogenic encroachment in aerial habitats and its impacts are not currently well-understood. Aerial insectivorous vertebrates are important components of biodiversity and provide substantial benefit to humans by consuming arthropod pests. Many of these insectivores are experiencing range-wide population declines. Estimates of the biomass and energy consumed by aerial insectivores are needed to gauge the magnitude of impacts of population declines on trophic integrity and ecosystem services provided by these animals. We develop an energetics model for a large and common avian aerial insectivore in North America, the Purple Martin. This model estimates that, in aggregate, Purple Martins consume  $354 (\pm 88)$  billion insects $\cdot$ y $^{-1}$  that have a biomass of  $90,945 (\pm 22,638)$  metric tonnes $\cdot$ y $^{-1}$ . The scale of this trophic impact suggests that ongoing aggregate declines in aerial insectivores has the potential to have substantial consequences for consumption of insect agricultural insect pests, such as migratory moths, which contribute substantially to the diet of many insectivorous vertebrates.

## **227 Sparks, Pavlacky, Hanni**

Abundance and distribution of Pygmy Nuthatch in the southern and northern Rockies. ROBERT A. SPARKS, DAVID C. PAVLACKY, JR. AND DAVID J. HANNI, *Rocky Mountain Bird Observatory, Fort Collins, CO*.

Relating abundance to landscape structure and assessing the spatial distribution of species are fundamental to ecological science and are critical for the conservation and management of declining species such as the Pygmy Nuthatch. Our objectives were to 1) model the effects of landscape structure on Pygmy Nuthatch abundance and 2) predict the distribution of the species in the Northern and Southern Rockies Bird Conservation Regions (BCR). We hypothesized an optimum Pygmy Nuthatch density in relation to elevation and ponderosa pine cover, and that density estimates would vary between the Northern and Southern Rockies BCR. We extended a generalized multinomial mixture model developed by Royle (2004, *Anim. Biodiv. Conserv.* 27: 375-386) and Chandler et al. (2011, *Ecology* 92: 1429-1435) to estimate population density, and probabilities of detection and availability for the Pygmy Nuthatch using data from the Integrated Monitoring in Bird Conservation Regions (IMBCR) program. The top model supported our hypothesis and identified an optimal ponderosa pine and elevation band. Pygmy Nuthatch density (km $^2$ ) was 7 times greater in the Southern Rockies ( $D = 8.9$ ,  $SE = 2.3$ ) than in the Northern Rockies BCR ( $D = 1.3$ ,  $SE = 0.6$ ) at the optimal values of ponderosa pine cover (66%) and elevation (2234 m). Availability was estimated at 0.04 ( $SE = 0.005$ ) and detection probability was estimated at 0.3 ( $SE = 0.03$ ). The spatially explicit map was useful for showing areas of high and low abundance within the Southern and Northern Rockies. Estimating detection and availability probabilities are important because observed counts are biased by imperfect detection and individuals are not present to be counted at all survey locations. Accounting for detection and availability is especially important when creating spatially explicit maps that represent spatial variation in abundance.

## **228 vacant**

## **229 Princé, Zuckerberg**

Climate change induced shift in North American wintering bird communities. KARINE PRINCÉ and BENJAMIN ZUCKERBERG, *Dept. Forest & Wildl. Ecol., Univ. Wisconsin-Madison, Madison WI*.

Several studies have documented range shifts of North American wintering bird species in response to recent climate change. However, details of how these shifts in species ranges might be driving changes in avian species communities across geographical scales is still lacking. Here, we intend to measure change in wintering bird community composition in response to climate change over time. This framework is based on a community temperature index (CTI) that directly reflects, for a given species assemblage, the balance between low- and high-temperature dwelling species. Using a long-term wintering bird data set from the Project Feeder Watch, a citizen science program operated by the Cornell Laboratory of Ornithology and Bird Studies Canada, we investigate the rate of changes in communities over a two-decades time period and whether these ongoing changes can be explained by contemporary changes in minimum temperature, provided by the Climate Analysis Service (PRISM data), during the core winter season in e. US. As expected, we found that CTI increased over time revealing that wintering birds are indeed rapidly tracking climate change. We also found that temporal trends in CTI differed according to a latitudinal gradient and that changes in wintering bird communities are related to the regional patterns of recent changes in climate velocity in e. US. We conclude that ongoing changes in

bird community structure are driven to a large extent by contemporary changes in climate and that CTI can be used as a simple indicator for how North American bird communities respond.

### **230 Townsend, Wheeler, Barker, Boyce**

Urbanization, disease, and philopatry of American Crows. ANDREA K. TOWNSEND, *Dept. Wildl., Fish & Cons. Biol., Univ. California-Davis, Davis, CA*, SARAH S. WHEELER, CHRIS BARKER and WALTER BOYCE, *School Vet. Med. Univ. California-Davis*

Birds in urban environments are faced with a suite of novel stressors, which can include chronic stress, malnourishment, high conspecific density, and exposure to toxins and pathogens. If these stressors suppress fitness of urban individuals, cities could serve as population sinks, even among species that reach their highest densities in urban environments (so-called "urban exploiters"). To date, however, studies that closely examine health parameters, disease, philopatry, and survival of wild birds on an urban-to-rural gradient are scarce. We examined comprehensive health profiles of one urban exploiter, the American Crow, on a highly modified urban-agricultural gradient in the Sacramento Valley of California, to test the hypothesis that disease prevalence would be higher, and survival lower, for birds in the urban environment. We monitored, banded, and evaluated the health and survival of 180 offspring in 120 crow nests in 2012 and 2013. Land cover characteristics (percent urban, agricultural, or natural) were quantified in each territory using the National Land cover Database. Apparent survival among offspring that lived long enough to be marked was low: of 98 birds marked in 2012, only 14 (14.3%) were still alive and detected one year after hatching. Most carcasses of dead birds recovered from the study area showed signs of disease, including poxviral dermatitis, trichomonas, systemic viral infections, pneumonia, trichomonas, and West Nile virus. Other birds died of trauma or acute toxicosis. Nestling survival probability decreased with percentage of urban land cover, whereas percentage of agricultural land cover had no directional effect on effect on survival. In contrast, the percentage of natural land cover in each territory had a strong positive effect on survival. Surprisingly, however, natal philopatry was highest among nestlings produced in urban territories. We are currently examining differences in hematology, blood chemistry, and parasites between the 2 environments, as well as the factors-including anticoagulant rodenticides and toxins-contributing to low productivity of crows in these highly human-modified urban and agricultural landscapes.

### **231 Wolf, E K Smith, Gerson, O'Neill, Mckechnie, Whitfield, Smit**

Sensitivity to heat stress varies greatly among avian orders; implications of warming for desert bird communities. BLAIR O. WOLF, ERIC K. SMITH, ALEX R. GERSON, JACQUELINE JENINIFER O'NEILL, *Dept. Biol., Univ. New Mexico, Albuquerque, NM*, ANDREW E. McKECHNIE, MAXINE C. WHITFIELD and BEN E. SMITT, *Dept. Zool. Univ. Pretoria, Pretoria, South Africa*.

Predicting how human-induced climate change will affect animal distribution, abundance and diversity requires an understanding of the mechanisms underlying both the direct and indirect effects of global warming on individuals. Although little studied, among the most important direct effects may be catastrophic mortality associated with extreme heat and drought. Climate models predict an increase in both the frequency and severity of these extreme climate events, and historical records demonstrate the potential for catastrophic mortality. Here we quantify the functional differences in avian sensitivity to heat stress across several orders of birds. We measured rates of evaporative water loss, resting metabolism and body temperature in birds exposed to varying levels of heat stress. Birds in the order Passeriformes and Strigiformes were the poorest performers and those from the Columbiformes and Caprimulgiformes performed best when exposed to extreme heat stress. These results have implications for understanding challenges to thermoregulation and water balance and well as reproduction in hot environments in a rapidly warming environment.

### **232 Wonder, Heath**

The effects of handling on the corticosterone stress response and fledging success in American Kestrel nestlings. ERIN L. WONDER and JULIE A. HEATH, *Dept. Biol. Sci., Boise State Univ., Boise, ID*.

Early exposure to stressors has been shown to affect later stress responses in both mammalian and avian species, with the potential for lasting effects perhaps depending, in part, on the magnitude of the stressor. Avian field studies often include physical handling of nestlings for the purposes of banding or morphometric measurements. We investigated the effects of stress due to investigator handling in

free-living American Kestrel nestlings to determine (1) if this brief, non-invasive stressor causes lasting changes in the stress response of handled birds and (2) if the timing of the stressor (early or late in the nestling period) is significant. Early-handled nestlings were gently held for 15 min daily for the first 7 d following hatching and late-handled nestlings were held for the same duration beginning on the 18th day post-hatching. While handled birds had lower average corticosterone levels in response to a standard hour-long restraint test when compared to control birds, there was no significant difference between birds handled early in the nestling stage and those handled later. We attribute the lower average CORT levels of handled birds to habituation to human handling rather than to developmental changes caused by early stress. We also assessed whether or not repeated daily removal of nestlings from the nest box would affect nest success and found no difference between early-handled, late-handled, and control clutches. These results suggest that the mild stressor of investigator handling is unlikely to have significant negative effects on the stress physiology or fledging success of young birds.

### **233 Fife**

Incidental take on nesting birds in a red pine plantation in southern Ontario. IAN FIFE, *Dept. Biol., Trent Univ., Peterborough, ON.*

Incidental take is mandated under section 12(h) of the Migratory Birds Convention Act (MBCA) in Canada. Forestry operations put migratory bird nests and eggs at risk and it is Ontario's policy to ensure that no species declines from forestry operations. To understand the impacts of harvesting the objective of my study was to locate bird nests within the study area prior to, during, and after harvest to measure the level of take occurring under single-tree selection harvesting. The goals are to measure nest success rate of 5 focal species and measure the proportion of nests that are incidentally taken from forestry operations. We found higher than average desertion rates of migratory birds (58 nests deserted of 243) within the study area. Desertion rates were affected by the study plots ( $X^2 = 8.208$ ,  $df = 3$ ,  $P = 0.04$ ) and observed nest desertion rate was highest in the study area that had previously been harvested before the summer of 2012 ( $X^2 = 2.278$ ). Neither American Robin, Red-eyed Vireo, Eastern Wood-pewee, or Rose-breasted Grosbeak (all  $P$ 's > 0.05) show significant treatment effects on daily survival rates, however for Ovenbirds we do not have sufficient sample size. As of yet this study is the first to determine the number of nests lost due to direct forestry activity making a very significant contribution for management policies and for determining specific contraventions of the MBCA. The results of my study will help forest managers to apply proper management strategies to decrease or eliminate take of nesting birds providing guidance about timing of harvest and the temporal extent of the residual effects.

### **234 vacant**

## **POSTER PRESENTATIONS:**

### **301 Aguilon, Duckworth.**

Cooperation and conflict among kin: disentangling the factors influencing dispersal in a passerine bird. STEPFANIE M. AGUILLON and RENEE A. DUCKWORTH, *Univ. Arizona, Tucson, AZ.*

Dispersal is a fundamental component of life history, but determining the causal factors behind individual dispersal decisions is difficult. It is known that competition and cooperation can play an important role. Western Bluebirds provide a unique opportunity to investigate the role of kin interactions mediated by aggressive behavior on dispersal, as they are secondary cavity nesters and facultative cooperative breeders. Cavity resources are limited, which could result in cooperation between kin to acquire shared resources or competition between kin to control resources. A long-term dataset on relatedness, natal and breeding location, cavity density, and aggression was used to test the importance of kin interactions. First-time breeding males dispersed non-randomly, settling closer than expected to their natal nest and father. Because fathers were frequently breeding at the natal nest, distance to both was strongly correlated. However, in cases where fathers did not return to breed, sons settled significantly closer to their natal nest suggesting that fathers may deter sons from settling as close to their natal territory as they would prefer. Unlike previous studies, aggression was unrelated to dispersal distance at this local scale. However, previous work was on populations at the initial stages of colonization and it is

possible that the dynamics of kin interactions change during the course of population colonization in response to changing levels of resources. These results support the importance of natal site familiarity and kin interactions in the dispersal decisions of Western Bluebirds, but further studies are necessary to disentangle the relative importance of each.

### **302 Anich, Worland, Martin**

Examining occupancy, abundance, and distribution of resident boreal birds in northern Wisconsin. NICHOLAS M. ANICH, MIKE WORLAND and KARL J. MARTIN, *Wisconsin Dept. Nat. Res., Ashland, WI.*

Although prevalent throughout Canada, resident boreal birds such as Spruce Grouse, Black-backed Woodpecker, Gray Jay, and Boreal Chickadee are fairly rare in the Upper Great Lakes region of the US, where they are at their southern range limit. These species are poorly studied in Wisconsin where they are also likely to be particularly vulnerable to negative effects of climate change. We conducted surveys using audio playback in black spruce (*Picea mariana*) and tamarack (*Larix laricina*) swamps between Mar and May 2012 - 2013 for these 4 bird species with the intent of estimating occupancy, abundance, population size, and investigating factors affecting their distribution in Wisconsin. At 65 randomly selected sites in 2012 we detected 24 Spruce Grouse, 26 Black-backed Woodpeckers, 92 Gray Jays, and 81 Boreal Chickadees. Based on a late spring in 2013, we expect detectability to differ between years for some species, particularly Spruce Grouse. In addition to using n-mixture models to model abundance and occupancy, planned analyses seek to relate bird occupancy or abundance to factors such as swamp microclimate and landscape-scale distribution of conifers.

### **303 Arns, Peer, Holt**

Does Brown-headed Cowbird parasitism increase bacterial contamination of host eggs? REBECCA M. ARNS, BRIAN D. PEER and SCOTT M. HOLT, *Dept. Biol. Sci., Western Illinois Univ., Macomb, IL.*

The Brown-headed Cowbird is a brood parasite that lays its eggs in nests of other birds. While it is known that cowbird parasitism is detrimental to hosts, it is unclear whether female cowbirds and their eggs introduce harmful bacteria into host nests when laying that could further increase the costs of parasitism. Such bacteria could account for the high percentage of unhatched eggs in parasitized nests and could also impact host nestling growth rates. Bacteria can penetrate eggs through the pores causing trans-shell infection and thus decreasing host fitness. This study examined whether cowbirds transfer harmful bacteria to the eggs of Red-winged Blackbirds. Bacterial samples were collected from cowbird and Red-winged Blackbird eggs, and host nestling growth rates were compared in parasitized and unparasitized nests. We discuss our results and their implications for fitness costs to hosts of avian brood parasites.

### **304 Arntzen, Thompson, Faaborg**

Improving survival estimates: an investigation of search bias. JULIANNA ARNTZEN, JOHN FAABORG, *Dept. Bio. Sci., Univ. Missouri-Columbia, Columbia, MO,* and FRANK R. THOMPSON III, *USDA Forest Service, North Central Res. Sta., Univ. Missouri-Columbia.*

Most annual survival estimates of Neotropical migrant songbirds are obtained from banding studies, which rely on recaptures or visual surveys that rarely extend past study boundaries. This may result in underestimation of return rates (apparent survival) when birds shift territories beyond search boundaries. To improve detection assumptions, we began a radio-telemetry study using 12-mon programmable radio transmitters in combination with traditional visual surveys. In Jun-Jul, 2012, we placed transmitters on 29 adult Ovenbirds (23 males and 6 females) captured on their breeding territories in a central Missouri forest fragment. The radios were programmed to become inactive for 12 mo after a 3-d test period, and resume for 10 d in Jun 2013. During 2013, we will make extensive recapture efforts, combining visual surveys and radio telemetry. Detections of radioed birds on the study site will allow us to estimate apparent survival, while inclusion of birds that have dispersed from the study area will give some idea of how much adult dispersal affects apparent survival estimates.

### **305 Atwell, Ketterson**

A backyard bird film for teaching behavior & evolution? An invitation for educators to evaluate the



**Ordinary Extraordinary Junco.** J. W. ATWELL and E. D. KETTERSON, *Dept. Biol., Indiana Univ., Bloomington, IN.*

Increasingly, the public has come to trust films and see them as a primary source of scientific truth – including wildlife and nature shows for information about animal behavior and evolution. For teachers, wildlife films can be effective but problematic in the classroom where they often fall between education and entertainment. For example, though highly engaging and illustrative, ‘blue chip’ or ‘high prestige’ wildlife films are often rife with anthropomorphism, oversimplification, and spectacular drama – issues that limit their pedagogical effectiveness. Further, wildlife films often focus on exotic organisms in far-off locales, in contrast to common wildlife easily observed by most people. Here we present a feature-length (88 min. total) science-centric documentary film project that aims to convey key themes in evolution, ecology, animal behavior, and the research process through a common and abundant backyard bird, the junco. The modular (3 - 20 min.) project is intended for college and advanced high school science classrooms in addition to public audiences. We invite its use and evaluation by our fellow educators.

### **306 Zimmerman, Chandler**

How important is structural variation within closed-canopy bottomland forests for managing breeding bird diversity? JARED A. ZIMMERMAN and C. RAY CHANDLER, *Dept. Biology, Georgia Southern Univ., Statesboro, GA.*

Bottomland hardwood forests dominate river floodplains and lowlands of the se. US. Past forestry practices create substantial variation in the structure and composition of these habitats, even for closed-canopy stands on similar sites. Does management for breeding bird diversity need to account for this variation, or is there a single management target for closed-canopy forest? To answer this question, we quantified habitat associations of the breeding bird community as well as 10 priority species within the closed-canopy bottomlands of the Altamaha River, Georgia. We conducted point-counts for breeding birds and quantified habitat characteristics at 54 stations. We found that the overall density of breeding birds, the density of breeding Neotropical migrants, and the Avian Conservation Score of stations did not closely track habitat variation within mature bottomlands. However, some individual species were sensitive to habitat variation within mature bottomlands. Yellow-throated Vireo and Hooded Warbler preferred slightly less canopy cover within mature bottomlands. Kentucky Warbler preferred stations with less variability in tree diameter and more shrubs. Altamaha River bottomlands support a diverse assemblage of breeding birds, including numerous Neotropical migratory species of regional conservation concern. The diversity of this assemblage is similar across a wide range of structural variation within closed-canopy forest, implying a single habitat management target when maximizing overall bird diversity. Managing for single species may require complex management.

### **307 Badami, Blustein, Bystrak, Collins, Relyea**

Changes in avian body sizes in response to climate change. STEVEN M. BADAMI, ERICA C. BLUSTEIN, *Rhodes Coll., Memphis, TN*, DANNY BYSTRAK, *Patuxent Wildl. Res. Center, Laurel, MD*, GEORGE E. RELYEA, *Univ. Memphis, Memphis, TN*, and MICHAEL D. COLLINS, *Rhodes Coll.*

The burning of fossil fuels and broad-scale land use changes, such as the conversion of forest to agriculture, are changing the Earth's climate. In the e. US, climates will become warmer, precipitation patterns will change, and more severe weather events will occur. Based on Bergmann's rule, increased temperatures are predicted to result in decreased avian body sizes, but more severe weather is predicted to select for greater fasting endurance and larger body sizes. We analyzed body size (wing length and body mass) data for >80,000 individuals of 68 species banded in the fall from 1980 - 2011 in Laurel, Maryland, and examined regional climate data from 1895 - 2011. Mean summer (May-Jul) and winter (Dec-Feb) temperatures, but not precipitation, have increased since 1895. Mixed models demonstrate that neither wing length nor body mass varies with year, but both show a significant year\*species interaction, indicating that changes in body size are species-specific. Wing length significantly increased in 12 species and declined in 2. Body mass increased in 5 species and decreased in one. Julian date, age, sex, age\*year and sex\*year were significant predictors of body size. Statistical models provide only weak evidence that changes in body size are related to migratory patterns (residents, short-distance and long-distance migrants) and no evidence that body size changes vary with breeding range or with BBS or CBC population trends. Our findings do not support the hypothesis that avian body sizes have generally decreased or increased in response to climate change; rather, species (and ages and sexes) have

responded individualistically.

### **308 Baumann, Wolf**

Tracing deuterium through birds and mammals along an elevational gradient in the Sangre de Cristo Mountains. MATTHEW J. BAUMANN and BLAIR O. WOLF, *Biol. Dept., Univ. New Mexico, Albuquerque, NM*.

Stable hydrogen isotopes (D, deuterium) have been used extensively to determine origins and movements of animals along latitudinal and elevational gradients. Few studies, however, have examined how elevational changes in deuterium values of precipitation are directly transferred into the food web. Because animals incorporate the local food web  $\delta D$  values into their tissues we should see tissue values that reflect elevational changes. Body water  $\delta D$  values should reflect an animal's current environment, as isotopes in the body water pool turn over at weekly (or more frequent) intervals. Keratinous tissue such as feathers, fur and nails are inert,  $\delta D$  values in these tissues are reflective of an animal's molt location, and will not change until a new feather or fur is grown. In this study we examine changes in deuterium isotope ratios in plant water, insect, bird and mammal body water, claws, feathers and fur as a function of elevation on a temperate mountain in central New Mexico. We found, as predicted,  $\delta D$  values of plant water are increasingly depleted with increasing elevation ( $P < 0.001$ ) and the body water pool of animals track these changes. 14 species of birds (63 individuals) were sampled along a 1200 m elevational gradient and showed a significant depletion of  $\delta D$  in body water with increasing elevation ( $P < 0.0001$ ) but feathers did not show a significant trend ( $P > 0.05$ ) in  $\delta D$  values. Two species of small mammals (32 individuals) also showed a significant depletion of  $\delta D$  body water with increasing elevation ( $P < 0.001$ ) but also showed a non-significant trend ( $P > 0.05$ ) in fur  $\delta D$  values. Fractionation and the use of deuterium enriched dietary water sources are likely to explain these results. Laboratory studies are still needed to assign specific mechanisms to the observed variation in the deuterium pools in the water and tissues of wildlife.

### **309 Bebus, Small, Schoech**

Developmental corticosterone levels are correlated with learning and exploratory behavior in Florida Scrub-Jays. SARA BEBUS, TOM W. SMALL and STEPHAN J. SCHOECH, *Dept. Biol. Sci., Univ. Memphis, Memphis TN*.

The level of corticosterone (CORT, the avian glucocorticoid) that an individual is exposed to during development may have long-term effects on behavior and cognitive abilities. We measured learning abilities and exploratory behavior of 14 Florida scrub-jays, at 10 - 11 months of age, in a captive setting. We recorded exploratory behavior upon introduction to the test cage. Nestling baseline CORT levels were positively correlated with the latency to explore the cage ( $F_{(1,10)} = 10.844$ ,  $p = 0.008$ ). Additionally, we tested each bird with a color association and a reversal learning task. These tasks required birds to locate food rewards buried in sand-filled wells of a particular color. After first learning a color (association task), we subsequently switched the reward color to evaluate reversal learning capability. Reversal learning is a measurement of behavioral flexibility. There was a trend towards a negative relationship between associative and reversal learning performance ( $r^2 = 0.37$ ,  $p = 0.064$ ). The ability of birds to learn the color reversal was positively correlated with their current baseline CORT levels ( $F_{(1,6,98)} = 7.33$ ,  $p = 0.030$ ). There was a positive correlation between nestling baseline CORT and associative learning performance ( $r^2 = 0.495$ ,  $p = 0.035$ ), and a trend towards a negative relationship between nestling baseline CORT and reversal learning performance ( $r^2 = 0.405$ ,  $p = 0.065$ ). Additional data from experiments conducted during the current season will be incorporated.

### **310 Bergeon Burns, Woltmann, Taylor, Stouffer**

Seaside Sparrow responses to the Deepwater Horizon oil spill. CHRISTINE M. BERGEON BURNS, STEFAN WOLTMANN, SABRINA S. TAYLOR and PHILIP C. STOFFER, *School Renew. Nat. Res., Agri. Center, Louisiana State Univ, Baton Rouge, LA*.

On 20 Apr 2010, the BP Deep Water Horizon drilling rig exploded 80 km off the coast of Louisiana, resulting in one of the most disastrous marine oil spills in history. To understand the effects of this and other oil spills on coastal marsh ecosystems, and to monitor recovery in the n. Gulf of Mexico, it is important to examine behavioral and physiological responses of affected populations over time. Our focus is the Seaside Sparrow, an abundant passerine bird that spends its entire life in coastal salt marshes. This species known to be sensitive to habitat modification, and so may be a valuable indicator of the

impact of environmental disturbance. From Apr-Jun 2012 and 2013, we monitored population density and nesting attempts of Seaside Sparrows in coastal Louisiana. We focused our efforts on plots located within the Barataria Bay area that vary in the degree of contamination from the oil spill, and confirmed that individual birds tend to remain on the same plot where they were first captured. Preliminary data indicate a lower abundance of Seaside Sparrows in more heavily oiled areas, as well as decreased nest success. We hypothesize that such effects may be attributable in part to increased stress hormones (e.g., corticosterone) in the heavily oiled areas. Ongoing work is also examining whether Seaside Sparrows exposed to oiled habitats show increased expression of CYP1A, a gene involved in the detoxification process in the liver.

### **311 vacant**

### **312 Bowers, White, Podgorski, Thompson, Sakaluk, Jaeckle, Harper**

Eggshell permeability in clutches of House Wrens: implications for hatching asynchrony. E. KEITH BOWERS, *Illinois State Univ., Normal, IL*, ABIGAIL WHITE, LAUREN PODGORSKI, *Illinois Wesleyan Univ., Bloomington, IL*, CHARLES F. THOMPSON, SCOTT K SAKALUK, *Illinois State Univ.*, WILLIAM B. JAECKLE and R. GIVEN HARPER, *Illinois Wesleyan Univ.*

Asynchronous hatching of eggs within clutches is a common pattern and occurs when 2 or more days elapse between the hatching of the first and last eggs of a clutch, whereas synchronous hatching occurs when all eggs of a clutch hatch within approximately 1 d. A population of House Wrens in central Illinois exhibits pronounced among-clutch variation in hatching spans, and maternal incubation behavior contributes to this variation: the onset of full incubation before clutch completion leads to asynchronous hatching, and delaying incubation until clutch completion leads to synchronous hatching. Eggshell characteristics may also contribute to variation in hatching spans, where differences in eggshell permeability can create differences in the rates of embryonic development between earlier- and later-laid eggs within clutches. In this study, we characterized among- and within-clutch variation in the permeability of House Wren eggshells to determine whether differences in eggshell permeability contribute to variation in hatching patterns. Within clutches, later-laid eggs had more pores/egg than earlier-laid eggs, but overall eggshell porosity did not change across the egg-laying sequence. Females that initiated full incubation before producing all the eggs of their clutch produced eggshells with more pores and slightly greater porosity, on average, than females that delayed incubation until clutch completion. Our data indicate that eggshell permeability varies substantially both within and among clutches, and that a dominant behavioral predictor of hatching asynchrony (i.e., onset of incubation) is correlated with the physical properties of eggshells that are produced.

### **313 Boyd, Schoech, Small**

Stress and parenting: Hormones and caring for offspring in cooperatively breeding Florida Scrub-jays. KATHLEEN M. BOYD, THOMAS SMALL and STEPHAN J. SCHOECH, *Univ. Memphis, Memphis, TN*.

Parental behavior can influence offspring success and may act to “program” the offspring’s phenotype. We investigated how food availability and parental “stress” levels influenced Florida Scrub-Jay parental behavior. Corticosteroids (CORT) are an important part of the vertebrate physiological stress response. Baseline and stress-induced CORT samples were collected during pre-breeding to assess parental condition. Video surveillance at nests was used to assess parental behavior. We found that baseline CORT levels predicted female behavior, but not male behavior, and food supplementation only altered female behavior. These data suggest that female parental behavior is more “plastic” than male parental behavior.

### **314 Brady, Gibbons, Cardiff, Remsen**

The Louisiana Bird Atlas Project: a data base of distributions and abundances of birds in Louisiana. MATTHEW L. BRADY, STEVEN W. CARDIFF, J. V. REMSEN, *Dept. Biol. Sci. and Mus. Nat. Sci., Louisiana State Univ., Baton Rouge, LA*, and RICHARD E. GIBBONS, *Houston Audubon Soc., Houston TX*.

The Louisiana Bird Atlas project is the first comprehensive database documenting the summer and winter distributions and abundances of birds in Louisiana. Over the last 6 yr data have been collected

using a volunteer-based, standard-effort protocol to build indices of relative abundance for all species of birds. These efforts represent the first time that such indices have been applied at a regional scale. The results from the atlas will provide key baseline data on bird populations and will have important implications for the conservation and management of critical habitat. Changes in relative abundances of bird populations at a local or regional level enable researchers, wildlife managers, conservation biologists, and policy makers to observe long-term trends in status, distribution, and abundance over species-wide distributions, and will provide accurate estimates of bird densities over varying environmental conditions. This is especially important in an era of rapid anthropogenic change in natural habitats, with implications for conservation, management, and monitoring, especially of threatened and near-threatened species, and species of special concern. Further, Louisiana's position on the Gulf Coast places it in an extremely important area for stopover and wintering habitat for many species of migrants. In this presentation, I will present preliminary analyses outlining the project goals, study design, and initial findings.

### **315 Brauch, Noon, Walker**

Improving population monitoring strategies for Greater Sage-Grouse: an application of dual frame sampling as an alternative to traditional lek counts. JESSICA E. BRAUCH, BARRY R. NOON, *Colorado State Univ., Ft Collins, CO*, and BRETT L. WALKER, *Colorado Parks & Wildl., Grand Junction, CO*.

Successful management and conservation of Greater Sage-Grouse populations requires accurate and defensible estimates of population size and trend. However, the use of lek count data to accurately estimate population size has been criticized. For this reason, the development of innovative methods for estimating populations of Greater Sage-Grouse is critical. The Parachute-Piceance-Roan (PPR) population of Greater Sage-Grouse is characterized by a low density of individuals that occupy difficult to access ridgetops at high elevations. The population is also subject to potential impacts from oil and gas development and pinyon-juniper encroachment into sagebrush habitat. We employed a dual frame sampling method during 2 consecutive lekking seasons to evaluate its potential as an alternative for monitoring this small, isolated population in nw. Colorado. Dual frame surveys were conducted by helicopter during a 3-wk period in the spring of 2012 and 2013. Two sampling frames consisting of 1 km<sup>2</sup> cells were surveyed a total of 3 times each season to locate and count both previously known and unknown leks. A total of 27 leks were detected in 19 of 39 list frame cells and 1 of 98 area frame cells in 2012 and a total of 22 leks in 19 of 55 list frame cells and 0 of 97 area frame cells in 2013. The average high count of males per lek was 3.4 and 3.5, respectively. Preliminary results indicate that dual frame sampling is a viable alternative to the use of standard lek counts in the PPR.

### **316 Bridge, Dow, Duckles, Davidson, Hahn, Lisovski, Rakhimberdiev, Schmaljohann, Seavy, Sumner, Wotherspoon, Winkler**

TAGS: A simple online tool for geolocator analysis. ELI S. BRIDGE, PHILIP DOW, JONAH M. DUCKLES, *Univ. Oklahoma, Norman, OK*, SARAH DAVIDSON, *Max Planck Institute for Ornithology, Radolfzell, Germany*, STEFFEN HAHN, *Swiss Ornithological Institute, Sempach, Switzerland*, SIMEON LISOVSKI, *Deakin Univ., Geelong, Victoria, Australia*, ELDAR RAKHIMBERDIEV, *NOIZ Royal Netherlands Institute for Sea Research, Texel, The Netherlands*, HEIKO SCHMALJOHANN, *Institute of Avian Research, Wilhelmshaven, Germany*, NATHANIEL E. SEAVY, *Point Blue Conservation Science, Petaluma, CA*, MICHAEL D. SUMNER, SIMON J. WOTHERSPOON, *Australian Antarctic Division, Kingston, Australia*, and DAVID W. WINKLER, *Lab. Ornithol., Cornell Univ., Ithaca, NY*.

The use of miniaturized light-level geolocation data loggers (henceforth geolocators) has revolutionized our approach to studying migration of small birds. However, the software tools commonly used to translate light-level data into locations generally lack sophistication, and the analyses they implement are not always repeatable. The Totally Awesome Geolocator Service (TAGS) is a simple, graphically oriented online platform for analyzing data collected from light-level geolocators. TAGS offers several improvements on earlier analysis tools including the following: 1) a flexible and intuitive graphical interface for visualizing, evaluating, and editing raw light-level data; 2) a full record of all data omissions or changes to enable repeatability of any analysis; 3) an interactive mapping facility to assist in data screening; 4) compatibility with Movebank.org that allows for processing of archived datasets and online storage of analysis results; 5) a variety of simple output formats that include not only location data but also data formats that integrate with more advanced analysis methods that can be implemented in the R computing environment. The free and open source tools implemented in TAGS will ensure that light-level

geolocator analyses are both accessible and repeatable, and will promote data sharing among researchers.

### **317 Brooks**

Ecology, behavior and reproduction of an introduced populations of Red-vented Bulbuls in Houston, Texas. D. M. BROOKS, *Houston Mus. Nat. Sci., Dept. Vert. Zool., Houston, TX.*

Results are reported from a citizen-science program to study ecology, behavior and reproduction of an invasive population of Red-vented Bulbul (*Pycnonotus cafer*) in Houston, Texas. The most frequent behaviors were foraging (n = 69), resting (45), and calling (29). The entire population occurred in urban areas. Bulbuls consumed berries (n = 8 species), fruits (n = 5), flowers (n = 5), and buds (n = 4); some insects were also included in the diet. Nine of the 20 species of identified plants consumed by bulbuls were exotics found within the native range of the bulbul, 6 were exotics found outside the native range, and 5 were native species. The most common of the 37 species of plants that bulbuls perched in were bamboo and crepe myrtle (n = 14 each), fig and tallow (n = 12 each). Bulbuls perched in 16 species of native plants, 15 species of exotics found within their native range, and 5 exotic plants found outside the native range. Flock size averaged 2.28 birds/flock (range = 1 - 22) and pairs were more frequent than singletons with the exception of late summer and fall. The largest flocks (12 - 22 birds) were immediately before and after the fall. Intraspecific territoriality was noted on only 2 occasions and interspecific interactions were sporadic, with 10 wins, 10 neutral, and 3 losses. Bulbuls were not migrants; peak observations were during spring and summer, with lower numbers during Oct. Description of reproductive chronology is provided, including courtship, gathering nest material, nesting, and fledglings. Comparisons in general biology are discussed between Houston bulbuls and native populations in Asia, with similarity noted in most cases. This alien population is probably not a serious environmental threat currently: it is not a serious agricultural pest or disperser of weedy seeds, not a serious competitor to other species, and the population has not expanded beyond the region of Houston.

### **318 Brown, Laughlin, Winkler, Sheldon**

Furcular fat and plasma corticosterone as indices of migratory readiness in Tree Swallows at a staging area in Louisiana. CLARE E. BROWN, *Dept. Biol. Sci. and Mus. Nat. Sci., Louisiana State Univ., Baton Rouge, LA*, ANDREW J. LAUGHLIN, *Dept. Ecol. & Evol. Biol., Tulane Univ., New Orleans, LA*, DAVID W. WINKLER, *Dept. Ecol. & Evol. Biol., Cornell Univ., Ithaca, NY*, and FREDERICK H. SHELDON, *Dept. Biol. Sci. and Mus. Nat. Sci., Louisiana State Univ., Baton Rouge, LA.*

Birds approaching their migratory departure date store energetic fuel for their migratory flight as body fat, and fat deposition can be gauged in live birds by visual observation of furcular fat levels. Baseline plasma corticosterone levels have also been correlated with migratory state and migratory restlessness. We investigated the relationship between furcular fat deposition and baseline plasma corticosterone in wild Tree Swallows at a migratory staging site in Louisiana. This relationship will serve as the basis for an index of migratory state, which we will use to group Tree Swallows into categories in order to compare brain gene expression among individuals with varying degrees of migratory readiness.

### **319 Buchanan, Neudorf**

Effects of resource availability and parental condition on Carolina Wren nestling sex ratio variation and survival in urban and natural ecosystems. ALYSON E. V. BUCHANAN and DIANE L. H. NEUDORF, *Sam Houston State Univ., Huntsville, TX.*

The purpose of this study was to determine how differences in food availability and parental condition between urban and rural habitats may relate to the sex ratio of nestlings in a monomorphic species, the Carolina Wren. We predicted that the rural habitat would have an unbiased sex ratio, better parental condition and parental care than the urban habitat. We predicted the sex ratios in the urban habitat should be female-biased because urban habitats are generally lower quality and sex allocation theory states mothers should invest more in their sons when environmental conditions are good. Preliminary results indicate that the sex ratio in the 2 habitats was similar (urban habitat was 45% males to 55% females; whereas, the rural habitat had 49% males to 51% females). Results of parental condition and provisioning in relation to nestling sex ratio will be discussed.

### **320 Young, Proudfoot**

Prevalence of haematozoa in migrating Northern Saw-whet Owls of eastern North America. EMMA I. YOUNG and GLENN A. PROUDFOOT, *Dept. Biol., Vassar Coll., Poughkeepsie, NY.*

We examined blood smears from 139 Northern Saw-whet Owls to ascertain the prevalence of haematozoa in this species during fall migration in eastern North America. Owls were captured with mist nets on the Mohonk Preserve near New Paltz, NY, from 1 Oct to 2 Dec 2011. Four genera of haematozoa were found, in addition to an unknown microfilaria: *Haemoproteus*, *Leucocytozoon*, *Plasmodium*, and *Trypanosoma*. Haematozoa were found in blood smears from both male and female birds and in all 3 age groups sampled, i.e., hatch year, second year, and after second year. *Leucocytozoon* was the most common parasite, with an overall prevalence of 49.6%. Prevalence of *Haemoproteus*, microfilaria, *Plasmodium*, and *Trypanosoma* was 5.0%, 5.0%, 10.0%, and 2.9%, respectively, and overall occurrence of infection was 64%. To the best of our knowledge, this is the first record of *Plasmodium* in Northern Saw-whet Owls, and the first study to document 5 genera of haematozoa in migrating populations of the species. Overall, females had a significantly higher body condition index (BCI) than did males. Uninfected females had a higher BCI than did uninfected males, as did infected juvenile females versus infected juvenile males. Infected hatch year females had a higher BCI than did infected adults, and after second year females had a significantly lower BCI than did birds of any younger age class. Revealing new host-parasite information, this study contributes to the Northern Saw-whet Owl information portfolio and may serve to direct future research decisions.

### **321 Burke, Faaborg, Thompson**

Use of regenerating clearcuts by mature forest breeding birds: convenience or necessity? ALICIA D. BURKE, JOHN FAABORG, *Div. Biol. Sci., Univ. Missouri, Columbia, MO*, and FRANK R. THOMPSON III, *USDA Forest Serv. Northern Res. Sta., Univ. Missouri.*

Several recent studies have documented late-successional birds shifting habitat-use from their mature forest-breeding habitat to early successional habitat. In species such as the Wood Thrush, all hatch-year birds appear to disperse to early successional vegetation upon independence. We wanted to determine if independent hatch-year birds captured in early successional habitat remained there for extended periods (suggesting that such habitat is a necessity), or if these habitats were only visited infrequently during foraging activities (which indicates convenience but not necessary). I chose to study 3 different species of juvenile, mature forest birds, Ovenbird, Worm-eating Warbler and Red-eyed Vireo during the independent post-fledging period, in the Missouri Ozarks. To determine habitat use, in the summer of 2012, we placed radio transmitters on 29 hatch-year birds captured in clearcuts and attempted to relocate them for 24 d, the life of the transmitter battery. Ovenbirds and Worm-eating Warblers remained in the early successional habitat where initially captured. Red-eyed Vireos predominately used late successional habitat surrounding the early successional habitat where they were captured. Management efforts have primarily focused on breeding habitat for migratory songbirds, but the post-breeding period could be equally important given that hatch-year birds can spend an equal or greater amount of time in this stage. More information is needed to determine how widespread this habitat shift is for mature forest breeding birds.

### **322 L Burns, Sigel**

Does specialization increase vulnerability to disturbance in forest birds? A study of the blue orbital ring. LYNDA BURNS and BRYAN J SIGEL, *Nevada State College, Henderson, NV.*

Greater ecological specialization has been proposed as a mechanism to explain the increased susceptibility of tropical species to human disturbance. One morphological feature found in birds across multiple families on at least 3 continents and several island groups is a blue orbital ring. Various descriptions as periorbital skin, ocular rings, eyelid rims, and narrow eyelid wattles, it is often found on forest understory birds, especially insectivores, which are known for dietary and habitat specialization, as well as vulnerability to disturbance. There are several hypotheses that attempt to explain the function of this feature in various species, including mating, same-sex recognition, or deterring predators. Recent research suggests that the blue coloration may enhance vision in low light habitats, particularly in the rainforest understory. Although this specialization would provide a valuable competitive advantage to insectivorous birds feeding on small mobile prey in low light environments, it may also be disadvantageous near disturbed or edge habitats by effectively blinding species with excessive light. We investigate whether there is a relationship between the possession of a blue orbital ring and sensitivity to disturbed habitat, as reflected by vulnerable and/or threatened status. This would demonstrate how an ecological

specialization may contribute to the decline of forest understory species resulting from deforestation and fragmentation.

### **323 Hanson, Bates, Reddy**

A morphometric study of the White-starred Robin (*Pogonocichla stellata*). MICHAEL HANSON, JOHN M. BATES, *Field Mus., Chicago, IL*, and SUSHMA REDDY, *Loyola Univ. Chicago, Chicago, IL*.

The White-starred Robin, *Pogonocichla stellata*, is a widespread songbird found in fragmented montane forests across sub-Saharan Africa. We conducted a study to test whether any substantial morphological differences exist between populations of this species, focusing on specimens collected in the Albertine Rift (subspecies *ruwenzorii*) and Eastern Arc Mountains (subspecies *orientalis*). These subspecies were chosen as the focus of this study due to the large numbers of specimens for each subspecies held in the Field Museum collections (150 *orientalis* specimens, 95 *ruwenzorii* specimens, and 67 specimens from 6 of 8 other subspecies). It should be noted that fewer females (105 individuals) than males (163 individuals) were present in the collection. The subspecies that were the focus of the study have wide ranges but live in small, highly localized habitats. We took standard morphological measurements and employed principal components and linear discriminant analyses to examine variation across subspecies and sexes. The principle components study points against strong morphometric differences between populations of the *ruwenzorii* and *orientalis* subspecies despite preliminary genetic analyses showing differentiation among populations. On the other hand, these analyses suggested the presence of size-based sexual dimorphism in *orientalis* and *ruwenzorii*, which was also supported by linear discriminant analysis. Other subspecies show some discrete groupings but this needs to be further tested with additional sampling.

### **324 Campbell, Omland**

Testing for female song in newly recognized species: the Puerto Rican Oriole. SUSANNA K CAMPBELL and KEVIN E OMLAND, *Univ. Maryland Baltimore County, Baltimore, MD*.

song is typically thought of as a male trait, especially in temperate zones. However, in tropical bird species, it is common for both males and females to sing. Unfortunately, many tropical birds are not well studied, so we do not have sufficient data on tropical female song. Previous work by our group suggests that the ancestor of all orioles had both female and male song (Price et al. 2009, **Proc. R. Soc. London B** 276: 1971-1980). Within temperate regions, female song has been selected against and lost repeatedly with movement north to temperate areas. The focus of the current project is to determine whether or not female Puerto Rican Orioles (*Icterus portoricensis*) sing. The Puerto Rican Oriole was only recently given full species status in 2010 by the AOU. Previously, the Puerto Rican Oriole, along with the Bahamas Oriole, (*I. northropi*), Cuban (*I. melanopsis*) and the Hispaniolan Oriole (*I. dominicensis*) were considered subspecies within the Greater Antillean Oriole. If we observe female song, we will compare recordings to those of male songs and assess the role that female song may play in mate selection and/or territory defense. This research will give us information valuable to more accurately reconstruct the ancestral state of the common ancestor to orioles. This study will also help us understand the evolution of oriole song in relation to breeding latitude, and lead to better understanding of a tropical icterid native to the US.

### **325 Carmi, Witt, Jaramillo, Dumbacher**

Phylogeography of the Vermilion Flycatcher, *Pyrocephalus rubinus* (Passeriformes: Tyrannidae). ORE CARMI, *California Acad. Sci., San Francisco, CA*, CHRISTOPHER C. WITT, *Mus. Southwest. Biol., Albuquerque, NM*, ALVARO JARAMILLO, *San Francisco Bay Bird Observ., Milpitas, CA*, and JOHN P. DUMBACHER, *California Acad. Sci.*

The 13 recognized subspecies of the Vermilion Flycatcher (*Pyrocephalus rubinus*) vary in degree of geographic isolation and phenotypic distinctness. Some authors suggest that subspecies *nanus* and *dubius* from the Galapagos constitute one or more separate species. To evaluate subspecies and species hypotheses, we carried out a molecular phylogenetic analysis of 10 of the 13 subspecies and 3 outgroups using preserved tissues when available, and toe pad samples for the Galapagos populations and one North American subspecies. We sequenced 2 mitochondrial loci (ND2, CytB) and 2 nuclear loci (ODC introns 6-7, beta-Fibrinogen intron 5). A most likely phylogenetic tree of mitochondrial alleles recovered 6 monophyletic clades with strong support and a seventh with mixed support. Nuclear data

supported some of these clades. Two broadly intergrading North American subspecies were not genetically distinct from each other, suggesting they should not be recognized as separate taxa. Four western South American subspecies were not genetically distinct from each other, but occur in a region with patchy habitat, suggesting they are recently isolated populations. Mitochondrial genetic distance, partial nuclear data, body size and plumage color suggest that elevation of Galapagos birds to one or more species is merited. Two strongly-supported mitochondrial clades were recovered within Galapagos subspecies *nanus*, dividing the form geographically in a way that conflicts with previous authors' hypotheses based on plumage color. Galapagos populations are in decline, with subspecies *dubius* now presumed extinct. Conservation measures should take into account the deep mitochondrial division within *nanus*.

### **326 Chua, Phillipps, Moyle, Sheldon**

Biogeography and taxonomy of birds of Maratua Island, Borneo. VIVIEN L. CHUA, *Louisiana State Univ., Baton Rouge, LA*, QUENTIN PHILLIPPS, ROBERT G. MOYLE, *Univ. Kansas, Lawrence, KS*, and FREDERICK H. SHELDON, *Louisiana State Univ.*

Although studies of bird biogeography in insular Southeast Asia using molecular methods are increasing in number, our understanding of bird evolution in the region is still poor. Among the dynamics that are especially intriguing and unknown is the interplay of populations between oceanic and continental islands. One example of this interaction is between continental Borneo and Maratua, a small oceanic island off its east coast. Birds on Maratua are morphologically highly differentiated from their counterparts on Borneo, despite close proximity, and most are in different subspecies based on descriptions in the 1930s. Here we provide genetic comparisons of 3 particularly distinct taxa: Black-headed Bulbul (*Pycnonotus atriceps*), Black-naped Monarch (*Hypothymis azurea*), and White-rumped Shama (*Copsychus malabaricus*). These comparisons show conclusively that the birds on Maratua are different species than their Bornean counterparts, and their marked differentiation is probably a function of founder effects and continued small population sizes.

### **327 Cleeton, Roy, Fredericks, Allan, Miller**

Assessing the contribution of migrating songbirds to the southward expansion of Lyme disease in the Midwestern US. SARAH H. CLEETON, *Prog. Ecol., Evol., & Conserv. Biol., Univ. Illinois at Urbana-Champaign, Champaign, IL*, CHRISTINE M. ROY, JAMES R. MILLER, *Dept. Nat. Res. & Environ. Sci., Univ. Illinois at Urbana-Champaign*, PAGE L. FREDERICKS and BRIAN F. ALLAN, *Dept. Entomol., Univ. Illinois at Urbana-Champaign*.

The black-legged tick (*Ixodes scapularis*) and the bacteria *Borrelia burgdorferi*, the causative agent of Lyme disease, are spreading in the US. To examine the role of migratory songbirds in the range expansion of this tick and pathogen, we captured migrants in central Illinois during the fall of 2012. Sites were located in forest fragments where *I. scapularis* are and are not established (Putnam and Champaign counties respectively). Ticks were removed from captured birds and blood samples were taken from select species. Ticks were subsequently identified and a combination of PCR and gene sequencing were used to determine if the ticks and avian blood samples contained *B. burgdorferi*. *Ixodes* spp. were detected on 10 birds, and 10 *I. scapularis* larvae were found on 2 migrants. *Borrelia burgdorferi* was detected in the blood of 9 out of 29 (31%) birds sampled despite the fact that only one of these birds had an attached tick. Differences in *Ixodes* spp. infestation and *B. burgdorferi* infection of birds differed by county. None of the removed ticks tested positive for *B. burgdorferi*, yet other pathogens were detected. Migratory birds may play a larger role in the dispersal of *B. burgdorferi* than *I. scapularis*.

### **328 Condon, Niemi, Etterson, Green**

The effects of urbanization on migrating birds on the western shore of Lake Michigan. ELISABETH L. CONDON, *Integrated Biosci. Prog., Univ. Minnesota, Duluth, MN*, GERALD J. NIEMI, *Nat. Resources Res. Inst., Duluth, MN*, MATTHEW A. ETTERTSON, *US Environ. Protection Agency, Duluth, MN*, and RICHARD GREEN, *Dept. Math. & Stat., Univ. Minnesota*.

Urbanization continues to transform the global landscape at an alarming rate, yet most ecological studies focus on more natural ecosystems. Many cities lie within major flyways for migrating birds, and our knowledge of how urbanization affects migrating birds is severely lacking. We studied spring migration in the Chicago region, an area of importance for migrating birds and an area of dense



urbanization. We used a design based on a combination of 3 fixed effects: forest patch size (large and small), distance to the Lake Michigan coastline (near and far) and surrounding urban context (urban and suburban). We used National Land Cover Data and US Census data to categorize all potential sites and then randomly selected 31 sites that adequately met our design. During May of 2012 we completed point count surveys 4 times at each site during the peak of the Neotropical passerine migration in the region. We also conducted vegetation surveys at the sites. Using stepwise model selection with AICc, the main effects could not explain overall migratory bird richness or abundance. Vegetation structure variables, such as canopy and sub-canopy density, had greater explanatory power on migrating bird species richness, evenness and abundance. Analyses of 20 species revealed variable patterns of the main effects and vegetation characteristics. We found no simple relationships with landscape characteristics, vegetation, or combinations to explain spring migratory movements of birds in this region. As urbanization intensifies in Chicago and elsewhere, more studies are needed to understand the needs of migrating birds in these landscapes.

### **329 Conkling, Martin, Belant, DeVault**

Factors affecting bird non-identification rates in aviation strike reporting. TARA J. CONKLING, JAMES A. MARTIN, JERROLD L. BELANT, *Mississippi State Univ., Mississippi State, MS*, and TRAVIS L. DeVAULT, *USDA Animal & Plant Health Inspection Serv., Natl. Wildl. Res. Center, Sandusky, OH*.

A primary concern for human-wildlife interactions is the potential impacts resulting from wildlife strikes (primarily birds) with aircraft. Identification of avian species responsible for collisions with aircraft is necessary for airport management to develop effective strategies to reduce collisions with these species. Also, it is important to identify regional, seasonal or temporal patterns in strikes with unidentified bird species that may limit the effectiveness of habitat management to reduce bird strikes. We analyzed U.S. civil aviation strike records from 1990 to 2010 in the Federal Aviation Administration's (FAA) National Wildlife Strike Database to examine patterns of collisions involving unidentified birds. We summarized variation in the ratio of incidents involving unknown bird species relative to total number of reported incidents (i.e., unidentified bird ratio) based on FAA region, year, season, and time of day. We reviewed 89,777 bird incidents in the database with 49% of incidents unidentified to species. Overall, the number of incidents involving unknown birds increased; however, the unidentified bird ratio declined from 0.59 in 1990 to 0.38 by 2010. Most FAA regions exhibited a declining unidentified bird ratio trend except the Southern region, which increased from 0.48 in 1995 to 0.68 in 2005, then declined to 0.53 by 2010. Unidentified bird ratios were greater during spring and fall bird migrations, especially for the Southern region. Ratios in all regions increased at dusk. Identifying areas and time periods with the greatest amount of unidentified strikes will help foster sound management and personnel training.

### **330 Wynia, Risch**

Prey delivery rates: the effects on songbirds when parasitized by Brown-headed Cowbirds. AMY L. WYNIA, and THOMAS S. RISCH, *Dept. Biol. Sci., Arkansas State Univ., State University, AR*.

Altricial nestlings require near-constant attention and care while in the nest. Adults utilize time and energy to promote proper growth and development of chicks to increase the likelihood of nest success by delivering prey frequently to chicks. Often, prey delivery rates are affected when nests are parasitized by Brown-headed Cowbirds. We calculated prey delivery rates for several songbird species, many of which had been parasitized by cowbirds in bottomland hardwood forests in se. Arkansas. We deployed video cameras (n = 81) and collected data at 4 sites from May - Jul 2010 - 2012. Contrary to our expectations, the presence of cowbird nestlings did not influence prey delivery rates at any nest, nor did the number of chicks/nest. However, the age of the chick and the number of delivery days/nest positively influenced the number of deliveries/h. As chicks develop, the demand for food increases, and adults deliver prey more frequently to satiate chicks' appetites. Prey size may also influence the number of deliveries per nest. Adults bringing larger items may not need to return as frequently as those bringing smaller items. Although the presence of cowbirds did not influence the number of deliveries, it may, however, affect the success of the nest. Particularly, host nestlings may be in poorer condition at fledging due to competition with cowbird nestlings, which may be detrimental for species of conservation concern.

### **331 Correll, B J Olsen, Hodgman**

Conservation from orbit; predicting tidal marsh bird communities via remote sensing. MAUREEN

CORRELL, BRIAN J. OLSEN, *Univ. Maine, Orono ME*, and THOMAS.P. HODGMAN, *Maine Dept. Inland Fish. & Wildl., Bangor ME*.

Tidal marshes along the northeastern seaboard of the US are vulnerable to habitat loss due to impacts of human development and climate change, particularly sea-level rise and extreme storm events (Greenberg et al 2006, **Stud. Avian Biol.** 32). Obligate tidal marsh breeders such as the Saltmarsh Sparrow, Nelson's Sparrow and Willet are especially at risk from the conversion of the high-marsh zone to low marsh or open water with sea-level rise. Collaborators with the Saltmarsh Habitat and Avian Research Program (SHARP) conducted avian and vegetation surveys in the summer of 2011 and 2012 in selected tidal marshes between Virginia and Maine. We then explored the relationship between these data and vegetation index values such as the Normalized Difference Vegetation Index (NDVI), the Normalized Difference Moisture Index (NDMI) and a unique vegetation index derived from Thematic Mapper band values from Landsat images collected within the time frame of our surveys. In the analyses conducted to date, we have developed a predictive tool to delineate high- and low-marsh zones within our study area. We also found significant differences in NDVI and NDMI values between survey points where Sharp-tailed Sparrows (Nelson's and Saltmarsh Sparrows) and Willets were detected versus where they were not. The end goal of this research is to produce a layer of high/low marsh zonation throughout our study area for use in future habitat analyses and conservation planning, as well as to create an add-in toolbox for use in GIS systems to provide managers with an increased ability to understand and prioritize conservation of northeastern North America's fragile coastal habitat.

### **332 Danner, Small, Masters, Lohr, Gill, Ryder, Fleischer**

Extra-pair paternity in a recently established population of Grasshopper Sparrows on a restored grassland in Maryland. JULIE E. DANNER, T. BRANDT RYDER, ROBERT C. FLEISCHER, *Center Conserv. & Evol. Genet., Smithsonian Natl. Zool. Park, Smithsonian Inst., Washington, DC*, DANIEL M. SMALL, *Chester River Field Res. Sta., Washington Coll., Chestertown, MD*, BRIAN S. MASTERS, *Dept. Biol. Sci., Towson Univ., Towson, MD*, BERNARD LOHR, *Dept. Biol. Sci., Univ. Maryland-Baltimore County, Baltimore, MD*, and DOUGLAS E. GILL, *Dept. Biol., Univ. Maryland, College Park, MD*.

Across many taxa, the incidence of extra-pair paternity is both widespread and highly variable. We examined the rate of extra-pair paternity in the ground-nesting, socially monogamous Grasshopper Sparrow. From 2005 - 2009, we examined a population of Grasshopper Sparrows on a restored grassland at the Chester River Field Research Center (CRFRC) in Queen Anne's County, Maryland. With microsatellite analysis, we found a high rate of extra-pair fertilizations (EPF) across all 5 yr. Approximately 60% of all broods had an EPF and 39% of all nestlings were the result of an EPF. Further, the majority of EPF's were with neighboring males. We calculated the opportunity for sexual selection by partitioning the total reproductive variance. Across all 5 yr, we found that within pair variance was the greatest contributor of male reproductive success. Further, we found a negative covariance indicating a trade-off between a male seeking extra-pair fertilizations and his within pair paternity.

### **333 Dauphine, Pyle, Badia, Lipp, Nell, Tranquillo, Taylor, Rowan**

Avian productivity, recruitment, and survival in Samoa, Polynesia. N. SUZANNE DAUPHINE, *Dept. Marine & Wildl. Res., Pago Pago, AS*, PETER PYLE, RUDY BADIA, DANIEL LIPP, COLLEEN S. NELL, KEEGAN TRANQUILLO, RON TAYLOR and ERIN ROWAN, *Inst. Bird Pop., Point Reyes Station, CA*.

We currently have very few data on the demographic rates (productivity, recruitment, and survival) of birds in Samoa, Polynesia. Application of standardized constant-effort mist-netting and modern capture-recapture analytical techniques is an effective means of monitoring demographic rates of many bird species (DeSante et al. 2005, **MAPS Manual**, IBP, Pt Reyes, CA). In 2012, American Samoa's Department of Marine and Wildlife Resources began collaboration with The Institute for Bird Populations to establish and operate the first 6 "Tropical Monitoring Avian Productivity and Survivorship" (TMAPS) stations on the island of Tutuila, American Samoa. This ongoing effort has thus far provided baseline data on trends, vital rates, and habitat associations, as well as information on molt, age, and sex, for bird species native to the Samoan archipelago. Here we describe preliminary results of this project, including a new Manual for Ageing and Sexing Landbirds of American Samoa. We use data from 172 museum specimens as well as 472 bird captures from American Samoa of 13 native and 3 introduced species of

birds made from 2012 - 2013. One species, Wattled Honeyeater (*Foulehaio carunculata*) made up 63% of captures. Capture rates for this and an additional 4 species (Collared Kingfisher, Cardinal Honeyeater, Polynesian Starling, Samoan Starling) were sufficiently high to effectively monitor demographic rates. Breeding for some species occurs year-round, with peak breeding for other species occurring at various times throughout the year.

### **334 Diamant, Carter, Daniel, Fonda, Hardie, Shufflebarger, Stanback**

Eastern Bluebirds eject model Brown-headed Cowbird eggs, but not white eggs. ELEANOR S. DIAMANT, ELLIOT W. CARTER, IAN J. DANIEL, CHRISTINA L. FONDA, BENJAMIN E. HARDIE, ERIN F. SHUFFLEBARGER and MARK T. STANBACK. *Dept. Biol., Davidson Coll., Davidson, NC.*

Prior research has demonstrated that Eastern Bluebirds typically eject model Brown-headed Cowbird eggs placed in their nest, but accept model bluebird eggs. However, such experiments fail to address the proximate basis of rejection/acceptance. Are bluebirds ejecting cowbird eggs because they are dissimilar to their own, or because they are cowbird eggs? We presented bluebirds with 3 types of artificial eggs: blue eggs resembling bluebird eggs, speckled eggs resembling cowbird eggs, and white eggs. If bluebirds remove speckled, but not white or blue eggs, it would suggest that selection has favored the specific ability to detect and remove cowbird eggs. If bluebirds remove both speckled and white eggs, but not blue eggs, it would suggest that bluebirds are simply operating under a rule of thumb: "eject non-blue (mismatched) eggs". While such a strategy presumably protects bluebirds from cowbird parasitism as effectively as a strategy specifically targeting cowbird eggs, it does involve a different sensory mechanism. This is not a trivial matter: adaptations must be understood from a mechanistic as well as a functional level of analysis. We found that bluebirds accepted both blue and white eggs, but ejected model cowbird eggs.

### **335 Drey, Martin, Riffell**

Avian community occupancy and patch disturbance in a heterogeneous landscape. KELSEY M. DREY, JAMES A. MARTIN and SAMUEL K. RIFFELL, *Dept. Wildl., Fish. & Aquaculture, Mississippi State Univ., Mississippi State, MS.*

The effects of landscape heterogeneity on community dynamics is a central topic of ecology. Fragmentation creates spatial heterogeneity influencing competition, predation, and resource availability. Simultaneously, patches are constantly changing because of disturbance and succession, creating dynamic environments at multiple spatial scales. Two potential hypotheses may explain the patterns of biodiversity in the context of patch and landscape heterogeneity. The intermediate disturbance hypothesis explains species diversity across a gradient of disturbance frequency or time since disturbance indicating moderate amounts of disturbance frequency maximizes diversity. Similarly, the intermediate heterogeneity hypothesis suggests biodiversity is maximized at moderate amounts of landscape heterogeneity. Our central question involves how diversity-disturbance relationships in birds along a disturbance gradient might be moderated by surrounding landscape heterogeneity. Our study system consists of production forestry which creates a heterogeneous landscape consisting of patches that vary in time since disturbance. We hypothesize that varying degrees of landscape heterogeneity will affect the shape and magnitude of bird community response to patch scale disturbance. We predict that alpha diversity within patches will follow the intermediate disturbance hypothesis. Also, we predict that greater amounts of landscape heterogeneity will increase the magnitude of that response to disturbance at the patch scale. We will use community occupancy sampling within disturbed habitat patches to test our hypotheses. Identifying and understanding relationships between overall landscape heterogeneity and bird community response to disturbance is critical for managing landscapes dominated by production forestry in ways that maximize biodiversity.

### **336 Duchardt, Miller, Debinski, Engle**

Nesting responses of grassland birds in areas managed with the fire-grazing interaction. COURTNEY J. DUCHARDT, JAMES R. MILLER, *Univ. Illinois, Urbana-Champaign, IL*, DIANE M. DEBINSKI, *Iowa State Univ., Ames, IA*, and DAVID M. ENGLE, *Oklahoma State Univ., Stillwater OK.*

Land managers are currently attempting to mitigate steep declines in grassland bird populations by restoring and managing grassland habitat, but the specific impacts of these management techniques on patterns of habitat selection and breeding success are not always quantified. The Grand River Grasslands of s. Iowa and n. Missouri are managed with treatments incorporating a combination of fire

and cattle grazing. One of these methods, patch-burn grazing, mimics historic disturbance regimes using the fire-grazing interaction to maintain the heterogeneous vegetation structure required to sustain the grassland bird community. We monitored nests of Grasshopper Sparrows, Eastern Meadowlarks, and Dickcissels, 3 grassland species experiencing population declines throughout their ranges, to quantify patterns of nest-site selection and nest success in response to management. We located and monitored 261 nests in 2012, and quantified vegetation both at nest sites and in available habitat. We used an information-theoretic approach to compare models predicting nest-site selection and nest-success based on both habitat features and management type to determine which factors are influencing these processes. We did not detect an effect of management type on daily survival rates for any species. Factors influencing nest-site selection were species-specific, but included strong selection for woody vegetation and high vegetation density by Dickcissels. While an increasing focus on grassland management is warranted, without understanding possible behavioral and fitness responses these efforts may be inadequate.

### **337 Durkin, Cohen**

Comparing trail cameras and video systems for shorebird nest monitoring. MAUREEN M. DURKIN and JONATHAN B. COHEN, *SUNY Coll. Environ. Sci. & Forestry, Syracuse, NY*.

Many ground-nesting birds are subject to a suite of nest predators during incubation. Typically, researchers must rely on tracks and signs at the nest to determine cause of loss. However, weather, substrate type, and monitoring frequency can make correctly identifying nest predators difficult. Other animals may subsequently be attracted to the depredated nest, further complicating identification. We field-tested 2 camera types for monitoring Snowy Plover nests to identify causes of nest loss. We used infrared trail cameras placed at nests at Gulf Islands National Seashore, FL. The cameras took photographs once per minute, or when motion-triggered. We also deployed 3 video monitoring systems on Snowy Plover nests at Tyndall Air Force Base, FL. These were infrared security cameras contained inside plastic buckets, which ran on batteries and recorded to a portable DVR. The unit was completely self-contained, and took continuous video of nests for up to 4 d. While trail cameras are less expensive and require minimal assembly, we found that they were not sensitive enough to fully capture nest depredation by other birds. We also suspect that cameras were not always triggered by ghost crabs depredating nests. However, reviewing the continuous video footage proved to be more time intensive than the trail camera stills. Both camera types succeeded in capturing mammalian predators at nests, and both ultimately revealed the identity of a nest predator that differed from what was identified using tracks. The best camera type for a particular study should take into account cost, predator type at a site, and time investment for footage review.

### **338 Eldredge, R L Curry**

Irruption Black-capped Chickadees integrate into local Carolina Chickadee flocks. CHRISTINE L. ELDRIDGE and ROBERT L. CURRY, *Dept. Biol., Villanova Univ., Villanova, PA*.

Migration patterns are best thought of as a continuum. At one extreme are annual migrants and at the other extreme, irrupting species. Irruptions may have impacts on local species (e.g. food competition). When Black-capped Chickadees (BCCH) irrupt into the Carolina Chickadee (CACH) range, the opportunity to study interactions between irruption (i.e., BCCH) and local (i.e., CACH) individuals arises. We conducted field observations in se. Pennsylvania to determine if irrupting BCCH integrate into local CACH flocks and if their spatial movements are similar to the local CACH. We monitored 16 BCCH and 86 CACH feeder visits from late Oct 2012 to early Apr 2013. We placed a total of 17 feeders equipped with radio frequency identification (RFIDs) on grids across 3 sub-sites. We recorded 17,478 BCCH and 137,756 CACH feeder visits, respectively. BCCH and CACH visited a similar number of feeders, suggesting both species have a range of roughly 400 m<sup>2</sup>. Out of 2,181 BCCH feeder visits, 60% occurred within 2 min of a CACH feeder visit and BCCH remained in the area until at least 31 Mar. Our results indicate irrupting BCCH spend the winter and at least the start of spring outside their normal range and spend over half of their time integrated into local CACH flocks. This suggests that irrupting BCCH have an impact on local CACH flocks for approximately 5 months.

### **339 Espinosa-Garrido, Méndez-Aranda, Gordillo-Martínez, Ríos-Muñoz, Navarro-Sigüenza**

A geographic and historical analysis of bird diversity in Mesoamerica. GERARDO ESPINOSA-GARRIDO, DANIEL MÉNDEZ-ARANDA, ALEJANDRO GORDILLO-MARTINEZ,

CÉSAR A. RÍOS-MUÑOZ, and ADOLFO G. NAVARROS-SIGÜENZA. *Mus. Zool., UNAM, Mexico DF, Mexico.*

Mesoamerica, which extends roughly from Mexico to Panama, represents an area of intense biotic interaction. Previous studies have recognized different biotic elements which represent a transition between the Nearctic and the Neotropics. However, intensity of ornithological research along the different countries and regions has been unequal, and no synthetic approach has been developed recently that embraces the region as a whole. Herein, we analyze the overall patterns of distribution of the birds of Mesoamerica, based on modern taxonomic approaches, the deep survey of specimen records, online databases, and Ecological Niche Models (ENM), to visualize geographic distribution of the biotic elements in the region, as well as patterns of ornithological exploration, species richness, endemism, and endangerment. The understanding of the distribution of birds will help in the understanding of the biogeography of the region and an updated approach in the identifications of conservation priorities of the avifauna.

### **340 Essian, Leonard**

An examination of prey in the guts of BoNT/E affected birds. DAVID A. ESSIAN and JILL B. K. LEONARD, *Northern Michigan Univ., Marquette, MI.*

Avian mortality caused by type E avian botulism occurs more frequently and is more widely distributed in the Great Lakes since 1999. Piscivorous waterbirds have experienced the greatest mortality, presumably because they ingest fish that carry type E botulism neurotoxin (BoNT/E); however, important vectors for botulism neurotoxin into fish eaten by birds have not yet been identified. Dreissenid mussels and round gobies (*Neogobius melanostomus*) are thought to play a role in the transfer of BoNT/E to piscivorous birds in the Great Lakes because they are dominant in benthic habitats where the botulism bacteria likely germinates, and because they are important prey items of several of the birds species that regularly die in botulism outbreaks. Round gobies that are >70 mm feed mainly on dreissenid mussels in the Great Lakes. My research objective is to analyze stomach contents of birds that die during botulism outbreaks in order to (1) Identify common prey items in BoNT/E positive birds; (2) Determine whether there are differences in the diets of BoNT/E positive and BoNT/E negative birds; and (3) Use length estimates of gobies found in the stomach contents of BoNT/E birds to infer likely trophic pathways for the toxin. Preliminary analysis of birds that died in botulism related outbreaks at Sleeping Bear Dunes National Lakeshore from 2007 - 2011 showed that round gobies were present in 89% of Common Loons (n = 18) and 69% of Double-crested cormorants (n = 13). Furthermore, the mean estimated length of round goby found in the stomachs of loons and cormorants was 114.5 mm ± 12.7 mm and 110.95 mm ± 13.17 mm respectively. This suggests that gobies and mussels may be important in the transfer of BoNT/E to birds. A more extensive analysis of the diet composition, mean prey size, and diet overlap of botulism positive and botulism negative birds from 2011 and 2012 could infer likely pathways of BoNT/E in Lake Michigan food webs, which will hopefully allow managers to generate plans for reducing avian mortality caused by the toxin.

### **341 Faaborg, Arendt, Toms, W A Cox, Canals Mora**

Long-term declines of winter resident warblers in a Puerto Rican dry forest. JOHN FAABORG, *Univ. Missouri-Columbia, Columbia, MO*, W. J. ARENDT, *US Forest Service, Luquillo, PR*, J.D. TOMS, *Eco-Logic Consulting, Victoria, BC*, W. A. COX, *Univ. Nebraska-Omaha, Omaha, NE*, and M. CANALS MORA, *Lajas, PR.*

We have been monitoring bird populations in sw. Puerto Rico using constant-effort mist netting since 1973, with intensive netting efforts since 1989. We ran lines of 16 12-m nets for 3 d in the same location annually in Jan, with one line operated from 1973 through 2013 (except 1977 and 1979) and 8 additional lines added in 1989 -1991, with the same 9 locations used since 1991. Most winter residents (92%) are captured early in the netting period. Total captures of winter residents were relatively constant before 2000, but have shown strong and consistent declines since. The 3 most common species (BAWW, AMRE and OVEN) show declines in both captures and estimated populations for at least the past decade, and sometimes longer. Other winter residents that are sometimes abundant (PRAW, NOPA, WEWA, and HOWA) show declines in capture rates, with few birds caught in recent years. The existence of declines in all species of winter residents is alarming. Explaining these declines is difficult, as these birds come from varying breeding locations. Weather conditions in PR have been overall warmer and wetter in recent years, but also more variable, which may have reduced insect

abundance.

### **342 Ferraroni, Silveira**

Morphological data do not support the São Francisco River as a geographical barrier for *Aratinga cactorum* (Aves: Psittacidae). ANNA FERRARONI, *Instituto de Biociencias da Universidade de São Paulo, São Paulo, SP, Brasil*, and LUÍS. F. SILVEIRA, *Museu de Zoologia da Universidade de São Paulo*.

Rivers have been considered an important ecological barrier for the dispersal of several bird species (Haffer 1992, **Bol. Mus. Paraense Emilio Goeldi** 8: 217-245). The São Francisco River separates numerous species of vertebrates (Naka et al. 2012, **Am. Nat.** 179: 115-132), and some authors (Juniper & Parr 1998, **Parrots**, Yale Univ. Press; Forshaw 2010, **Parrots of the world**, A&C Black Publ.) suggested that it also affects *Aratinga cactorum* (Cactus Conure), a small conure endemic of caatinga that occurs throughout the Neotropics (Collar 1997, in **Handbook of birds of world**, 4: 430). Two subspecies are currently recognized and it is assumed that the river is the geographical barrier separating them. *A. c. cactorum* is restricted to south, whereas *A. c. caixana* occurs west and north of the river. The aim of this study was testing the existence of such barrier and the morphological differences reported in the literature for *A. cactorum*, in order to investigate the variation within the genus *Aratinga*. A total of 62 specimens deposited in the collection of MZUSP were analyzed and measured (exposed culmen, width of bill at base, wing, tail and tarsus length), specimens were mapped in ArcGis 9.3 and morphometric analyses run in Statistica 7. Results highlight the absence of significant morphological differences between the 2 taxa, suggesting that the São Francisco River does not represent a barrier for this species. We hereby suggest that *Aratinga cactorum caixana* Spix, 1824 should be considered as a synonym of *A. cactorum* (Kuhl, 1820).

### **343 Fonda, Diamant, Carter, Daniel, Hardie, Parkes, Ptaschinski, Shufflebarger, Stanback**

Eastern Bluebirds respond to visual cues of nest predation, but not olfactory cues. CHRISTINA L. FONDA, ELEANOR S. DIAMANT, ELLIOT W. CARTER, IAN J. DANIEL, BENJAMIN E. HARDIE, PRESLEY S. PARKES, JENNA S. PTASCHINSKI, ERIN F. SHUFFLEBARGER and MARK T. STANBACK, *Dept. Biol., Davidson Coll., Davidson, NC*.

We used visual and odor cues to test whether Eastern Bluebirds can detect and respond appropriately to the threat of nest predation. To test their response to visual cues, we placed (for 15 min) either a rubber black rat snake (*Elaphe obsoleta*) or a control item (plastic Northern Cardinal) on nest boxes containing partially completed bluebird nests and recorded whether the bluebirds continued nesting. We restricted our analyses to trials in which the initial nest start was no more than 50% complete. Bluebirds exposed to a rubber snake abandoned their nest significantly more often than bluebirds exposed to a model cardinal, though the majority of snake-exposed bluebirds continued nesting at the same cavity. Interestingly, bluebirds that mobbed the rubber snake were significantly more likely to abandon their nest than were bluebirds that did not mob the snake. To test their response to odor cues, we applied either raccoon (*Procyon lotor*) urine or vinegar (control) to partially completed bluebird nests and recorded whether the bluebirds continued nesting. We found no difference in the propensity of bluebirds to abandon their current nest in response to urine vs. vinegar. Our results suggest that bluebirds are more sensitive to visual than olfactory cues of nest predation.

### **344 Fraser, Stutchbury**

Repeat tracking of individual trans-hemispheric migratory songbirds to examine phenotypic plasticity in spring migration timing and routes. KEVIN C. FRASER and BRIDGET J. M. STUTCHBURY, *Dept. Biol., York Univ., Toronto, ON*.

Tracking the start-to-finish migration of individual songbirds over multiple years can yield important new insights into the phenotypic plasticity of migratory behavior (Stanley et al. 2012 **PLOS ONE** 7(7):e40688). We tracked the trans-hemispheric journeys of over 100 individual Purple Martin; a declining migratory songbird that travels between the Amazon basin and breeding colonies in North America. Additionally, we tracked a subset of these individuals for a second year to compare within- and between-individual variation in spring migration timing, rate, and routes. We predicted higher consistency in timing as compared to spatial variables, owing to greater expected endogenous control of migratory schedules. We show that migration timing was highly variable between individuals and that most (59-87%)

within-population variation in breeding arrival date was explained by departure date from South America, with no differences between the sexes. Preliminary within-individual analyses suggest that breeding arrival date was the most repeatable, with greater variation between years in migration routes and en route timing. Examination of phenotypic plasticity in migratory behavior will improve our understanding of the relationship between population declines and global environmental change.

### **345 Fristoe**

The contribution of migrants to North American winter bird communities. TREVOR S. FRISTOE, *Dept. Biol., Univ. New Mexico, Albuquerque, NM.*

Avian migration is perhaps the most conspicuous seasonal change that occurs in vertebrate communities of the temperate zone. While many migrants depart to the tropics after breeding, others overwinter in communities across the temperate zone. It is not understood what affect these short-distance migrants have on the composition of winter bird communities or what environmental factors allow them to persist in these communities alongside year-round residents. In order to determine how migrants contribute to species richness, abundances, and energy use in winter bird communities across North America, I used data on passerines from 2,251 Christmas Bird Count survey locations and scaling relationships for field metabolic rate as a function of body size and taxonomic group. The proportion of migratory species in winter bird communities declines with increasing latitude while the proportion of migratory individuals and energy use peaked in 2 geographic regions: low latitude deserts and in Northern portions of the Great Plains. Regression analysis revealed that migrants had the greatest contribution to species richness in environments with high annual productivity. However, only locations with high summer relative to annual precipitation provided the resources able to support large proportions of migratory individuals or energy use. Future shifts in winter bird community composition are likely to occur as climate change continues to alter seasonal patterns of precipitation across North America.

### **346 Fudickar**

Dissolving dichotomies: obligate and facultative migration in a partially migratory songbird population. A. M. FUDICKAR, *Max Planck Inst. Ornithol., Radolfzell, Germany, and Dept. Biol., Indiana Univ., Bloomington, IN.*

Migratory animals move seasonally between habitats: tracking resources, evading predators, and reproducing. Partial migration, when a population consists of migratory and sedentary individuals, is an intermediate stage between fixed migratory and sedentary life histories. Although partial migration is common among birds, mechanisms acting on individuals and populations are incompletely known. Using measures of energetic and hormonal state combined with year round tracking over 4 yr I tested several classical hypotheses of partial migration: the 'Arrival Time'-, 'Dominance'- and 'Thermal Tolerance'-hypotheses and measure consistency in individual migratory behavior in a population of European Blackbirds (*Turdus merula*) breeding in sw. Germany. Two distinct periods of departures from the breeding grounds were observed during the study; one in early autumn, and another during the midst of winter. While blackbirds that migrated in autumn were never observed overwintering within 300 km of the study site, individuals that departed in winter were observed between 40 and 400 km. Females were more likely to migrate in autumn than males but there was no difference in age or body size of migrants and non-migrants in autumn. Individual autumn migration strategies and the timing of individual movements were consistent across years, suggesting that intrinsic control mechanisms may play a pivotal role in the decision and timing of migration of partially migratory blackbirds. Just prior to autumn migration, migrants had higher fat scores than non-migrants and tended to have higher levels of baseline corticosterone, both indications of preparation for migration. Unlike autumn migrants, there was no difference between tendencies of males and females to depart in winter, nor were there any differences in body size or age of individuals that departed in winter. Collectively, the results suggest the co occurrence of obligate and facultative migration in a breeding population.

### **347 Wright, R L Curry, Nelson**

Innate preferences for conspecific song in two closely related chickadee species: potential consequences for hybridization. STEPHANIE G. WRIGHT, DOUGLAS A. NELSON, *Dept. EEO Biol., Ohio State Univ., Columbus, OH,* and ROBERT L. CURRY, *Dept. Biol., Villanova Univ., Villanova, PA.*

Several songbird species are known to have an innate "template-based" preference to learn their

own species' song. If 2 closely related songbird species have overlapping distributions, then differences in the flexibility of species-specific song learning templates may influence the species' propensity to hybridize. Theoretical work suggests that when songbird populations come into secondary contact the population with the less restrictive innate song learning template will more easily invade the population with a more restrictive template than vice versa, favoring movement of genes from the population with a more flexible template into the population with the more restrictive template. Black-capped (BCCH) and Carolina (CACH) chickadees are 2 closely related songbirds that hybridize where their ranges overlap. In 2011 and 2013 we hand-raised genetically pure BCCH and CACH nestlings and tested them for their ability to recognize and discriminate between BCCH and CACH song by measuring the rate of begging calls given in response to song playback. In 2011, only BCCH fledglings showed a trend to respond more to conspecific song and an ability to discriminate between BCCH and CACH songs; as adults BCCH sang only conspecific song, while adult CACH often sang both chickadee species' songs. Results in 2013 are expected to support these data, indicating that the innate song learning template of BCCH is more selective than that of CACH. Species differences in the selectivity of song learning may help explain geographic patterns of song repertoires observed within the chickadee hybrid zone as it moves northward.

### **348 Gaffney, Carling, Cheviron**

Geographic extent of hybridization between Black-capped and Mountain Chickadees. ARIEL M. GAFFNEY, *School Integrat. Biol., Univ. Illinois at Urbana-Champaign, Urbana, IL*, MATT D. CARLING, *Dept. Zool. & Physiol., Univ. Wyoming, Laramie, WY*, and ZACHARY A. CHEVIRON, *Dept. Animal Biol., Univ. Illinois at Urbana-Champaign*.

Hybrid zones are natural laboratories for studying genetic mechanisms that underlie speciation and adaptation. North American chickadees (genus *Poecile*) collectively occupy one of the broadest altitudinal and latitudinal ranges of any avian genus on the continent, and hybridization is relatively frequent in areas of overlap between the species. Hybrids between 2 closely related chickadees, *Poecile atricapillus* and *Poecile gambeli*, have been reported from several localities in w. North America, but the geographic extent of hybridization between these species has not been systematically studied using genetic techniques. We sampled 81 individuals ( $n = 29$  *P. atricapillus*,  $n = 52$  *P. gambeli*) from 22 areas of range overlap in the w. US, and genotyped each individual at a 6 unlinked genetic loci. Using *these genetic data, we examined the frequency and geographic extent of hybridization between P. atricapillus and P. gambeli*, and tested for correlations between hybridization frequency and several environmental variables (e.g., elevation and latitude). We uncovered a clear altitudinal pattern in hybridization frequency, with hybrids occurring most frequently within a narrow band of elevations (2000 - 2500 m a.s.l.). Of the 81 sampled individuals, 19.8% were inferred to be admixed. Moreover, the direction of admixture was asymmetric, with a greater proportion of birds phenotypically *identified as P. atricapillus* exhibiting evidence of admixture (24% *P. atricapillus* vs. 17% *P. gambeli*). This study represents the most geographically extensive sampling effort to infer hybrids using genetic methods, and our estimate of hybridization frequency is substantially greater than those estimated from previous studies.

### **349 Gawne, Oguchi, Owen**

Leukocyte profiles of migrating Gray Catbirds in relation to habitat use. CARRIE E. GAWNE, YUSHI OGUCHI and JEN C. OWEN, *Dept. Fish. & Wildl., Michigan State Univ., East Lansing, MI*.

Conservation efforts for landbird migrants are most often focused on breeding and wintering grounds, but migratory stopover sites play a significant role in the health and survival of migrating birds. Migrating birds stop periodically to rest and replenish depleted fat stores and recover reduced immune function. During fall migration fruit is a critical resource, but relatively little is known about how the consumption of different types of fruit impacts a bird's immune system. In this study we evaluated the immune status of migrating Gray Catbirds in 2 shrubland habitats, one dominated by native species and the other by invasive species. Native fruits are typically very nutrient-dense, whereas invasive fruits tend to have less nutritional value but are higher in immunostimulatory carotenoids. We predicted that Gray Catbirds stopping over in invasive habitats would show stronger immune function relative to conspecifics in native habitats due to higher levels of carotenoids in invasive fruits. Using mist nets, we captured Gray Catbirds, collected blood sample from the brachial vein, and made a blood smear to assess leukocyte profile. We will compare absolute leukocyte counts and granulocyte to lymphocyte ratio between habitat types. Preliminary results suggest there is no difference in total leukocyte count between habitat types;



however, further data collection and analysis will be performed and presented.

### **350 George, Thompson, Faaborg**

Effects of season and air temperature on snake activity patterns: implications for nest predation. A. D. GEORGE, *Div. Biol. Sci., Univ. Missouri, Columbia, MO*, F. R. THOMPSON, III., *USDA Forest Serv., Northern Res. Station, Columbia, MO*, and J. R. FAABORG, *Div. Biol. Sci., Univ. Missouri*.

Nest predation is the leading cause of nest failure for many Neotropical migrant songbirds, and the black ratsnake (*Elaphe obsoleta*) has been identified as the most frequent nest predator in fragmented Midwestern landscapes. While recent studies have correlated higher nest predation rates to air temperature or snake activity, logistical challenges have thus far prevented rigorous investigations of how snakes that depredate bird nests respond to weather. We used radio-telemetry and detailed local weather data to model snake activity as it relates to nest-predation risk. In 2010 - 2013 we radio-tracked 56 black ratsnakes in the fragmented region of central Missouri. We relocated each snake 4x per week during the bird breeding season, and used both movement frequency and distance between subsequent locations as indices of activity. We used generalized linear mixed models within an information-theoretic approach to evaluate seasonal and weather variables as potential predictors of snake activity. While snakes were generally sedentary, air temperature had a strong effect on activity early in the season when snakes were likely limited by cooler temperatures, but this effect dissipated as the season progressed. Birds might avoid nest-predation by nesting earlier when snakes are less active, but warmer springs associated with climate change might expose birds to increased risk.

### **351 Gillespie, Jawor**

Testosterone, plumage, and feeding behavior in the Eastern Bluebird. LAUREN M. GILLESPIE and JODIE M. JAWOR, *Univ. Southern Mississippi, Hattiesburg, MS*.

Eastern Bluebirds are of conservation interest as loss of nesting habitat due to urbanization caused populations to decrease, however, through use of artificial cavities, populations are rebounding. Bluebirds are a socially monogamous, biparental species and display territorial aggression, especially towards conspecifics. These behaviors have been shown to be hormonally mediated in other avian species and we investigate links between testosterone (T) and both aggressive and parental care in a bluebird population in the se. US. In 2012, adults were captured during nestling feeding to collect blood to analyze circulating T levels; morphometric measures and plumage samples were also collected. Plasma T did not differ between males and females and was not correlated with feeding rate, body mass, tarsus length, tail length or wing chord in either sex. Date of bleed for males was correlated with date of capture; males bled earlier in the spring have higher T. Melanin plumage was not correlated with plasma T or feeding rates in either sex; female plumage was significantly brighter than male plumage. In 2013, adults were captured during territory intrusions to collect aggressive behavioral data, T levels, morphometric measures and plumage samples. Strong behavioral responses to simulated territory intrusions have been observed and samples are still under collection. There are few accounts in the literature regarding hormonal correlates of male behaviors in bluebirds and even less information for females; this study provides preliminary information on female behavioral endocrinology in bluebirds.

### **352 Gowen, Cicero, Peterson, McCormack**

Genetic structure in Western Scrub-Jays based on nuclear markers. FIONA C. GOWEN, *Moore Lab. Zool., Occidental Coll., Los Angeles, CA*, CARLA CICERO, *Mus. Vert. Zool., Univ. California Berkeley, Berkeley, CA*, A. T. PETERSON, *Univ. Kansas, Lawrence, KS*, and JOHN E. McCORMACK, *Moore Lab. Zool*

The Western Scrub-Jay contains 2 distinct mitochondrial DNA (mtDNA) lineages (coastal and interior) that are roughly 2% divergent and meet in only a few contact zones in the w. US. Although there appears to be little gene flow beyond the hybrid zone, mtDNA is known to show reduced introgression in birds due to Haldane's Rule. Therefore, the mtDNA pattern may not be reflective of introgression in the full genome. To assess introgression in nuclear DNA between the 2 lineages, and to provide a species-wide portrait of genetic structure and gene flow, we genotyped 690 Western Scrub-Jays at 13 microsatellite loci, including all parts of their wide geographic range in the US and Mexico. Our results show that nuclear markers introgress farther geographically than mtDNA, but that introgression is still limited to areas near the hybrid zone. Western Scrub-Jays as a whole contain considerable genetic structure with STRUCTURE results supporting several genetic groupings. Based on phenotypic

differences and limited gene flow, our recommendation is that Western Scrub-Jays be split into several species.

### **353 Griffiths, J C Ross, Keen, Lanzone, Farnsworth**

Acoustic characteristics of the American Redstart flight call and an examination of call variation in relation to age and sex. E. T. GRIFFITHS, J. C. ROSS, S. C. KEEN, *Lab. Ornithol., Cornell Univ., Ithaca, NY*, M. LANZONE, *Powdermill Avian Res. Center, Carnegie Mus. Nat. Hist., Pittsburgh, PA*, and A. FARNSWORTH, *Lab. Ornithol.*

Many passerines emit species-specific flight calls during migratory and non-breeding periods. American Redstart gives a distinctive flight call, having a unique shape relative to most warbler calls. However, these calls are highly variable exhibiting a wide frequency and duration range, and an inconsistent contour structure with variation in modulation and pattern. Despite continued and growing interest in passerine flight calls, little is known about the extent of call variation and any contributing factors. To investigate the extent of variation between sexes and ages, we analyzed 790 American Redstart flight calls recorded from 80 wild birds temporarily placed in a recording chamber before release. We present the descriptive statistics of robust spectrographic measurements for evaluated calls. Through visual analysis, we define 7 call variants and identify spectrographic traits that are common across all calls in our dataset. We examined the correlation between spectro-temporal call measurements and the age and sex of the caller, and found that age correlated strongly with call variability. Hatch year birds accounted for much of the variability we documented, and gave call variants not observed in older birds. Additionally, numerous robust spectrographic measurements differed significantly between the sexes. These findings suggest that age and sex affect flight call structure, contributing to the high degree of variation. Our results have implications for biological and conservation applications, alike, in that a deeper understanding of the causes of call variation may yield clues about passerine communication and function of flight calls.

### **354 Gurguis, Duckworth**

Early ontogeny origin of consistent individual differences in a passerine bird. CHRISTOPHER I. GURGUIS and RENÉE A. DUCKWORTH, *Dept. Ecol. & Evol. Biol., Univ. Arizona, Tucson, AZ*.

Begging behavior is common among animals with parental care and critical to survival; yet there is extensive variation in begging behavior and the causes of this variation are unclear. Past research has implicitly assumed that this behavior is flexible enough to change rapidly in response to environmental conditions. Work on animal personalities, however, suggests that behavioral flexibility may be quite limited. Here, we investigated whether variation in begging behavior reflects a flexible response to short-term changes in environment or consistent differences among individuals. We predicted that if variation in begging was a short-term response to environmental variation, then parental feeding rates should be negatively correlated with begging intensity as satiated broods should beg less. Alternatively, if variation was due to consistent differences among individuals, then begging should be repeatable over time and unrelated to environmental context. Brood begging intensity was unrelated to parental feeding rate ( $F = 1.29$ ,  $p = 0.3173$ ,  $n = 13$ ), however, there was an effect of maternal age (Satterthwaite  $p = 0.0117$ ,  $n = 13$ ). Further, variation in begging behavior was repeatable ( $r$ ) within individuals ( $r = 0.289$ ,  $F = 1.84$ ,  $p = 0.046$ ,  $n = 15$ ) and differed significantly among broods ( $r = 0.253$ ,  $F = 2.36$ ,  $p = 0.0115$ ,  $n = 13$ ). We suggest that begging response is not a completely flexible response to environment. Rather, flexibility in begging behavior is limited, perhaps by underlying genetic variation or early ontogeny effects. Future work will investigate the relative importance of genetic and environmental influences.

### **355 Gutierrez-Pinto, McCracken, Alza, Tubaro, Kopuchian, Astie, Cadena**

Testing adaptive hypotheses at a continental level: phylogeography, hemoglobins and morphology of Torrent Ducks. N. GUTIERREZ-PINTO, *Lab. de Biología Evolutiva de Vertebrados, Univ. de los Andes, Colombia*, K. G. MCCRACKEN, *Inst. Arctic Biology, Univ. Alaska Fairbanks, AK*, L. ALZA, *Corbidi, Peru*, P. TUBARO, C. KOPUCHIAN, *Mus. Argetino de Ciencias Naturales, Argentina*, A. ASTIE, *Inst. Argentino de Invest. de las Zonas Áridas*, and C D CADENA, *Lab. de Biología Evolutiva de Vertebrados, Univ. de los Andes, Colombia*.

High-elevation environments pose ecophysiological challenges for organisms, including low temperatures and reduced oxygen availability, and many adaptive strategies to overcome such challenges

have been documented. Among the most studied are Bergmann's and Allen's Rule, which indicate that organisms living in colder habitats, including those at high elevations, tend to be larger and to have smaller limbs, respectively, to minimize heat loss through body surface. Also, organisms show physiological adaptations to deal with hypoxia via changes in the hemoglobin structure that increase its affinity to oxygen. We evaluated high-altitude adaptations in Torrent Ducks along replicate elevational gradients in different regions by evaluating morphological variation related with temperature and genetic variation in hemoglobin with respect to elevation. We found a deep genetic subdivision in mtDNA of Torrent Duck populations, recovering distinct clades for northern, central, and southern Andes. We did not find a clear association of hemoglobin variants with elevation, but we cannot discard the existence of a cline in allele frequency for one of our study rivers. We found that Torrent Duck morphology is consistent with Bergmann's rule over the thermal gradient associated with latitude, but not in thermal gradients associated with elevation. Similarly, Allen's rule seems to apply only over thermal gradients associated with latitude and not along the gradient associated with elevation. In sum, our results highlight the importance of studying organismal variation across continuous elevation gradients because they allow uncovering the interaction between natural selection and gene flow.

### **356 Lerner, Kabra, Wadleigh, Ove**

Supermatrix phylogeny and new taxonomy of the booted eagles (Accipitriformes: Aquilinae). HEATHER R. L. LERNER, SONIA KABRA, RACHEL WADLEIGH, *Joseph Moore Mus., Earlham Coll., Richmond, IN*, and JAN OVE GJERSHAUG, *Norwegian Inst. Nature Research, Trondheim, Norway*.

The eagles in the subfamily Aquilinae have fully feathered tarsi and belong to a monophyletic group separate from other groups of eagles like sea eagles (Haliaeetinae), harpy eagles (Harpiinae), solitary eagles (Buteoninae) and snake eagles (Circaetinae). There has been active genetic research on this group of eagles in recent years aimed at clarifying phylogenetic relationships, but no single analysis has included all species of booted eagle. Previous analyses have identified 3 polyphyletic genera within Aquilinae, such that taxonomic revision is needed. Here, we analyze published sequences from 6 loci for all 38 extant species of booted eagles and one extinct species (Haast's Eagle, *Harpagornis moorei*), more species than have ever before been analysed together. Using these new phylogenetic trees and considering previous taxonomic proposals, we also make taxonomic recommendations. We find molecular support for 5 major clades within the booted eagles: *Nisaetus* (10 species), *Spizaetus* (4 species), *Clanga* (3 species), *Hieraaetus* (6 species) and *Aquila* (11 species), requiring generic changes for 14 taxa. Additionally, *Hieraaetus kienerii* does not share a close relationship with any other eagle, and we support placing it in a new monotypic genus: *Lophotriorchis*.

### **357 Hanser, Knick, Leu**

Migratory pathways of sagebrush-obligate passerines in the intermountain west. STEVEN E. HANSER, STEVEN T. KNICK, *US Geol. Surv., Boise, Idaho, ID*, and MATTHIAS LEU, *Coll. William & Mary, Williamsburg, Virginia, VA*.

The identification of pathways between seasonal ranges of sagebrush-obligate passerines is an important first step for understanding this relatively unknown portion of their life-history. Based on isotope levels measured in feathers of Brewer's and Sage sparrows from 4 breeding locations and 79 winter locations, birds at each breeding location were assigned to one or more potential winter locations using an index of similarity. We then used circuit theory to model the potential flow of individuals across a surface of variable resistance between breeding and wintering locations. Using identified breeding and wintering habitat characteristics, we developed a resistance surface that represented a relative index of suitability for movement across the landscape. Preliminary analyses indicate that unsuitable habitat types and major topographic features represent obstacles for movement and may lead to the concentration of migrating individuals at pinch points along migratory pathways. Identification of migratory pathways and pinch points can inform future conservation actions to improve or maintain conditions in these key areas for migrating Brewer's and Sage sparrows.

### **358 Hargrove, Unitt**

Responses of birds to large-scale wildfires in southern California. LORI HARGROVE and PHILIP UNITT, *Dept. Birds & Mammals, San Diego Nat. Hist. Mus., San Diego, CA*.

In 2002 and 2003, ~4000 km<sup>2</sup> of s. California burned in the region's largest fires over a century. Though an understanding of species' responses to fire is essential for good management, past such studies have taken place largely in commercially logged forests or other habitats not characteristic of s. California. We established 39 survey routes post-fire in areas of San Diego County burned in the Pines and Cedar fires, plus 7 routes in nearby unburned habitat to serve as controls. From 2002 to 2007, we surveyed these routes repeatedly, 4× in spring and 3× in winter. We also compared abundances post-fire to those pre-fire with data for the San Diego County Bird Atlas. We assessed each species' response to the fires and trends post-fire, and then related those response variables to various life-history traits. Responses and trends were diverse, with 67 of 100 species responding negatively, 8 positively. Sedentary habits, narrower distribution within San Diego County, and association with coniferous forest were linked to negative response. Among the species affected adversely, recovery of those building nests in the canopy of trees was poorest. Surprisingly, an estimate of reproductive potential had little association with post-fire trends. Annual rainfall during the study varied widely, but paralleled many species' trends. The area of California burned annually is expected to increase by 9 - 15% by 2100. Species most at risk from increasing fires include rare and patchily distributed species such as the Gray Vireo and coniferous woodland species such as the White-headed Woodpecker.

### **359 Hartland, Fischer, Miller**

The relationship between body condition and potential plumage signals in the American Goldfinch across an urbanization gradient. R. HARTLAND, JASON FISHER and J. R. MILLER, *Univ. Illinois, Urbana, IL*

Birds use the colors and patterns of their plumage for communicating such things as, mate selection, establishing dominance hierarchies and distracting predators away from nesting sites. Typically, better conditioned birds have better plumage, which can lead to higher reproductive output. In some species, coloration is connected to diet such that birds in better nutritional condition have brighter or larger color patches. For example, in the American Goldfinch, yellow coloration is derived from carotenoids in their diet. White feather patches have traditionally been ignored as a diet-related trait because researchers believed white was physiologically easy to manufacture. However a recent study found that captive Dark-eyed Juncos that were provided a high protein diet regrew their tail feathers with larger patches of white than others on a lower protein regimen. Males with more tail white were found to be more attractive to females. Based on the research with Dark-eyed Juncos we hypothesized that American Goldfinches also use patches of tail white to communicate information about body condition. If this is true, then it could follow that condition and tail white would improve with greater food availability. It has been shown that bird feeders are more abundant in more urbanized areas. Consequently, we anticipated that condition and tail white would increase with urbanization.

### **360 Hennig, Benson, Stodola, Yetter, Stafford**

Estimating spring-migrating waterfowl abundance in the Lower Wabash River region using a grid-based aerial-sampling approach. JACOB D. HENNIG, THOMAS J. BENSON, KIRK W. STODOLA, *Illinois Nat. Hist. Surv. and Dept. Nat. Res. & Environ. Sci., Univ. Illinois, Champaign, IL*, AARON P. YETTER, *Illinois Nat. Hist. Surv., Bellrose Waterfowl Res. Center and Forbes Biol. Sta., Havana, IL*, and JOSHUA D. STAFFORD, *South Dakota Coop. Fish & Wildl. Res. Unit, South Dakota State Univ., Brookings, SD*.

Anecdotal evidence suggests the Wabash River region in southeastern Illinois and southwestern Indiana is regionally important for wintering and spring-migrating waterfowl. This area contains a considerable amount of suitable habitat and preliminary surveys suggest extensive use by waterfowl; however, robust estimates of waterfowl use in this region are lacking as is information about factors influencing distribution and abundance. Examining abundance, population trends, or habitat-use of non-breeding waterfowl often involves aerial surveys. Most surveys, however, are not designed to explicitly estimate error. To begin addressing these topics, we implemented a new aerial-survey method designed robustly to estimate waterfowl abundance and examine distribution in the Wabash River region. We divided the 100-yr floodplain into 260-ha grid cells and using a stratified random sampling approach, aerially surveyed selected cells each week from mid-Jan through early-Apr in 2012 and 2013. Within each week, we re-sampled a subset of the previously surveyed cells using both aerial and ground-based surveys. Using this approach, we were able to investigate spatial and temporal patterns of waterfowl abundance while estimating error. In both years, we estimated a peak abundance of 300,000 ducks with

a coefficient of variation < 25%. Beyond estimating abundance, we used landscape-level predictors such as total crop cover, wetland acreage, and mean elevation per cell to map weekly duck distribution in the region. Our results confirm that the Wabash River region supports a significant population of spring-migrating waterfowl. Furthermore, the grid-based aerial-sampling method proved successful and modifications of this approach may be effectively applied to other regions and taxa.

### **361 Holoubek, Jensen**

Bird occupancy in relation to habitat structure in the Cross Timbers oak savanna of Kansas. NATHAN S. HOLOUBEK and WILLIAM E. JENSEN, *Emporia State Univ., Emporia, KS.*

Oak savanna, once widespread across central North America, has functionally vanished from most of its range. Our objective was to quantify avian habitat associations across a gradient from open-canopy oak savanna to closed-canopy forest in the Cross Timbers region of se. Kansas during the typical songbird breeding season. Using 2012 point-count data (data collection will be completed in summer of 2013), we modeled species-specific site occupancy ( $\psi$ ) probabilities against vegetative variables using program Presence. We first established the best predictors of detection probability ( $p$ ) and used these when modeling  $\psi$ . Of 28 species modeled,  $\psi$  for 17 was strongly associated with vegetative variables, such as landscape-level tree cover and point-count-scale tree density, canopy cover, and shrub density. From the relationships we found, species could generally be characterized as being associated with closed-canopy forest, woodland, or open savanna. Savanna-associated species included Northern Bobwhite, Eastern Kingbird, Northern Mockingbird, Brown Thrasher, Field Sparrow, Lark Sparrow, Dickcissel, and Orchard Oriole. Several of these species are of conservation concern in Midwestern states and may benefit from reductions in tree density within otherwise closed-canopy forest. Quantifying bird habitat use in oak savanna will be useful in guiding savanna restoration for avian conservation.

### **362 Homoya, Dunning, Moore, Jukema**

Wind energy and American Golden-Plovers: Implications for a species of special concern in west-central Indiana. WESLEY T. HOMOYA, JOHN B. DUNNING, Jr., JONATHAN W. MOORE and JOOP JUKEMA, *Dept. For. & Nat. Res., Purdue Univ., W. Layette, IN.*

Wind energy development in Benton and White counties, IN, may impact the spring migration of the American Golden-Plover, a species of regional conservation interest. This highly migratory species winters in lower South America and breeds in the arctic, and in between spends up to 4 wk in Midwestern agricultural fields in Apr and May. The State of Indiana has classified the golden-plover as a Species of Special Concern because of its dependence on suitable stopover habitat within the state and a portion of Benton County was deemed an Important Bird Area by the National Audubon Society. In recent years, this same region has been the location of extensive wind-energy development. In spring 2011 - 2012, we conducted field research to determine if golden-plovers avoid areas with wind turbines. We recorded locations of foraging flocks relative to wind turbines to determine if plovers avoided fields close to turbines. Concurrently, we used stable-isotope analysis to understand the importance of Indiana farmlands in the annual cycle of the species. In spring 2010 we caught 97 plovers and collected feathers from various feather tracts of each bird. We analyzed the feather isotope ratios to identify the general geographic area in which the feathers were grown. This is establishing conclusively whether the plovers are doing their spring molt of body feathers in west-central Indiana. Pausing in migration to grow a new set of feathers is an uncommon life-history strategy in birds, and if confirmed would suggest that the large agricultural fields of west-central Indiana are an important region for this species.

### **363 Gleditsch**

Living with aliens: effects of invasive shrub honeysuckles on avian nesting ecology. JASON GLEDITSCH, *Biol. Dept., Pennsylvania State Univ. University Park, PA.*

Invasive species have come to the forefront of conservation biology as a major threat to native biodiversity. Many studies have shown negative effects of invasive shrubs on native fauna, but sometimes such effects can be confounded with neutral or positive outcomes. Here we investigated the effects of shrub honeysuckles (*Lonicera* spp.) on the nesting ecology of native birds in 7 study sites in central Pennsylvania. We examined how the abundance of shrub honeysuckles influenced the selection of nesting substrates, habitat, nest predation rates, and parental care behavior and nestling development (focusing on the Grey Catbird). We found that birds had a strong bias towards nesting in honeysuckle substrates, but not for nesting in honeysuckle-dominated habitats. Nest predation rates were affected by

the density of nests in a habitat, but not by the abundance of honeysuckles in such habitats. On the other hand, the amount of honeysuckle in the habitat had a significant effect on some parameters of parental care behavior: catbirds fed nestlings more fruit and had a higher nest visitation rates in areas of high honeysuckle density. Catbird nestlings in areas of high honeysuckle density also showed significantly higher mass-tarsus ratios, suggesting a good (or better) physiological condition of catbird nestlings at the time of fledgling. Our study shows that honeysuckle dominated habitats could have equivocal effects on native bird species, and that widespread categorizations like “ecological traps” can be premature and unsubstantiated.

### **364 Jawor, Duckworth**

Modulation of corticosterone in the Northern Cardinal. JODIE M. JAWOR and BENJAMIN M. DUCKWORTH, *Biol. Sci. Dept., Univ. Southern Mississippi, Hattiesburg, MS.*

Seasonal modulation of the adrenocortical response (e.g., ‘stress response’) appears to be ubiquitous in mid- to high-latitude vertebrates (including birds) but relatively few studies have investigated seasonality in stress responses in tropical vertebrates. Potentially, milder climates could select for less robust corticosterone (CORT) secretion across seasons and in response to stress. Here we assess CORT in a temperate dwelling passerine of tropical-descent to examine whether strong seasonal variation exists in stress responses in species living in milder climates. We examined seasonal and sex differences in the stress response in a banded population of Northern Cardinals in s. Mississippi in 2012 - 2013. A standardized stress protocol was used after cardinals were caught; here an initial blood sample is taken <3 min upon capture and a second sample taken after 30 min for stress-induced CORT changes. Almost all individuals mounted a stress response following capture; there were no differences between the sexes or between the non-breeding season (Oct to Feb) and pre-breeding (Mar and Apr). Correlations have been found between temperature and the amplitude of the stress response in the pre-breeding season. Samples for the breeding season (May to Oct) are still under collection. Current data suggests that season may not be as strong an influence in cardinals as in other temperate inhabitants and that breeding condition may influence the level of stress response. Hemolytic complement aspects of the immune system will also be analyzed to increase our understanding of the seasonal correlations between CORT and immunity.

### **365 Jedlicka, Greenberg, Raimondi**

Avian use of habitat fragments in California oak-vineyard landscapes. JULIE A. JEDLICKA, *Dept. Environ. Sci., Policy & Manage., Univ. California, Berkeley, CA*, R. GREENBERG, *Migratory Bird Center, Smithsonian Conserv. Biol. Inst., Natl. Zool. Park, Washington, DC*, and P. RAIMONDI, *Dept. Ecol. & Evol. Biol., Univ. California, Santa Cruz, CA.*

In California, oak woodlands are being converted into vineyards, resulting in a loss of songbird nesting sites. Although many vineyards contain wooded riparian habitat, no previous research has examined the avian species composition in oak-vineyard landscapes. We compared the avian communities associated with vineyard and riparian habitats and tested to what degree the oak-riparian woodlands in vineyard landscapes continue to support birds associated with native oak woodland habitat. We further tested whether the presence of nest boxes in vineyard and riparian areas altered avian species composition in the landscape. Mist nets were used to survey the avian community in vineyard and riparian habitat at 4 sites during the breeding season. Permutational ANOVAs, using presence-absence data from captures, identified habitat, site, and time as highly significant main effects that explain differences in species composition. Establishment of songbird nest boxes did not alter the presence-absence of avian species. Two-thirds of the birds identified as woodland species in prior studies were found in riparian areas adjacent to vineyards, including watch list species such as the Olive-sided Flycatcher, Oak Titmouse, Nuttall’s Woodpecker, Yellow-breasted Chat, and Yellow Warbler. Overall the species composition of birds using riparian habitat was greater and significantly different from those found in the vineyard. This highlights the importance of maintaining natural areas like riparian habitat in agricultural landscapes.

### **366 K E Johnson, Owen, Bocetti**

Pairing success of Kirtland's warbler in marginal habitat. KIRSTEN E. JOHNSON, JENNIFER C. OWEN, *Michigan State Univ., East Lansing, MI*, and CAROL I. BOCETTI, *California Univ. Pennsylvania, California, PA.*

Kirtland's Warbler is an endangered passerine that nests exclusively in a small area of jack pine (*Pinus banksiana*) forests in n. Michigan. Over the past 50 yr, state and federal agencies have been managing these forests in an attempt to increase the Kirtland's Warbler population. The main approach has been to increase habitat area by planting uniquely designed jack pine stands. Kirtland's Warblers have been found to highly select for habitat dominated by jack pine aged 5 - 24 yr. However, as plantations replace aging wildfire stands, the proportion of marginal habitat, that is described as immature (0 - 5 yr), is increasing. We predict that males will be relegated to marginal habitat through increased competition and territoriality in the optimal habitat, and as such will be unsuccessful at finding a mate and have lower reproductive success. During summer 2013 we will quantify pairing success at 6 study sites (3 marginal and 3 optimal) selected from USFS and MDNR plantation installations. Males will be captured using mistnets and color banded. The mating status of color-banded males will be determined and classified as solitary, monogamous, or polygynous. Reproductive success of males in marginal and optimal habitats will be compared. This research aims to determine the relative success of Kirtland's Warbler males at attracting and finding a mate in young plantation stands which are considered marginal habitat. Ultimately, the findings of this study will help guide planting and harvesting practices for jack pine habitat to optimize breeding habitat for Kirtland's Warblers.

### **367 J A Jones, Harris, Siefferman**

Past territory use and level of interspecific competition influences the timing of territorial establishment and level of aggression in a non-migratory passerine. JOHN A. JONES, MORGAN R. HARRIS and LYNN SIEFFERMAN, *Biol. Dept., Appalachian State Univ., Boone, NC.*

Although timing of territory establishment is considered an important predictor of breeding success in migratory species, comparatively little research has focused on criteria for settlement time in non-migratory birds. Moreover, competition for nesting sites may influence settlement time and variation in aggressive territorial behavior among birds. Our field site is a mosaic of areas where 1) Eastern Bluebirds and Tree Swallows compete for nesting sites and 2) areas where bluebirds breed with little interaction with Tree Swallows. Further, Tree Swallows represent a novel selection pressure at our field site. We investigated whether past territory use and current competition between Tree Swallows and Eastern Bluebirds predicted aggressiveness and time of territorial settlement in bluebirds. We quantified rates of nestbox occupancy rates over the past 4 yr and measured aggression and settlement time using response to playback. Bluebirds settled more quickly on and were more likely to defend sites that had higher bluebird occupancy in past years and in areas where few Tree Swallows historically settled. However, the bluebirds that settled in areas with swallows behaved more aggressively compared sites without swallows. Together these data suggest that past territory use influences settlement timing and suggests that the swallow range expansion is selecting for aggressive bluebirds.

### **368 M A Jones**

Leg injuries to birds caused by color bands. How widespread is the problem? MEGAN A. JONES, *Dept. Biol. Sci., Florida State Univ., Tallahassee, FL.*

The use of plastic or metal color bands (rings) on legs is a common method for individually marking birds. The use of color bands is an essential component of many behavioral and population dynamic studies. However, there are potential problems with this method. Griesser et al. (2012, **PLoS ONE** 7(12): e51891) describe several band related injuries from studies around the world. They suggest that the increased static of Darvic (PVC) color bands may attract spider web and cause leg injuries in Purple-crowned Fairy-wrens. Here I present information on incidence of leg injuries in color-banded White-ruffed Manakins (*Corapipo altera*). The study population has been color banded over the past 6 yr. In the first 2 yr we used nylon color bands (Red Bird Products), switching to acetal (Avinet) and Darvic (A.C. Hughes) bands in subsequent years. In the first 4 yr we found no leg injuries related to the color bands. However, in year 5 and 6 we found several birds with injuries related to material wrapping around the leg under only the Darvic color bands. This resulted in minor leg deformation, infected wounds, or in the case of 2 birds, a missing foot. As biologists we are loath to acknowledge that our research methods are potentially injuring individuals or changing the very population or behavior dynamics that we are studying. The goal of this poster is to share information about the problems in the study population with other researchers who use similar techniques and, since Darvic bands are replacing celluloid color bands, to start a conversation to determine how common this problem is.

### 369 Joos, Faaborg, Thompson

Survival and population dynamics of Bell's Vireos in central Missouri. CARA JOOS, *Div. Biol. Sci., Univ. Missouri, Columbia, MO*, FRANK THOMPSON III, *Northern Res. Station, US Forest Serv., Univ. Missouri-Columbia*, and JOHN FAABORG, *Div. Biol. Sci., Univ. Missouri*.

The central US subspecies of Bell's Vireo (*Vireo belli bellii*) is a scrub breeding Neotropical migrant which is estimated to be declining throughout its range. Either fecundity and/or survival are underestimated in the field, or demographic variation due to habitat quality has been missed. Our objective was to investigate the causes of the disparity in population growth estimates. We selected 8 sites with breeding Bell's Vireos in central Missouri that encompassed a broad range of habitat variation. We modeled annual adult apparent survival (survival hereafter) by sex, study site and previous year's reproductive success. We used our survival and fecundity from the same population, in Leslie matrix models to estimate the finite rate of increase ( $\lambda$ ) for sites and the population as a whole. Mean survival for males and females was  $0.52 \pm 0.03$  and  $0.51 \pm 0.26$  respectively. Males who bred successfully the previous year had the highest survival rate ( $0.66 \pm 0.06$ ) compared to unsuccessful males ( $0.41 \pm 0.07$ ) and those with unknown history ( $0.51 \pm 0.06$ ). Site specific  $\lambda$  varied from 0.31 to 1.05. Our estimate of  $\lambda = 0.77$  for our entire population was lower than previously reported, but one site-specific  $\lambda$  was higher than that reported 10 yr prior. We may not have underestimate survival or productivity, but chose sites with  $\lambda < 1$ . We captured variation in habitat quality and demography but do not know how well this represents variation in Bell's Vireo habitat within the region. A spatially explicit source/sink model is necessary to identify and describe Bell's Vireo habitat within the region and assess proportion of high versus low quality habitat.

### 370 Kahle, Flannery, Dumbacher

Correlates of avian building strikes at a glass façade museum surrounded by avian habitat. LOGAN KAHLE, MAUREEN FLANNERY and JOHN P DUMBACHER, *Dept. Ornithol. & Mammal., California Acad. Sci., San Francisco, CA*.

Bird window collisions are the second largest anthropogenic cause of bird deaths in the world. Effective mitigation requires an understanding of which birds are most likely to strike, when, and why. Here, we examine 5 yr of avian window strike data from the California Academy of Sciences – a relatively new museum with significant glass façade situated in Golden Gate Park, San Francisco. We examine correlates of window-killed birds, including age, sex, season, and migratory or sedentary tendencies of the birds. We also examine correlates of window kills such as presence of habitat surrounding the building and overall window area. We found that males are almost 3 times more likely than females to mortally strike windows, and immature birds are 3 times more abundant than adults in our window kill dataset. Among seasons, strikes were not notably different in spring, summer, and fall, however they were notably reduced in winter. There was no statistical effect of building orientation (north, south, east, or west), and the presence of avian habitat directly adjacent to windows had a minor effect. We also report ongoing studies examining various efforts to reduce window kill (primarily external decals and large electronic window blinds.) We hope that improving our understanding of the causes of the window strikes will help us strategically reduce window strikes.

### 371 Khan, Augustine

Effect of microhabitat on the reproductive success of House Wrens. MOHAMMAD Z. KHAN, and JACQUELINE K. AUGUSTINE, *Dept. Evol., Ecol. & Organismal Biol., Ohio State Univ., Lima, OH*.

Habitat characteristics influence the survival and reproduction of animals. House Wrens are an abundant species of songbird, are tolerant of humans, and nest readily in artificial nest boxes. We hypothesized that House Wrens would attempt more nests and raise more young in areas that contained more natural vegetation. Nesting boxes were placed in 3 habitats (100 - 123 boxes/yr): a woodland area, a golf course, and a residential area. We quantified the surrounding habitat characteristics within 15m of a nest box (average territory size): % canopy cover, % shrub cover, % natural grass cover, % mowed grass cover, number of trees >10 cm in diameter, and the presence or absence of blacktop, pine trees and other human structures. Between Apr and Aug 2010 - 2012, nesting success was monitored via checking the nest boxes at least twice a week for signs of activity such as the formation of nests or the appearance of eggs. Nestlings were banded when 10 d old. We observed that more nests were attempted in boxes without blacktop or pine trees, but with human structures, such as fences. Given that a nest was successful, the number of nestlings banded increased with more vegetation, but decreased



with the number of trees and with the presence of human structures. Our hypothesis was supported; house wrens attempt more nests and produced more nestlings in natural areas without blacktop and pine trees. This research supports the idea that human alteration of habitats may be detrimental to reproduction of songbirds.

### **372 Knick, Leu, Rotenberry, Hanser, Fesenmyer**

Diffuse migratory connectivity in two species of shrubland birds: evidence from stable isotopes. STEVEN T. KNICK, *US Geol. Surv., Boise, ID*, M LEU, *Biol. Dept., Coll William & Mary, Williamsburg, VA*, JOHN T. ROTENBERRY, *Coll. Biol. Sci., Univ. Minnesota, St. Paul, MN*, STEVEN E. HANSER, *US Geol. Surv., Boise, ID*, and KURT A. FESEMYER, *Trout Unlimited, Boise, ID*.

Brewer's Sparrows and Sage Sparrows share similar breeding requirements for sagebrush (*Artemisia* spp.) habitats but have different population trends that might be related to winter location. To link breeding and winter ranges, we created predictive deuterium ( $\delta^2\text{H}$ ) and nitrogen ( $\delta^{15}\text{N}$ ) isoscapes for each species modeled from isotope levels measured in feathers of 264 Brewer's and 82 Sage sparrows and environmental characteristics at capture locations across their breeding range. We then used feather  $\delta^2\text{H}_f$  and  $\delta^{15}\text{N}_f$  measured in 1,029 Brewer's and 527 Sage sparrows captured on winter locations in sw. US to assign probable breeding ranges. Intra-species mixing from populations across the breeding range was strong for both Brewer's and Sage sparrows on winter ranges. Both species had more northerly breeding locations in the eastern part of their winter range, likely due to continental distribution of sagebrush. Winter location was not related to breeding population trends estimated from USGS Breeding Bird Survey routes for Brewer's Sparrows but increased with more easterly winter locations for Sage Sparrows. Brewer's and Sage sparrows captured at the same winter location did not share predicted breeding locations or population trends. The diffuse level of migratory connectivity displayed by Brewer's and Sage sparrows, measured at the coarse spatial resolution in our analysis, suggests that local environments rather than broad regional characteristics are primary drivers of annual population trends.

### **373 Kocek, Cohen, Elbin**

Characteristics of salt marshes in New York City preferred by nesting Saltmarsh Sparrows. ALISON R. KOCEK, JONATHAN B. COHEN, *SUNY-ESF, Syracuse, NY*, and SUSAN B. ELBIN, *New York City Audubon, New York, NY*.

Sea level rise and anthropogenic factors have accelerated tidal salt marsh loss along the eastern seaboard of the United States. The Saltmarsh Sparrow (SALS), a tidal marsh obligate species, has mirrored this decline and is considered a species of highest conservation priority, and placed on the 'Vulnerable' list by IUCN in 2004. Habitat characteristics of sites that support SALS reproductive success must be quantified to inform marsh restoration plans that may benefit nesting SALS, and New York City has ongoing salt marsh restoration projects. In 2012, we surveyed 11 marshes in the NYC area for SALS nesting presence. SALS were found breeding at 3 sites, at which twice-weekly systematic nest searches and checks were performed. At all sites, monthly invertebrate sweep-net sampling, monthly vegetation sampling, and regular 10-min disturbance samples were performed. Using ANOVA for regression, we found that SALS nesting presence in NYC cannot be explained based upon machine noise occurrence, prey abundance, or abundance of high elevation within a marsh. Presence of avian nest predators may significantly affect nesting presence of SALS in NYC which contrasts with finding by Gjerdrum et al. (2005, *Condor* 107: 849-862) indicating that marsh elevation has the highest impact on SALS nesting occurrence. SALS in NYC have also shown a preference towards nesting in tall vegetation (*Spartina alterniflora*) in low elevation areas of marshes leaving nests more exposed to predation than traditional nest locations which are hidden in short grasses at high marsh elevations. Further analysis is pending to provide support for a correlation between nest vegetation preferences and avian predator avoidance.

### **374 Kreun, Manthey, Klicka, Spellman**

Comparative genomics of Pleistocene divergence. LINDSEY M. KREUN, GARTH M. SPELLMAN, *Black Hills State Univ., Spearfish, SD*, JOE D. MANTHEY, *Univ. Kansas, Lawrence, KS*, and JOHN KLICKA, *Burke Mus., Univ. Washington, Seattle, WA*.

It has been hypothesized that the Pleistocene glacial period was a critical time for diversification in temperate woodland birds. The episodic nature of this glacial period created a unique environment for speciation, with many opportunities for divergence in parapatry and the possibility for secondary contact

following divergence in allopatry. These conditions are conducive to the formation of phylopecies, and in the past several decades, phylogeographic studies have discovered many pairs of phylopecies whose divergence dates back to the Pleistocene glaciation. In this study we examine the genomics of Pleistocene divergence in 6 pairs of phylopecies (revealed through analysis of mitochondrial DNA) of North American pine-oak forest birds. Our objectives are to explore whether genomic divergence corroborates mtDNA divergence and determine the relative importance of gene flow during or after divergence across phylospecies pairs. In order to address this, RADtag sequencing was used to conduct a partial genome scan. Cluster and species tree analyses were used to infer phylogenetic structure. We evaluated the extent of gene flow using  $F_{st}$  values across thousands of loci and used coalescent simulations to identify models of divergence consistent with the genomic data. We show that clades resolved using mitochondrial DNA in some cases represent maternal lineages only, while genomic data often reveals elevated levels of admixture between the phylospecies.

### **375 Krilow, Iwaniuk**

A morphometric analysis of wing shape variation among grouse (Aves: Galliformes). JUSTIN M. KRILOW and A. N. IWANIUK, *Dept. Neurosci., Univ. Lethbridge, Lethbridge, AB.*

Wing morphology is correlated with flight performance and ecology among birds. However, most studies have approached wing shape variation broadly, focusing on comparisons across orders with relatively little data available on wing shape variation within families and subfamilies. Grouse (Tetraoninae) are an ideal group within which to examine wing shape variation because they share many life history variables, but differ significantly in habitat preference and in the use of wings in courtship displays. Variation in wing shape among grouse could therefore vary according to habitat, courtship display or both. Here, we examined wing shape variation among grouse from spread wing specimens in the Burke Museum of Natural History (Seattle, WA) collection using linear measurements and landmark-based geometric morphometric (GM) analyses. 230 spread wing specimens representing 13 species were measured and photographed. Traditional morphometric measurements included: primary feather length, aspect ratio, wingspan, wing loading, surface area, porosity (i.e., degree to which there are gaps between the flight feathers) and camber. A principal component analysis on primary feather lengths yielded some separation of species according to genus and habitat. The GM analyses also showed that wing shape varies significantly among genera and habitats within multidimensional space. In addition, significant differences in wing shape within habitat types appear to reflect courtship behavior. Overall, we conclude that wing shape is differentiated according to habitat preference, and to a lesser extent courtship behavior, in grouse thereby supporting patterns observed across avian orders and families. Our results also demonstrate that GM analyses can be effectively used to examine patterns of wing shape evolution in birds.

### **376 Hudson, Price**

Song divergence, plumage divergence and assortative mating in bird hybrid zones. EMILY J. HUDSON, *Univ. Nebraska- Lincoln, Lincoln, NE*, and TREVOR D PRICE, *Dept. Ecol. & Evol., Univ. Chicago, Chicago, IL.*

It has been demonstrated that in birds, traits like plumage color and song are important for mate choice. Indeed, it has been argued that pre-mating isolation resulting from divergence in these traits is the critical step to speciation in birds. This study tests the assumption that trait divergence in allopatry correlates with reproductive isolation by examining an important stage in speciation: when allopatric populations move back towards sympatry via a hybrid zone. We measured the degree to which divergence in signals (plumage color and song) predicts reproductive isolation (assortative mating) in a variety of well-studied hybrid zones. Sixteen pairs of hybridizing species or subspecies were chosen for this analysis, based on the availability of reliable assessments of assortative mating in the literature. We use color (measured by spectroscopy) in 12 standard plumage patches, and several easily quantified song characteristics, as indicators of divergence in traits that are likely to be relevant in species recognition. Although our dataset is limited, our preliminary results indicate that there is little correlation between degree of divergence in song and plumage, and presence or absence of assortative mating in the hybridizing species pairs studied. While species clearly do use visual and auditory signals as a cue in species recognition, our results suggest that trait divergence alone is not an adequate method for inferring species status in allopatry, nor is pre-mating isolation a necessary prerequisite for the formation of reproductively isolated populations. Rather, we argue that the presence of post-mating isolation is at least

an equally critical factor in speciation, since the resulting reinforcement is what narrows and strengthens mate choice preferences. Assessing fitness of hybrids is a difficult but important next step to understanding and quantifying the role of reinforcement.

### **377 Latimer, Harris, Sieffermen**

Prey abundance influences plumage coloration and body mass in nestling Eastern Bluebirds. PATRICK LATIMER, MORGAN R. HARRIS and LYNN SIEFFERMAN, *Biol. Dept., Appalachian State Univ., Boone, NC.*

Although the condition-dependence and signaling function of ornamental plumage coloration among adult males is well studied, little research has focused on the information content of ornamental coloration among juvenile birds. Eastern Bluebird nestlings grow their nuptial plumage while in the nest, making them an ideal species to study the development and function of elaborate plumage. In this species, male plumage coloration functions in the juvenile stage in parent-offspring interactions and in the adult stage as a sexually-selected trait. Using a correlational approach, we tested the effects of prey abundance on the structural plumage coloration and body mass of Eastern Bluebird nestlings. We used sweep netting to quantify the biomass of arthropods typically fed to nestling bluebirds. Male nestlings in habitats with greater prey abundance grew brighter plumage while female nestlings grew larger body size. Our results suggest that male and female nestlings differentially allocate resources towards body growth and development of ornamental plumage. These data demonstrate that UV-blue structural plumage in juvenile eastern bluebirds is at least partially condition-dependent and helps to explain why color influences social interactions.

### **378 Lauron, Loiseau, Archer, Smith, Bowie, Spicer, Sehgal**

Patterns of cospeciation and host switching in avian malaria parasites of African sunbirds (Family Nectariniidae). ELVIN J. LAURON, CLAIRE LOISEAU, HOLLY ARCHER, THOMAS B. SMITH, RAURI BOWIE, GREG SPICER and RAVINDER N. M. SEHGAL, *San Francisco State Univ., San Francisco, CA.*

The malaria parasite *Plasmodium falciparum* is one of the world's most devastating and widespread parasites, killing more people than any other parasitic infection. Parasites of this genus can also exploit multiple vertebrate hosts including reptiles, mammals, and birds. Furthermore, malaria parasites of birds are found on all continents of the world except Antarctica. The potential for these widely spread avian *Plasmodium* parasites to switch into new hosts has conservation implications, as was seen in the endemic bird populations of Hawaii. The host-specificity, pathogenicity, and geographical distribution of avian *Plasmodium* are influenced by the life history of the host-parasite relationships. However, understanding these processes requires an extensive sampling of parasite distributions across hosts. We thus sought to understand the history of avian *Plasmodium* and the widespread bird family, Nectariniidae. It has been suggested that these birds originated in Asia and then rapidly diversified in Africa. To determine whether Nectariniidae speciation led to congruent parasite speciation in Africa, we generated a Nectariniidae phylogeny and a three-genome phylogeny of avian *Plasmodium* found in Nectariniidae. These phylogenies were used to perform cophylogenetic analyses. Our cophylogenetic analyses indicates the extent of avian *Plasmodium* parasite cospeciation, host switching, and duplication events that occurred in the African sunbirds.

### **379 Leonard**

Ecological factors predicting singing on the nest. MAUREEN LEONARD, *Mount Mary Coll., Milwaukee, WI.*

Singing on the nest is a relatively uncommon behavior, occurring in 10% of North American breeding birds. There is evidence that incubation sharing and taxonomic family are predictors of this behavior, as well as solitary nesting (Leonard 2008, *Can. J. Zool.* 86:1101-1110). This study seeks to identify any common patterns in ecological factors such as nesting habitat, distribution, or demography that may also influence this behavior. Data were collected from the **Birds of North America** species accounts for both singers on the nest and non-singers to identify these factors.

### **380 Lincecum, Evans, Maness**

Monitoring flight calls of nocturnal avian migrants to identify rare or secretive species. VICTOR C.

LINCECUM, *School Biol. Sci., Louisiana Tech Univ., Ruston, LA*, WILLIAM R. EVANS, *Oldbird, Inc., Ithaca, NY*, and TERRI J. MANESS, *School Biol. Sci., Louisiana Tech Univ*

Acoustic monitoring of the calls of nocturnal migrants provides a powerful tool for assessment of migratory behavior and routes. In particular, these relatively simple species-specific calls may be used to identify and estimate the minimum number of individuals of rare or secretive species moving through an area. In Oct 2012, we placed a pressure-zone microphone on the roof of the Biology building on the campus of Louisiana Tech University, Ruston, LA. The microphone was attached via an audio cable to a desktop computer which recorded continuously from 18:00 - 06:00 each night in a wav format. Wav files were analyzed with software that detects bursts of acoustic energy in the 6 - 10 kHz range, which is the vocal range of most North American warbler and sparrow species. Spectrograms of calls were compared with calls of verified identity. In Nov and Dec 2012, we recorded the flight calls of American Tree Sparrows, a previously undocumented species in Louisiana. We also identified several individuals of secretive grassland species: Grasshopper, Henslow's, and LeConte's Sparrows. These species were rarely or never reported by area birders submitting their sightings to eBird. Acoustic monitoring is a relatively inexpensive method of providing presence and movement information of birds that are difficult to visually detect and study. These data are critical for establishing conservation corridors, placement of wind turbines or communication towers, and detection of altered migration behavior with changing climate.

### **381 Liu, Swanson**

Plasma corticosterone levels suggest similar stopover habitat quality for riparian corridor woodlands and anthropogenic woodlots in the Northern Prairie region. MING LIU and DAVID L. SWANSON, *Dept. Biol., Univ. South Dakota, Vermillion, SD*.

Woodland habitats are scarce in the Northern Prairie region. Migrating landbirds use both natural riparian corridor woodlands and human-planted woodlots as stopover sites to refuel, but whether the 2 woodland types offer similar quality habitats for meeting the energetic demands of migration is unknown. Plasma corticosterone (CORT) is a common stress hormone in birds and patterns of plasma CORT secretion are related to body condition and, therefore, habitat quality, with higher baseline CORT levels and lower increments of CORT levels in response to stress (i.e., stress response) in poorer quality habitats. We assessed habitat quality by measuring plasma CORT in blood samples collected from migrating birds during spring and fall migrations in the 2 habitat types. We collected 2 blood samples from each bird, one within 3 min of capture for measurement of baseline CORT (CORTB) and another after 30 min of restraint stress (CORT30). We tested for differences between birds in the 2 habitat types for CORTB, CORT30, and the magnitude of the stress response (CORT30 - CORTB) for foraging guilds, taxa, and individual species. We found that while plasma CORT increased significantly for all bird groups following 30 min of restraint stress, neither baseline CORT nor the magnitude of the stress response differed significantly between birds in the 2 habitats. These data suggest that both natural riparian corridor woodlands and anthropogenic woodlots provide similarly suitable stopover habitats in the Northern Prairie region.

### **382 Lozano-Jaramillo, McCracken, Alza, Cadena**

Combining phylogeography and the geography of adaptation to understand population history: Ruddy Ducks in the New World. MARÍA LOZANO-JARAMILLO, *Lab. Biol. Evol. de Vert., Depto. de Ciencias Biológicas, Universidad de Los Andes, Bogotá, Colombia*, KEVIN McCracken, *Inst. Arctic Biol. & Dept. Biol. & Wildl., Univ. Alaska, Fairbanks, AK*, LUIS ALBERTO ALZA, *Inst. Arctic Biol.; Dept. Biol. & Wildl., Univ. Alaska, and Centro de Ornitología y Biodiversidad (CORBIDI), Lima, Perú*, and CARLOS DANIEL CADENA, *Lab. Biol. Evol. de Vert., Depto. de Ciencias Biológicas, Universidad de Los Andes*

Phylogeography largely focuses on finding associations between geography and putatively neutral genetic variation, but variation in genes of functional importance can also be used to examine the phylogeographic history of species. Species with populations exposed to a variety of environments, such low- and high-elevation habitats, are expected to show local adaptations in different populations, such that individuals will exhibit better performance in their native environments relative to others. Here, we test a demographic hypothesis of historical gene flow of Ruddy Ducks, a widely distributed species in the New World, into South America from North America, using multilocus analyses, including genes of functional importance, and for the first time including samples from the Colombian Andes. We also examined whether the Colombian Ruddy Duck population is of hybrid origin, as previously suggested, and evaluated

signs of adaptive signatures of hemoglobin adaptation to life at high elevations. Our results suggest that the biogeographic and population genetic history of Ruddy Ducks is more complex than previously elucidated, with genes moving most likely from the Southern Andes to Colombia. We also find strong evidence to support that the Colombian population might be of an old hybrid origin. Taken together, our results indicate that it is crucial to include samples from Colombia when evaluating phylogeographic and populations genetics questions.

### **383 Wingert, Benson**

Factors associated with occupancy of Barn Owl nest boxes in Illinois. AMBER K. WINGERT and THOMAS J. BENSON, *Dept. Nat. Res. & Environ. Sci., Univ. Illinois, Champaign, IL.*

Barn Owl populations have decreased in the Midwestern US in recent years, and they are listed as endangered in several states, including Illinois. This is largely due to the loss of grassland habitat to increased row cropping and development, as well as a potential decrease in suitable nesting substrates. To deal with the problem of nest site scarcity, many states, including Illinois, have initiated nest-box programs. In Illinois, >250 nest boxes have been installed throughout the state since 1990. However, monitoring of these nest boxes has been intermittent. We set out to examine factors associated with nest box use and estimate the number of occupied nest boxes in Illinois. We monitored >100 previously installed nest boxes located throughout Illinois, and examined landscape composition and structure at Barn Owl nest sites and unoccupied boxes. Although most boxes were unoccupied, we found that a number of factors, including box age and grassland cover in the surrounding landscape, were associated with nest box use. In addition to improving our understanding of Barn Owl ecology, this information will aid in the placement of future nest boxes and will contribute.

### **384 Mackin**

Available breeding habitat and population estimate for Audubon's Shearwater in the Caribbean. WILLIAM A MACKIN, *Seabird Working Group, Soc. for the Cons.Study of Carib. Birds*

Audubon's Shearwater (*Puffinus lherminieri*) is a small Procellariiform with at least 10 subspecies pan-tropically. These nocturnal, cavity nesting birds are notoriously difficult to census. This paper presents the best estimate of population size for all known colonies, including the results of surveys using circular plots at 4 colonies and counts and nocturnal visits at 10 other colonies. Known colonies were compiled by dozens of researchers in the Caribbean since 1984 and a database of their results is available at wicbirds.net. The current population has a minimum of 8900 breeding pairs with as many as 30,000 pairs if reported colonies that have not been surveyed have similar population densities to colonies that have been visited. If similar methods are used to estimate populations that were extirpated when humans arrived, there were likely more than 300,000 and possibly 1,000,000 breeding pairs of this species in the Caribbean before the arrival of humans. From a conservation standpoint, half the remaining population is on the Cay Sal Bank at on one 29 ha island, and Barn Owls are killing high numbers of breeding-age adults and appear to be impacting populations at the best-studied colonies.

### **385 Mager**

Just like dear old dad? Are there similarities in the aggressive threat vocalizations of father and son Common Loons? JAY MAGER, *Dept. Biol. & Allied Health Sci., Ohio Northern Univ., Ada, OH.*

Common Loons are long-lived migratory waterbirds in which young males exhibit natal area fidelity. Consequently, many young males return and vie for breeding territories with individuals that likely vary in their relatedness. To acquire and defend these territories, males communicate identity, fighting ability, and aggressive motivation through vocalizations called yodels that consist of a single introductory phrase followed by a strophe of two-syllable repeat phrases. Here, I present findings of initial comparisons of yodels produced by twenty fathers and sons within a population of breeding loons in north-central Wisconsin. Sons produced significantly longer yodels than their fathers as a consequence of producing more repeat syllables, thereby conveying a greater degree of aggressive motivation. Additionally, fathers and sons produce repeat phrases of similar duration, and father-son correlations indicate this relationship significantly varies with each pair. This finding evokes the question of whether males can communicate/assess their relatedness with conspecific rivals through information within these repeat phrases, and necessitates further studies to test associated predictions.

### **386 Maley, Saucier, Carling**

Refutation of Wyoming nesting record of the Pacific Wren. JAMES M. MALEY, JACOB R. SAUCIER and MATTHEW D. CARLING, *Mus. Vert., Dept. Zoo. & Phys., Univ. Wyoming, Laramie, WY.*

The nesting status of the Pacific Wren (*Troglodytes pacificus*) in Wyoming is not clear. According to several sources Wyoming is not part of the distribution, but this is contradicted by several other sources. On the basis of 2 immature specimens (USNM 228577 and 228578), collected by Alexander Wetmore in the Tetons on 27 Aug and 15 Sep 1910, Allan Phillips suggested there might be an undescribed subspecies that nests in nw. Wyoming. The only physical confirmation of nesting in the state is reportedly a single specimen taken from a nest with 2 fledglings in the Freezeout Hills of central Wyoming in 1897. Unfortunately, at some point between 1897 and 1910, this specimen was removed from the University of Wyoming Museum of Vertebrates (UWYMV) and could not be located for examination. While recently inventorying, organizing, and returning specimens from the teaching collection that belong in the vertebrate collection, Maley found the missing specimen (UWYMV 740). Examining the specimen closely, we identified it as a juvenile House Wren (*T. aedon*). Therefore we conclude that despite suspected nesting of Pacific Wren in Wyoming, this has yet to be confirmed.

### **387 Malloy, Bahmani, Jacobsen, Gobbert, Omland**

How well do species tree methods deal with gene flow? The case of mitochondrial introgression in the Northern Oriole complex. JOHN MALLOY, LEILA BAHMANI, FRODE JACOBSEN, MATTHIAS GOBBERT, *Dept. Math., Univ. Maryland Baltimore Co., Baltimore, MD*, and KEVIN OMLAND, *Dept. Biol. Sci., Univ. Maryland Baltimore Co.*

Although molecular data have generally improved our understanding of relationships among closely related bird species, most of these data come from a single locus, mitochondrial DNA. More and more cases of introgression in general, and mitochondrial introgression in particular, are being documented in birds. Even in studies that include nuclear data, nDNA sequences are frequently just combined with mtDNA (concatenated). However, given the high variability and informativeness of mtDNA, it is possible that mtDNA will just overwhelm the nDNA signal in many cases. We recently documented a case of mitochondrial introgression from the Baltimore Oriole lineage (*Icterus galbula*) into that of the Mexican Black-backed Oriole lineage (*I. abeillei*). Multiple methods for analyzing nuclear autosomes and Z-chromosomes, both separately and combined, all recover the traditional close relationship between *I. abeillei* and *I. bullockii* (Black-backed + Bullock's). However, simple concatenation of mtDNA and nDNA produces the mtDNA tree (Black-backed + Baltimore). Only when we artificially replicate the nDNA data 6 times is there enough signal in the nuclear data to overwhelm the misleading mitochondrial signal. We are currently testing how well species tree algorithms including \*BEAST (a coalescent based method) and BUCKy (a consensus based method) deal with introgressed loci, such as this example of highly incongruent mtDNA in the Northern Oriole group.

### **388 Maness, Anderson**

Mate choice in a male-biased population. TERRI J. MANESS, *School Biol. Sci., Louisiana Tech Univ., Ruston, LA*, and DAVID J. ANDERSON, *Biol. Dept., Wake Forest Univ., Winston-Salem, NC*.

Behavioral ecologists traditionally link "individual quality" with exaggerated secondary sexual characteristics or suites of phenotypically variable cues or behaviors. Life history theory suggests that high quality individuals are better able to afford investment in breeding than are low quality individuals, and so should express these relevant cues in a more attractive manner. Populations with biased operational sex ratios provide opportunities to investigate mate choice since the bias offers members of the limiting sex the opportunity to choose among competing potential mates. We investigated mate choice in a male-biased population of Nazca Boobies and tested the hypothesis that males selected as mates are in better condition than are males not selected as mates. We weighed and collected serum samples from males 2 mon prior to the egg laying period and performed a clinical health screen of serum enzymes, proteins, and metabolites. We also measured baseline corticosterol (stress hormone) and immunoglobulin IgY. Nazca Booby males that were selected as mates were heavier, structurally smaller, less likely to have an infection, had better long-term nutritional status, and more muscle mass/more exertion than did males not selected as mates.

### **389 Marsh, Bayne, Wellicome**

The influence of land-cover type and vegetation on nocturnal foraging activities and vertebrate prey acquisition by Burrowing Owls. ALAN MARSH, E. BAYNE, and T. WELLICOME, *Dept. Biol. Sci., Univ. Alberta, Edmonton, AB.*

Studies of foraging-habitat selection tend to interpret patterns of animal presence within an "available" area using a Resource Selection Function (RSF). Often, the animal's locations are assumed to correlate with successful foraging, without explicit evidence that this assumption is valid. We determined third-order selection patterns of nocturnally foraging Burrowing Owls using a presence-only RSF, and compared that model to one that incorporated prey capture locations (CRSF). We also compared net prey returns in each habitat type to better measure habitat optimality. Finally, we measured 4th order selection at foraging and random locations. The RSF method did not approximate prey capture patterns, and the conclusions of this model inaccurately predicted foraging habitat suitability. Burrowing Owls successfully forage in each cover type, albeit where vegetation is sparser than average, with higher net returns in native grass than agriculture. Conservation efforts should focus on ensuring heterogeneity of plant heights and densities across the landscape.

### **390 Mauck, Hosner, Moyle, Cracraft**

Origin and biogeographic history of the family Trogonidae. WILLIAM M MAUCK III, JOEL L. CRACRAFT, *Dept. Ornithol., Am. Mus. Nat. Hist., New York, NY*, PETER HOSNER and ROBERT G. MOYLE, *Dept. Ecol. & Evol. Biol. and Biodiversity Inst., Univ. Kansas, Lawrence, KS.*

Trogons are relatively sedentary wet-forest dwelling birds that have a pantropical distribution. Trogonidae are traditionally divided into 3 subfamilies that correspond to the world's major tropical areas (Apalodermatinae in Africa, Harpactinae in Asia, and Trogoninae in the Neotropics). Several molecular studies have investigated the origin and relationships among trogons with strong support the different genera, but only moderate or low support for early relationships. To resolve the early divergence of trogons and understand the current distribution patterns of these birds we sequenced fourteen trogon species representing the major lineages and 4 outgroups for 14 genes, including 13 nuclear loci and one mitochondrial gene. Each locus was analyzed separately as well as combined in a concatenated dataset with models of evolution estimated for each gene and codon position. The overall phylogeny is well supported. The trogons of Africa and the Neotropics each form a monophyletic group. However, the Asian genus *Apalharpactes* and *Harpactes* are not sister to each other. The Asian genus, *Harpactes*, is monophyletic and forms a clade with African trogons. This African and *Harpactes* clade is sister to the Neotropical trogons. The other Asian genus, *Apalharpactes*, is sister to all trogons. Biogeographically, the origin of trogons is Old World and not New World as had been previously proposed. Trogons have complex biographical patterns that can be reconciled with paleoclimatology and paleoecology.

### **391 Mitchell, Martin**

Life histories of high elevation tropical birds in Malaysian Borneo, ADAM MITCHELL and T. E. MARTIN, *Missoula, MT.*

Avian life history strategies (i.e., clutch size, relative egg mass, duration of incubation/nestling periods, reproductive output, juvenile survival, adult survival, etc.) vary greatly along both latitudinal and elevational gradients (Lack 1947, *Ibis* 89: 302-352; Badyaev & Ghalambor 2001, *Ecology* 82: 2948-2960). While latitudinal life history variation has been extensively studied, elevational studies are few, and have mostly been conducted in temperate locations. Theory suggests that species living and breeding at high elevations in temperate areas should have slower life history strategies, both inter- and intraspecifically (Badyaev & Ghalambor 2001; Bears et al 2009, *J. Anim. Ecol.* 79: 365-375; Lu et al 2010, *J. Field Ornith.* 81: 167-175; Yang et al 2012, *Zool. Sci.* 29: 419-422). This is due to potential limitations on food availability as well as harsher and more variable climatic conditions. These stresses may change the parental investment requirements therefore shaping the evolution of different life history strategies. These same driving forces are also present on tropical mountains and may cause similar differences in life history strategies along elevational gradients. There are, however, very little data available on the life histories of high elevation birds in the tropics. Here, we will present some of the first data for tropical, high elevation avian life histories from our field site at 3200 m on Mt. Kinabalu in Malaysian Borneo. While currently in the midst of our first field season, preliminary data appear to show that high elevation birds are on the slower end of the slow-fast life history gradient compared with birds breeding at our mid-elevation site at 1500 m. This is demonstrated by smaller mean clutch sizes and longer developmental periods. These data expand the knowledge of elevational life history variation to tropical locations, and will

hopefully provide clues to the forces that drive these patterns.

### **392 Moore, Green**

The impact of human disturbance on the foraging ecology of Green Herons. AMANDA A. MOORE and M. CLAY GREEN, *Texas State Univ., San Marcos, TX.*

Human recreational activities in aquatic systems may influence the occurrence, abundance, and habitat use of waterbirds. Negative impacts on waterbirds from human disturbance include the reduction of feeding times (Stolen 2003, **Waterbirds** 26: 429-436), alteration of habitat use, disruption during breeding season (Klein et al. 1995, **Cons. Biol.** 9: 1454-1465), increased energetic demands, increased competitor density, or decreased individual quality (Gill et al. 2001, **Biol. Cons.** 97: 265-268). We are investigating the potential influence of human recreational activity on the foraging success and foraging movements of Green Herons. Our study sites are in central Texas at the headwaters of the San Marcos River, an aquifer-fed river that flows through an urban area; the river varies in its degree of human recreational activity and thereby disturbance varies across sites. Generally, disturbance decreases downstream as the river flows through and away from the urban areas. During spring 2013, we assessed the effects of human recreational disturbance on Green Herons through the use of focal observations 3+ times per week at randomly determined time intervals. During 20-min observation periods, we collected behavioral data to assess time budgets, as well as data on the nature and distance of human disturbance in the direct vicinity. We also uniquely marked individuals (i.e., color bands) to determine individual foraging behavior, foraging territories and foraging habitat in relation to nesting areas. Our data suggests Green Herons forage in areas susceptible to human disturbance presumably due to available foraging habitat but disturbance does affect an individual's time budget; birds are periodically flushed or interrupted during disturbance events which affects their overall time budgets.

### **393 Murray**

Video evidence of infanticide by a female Red-winged Blackbird. LES D. MURRAY, *Div. Sci. & Engineering, Penn State Abington, Abington, PA.*

I video recorded infanticide by a female Red-winged Blackbird at a nest at Valley Forge National Historical Park, PA. The nest was found on 05 Jun 2012 with at least 2 nestlings, approximately 3-d old. On returning to the nest at 07:40 on 08 Jun to install a video camera, 2 chicks were seen in the nest. After preparation of the video equipment, approximately 15 m from the nest, one chick was found on the ground at the base of the nest. The nest was empty on the next scheduled nest check. The video showed a female making several feeding trips and removing fecal sacs from the nest immediately after camera installation. A presumed second female attacks the chick and removes it from the nest at 09:04 on 08 Jun (84 min after camera installation); the chick eventually falls to the ground. The presumed mother returns to the empty nest, but discontinues visits to the nest 7 h after the infanticide. Females of polygynous breeding species, such as Red-winged Blackbirds, might be expected to commit infanticide to secure more resources or male parental care for her own offspring. Infanticide in Red-winged Blackbirds appears to be rare since it has not been reported previously for this well studied species, but instances of infanticide could be confused with predation events upon finding an empty nest without observation of the nest fate.

### **394 Naylor, Grindstaff**

The effects of environmentally relevant doses of 17  $\alpha$ -ethinylestradiol on stress response in Zebra Finches. MADELEINE F. NAYLOR and JENNIFER L. GRINDSTAFF, *Zool. Dept., Oklahoma State Univ., Stillwater, OK.*

Endocrine disrupting chemicals (EDCs) have been entering our water systems through sewage effluent for over 50 yr. 17  $\alpha$ -ethinylestradiol (EE2), the synthetic estrogen in birth control pills, is considered an estrogenic EDC because it has the ability to bind to estrogen receptors in the same manner and affinity as endogenous estrogen. EE2 does not readily filter out of contaminated water in treatment plants and is found in wastewater effluent; therefore, environmental levels of EE2 are concerning because its effects are likely similar to the effects of endogenous estrogens. EE2 is an introduced stressor to the environment; however, organisms are also exposed to natural stressors such as limited food availability. The objective of my study is to quantify the combined effects of EE2 and food limitation on the stress response of Zebra Finches (*Taeniopygia guttata*). Specifically I will quantify the effect of EE2 on



production of the stress hormone, corticosterone (CORT). If EE2 exposure influences the stress response, then fasted EE2 birds should have higher CORT levels when compared to fasted control birds. Our understanding of how EE2 influences adult bird physiology and behavior is limited because previous studies have focused on EE2's effects on development. Our study will contribute to our knowledge of the effects of exposure to environmentally relevant levels of EE2 on adult birds. Furthermore, results found in this study can be extrapolated to birds that are naturally exposed to EE2 and will help to determine whether wild birds are at risk from EE2 exposure.

**395 Nelson, Sehgal**

Mapping the spread of infectious disease in a migratory songbird. ALLISON NELSON and RAVINDER SEHGAL, *San Francisco State Univ., San Francisco, CA.*

To ensure the population stability of migratory songbirds, it is crucial to identify their breeding, wintering and stopover sites, as well as their migration routes. Only then can we understand a species' ecological requirements throughout its geographic range and identify threats faced throughout the annual cycle. Migratory birds can contract haemosporidian (blood) parasites that cause chronic or fatal disease, such as avian malaria. However, we know little regarding the location of parasite transmission and the role that migratory birds play in the spread of these deadly diseases. We will examine mitochondrial cytochrome b sequences from blood samples of Hermit Thrushes and Swainson's Thrushes to identify parasite lineages hosted by these species. We will estimate and map patterns of transmission using (1) locations of blood collection and (2) breeding locations estimated by collaborators through analysis of isotope signatures, single-nucleotide polymorphisms (SNP), and microsatellite data. In conjunction, we propose to use geolocators to clarify the migratory geography of Hermit Thrushes that breed in the San Francisco Bay Area and confirm transmission sites that have been estimated using molecular analysis.

**396 Newtoff**

Spatial variability in mercury exposure and diet in Brown Pelicans in North Carolina. KIERSTEN N. NEWTOFF, *Dept. Biol. & Mar. Biol., Univ. North Carolina Wilmington, Wilmington, NC.*

Mercury is a heavy metal that bioaccumulates in food chains and causes detrimental effects on organisms that consume it. Seabirds, such as Brown Pelicans, serve as apex predators in aquatic food chains and therefore have the highest concentrations of mercury when it is present, making them ideal biomonitors of contaminants in these ecosystems. Here, I will use mercury and stable isotope analyses (measure of diet;  $\delta^{13}\text{C}$ : general feeding location,  $\delta^{15}\text{N}$ : trophic level of diet) on chick feathers and eggshells collected from Brown Pelican breeding sites to test hypotheses on mercury availability and distribution associated with this species. Pelican diet and exposure to local pollutants are expected to vary between the 2 regions (watersheds) along the North Carolina coast where Brown Pelicans breed each summer: the Cape Fear River and Pamlico Sound. Oysters and freshwater fish have showed varying levels of mercury concentration between these watersheds in previous studies. Regurgitated fish and other prey samples will be collected opportunistically during the breeding season to identify specific prey species and determine if dietary changes occur during the breeding season. It is also possible that Brown Pelicans serve as a biovector, an organism that transports material from one location to another – in this case, moving mercury from an aquatic ecosystem through diet and releasing it in terrestrial ecosystems through guano and material decomposition (eggs, feathers, carcasses). Soil samples will be collected at one breeding and non-breeding location to determine if the presence of pelicans affects mercury concentrations in sediments.

**397 vacant**

**398 vacant**

**399 Oguchi, Owen**

Physiological and immunological consequences of using differential stopover habitats in fall migrating landbirds. YUSHI OGUCHI and JEN OWEN, *Dept. Fish. & Wildl., Michigan State Univ., East Lansing, MI.*

Migrating birds experience high energetic demands and immunomodulation. Reduction in immune function is particularly prominent in individuals in poor energetic condition, and the ability to refuel at

stopover sites is important in restoring immunity. However, stopover habitat is being altered due to land-use changes such as the introduction of invasive, fruit-bearing plant species. These invasive plants offer very different foraging and nutritional opportunities than native shrubs. However, knowledge is lacking on how that difference affects migratory birds, particularly during fall migration when migrants primarily consume fruits to meet energetic demands. We tested whether energetic and physiological conditions vary as a function of habitat used by measuring body condition, constitutive innate immunity (natural antibodies and complement cascade), total carotenoids, and plasma metabolites of Gray Catbirds and Swainson's Thrushes captured in either native or invasive shrubland in central Michigan during fall migration. Preliminary results show a trend toward greater mass gain in birds occupying native habitats versus individuals that are captured and recaptured in invasive habitats. In addition, birds initially captured in native habitats are less likely to switch to invasive habitat compared to birds initially captured in invasive habitats. Hematocrit was significantly lower in Gray Catbirds captured in invasive habitats but we observed no differences in constitutive immunity between habitat types. These and other results will be presented and discussed in relation to the effect landscape changes have on health and physiology of migrating birds.

#### **400 Okahisa, Morimoto, Takagi**

Lack of experience in local nest predation causes unsuitable nest site selection in the Narcissus Flycatcher. YUJI OKAHISA, GEN MORIMOTO, *Dept. Life Sci, Rikkyo Univ., Tokyo, Japan*, and KENTARO TAKAGI *Japan Bird Res. Assoc., Tokyo, Japan*.

Even though migratory birds have high dispersion ability, the males return to a specific breeding territory. The most widely accepted explanation for this phenomenon is that site fidelity is directly beneficial since the skills for finding food or a good site and reproductive success improve with experience. However, the effect of the lack of information caused by immigration to an unfamiliar area has not been elucidated. The Narcissus Flycatcher, *Ficedula narcissina*, is a migratory, small, Asian passerine. It has strong territory fidelity and returns to the same territory even when prior breeding has failed. To understand the effect of dispersal without any local experience, we compared the nest site selection and reproductive success of philopatric adults, immigrant adults, and yearlings and studied improvements in suitable nest site selection in philopatric individuals. Our findings showed that the nests in lower locations were depredated more often. The immigrant adults and yearlings were affected by the high predation rate as they made nests in lower locations. However, the philopatric individuals nested in higher locations and thus avoided nest predation. Individuals made their nests in a higher location if their nests had been depredated the previous year. In addition, reproductive success was influenced by experience in nest predation. The birds could not understand a suitable nest site until the nest was depredated; therefore, lack of experience in local nest predation was detrimental to them.

#### **401 Omland, Kearns, Webb, Marzuff, A Johnson**

Deep mitochondrial divergence within Common Ravens: speciation in reverse in the western US and Canada? KEVIN E. OMLAND, ANNA KEARNS, *Dept. Biol. Sci., Univ. Maryland Baltimore Co., Baltimore, MD*, WILLIAM C. WEBB, JOHN M. MARZLUFF, *Univ. Washington, Seattle, WA*, and ARILD JOHNSON, *Univ. Oslo, Oslo, Norway*.

There is increasing evidence that gene flow between phenotypically distinct species is a common and important evolutionary process. Introgressive hybridization can result in at least 3 different outcomes: simple introgression, hybrid speciation, or speciation in reverse. However, only speciation in reverse results in a decrease in species diversity, and only speciation in reverse requires the complete breakdown of reproductive isolation. More and more cases have been documented in several animal lineages, especially in fishes. However, most of these cases involve recent divergences (e.g., ~12,000 ybp) and are human caused. In contrast, several cases in birds seem to be much older and show no role for human disturbance. Common Ravens have 2 deeply diverged mitochondrial clades that are widely sympatric over the western US (Omland et al. 2000, *Proc. R. Soc. London B* 267: 2475-2482). We found no evidence of phenotypic differences between the clades and no evidence of reproductive isolation (Webb et al. 2011, *Molec. Ecol.* 20: 2390-2402). We are now using a range of multilocus coalescent approaches to test the hypothesis of speciation in reverse, focusing especially in se. Alaska and w. Canada.

#### **402 Oxenrider, Augustine**

Habitat characteristics of Greater and Lesser Prairie-Chicken leks in a recently developed hybrid zone. KEVIN J. OXENRIDER, *Dept. Evol., Ecol. & Organ. Biol., Ohio State Univ., Columbus, OH*, and JACQUELINE K. AUGUSTINE, *Dept. Evol., Ecol. & Organ. Biol., Ohio State Univ., Lima, OH*.

A recent range expansion has led to historically isolated populations of Greater and Lesser Prairie-Chickens (*Tympanuchus cupido* and *T. pallidicinctus*, respectively) to overlap in w. Kansas. As a result, mixed-species leks have formed. The goal of this study was to determine if natural behavioral isolation mechanisms exist between Greater and Lesser Prairie-Chickens by determining if both species have differing habitat preferences when selecting lek sites and display territories on the lek. In Apr 2013, vegetation surveys were conducted on active prairie-chicken leks in Gove and Lane Counties, KS, to determine lek habitat preferences by Greater and Lesser Prairie-Chickens in the hybrid zone. Lek habitat was examined by comparing grass height, litter depth, biomass density, and percent ground cover measurements between leks with differing species attendance ratios using modified methods from Hunt & Best (2010, *Southwest. Nat.* 55: 477-487). To determine whether Greater and Lesser Prairie-Chickens prefer different lek microhabitats, male territories were mapped on pure and mixed-species leks and territorial habitat preference was examined by comparing grass height, litter depth, biomass density, and percent ground cover measurements at the center of the individual's territory and at 1m in the 4 cardinal directions. These data suggested that habitat surrounding the lek influenced the species attendance ratio, but vegetative characteristics within each male's territory varied little between species. Data from this study furthers our knowledge on isolation mechanisms between Greater and Lesser Prairie-Chickens and will aid in management decisions for both species in the hybrid zone.

#### **403 vacant**

#### **404 Phillips, Sanchez, Patricell**

What does Gloger's Rule describe? A comparison of climatic factors and coloration in the Song Sparrow. JENNIFER L. PHILLIPS, AMY E. SANCHEZ and GAIL L. PATRICELLI, *Dept. Evol. & Ecol., Univ. California-Davis, Davis, CA*

Ecogeographic rules have long been studied for their potential to reflect common selective pressures across wide geographic ranges and among diverse taxa. As such, they have the potential to show how phenotypic traits, such as morphology and coloration, can be shaped by geographic and climatic variables. While Bergmann's and Allen's Rule have been extensively studied, Gloger's Rule has remained poorly understood. Originally, Gloger's Rule was formulated as the pattern of organisms being darker in wet, warm habitats. More recently, additional relationships have been proposed between climatic and geographic variables and coloration under the umbrella of Gloger's Rule, including precipitation, temperature, relative and absolute humidity, latitude, sun exposure and evapotranspiration. In this study, we examined how these geographic and climatic variables relate to spectral reflectance in the Song Sparrow. The Song Sparrow has been repeatedly described as a follower of Gloger's Rule, making it an ideal study taxon. We measured reflectance of 485 individuals from museum collections and used previously published climate records for the locations of collection. Results will be discussed in the context of previous definitions of Gloger's Rule and implications for evolutionary pressures driving this pattern.

#### **405 Miller, Buitrago**

A review of species limits in the Variable Mountain Gem complex (*Lampornis* sp.). MATTHEW J. MILLER and DANIEL E. BUITRAGO, *Smithsonian Tropical Res. Inst., Panamá, República de Panamá*.

Two species are recognized in the Variable Mountain-Gem group (*Lampornis castaneiventris* and *L. calolaemus*) of hummingbirds based on whether males have white or violet gorgets. This single character has been used to establish species limits in the group, despite the disjunct geography of violet-throated forms as well as racial variation in both white-throated (*castaneiventris* and *cinereicauda* spp.) and violet-throated forms (*calolaemus*, *pectoralis*, and *homogenes* spp.). However, the discovery of a phenotypically-distinctive new taxon in the species group from Cerro Hoya in the Azuero Peninsula of Panama further raises the possibility the current taxonomy of Variable Mountain-Gems does not reflect biological reality. An initial analysis of mitochondrial DNA variation across the range of Variable Mountain-Gems found that the 2 isolated and peripheral of violet-throated populations (*pectoralis* and

**taxon nova**) formed unique, well-differentiated, clades while the remaining contiguous violet- and white-throated taxa showed no phylogeographic structure and frequently shared a few widespread haplotypes. This pattern was confirmed from the sequence data from several nuclear introns. Likewise, these 2 isolated populations showed differentiation in common mensural characters while the remaining forms did not. However, a detailed review of male specimens across the contact zones of *calalaemus* (violet-throated) and *cinereicauda* (white-throated) in Costa Rica and *castanoventris* (white-throated) and *homogenes* (violet-throated) indicates in both cases that throat-color groups are well-delimited geographically and have well-sampled, and well-identified contact zones, yet almost no geographic overlap of throat- color forms and little apparent hybridization, suggesting active assortative mating. This evidence argues for the recognition of at least 5 species in the group, instead of lumping all 6 taxa into a single species which is the only other reasonable alternative given our data.

#### **406 Potter, Hyde, Pier, Voss**

A comparison of the bacterial microflora found on House Wren and American Kestrel eggs. BETH A. POTTER, EMILY J. HYDE, HOLLY N. PIER and MARGARET A. VOSS, *School Sci., Penn State Erie, The Behrend College, Erie, PA.*

It is generally accepted that avian eggs acquire a microflora during ovipositioning. The goal of this study was to identify and compare the egg microflora of 2 avian species, House Wrens and American Kestrels. The nesting habitats and incubation behavior are different between these 2 species. For instance, House Wrens build their nests from twigs, grass, leaves, and feathers, while American Kestrels use tree cavities and do not utilize any external materials. Both birds exhibit intermittent incubation; however kestrels show a more pronounced asynchronicity in hatching. Culture-dependent techniques combined with sequencing of the 16S rRNA gene were used to identify bacteria collected from egg surfaces throughout incubation. Bacteria within the Actinobacteria, Firmicutes, and Proteobacteria phyla were isolated for both species; however, the abundance of each differed between the 2 species (4.96, 50.67, and 44.36% respectively for House Wrens and 79.84, 18.52, and 1.64% respectively for American Kestrels). For both species, *Staphylococcus* was the dominant genus within the Firmicutes phylum and *Pseudomonas* was the dominant genus within the Proteobacteria phylum. However, for the Actinobacteria phylum, the 2 avian species had a completely different bacterial genera composition. *Cellulomonas*, *Plantibacter*, *Rhodococcus*, and *Sanguibacter* were found in House Wrens while *Microbacterium*, *Arthrobacter*, and *Curtobacterium* were found on the eggs of American Kestrels. Our results suggest that the bacterial microflora found on avian eggs is not static between species and is likely influenced by different nesting and incubation behaviors.

#### **407 Prevost, Hockman, Buehler, Menachery, Worley, Wilkerson, Smith, Fischer**

Investigating the abilities of Autonomous Aerial Acoustic Recording Systems (AAARS) to monitor grassland bird populations in inaccessible areas. STEPHANIE C. PREVOST, EMILY V. HOCKMAN, DAVID A. BUEHLER, MATHEW G. MENACHERY, STACY K. WORLEY, JOHN B. WILKERSON, DAVID R. SMITH, *Univ. Tennessee, Knoxville, TN*, and RICHARD A. FISCHER, *US Army Engineer Res. & Develop. Center, Environ. Lab., Vicksburg, MS.*

The need for improvements in avian wildlife monitoring efficiency, accuracy, and scope has led to increased development and use of new technologies such as autonomous recording devices. This project introduces a novel autonomous recording system that addresses these issues as well as the specific problem of ground-based land accessibility. Military installations, which host a disproportionately high number of threatened, endangered, and at-risk species (TER-S) compared to other federal lands, pose this problem in the form of sizeable impact areas that are too hazardous to traverse on the ground. The objectives of this research are, first, to demonstrate and evaluate the abilities of autonomous aerial acoustic recording systems (AAARS) to monitor grassland bird species and determine accurate density estimates. Second is to compare AAARS with traditional point-count and line-transect observer survey methods. Third is to describe vocal behavior attributes that affect aural detection. Focal grassland species include Northern Bobwhite, Prairie Warbler, Bachman's Sparrow, Field Sparrow, Grasshopper Sparrow, and Henslow's Sparrow.

#### **408 Pusch, Thompson, Navara**

Chronic stress and gonadotropin inhibitory hormone expression in White Leghorns. ELIZABETH A.

PUSCH, JUDD A. THOMPSON and KRISTEN J. NAVARA, *Dept. Poultry Sci., Univ. Georgia, Athens, GA.*

The hypothalamic neuropeptide gonadotropin inhibitory hormone (GNIH) reduces the production of reproductive hormones from the brain and acts as negative feedback on the reproductive system. However, it is unknown if this reduction is part of the mechanism that inhibits reproduction in response to stress. To determine whether GNIH expression is increased by chronic stress white leghorns were exposed to 3 treatments (food restriction, corticosterone administration, and social instability). Reproductive performance was then assessed and brains were collected to measure GNIH expression. Hens in the food restriction and corticosterone administration treatment groups had significantly greater plasma corticosterone levels when compared to controls. Hens that received corticosterone treatment stopped producing eggs, had regressed ovaries, increased body fat, and enlarged livers. Hens in the social instability and corticosterone treatment groups laid significantly lighter eggs compared to controls. The relationships of the treatments and reproductive output parameters will be discussed in relation to patterns of GNIH expression.

#### **409 Randall, Neudorf.**

Song delivered by male Carolina Wrens during nestling provisioning in urban and rural habitats. C. A. RANDALL and D. L. H. NEUDORF. *Sam Houston State Univ., Huntsville, TX.*

Male Carolina Wrens often sing at the nest prior to feeding their nestlings. We tested the hypotheses that male song at the nest serves as a communication tool to both the female and also the nestlings. We quantified the incidence of male song during nestling provisioning by video recording and direct observation in both urban and rural environments. We observed female responses and recorded nestling begging responses to male song at the nest to test our hypotheses. We will discuss the possible functions of male song during provisioning and variation in male song usage in the 2 habitats.

#### **410 Rheindt, Fujita, Wilton, Edwards**

Introgression and phenotypic assimilation in *Zimmerius* flycatchers (Tyrannidae): population genetic and phylogenetic inferences from genome-wide SNPs. FRANK E. RHEINDT, *Dept. Biol. Sci., Natl. Univ. Singapore*, MATTHEW K. FUJITA, *Dept. Biol., Univ. Texas at Arlington, Arlington, TX*, PETER R. WILTON and SCOTT V. EDWARDS, *Dept. Organ. & Evol. Biol., Harvard Univ., Cambridge, MA.*

Genetic introgression is pervasive in nature and may lead to large-scale phenotypic assimilation of populations, but there is limited knowledge on the relationship between the magnitude of phenotypic changes and levels of genetic introgression. Using bioacoustic, biometric and spectrophotometric data from a flycatcher (Tyrannidae) system in the Neotropical genus *Zimmerius*, we document a mosaic pattern of phenotypic admixture in which a population of *Z. viridiflavus* in n. Peru ('mosaic') is vocally and biometrically similar to conspecifics to the south but shares plumage characteristics with a different species (*Z. chrysops*) to the north. To clarify the origins of the mosaic population, we used the RAD-seq approach to generate a dataset of 37,361 putatively unlinked genome-wide SNPs. A range of population-genetic diagnostics shows that the genome of the mosaic population is largely indistinguishable from *Z. viridiflavus* and distinct from *Z. chrysops*, and the application of parsimony and species tree methods to the genome-wide SNP dataset confirms the close affinity of mosaic population with *Z. viridiflavus*. Even so, using a subset of 2710 SNPs found across all sampled lineages in configurations appropriate for a recently proposed statistical ('ABBA/BABA') test that distinguishes gene flow from incomplete lineage sorting, we detected low levels of gene flow from *Z. chrysops* into the mosaic population. Mapping the candidate loci for introgression from *Z. chrysops* into the mosaic population to the zebra finch genome reveals close linkage with genes significantly enriched in functions involving cell projection and plasma membranes. Introgression of key alleles may have led to phenotypic assimilation in the plumage of mosaic birds, suggesting that selection may have been a key factor facilitating introgression.

#### **411 Rivera-Cáceres**

Plain Wrens adjust their singing timing based on self and partner's cues to perform precisely coordinated duets. KARLA D. RIVERA-CÁCERES, *Univ. Miami, Miami, FL.*

Precise temporal coordination appears to be an important signal during duetting for several species. However, the mechanism by which precise duets are achieved has been barely addressed. Two

alternative mechanisms might explain duet precision: a) individuals possess a fixed rhythm with which they sing and their partner's songs fall between the silent periods or b) individuals assess the timing of each song given by their partners and modify their singing behavior accordingly. If b) is true variation in singing timing should be explained by cues available within the duet. In this study I test this prediction in a highly precise duetting species, the Plain Wren (*Cantorchilus modestus zeledoni*). I used a General Linear Mixed Model to analyze the effect of the variation in singing behavior of male and female Plain Wrens on the duration of their inter-phrase intervals (i.e., the time from the end of a song of one individual to the beginning of the next song from the same individual). Results indicate that both male and female plain wrens use information from their own songs and their partner's songs to perform syllable-by-syllable adjustments in their singing timing to achieve highly precise duets.

#### **412 Rogers**

Evidence for cost of fattening from natural populations. CHRISTOPHER M. ROGERS, *Avian Biol. Lab., Dept. Biol. Sci., Wichita State Univ., Wichita, KS.*

Optimal body mass models for small wintering birds are a cornerstone of behavioral ecology, and depend on the existence of costs and benefits of fat reserves. It is generally accepted that fat confers a benefit of fasting capacity, but there is little evidence of fat cost from natural populations. Hypothesized costs of elevated fat levels include reduced flying ability and increased exposure to predators while feeding to fatten. The general cost hypothesis predicts that wintering bird species that occupy dense (closed) cover should experience lower predation risk than those that occupy more open habitats. Thus closed-cover species should show higher fat reserves, and higher wing loading due to increased fat reserves, than open-cover bird species. These predicted patterns were observed over 2 winters in s.-central Kansas: both variables were significantly lower in 2 open-cover species (Dark-eyed Junco, American Tree Sparrow) than in 7 closed-cover feeding species (6 sparrow species in the genera *Melospiza*, *Passerella*, and *Zonotrichia*, and the Spotted Towhee). Among closed-cover species, fat reserve and wing loading increased with rank body size; the 2 open-cover species showed values for these variables outside the 95% confidence interval of the body size-wing loading regression for the closed-cover species. The alternative hypothesis of lower fat due to greater exposure in open-cover species was not supported, as both juncos and tree sparrows showed greater fat in midwinter, a common pattern among temperate-wintering birds. The present results suggest costs of body fat in natural populations of small-bodied wintering birds, and help to verify the cost-benefit theoretical approach to studying the relationship between a surrogate fitness variable (winter survival probability) and a variable winter environment.

#### **413 Sackinger, Augustine**

Do male House Wrens vary their singing among various reproductive stages? NATHANIEL J. SACKINGER and JACQUELINE K. AUGUSTINE, *Dept. Evol., Ecol. & Organismal Biol., Ohio State Univ., Lima, OH.*

The vocalizations of male songbirds can function in attracting mates and in defending territory. If song is used for attracting a mate, song output should decline following pairing. If song is used primarily for territory defense, song output should be constant throughout reproduction, because territories are maintained throughout multiple reproductive attempts within one breeding season. The purpose of this study was to determine whether the song of male House Wrens changes throughout the reproductive cycle in accordance to one of these predictions. Male House Wren song was recorded by attaching a microphone to the pole holding the nesting box during 4 different stages of reproduction (nest-building, laying, incubation, and nestling feeding). The vocalizations were analyzed for song rate (# songs/minute), duration (length of each song), and frequency. Song length and rate was found to be greatest during nest-building and laying and lowest during nestling feeding. Results indicate that song may be used primarily for finding mates, and not territory defense. However, we may not be detecting song used during territorial defense, as our microphone was stationary and located on the nesting box. Future studies should follow individual males to determine whether males also sing away from the nest box, and shift the location of singing during the breeding season.

#### **414 Sanin, Shearer, Cracraft**

Comparative phylogeography of three genera of Birds of Paradise (Paradisaeidae) across the highlands of New Guinea. CAMILO SANIN, JESSICA A. SHEARER and JOEL CRACRAFT. *Am.*

*Mus. Nat. Hist., New York, NY.*

The island of New Guinea is one of the world's hotspots of biodiversity and endemism. However, avian biogeographic patterns on the island remain largely unknown. Specifically, understanding the circumstances that promote the isolation and differentiation of populations is key in the study of the origin and diversification of New Guinean biota. The bird-of-paradise complex (Paradisaeidae) comprises approximately ninety species that are distributed in Australasia and Wallacea. The vast majority of the species are endemic to New Guinea and occupy a wide variety of environments ranging from lowland habitats to the highest peaks of the Central ranges. Here, we study 3 genera whose distributions span low montane to high montane rainforests in New Guinea. *Lophorina*, *Paradigalla*, and *Pteridophora* co-occur in the central ranges of the island. On the far-western Arfak Peninsula, *Lophorina* and *Paradigalla* have distinct forms. Other distinct forms of *Lophorina* are found in the mountains of the Papua and Huon Peninsulas, where *Paradigalla* and *Pteridophora* are absent. We found significantly different levels of genetic structure within these genera that roughly correspond to current taxonomy. We use GIS tools including present topographic and climatic data, as well as projections of the climate during the Last Glacial Maximum and the Last Inter Glacial, to examine these differing phylogenetic structures in light of the altitudinal ranges each genus occupies, and the environmental stability of the areas in which they occur.

#### **415 Santiago-García, Vázquez-López, Ramírez-Barrera, Zamudio-Beltrán, Hernández-Baños**

Genetic variation in Mexican populations of *Picooides fumigatus* (Picidae). JESÚS SANTIAGO-GARCÍA, MELISA VÁZQUEZ-LÓPEZ, MARISOL RAMÍREZ-BARRERA, LUZ ESTELA ZAMUDIO-BELTRÁN and BLANCA ESTELA HERNÁNDEZ-BAÑOS. *Museo de Zoología. Depto. Biología Evolutiva. Facultad de Ciencias, Universidad Nacional Autónoma de México, DF, México*

*Picooides fumigatus* is currently divided in 5 subspecies according to subtle morphological differences. Two of these subspecies occur in México (*P. f. sanguinolentus* and *P. f. oleagineus*). We used mitochondrial (ND2) and nuclear (ACO1 INTRON-10) DNA sequences to investigate genetic variation of the 2 Mexican subspecies. The  $F_{st}$  value obtained (0.91521) indicates that genetic variation among populations is larger than within each population. Mismatch analysis showed that the populations are in demographic balance. Maximum Parsimony, Maximum Likelihood, and Bayesian Inference analyses support the hypothesis that the Mexican subspecies are 2 evolutionary lineages. *P. f. sanguinolentus* includes samples from the states of Oaxaca, Campeche and Chiapas, and *P. f. oleaginous* includes samples from Hidalgo, Veracruz and Puebla. Financial support provided by PAPIIT-UNAM IN225611.

#### **416 J M Sardell, Uy**

Confirmation and characterization of a recently-established hybrid zone between Melanesian honeyeaters (genus *Myzomela*). JASON M. SARDELL and J. ALBERT C. UY, *Dept. Biol., Univ. Miami, Coral Gables, FL.*

Understanding the dynamics of speciation with gene flow is key to explaining the origin and maintenance of biodiversity, and recently-established hybrid zones offer unique opportunities to test speciation models. Two species of *Myzomela* honeyeaters, *M. tristrami* and *M. cardinalis pulcherrima*, are found along the coast of Makira in the Solomon Islands and appear to fill very similar ecological niches in sympatry. However, collection records suggest that sympatry of the 2 species is a recent phenomenon with *M. cardinalis* colonizing Makira from nearby satellite islands in the late 19th-century (Mayr & Diamond 2001, **Birds northern Melanesia**, Oxford U. Press). Moreover, putative hybrids were collected during early expeditions, but had not been reported since the 1920s. In 2013, we visited Makira and collected blood samples from *Myzomela* within and outside the zone of secondary contact (ZSA). Two of 57 captured birds from the ZSA (3.5% of captures) exhibited hybrid plumage, confirming that hybridization is rare but more common than previously thought. Indeed, population genetics analysis reveals extensive unidirectional mtDNA introgression from the invading species (*M. cardinalis*) to the native species (*M. tristrami*), despite significant divergence (6.7 - 7.3%) in ND2 mitochondrial gene haplotypes between species. This result is consistent with strong asymmetric preferences for conspecific mating and contradicts the pattern of asymmetrical gene flow from native to invading species that has been observed in nearly all shifting avian hybrid zones (Rheindt & Edwards 2011, **Auk** 128: 620-632).

#### **417 Sáyago, Martínez, Salinas, Barranco, Ibarra-Manríquez**

Performance of birds as surrogate group of plants. ROBERTO SÁYAGO, *Unidad Académica en Desarrollo Sustentable, Campus Costa Grande, Universidad Autónoma de Guerrero, Guerrero, México*, JUAN MARTÍNEZ, MIGUEL ANGEL SALINAS, MARIA de las NIEVES BARRANCO and GUILLERMO IBARRA-MANRÍQUEZ, *Centro de Investigaciones en Ecosistemas, Universidad Nacional Autónoma de México, Michoacán, Morelia, México*.

The selection of priority areas for biological conservation in a megadiverse country is a challenging task. The use of surrogate groups has been proposed to achieve this purpose; these are groups of well known taxa, and the approach assumes that the diversity and endemism patterns of the surrogate group are similar to those of other less known taxa. The aim of this study was to evaluate the congruence in the selection of priority conservation areas based on bird and on woody flora diversity patterns, 2 taxa that have often been considered as surrogate groups. We compared species diversity, endemism and rareness of birds and woody plants in 13 study sites of tropical dry forest in Colima, Mexico. We found 128 bird species and 301 woody flora species; 9 sites were needed for birds, and 12 for woody flora, to have all the species recorded represented at the sites. Similarly, 5 sites for birds, and 10 for woody flora were needed to have all endemic species represented at the sites. If we were to protect 3 sites, selected among the first 6 ranked sites, we would protect 82% of bird species richness and 49% of woody plant species richness. We did not find a relationship between diversity and endemism of birds and woody plants across sites; however, because gamma and beta diversity of woody plants are greater than that of birds in Mexican tropical dry forests, using plants as the surrogate group resulted better to protect overall biodiversity.

#### **418 Scardamaglia, Reboreda**

Ranging behaviour of brood parasitic Shiny and Screaming Cowbirds while searching for host nests. ROMINA C. SCARDAMAGLIA and JUAN C. REBORDA, *Univ. de Buenos Aires, Buenos Aires, Argentina*.

Females of brood parasitic cowbirds lay eggs in nests of other species, the hosts, which provide the totality of parental care. Parasitism occurs at dawn and during the rest of the morning, cowbird females search for nests where to lay eggs on subsequent days. Shiny Cowbird (*Molothrus bonariensis*) females search for nests alone while it has been suggested that females of the Screaming Cowbird (*M. rufoaxillaris*) are aided by males. We studied nest-searching behavior in both species at a site in Buenos Aires Province, Argentina. We fitted female and male Shiny and Screaming cowbirds with 1.2 g radiotransmitters and tracked each individual during 3 - 6 consecutive days from dawn to dusk. We found considerable overlap between the morning ranges of the same individual in consecutive days. For cowbirds tracked for > 3 d, the addition of new area to their range decreased over time. There was a marked overlap in the ranges of male and female Screaming Cowbirds that were caught together as opposed to those that were caught separately. Our results indicate that Shiny and Screaming cowbird females use relatively constant areas for nest searching and that female and male Screaming Cowbirds search for nests together.

#### **419 Schneider, Kirchman**

Range expansion and the breakdown of Bergmann's rule in Red-bellied Woodpeckers. KATHRYN J. SCHNEIDER, *Hudson Valley Community Coll., Troy, NY*, and JEREMY J. KIRCHMAN, *New York State Mus., Albany, NY*.

We used data from museum specimens to examine geographic and temporal variation in body size in the Red-bellied Woodpecker (*Melanerpes carolinus*), a species undergoing dramatic northward range expansion. We plotted georeferenced occurrence data from Christmas Bird Counts, the USGS Breeding Bird Survey, and the holdings of 26 natural history museums to document the actual historical pattern of range dynamics in *M. carolinus*. Christmas Bird Counts, but not museum specimens, indicate a trend of slow northward expansion beginning as early as the 1910s, and all data sets show rapid expansion to the north and west since the 1950s. Geographic variation in body size of birds collected prior to the period of rapid expansion follows Bergmann's rule, with larger birds occurring in northern latitudes, but this pattern breaks down in the sample of birds collected after the onset of rapid expansion, suggesting that warming air temperatures since the 1950s have enabled northward range expansion in a species previously limited by cold temperatures. Birds collected at the northern boundary of their range



before 1940 were larger than in birds collected in recent decades from the same latitudes. "Pioneer" birds (i.e., those collected in recent decades from latitudes north of their previous range limit) are smaller than birds collected before 1940 at the former northern boundary of their range, further supporting the hypothesis that Red-bellied Woodpeckers have been released from a former ecological or physiological constraint in the face of climate warming.

#### **420 Seo, Ueda**

Arrival order in relation to male quality and territory characteristics in the Blue-and-white Flycatcher. K. SEO and KEISUKE UEDA, *Dept. Life Sci., Rikkyo Univ. Tokyo, Japan*

The arrival date of migratory birds may reflect male quality with earlier arriving males claiming better quality of territories than later arriving males. We studied the relationships between the arrival date of males at the breeding site, the characteristics of territory, and male quality in Blue-and-white Flycatchers (*Cyanoptila cyanomelana*) in a river valley in Karuizawa, Japan. We measured the size and altitude of territories, the width and depth of the water in the valley, and the forest type in the territory. We compared the arrival date with male's body condition and age as indicators of their phenotypic quality. We also measured the size of melanin patch, which covers the bird's head and breast, and the size of white patches on tail feathers which might be status signal in this species. We found that males that arrived earlier were older and in better body condition than later arriving males. Moreover, early arrivers had larger melanin-based and white patches of plumage. The early arriving males also had larger territories and they preferred to establish territories with wider and deeper stream flow and taller trees. Therefore, our results showed the importance of the arrival order and age effect of males in migratory birds to occupy better territory in breeding place.

#### **421 Skrade, Dinsmore**

The effect of egg crypsis on Mountain Plover nest survival. PAUL D. B. SKRADE and STEPHEN J. DINSMORE, *Dept. Nat. Res. Ecol. & Manage., Iowa State Univ., Ames, IA.*

The coloration of exposed eggs of ground-nesting birds is thought to function as camouflage to reduce predation, with eggs that more closely match the area around the nest having greater survival. We tested this hypothesis using digital photographs of 374 Mountain Plover nests and the substrate surrounding each nest to produce covariates for nest survival models. Two covariates represented the difference between the color of the eggs and that of the substrate in 2 different color spaces: the L\*a\*b\* color space, which approximates human vision, and the 3-dimensional RGB color space, which is used to display electronic images. Other covariates included the average egg and substrate colors, and variation in both egg and substrate color. Nest survival decreased as the difference between the color of the eggs and substrate increased for both L\*a\*b\* (BetaLab = -0.021, SE = 0.024, 95% CI: 0.069, 0.026) and RGB (BetaRGB = -0.004, SE = 0.005, 95% CI: 0.013, 0.005) values. Similarly, nest survival decreased as the variability in color in the substrate surrounding the nest decreased (BetaSDSub = 2.624, SE = 2.846, 95% CI: 2.954, 8.202), although after model-averaging these effects were not well-supported. Model-averaged estimates of daily nest survival ranged from 0.90 to 0.98 (unconditional SEs from 0.004 to 0.129). Our results support the egg crypsis hypothesis because nests that most closely match their surroundings had greater survival.

#### **422 Specht, Arnold**

Estimating survival and recovery rates of Wilson's Snipe in Eastern and Central North America. H. M. SPECHT and T. W. ARNOLD, *Dept. Fish., Wildl. & Conserv. Biol., Univ. Minnesota, St Paul, MN.*

Wilson's Snipe population indices have declined since the Breeding Bird Survey began in 1966. Management to address these declines has been limited by lack of information on snipe population parameters. Adult survival is the population parameter with the greatest influence on population growth. We used a Brownie model to estimate annual adult survival and recovery from 1961 - 1980 in eastern and central North America using banding and recovery records provided by the USGS Bird Banding Lab. Recovery rates increased slightly with time, but remained below 0.01, while survival rates trended upward from 0.569 to 0.694. Season and region were not found to be important with cohort-based models. A point estimate of survival of 0.636 ( $\pm$  0.029) provides an improvement upon the single existing life-table based estimate of 0.498 ( $\pm$  0.058) provided by Tuck (1972, **Snipes**, Can. Wildl. Ser.). Individual-based modeling could improve our estimate, identifying the interactive effects of age, region and season on

survival rates. Modern estimates should, hereafter, be used for demographic modeling.

#### **423 Spellmeyer, Rogers**

Reversing songbird decline: Overwinter food supplementation significantly increases assumed survival of the Dark-eyed Junco. ANDREW J. SPELLMEYER and CHRISTOPHER M. ROGERS, *Dept. Biol. Sci., Wichita State Univ., Wichita, KS.*

The North American Breeding Bird Survey indicates a long-term decline of the Dark-eyed Junco. Our research objective is to advance current knowledge of avian demographics, particularly in the nonbreeding season. An emphasis on increased overwinter survivorship may halt abating population trends. Strong flock fidelity and small overwinter home range of juncos makes them exceptional models for studies investigating seasonal mortality. Using experimentally varied food supply, we measured the site persistence of color-banded food supplemented and non-supplemented flocks after a 60-d period using mark and resight methods. The effect of overwinter food supplementation significantly elevated site persistence in 2011, 2012, and 2013 [ $n = 64$ ,  $X^2 = 31.76$ ,  $p < 0.001$ ;  $n = 71$ ,  $X^2 = 6.50$ ,  $p < 0.025$ ;  $n = 74$ ,  $X^2 = 30.73$ ,  $p < 0.001$  respectively]. Additionally, average daily temperature, snowfall, and snow accumulation significantly decreased persistence among non-supplemented flocks in cold winters (2011, 2013) compared to mild winters (2012). Asymptotic distributions of sampling efforts indicate all present juncos were observed. The expectation from literature is that absentee birds represent mortality rather than dispersal. Supplemental feeding in the nonbreeding season may provide a useful conservation tool for reversing population declines of granivorous birds. An emphasis on this conservation approach may be important in a nonbreeding landscape characterized by habitat loss and habitat degradation.

#### **424 Stodola, Ward**

Does social inertia limit a species geographic range? K. W. STODOLA and M. P. WARD, *Dept. Nat. Res. & Environ. Sci., Univ. Illinois, Urbana, IL.*

The geographic range of a species is the product of habitat suitability and the dispersal capacity of a species. Multiple abiotic, biotic, and evolutionary constraints interact to influence species persistence and limit potential suitable habitat. Dispersal capabilities then refine the geographic range by influencing colonization potential. Consequently, a mismatch arises between the current and potential geographic range of a species, which is only expected to increase as climate warms and habitat shifts. Birds are highly mobile and should be able to track shifts in habitat quality. However, certain habitat selection behaviors may preclude birds from occupying large areas of presumably suitable habitat. Specifically, we believe that the use of social cues in selecting habitat restricts many species from occupying otherwise suitable habitat and thus limits the geographic range, a term we call social inertia. We developed a spatially-explicit individual-based stochastic model to explore this question. We demonstrate how conspecific attraction can limit a species range in a changing environment and how this can have population-level consequences. In addition, we are investigating the prevalence of social inertia in the field and are gathering preliminary data.

#### **425 Stratford, Fetcher, Pike, Golecki, Anderson, Jescavage, Kaiser, Janosov**

Trophic structure of grassland birds in a forested landscape: insights from stable isotopes. JEFF STRATFORD, NED FETCHER, COLLEEN PIKE, ALEXA GOLECKI, KEVIN ANDERSON, KATIE JESCAVAGE, RYAN KAISER and JOHN JANOSOV, *Wilkes Insti. Environ. Sci., Wilkes Univ., Wilkes-Barre, PA.*

Grasslands are uncommon habitats in the ne. US and habitat restoration efforts are often targeted at grasslands birds. Here, we report on the use of stable isotopes of carbon and nitrogen to determine the role of birds in food webs of 2 restored grasslands in ne. Pennsylvania. We captured birds at a Superfund site in 2008 - 2010 and a Conservation Reserve Enhancement Program (CREP) farm in 2012. Both sites were dominated by warm season grasses (WSG) that use the C4 photosynthetic pathway interspersed with forbs and shrubs that use the C3 pathway. Feather samples were taken from 14 birds of 8 species and analyzed for  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$ . Although the sites were predominately WSG, birds were consuming both C3- and C4-derived carbon, with the exceptions of a Chipping Sparrow and a Song Sparrow whose diets consisted almost entirely of C4-derived carbon. Sparrows were primarily second level consumers – eating phytophagous insects as well as some plant- derived material. Eastern Bluebirds, Northern Mockingbirds, and Common Yellowthroats were tertiary consumers. Tree Swallows, which nested at the center of the sites, were fourth-level consumers. Our results suggest that birds are using several carbon sources as

well as different trophic levels in these restored grasslands.

**426** vacant

**427** Sullivan, Creager

Lifetime achievement awards or “mate choice” award? KIM SULLIVAN and MaLaura CREAGER, *Dept. Biol., Utah State Univ., Logan, UT.*

Women began receiving PhDs in ornithology in large numbers in the 1970s. As their careers matured they became eligible for lifetime achievement awards from the ornithological professional societies. We examined membership lists, meeting records, and award notices for 3 ornithological societies (American Ornithologist’s Union, Cooper Ornithological Society and Wilson Ornithological Society) from 1980 to 2010 to examine trends in the recognition of women in ornithology. In the 1980s few women received lifetime achievement awards but the numbers increased in the 1990s and 2000s to the number expected based on the proportion of 20+ yr members who are women. The gender composition of the awards committee had no effect on the gender of the awardee. Surprisingly, women married to other ornithologists are much more likely to receive lifetime achievement awards and the trend has been increasing over the past 2 decades.

**428** Swanson, Murphy, Jaeckle, Harper

Corrosion casts: a novel application of PU4ii resin for visualizing eggshell pore morphology. MARK T. SWANSON, JASON P. MURPHY, WILLIAM B. JAECKLE and R. GIVEN HARPER, *Dept. Biol., Illinois Wesleyan Univ., Bloomington, IL.*

Pores in avian eggshells facilitate gas exchange between the external environment and the embryo. To visualize the three-dimensional morphology of eggshell pores we devised a novel application of PU4ii (VasQtec), a polyurethane-based resin which is typically used to create vascular corrosion casts. A gentle vacuum was used to draw unpolymerized resin into the pores of cleaned eggshell fragments; the resin polymerized within 24 h at 21°C. The CaCO<sub>3</sub> components of eggshells were dissolved using 10% HCl, and the resulting casts were rinsed with distilled water, air-dried, and examined using a JEOL-5800 scanning electron microscope. This protocol was used to examine pores of eggshells of the chicken, Common Grackle, and Brown-headed Cowbird. Casts of eggshell pores from all species shared a common feature of tubular air spaces in the middle of the palisade layer. Eggshell pores of grackles and cowbirds widened markedly as they opened to the exterior of the shell, while eggshell pores of chickens widened slightly. The walls of the eggshell pores of all species were not uniformly smooth. Small (ca. 1 µm) hemispheric concavities were present in the shell matrix bounding the pore spaces. The abundance and distribution of these concavities varied in eggshells of cowbirds and grackles, but this feature was rarely found in chicken eggshells. Using polyurethane casts, the morphology and distribution of eggshell pores can be easily observed and this technique allows for comparison of eggshell pore morphology among birds from different taxonomic groups or with diverse life history strategies.

**429** Szabo, Cavaghan, Hurley, Irwin

OMBIRDS: A new template for creating a media voucher for archiving avian blood and their derivatives (Online Museum of Bird Images and Recordings associated with DNA Samples). ILDIKO SZABO, STEPHANIE CAVAGHAN, GRANT HURLEY and DARREN E. IRWIN, *Beaty Biodiversity Mus., Univ. British Columbia, Vancouver, BC.*

In order to increase the long-term utility of avian blood samples collected from released birds, the research community would benefit from having a standardized template for storing all the georeferencing, morphometric, and digital media information associated with each avian blood sample in one database record to create a “media voucher.” Freezing and archiving tissue, blood, and their derivatives for decades is expensive. Doing so for unvouchered material is problematic. It is hoped that the creation of this protocol will encourage researchers to create a media voucher for all blood extracted from uncollected birds and will result in more blood samples being accessioned into museum collections. In this paper we outline a protocol that has been implemented in the Irwin Lab at the University of British Columbia. We introduce a new acronym to describe an online database linking georeferenced avian blood samples with digital files (image, song, and/or video), citations, and morphometric data: OMBIRDS stands for Online Museum of Bird Images and Recordings associated with DNA Samples. We will show what an OMBIRDS

record looks like, how it is interactive with the Macaulay Library of Natural Sounds, and how to search for OMBIRDS on ORNIS (a division of VertNet). This proposed OMBIRDS protocol could be used for all vertebrate classes and some invertebrate taxa. The acronym is designed so that the 3rd letter can be modified to identify the taxon, e.g. OMMIRDS for OM of Mammal IRDS, OMHIRDS for OM of Herps IRDS, etc. We hope that OMBIRDS will be a useful contribution to the scientific and museum communities for promoting the archiving and access of animal blood samples and their derivatives, especially those that have been used in publications (analogous to the Dryad Database).

#### **430 Takushi, Jaeckle**

A modified method to measure gas exchange through pores in eggshell fragments. SARAH TAKUSHI and WILLIAM JAECKLE. *Dept. Biol., Illinois Wesleyan Univ., Bloomington, IL.*

Gas exchange through pores in bird eggshells is necessary for normal embryonic development. Rates of gas exchange across eggshells vary among species and may also differ among eggshell regions within species. Differences in gas exchange positively correlate with development rate and negatively correlate with incubation time. Using eggshells of Brown-headed Cowbirds we evaluated and subsequently modified the method described by Portugal et al. (2010, **Proteome Sci.** 8:40) to measure water vapor movement through eggshell pores. These modifications allowed for differentiation between water vapor movement through eggshell pores and water vapor loss through imperfections in the seal of the gas-exchange chamber. The magnitude of this error was measured by comparing rates of water vapor movement before and after sealing each eggshell fragment with molten wax. Correcting for this residual water vapor movement significantly reduced reported rates of gas exchange through eggshell fragments with ( $t_{0.05,(24)} = 6.47$ ,  $p < 0.001$ ) and without ( $t_{0.05,(29)} = 3.61$ ,  $p < 0.005$ ) an internal membrane; an internal membrane did not significantly affect corrected rates of gas exchange ( $t_{0.05,(54)} = 0.261$ ,  $p = 0.795$ ). The percent difference between uncorrected and corrected rates of gas exchange was variable ( $60 \pm 116\%$ , mean  $\pm$  SD). Surprisingly, comparisons between corrected rates of gas exchange and rates predicted from measurements of eggshell porosity revealed no significant correlation for fragments with ( $r = 0.264$ ,  $p = 0.212$ ,  $n = 24$ ) and fragments without ( $r = -0.241$ ,  $p = 0.217$ ,  $n = 28$ ) an internal membrane. We hypothesize that this result is explained by the presence of material within eggshell pores, which reduced our ability to accurately detect and measure pores using light microscopy. Indirect estimates of gas flux across eggshells based on measurements of pore number and size are sensitive to such occlusions and may underestimate rates of gas exchange through avian eggshells.

#### **431 Tarr, Aycrigg, Lonneker, Rubino, Boykin, Laxson, McKerrow, Beauvais, Gotthardt, Gould**

Modeling vertebrate species in the US: Species modeling efforts of the Gap Analysis Program. NATHAN TARR, *North Carolina State Univ., Raleigh, NC*, JOCELYN AYCRIGG, *Univ. Idaho, Moscow, ID*, MATT RUBINO, *North Carolina State Univ.*, KEN BOYKIN, *New Mexico State Univ., Las Cruces, NM*, THOMAS LAXSON, *Univ. Idaho*, ALEXA MCKERROW, *US Geol. Surv., Raleigh, NC*, GARY BEAUVAIS, *Univ. Wyoming, Laramie, WY*, TRACEY GOTTHARDT, *Univ. Alaska, Anchorage, AK*, and WILLIAM GOULD, *USDA Forest Service, Rio Piedras, PR.*

A goal of the Gap Analysis Program (GAP) is to map the range and distribution of each terrestrial, vertebrate species, including ~800 birds, to assess biodiversity conservation within the entire US. To achieve this goal, we map species' ranges using 12-digit hydrologic units attributed with species' seasonal use. These range maps provide a boundary within which we build habitat distribution models that predict suitable areas for occupation. Our deductive habitat models, spatial subsets of species' ranges, are based on habitat associations described in peer-reviewed literature and expert input. We build models using a suite of national, spatial data layers including National GAP Land Cover, elevation, hydrological characteristics, distance to or from forest edge, and habitat patch size. Our ranges, habitat models, and national data layers are available for viewing and download from [gapanalysis.usgs.gov](http://gapanalysis.usgs.gov). For bird species, we currently have completed > 730 ranges and > 660 habitat models, which include most bird species found in the conterminous US. These bird species ranges and models inform regional and national biodiversity conservation assessments and provide a base from which we can improve range and distribution maps as new data become available. Our distribution models are informing the Western Governors' Association's regional Crucial Habitat Assessment Tool and an assessment of landscape effects of biofuels production on wildlife habitat in North Carolina. We are currently trying to improve several models using species occurrence data with inductive modeling techniques and will conduct a national biodiversity assessment of vertebrate species in the future.

#### **432 Tegeler, Vitz, Lanzone, Deleon, Grove**

Banding and flight call acoustic data: gaining more insight into avian migration. AMY K. TEGELER, ANDREW VITZ, MICHAEL LANZONE, EMMA DELEON and LEWIS GROVE, *Carnegie Mus. Nat. Hist., Powdermill Nature Reserve, Rector, PA.*

Bird banding has a long history in North America and provides valuable data used to estimate bird population trends (Lloyd-Evans & Atwood 2004, *Wilson Bull.* 116: 1-16). More recently researchers have begun recording nocturnal flight calls as a method to study avian populations (Evans and O'Brien 2002, **Flight calls**, Oldbird, Ithaca, NY; Farnsworth 2005, *Auk* 122: 733-746; 2007, *Wilson J. Ornithol.* 119: 334-341). However, it is unclear how flight call counts correspond to the number of birds captured by bird banding, or the ability of each method to detect different types of species. We examined banding and flight call data collected at Powdermill Nature Reserve, Rector, PA, for 125 dates from 1 Aug to 31 Oct 2004 - 2007. We did not find a relationship between the number of flight calls recorded each night and the number of birds captured in mist-nets the next morning when all nocturnal migrants were included, nor with only those species known to emit nocturnal flight calls. Nocturnal flight call recordings detected a higher proportion of thrushes, while banding detected a higher proportion of sparrows. Similar proportions of warblers were detected using both methods. Banding sampled more species, including species not known to nocturnally flight call. Nocturnal flight call recording detected 2 species not detected by banding, possibly because we were able to record more hours than the mist-nets were open. Nocturnal recordings also sampled from individuals flying overhead so was not as affected by the local habitat. Banding and acoustic surveys examine different facets of bird migration and when combined, can yield important information about migration, population trends, and habitat use and quality.

#### **433 Tenorio, Bravo, Isler, Brumfield, Cadena**

Effect of dispersal abilities and climatic niche breadth on avian diversification rates. ELKIN TENORIO, CARLOS D. CADENA, *Dpto. Ciencias Biológicas, Univ. de los Andes, Colombia*, GUSTAVO A. BRAVO, ROBB T. BRUMFIELD, *Dept. Biol. Sci. and Mus. Nat. Sci., Louisiana State Univ., Baton Rouge, LA*, and MORTON L. ISLER, *Natl. Mus. Nat. Hist., Smithsonian Inst., Washington, DC.*

Understanding the factors that promote diversification and determining how such factors vary geographically in relation to environment is an issue of interest to ecologists and evolutionary biologists. Dispersal abilities have been shown to partially explain variation in diversification rates, but how this relationship may change under different geographical and environmental contexts remains unknown. Here we use morphological, climatic and phylogenetic data sets to evaluate the hypothesis that speciation rates are jointly influenced by dispersal abilities and by thermal tolerances of species, and that the relative importance of these variables depends on the geographic and environmental contexts. To test this hypothesis, we used 4 avian clades endemic to the New World showing contrasting distribution patterns (highlands or lowlands). Our results showed that regardless of the geographic area, the dispersal abilities were related to speciation rates. Also, in concordance with our hypothesis, thermal niche breadth was significantly related to speciation rates in highland clades, likely by the interaction with the thermal stratification that promote speciation in the tropics. However, contrary to our prediction, thermal niche breadth also related significantly to speciation rates in clades diversifying in the lowlands, where we assumed the temperature is relatively uniform in space. Our results may give insights about the role that the interaction between organismal traits and environmental variation influences speciation and possibly accounts for spatial patterns of diversity.

#### **434 Termignoni, Baker, Escalante**

Cooperative breeding in the Yucatan Jay: social organization varies with environmental conditions. FLAVIA TERMIGNONI GARCIA, C. C. M. BAKER and P. P. ESCALANTE, *Instituto de Biología, Departamento de Zoología, UNAM, Mexico City, Mexico*

Cooperative breeding in birds may be viewed as an adaptation to scarce or variable resources. The degree of cooperative breeding may then vary within a species, across both time and space, depending on resource scarcity and environmental variability. Such variation in cooperative breeding is likely to be reflected in the size and composition of social groups. Intraspecific variation in social organization has already been shown to be linked to environmental conditions in crows, fish and mice. However, detailed field observations of alloparenting and other behaviors are necessary to shed light on

the nature of the connection between social organization and cooperative breeding. The cooperatively breeding Yucatan Jay (*Cyanocorax yucatanicus*) is found in dry, sub-dry and evergreen tropical forests of the Yucatan Peninsula. Previous studies have already shown variation in body size among these habitat types. Here we present field data for 56 social and territorial groups of *C. yucatanicus* over the 2012 and 2013 reproductive seasons. We find that group size and composition, and frequency of alloparenting behaviors, vary with both habitat type and rainfall predictability. Our results support the idea that cooperative breeding is an adaptation to scarce or variable resources in this species.

**435** vacant

**436** Thrimawithana, Ortiz-Catedral, Rodrigo, Hauber

Reduced total genetic diversity following translocations? A metapopulation approach. AMALI H. THRIMAWITHANA, *Bioinformatic Inst., School Biol. Sci., Univ. Auckland, Auckland, New Zealand*, LUIS ORTIZ-CATEDRAL, *Inst. Nat. Sci., Massey Univ., Albany, New Zealand*, ALLEN RODRIGO, *Dept. Biol., Duke Univ. and Natl. Evol. Synthesis Center, NSF, Durham, NC* and MARK E HAUBER, *Animal Beh. and Conserv. Prog., Dept. Psychol., Hunter Coll. and Grad. Center, City Univ. New York, New York, NY*.

Conservationists and wildlife managers around the world use translocation to new and safe habitats as a highly successful tool for preserving and propagating threatened species whose populations are surviving at few and vulnerable localities. The success of translocations is typically defined as the establishment of a self-sustaining population. However, this definition overlooks the genetic consequences of translocations at the metapopulation scale, especially when maintaining genetic diversity is a potentially critical component of the immediate success criteria or, when it is a specific aim of long term management goals for the translocated population. We evaluated the potential effects of translocation on the total genetic diversity of a metapopulation in a common scenario: a small source and a nearby translocated population on a recently predator-proofed large site. Specifically, we tested the counterintuitive hypothesis that translocation and subsequent migration between an expanding, recently established population and the source/original population might actually result in the suppression of genetic diversity specifically, in the source and overall, in the metapopulation. The genetic consequences of translocations are predicted to be complex. Critically, however, under a higher rate of migration, higher carrying capacity, and smaller initial size of the translocated population, the total genetic diversity of the metapopulation may become suppressed following a translocation, compared to a population left undisturbed. If, however, translocations are carried out under a broader set of conditions, the overall genetic diversity should be preserved in the source population and become increasingly higher in the nearby translocated population. These results confirm the overall importance of translocation as a highly effective and successful conservation genetic tool.

**437** vacant

**438** Tonra, Marra, Willard, Holberton

Using building strikes in Chicago to compare the relative influence of endogenous and environmental factors on breeding preparation in migrating Ovenbirds. CHRISTOPHER M. TONRA, PETER P. MARRA, *Smithsonian Conserv. Biol. Inst., Washington, DC*, DAVID WILLARD, *Field Mus., Chicago, IL*, and REBECCA L. HOLBERTON, *Univ. Maine, Orono, ME*.

In spring, long-distance migratory birds must complete migrations thousands of miles long while simultaneously undergoing the physiological transition into a breeding state. The relative influence of environmental and endogenous factors in determining variation in breeding preparation is not well understood. We measured gonad size and stable isotopes in multiple tissues of migrating Ovenbirds collected in spring (2010, 2011), after building collisions in Chicago, IL. We used stable-hydrogen isotopes in tail feathers as a measure of breeding latitude and, thus, distance to breeding site from Chicago. If endogenous timing is a strong determinant, birds closer to breeding sites should have more advanced preparation (i.e., larger gonads). We used stable-carbon and -nitrogen isotopes in toenails to measure variation in environmental conditions on the wintering grounds. In both males and females, there was significant annual variation in the best predictors of gonad size. In 2010, males from dryer habitats had larger testes during migration. However, in 2011 there was no habitat relationship, but males and

females closer to breeding sites had larger gonads. Overall, our stable isotope variables were better predictors of gonad size than calendar date. This study is ongoing, but thus far it appears that environmental conditions at non-breeding sites may influence breeding preparation for males in some, but not all, years.

#### **439 Van Doren, Geevarghese, Hochachka, Irvine, Webb, Sheldon, Farnsworth**

Morning flights of migrating birds relate to density of nocturnal migration and direction and speed of nocturnal winds aloft. BENJAMIN M. VAN DOREN, WESLEY M. HOCHACHKA, *Lab. Ornithol., Cornell Univ., Ithaca, NY*, JED IRVINE, *Dept. Computer Sci., Oregon State Univ., Corvallis, OR*, KEVIN W. WEBB, *Lab. Ornithol.*, JEFFREY GEEVARGHESE, DANIEL SHELDON *Dept. Computer Sci., Univ. Massachusetts, Amherst, MA*, and ANDREW FARNSWORTH, *Lab. Ornithol.*

Morning reorientation flights of nocturnal migrant passerines have been widely observed, and understanding morning flight and its correlates may be important for developing a full knowledge of the ways birds use stopover habitat and respond to local conditions by orienting during and after nocturnal movements. To date, however, the causes and functions of morning reorientation remain sparsely studied. We examined these "morning flights" from 7 locations in the ne. US during fall migration of 2010, in order to identify associations between morning reorientation and magnitude of nocturnal flights, regional weather patterns, and local topography. Our data are composed of observations of roughly 15,000 reorienting passerines during 84 observation periods. We quantified nocturnal migratory flights by analyzing WSR-88D imagery and by counting nocturnal flight calls from autonomous recording stations. We manually classified synoptic weather conditions using continent-scale maps. We found significant relationships between morning flight size and both nocturnal migration density and winds aloft: more reorienting migrants were observed following larger nocturnal movements, and when nocturnal winds were stronger, more northerly, and more westerly. Additionally, morning flight orientation did not change appreciably with differing nocturnal winds. Instead, migrants flew in westerly directions at nearly all locations, although topographical features appeared to bias flight direction. These results are consistent with morning flight functioning in part to correct for wind drift and to facilitate the search for suitable stopover habitat.

#### **440 Verheijen, Sandercock**

Apparent adult survival estimates for seventeen songbird species in northeast Kansas. BRAM H. F. VERHEIJEN and BRETT K. SANDERCOCK, *Div. Biol., Kansas State Univ., Manhattan, KS*.

Many songbird species in the US are declining in population numbers. Ongoing declines are thought to be related to habitat loss caused by land-use change, agricultural intensification, and habitat fragmentation. Adult survival is the demographic parameter that often contributes most to population change of songbirds, especially in declining populations, and is therefore important to estimate when constructing population models. Understanding adult survival and site fidelity of declining species will form the basis for further ecological research and conservation efforts. Unfortunately, adult survival estimates are lacking in many songbird species. In this study, we analysed mark-recapture encounter histories of seventeen species of songbirds that were collected during a 14 yr mist netting effort at the Ft. Riley Military Reserve in ne. Kansas. We estimated apparent adult survival ( $F$ ) and detection probability ( $p$ ) for both male and female songbirds of all species and related variation in estimates to breeding habitat and residency status. We found that apparent survival was higher in males for most species, but detection probability did not differ between sexes. Songbirds breeding in shrubs had a higher apparent survival than species breeding in forests, which could be due to low abundance and patchiness of shrubs as breeding habitat. This study provides the first apparent survival estimates for 7 species of songbirds, which can be used to improve current population matrixes. In addition, this study will improve our understanding of songbird demography and will benefit conservation efforts in the future.

#### **441 Walsh, Kovach**

Developing a genetic hybrid index for Saltmarsh and Nelson's Sparrows. JENNIFER WALSH and ADRIENNE I. KOVACH, *Univ. New Hampshire, Durham, NH*.

Hybridization is influential in shaping species dynamics and has a number of conservation and evolutionary implications. Investigating patterns of interspecific hybridization requires the accurate identification of genotypic classes of hybrid individuals. These genotypic classes are important for estimating rates of introgression and for inferring spatial and temporal changes in the hybrid zone. To

quantify patterns of introgression between 2 tidal marsh endemic birds, the Nelson's and Saltmarsh sparrow, we used a next generation sequencing approach to develop a set of diagnostic genetic markers for these species. We designed primers to isolate 37 potentially diagnostic microsatellite loci identified from whole genome sequences that differed in repeat length between the species. These loci were first screened in 12 individuals of each species to evaluate species-specific patterns. 12 diagnostic or near diagnostic loci were identified and then screened in 100 additional allopatric and sympatric Nelson's and Saltmarsh sparrows. To evaluate whether the diagnostic loci provided increased resolution for hybrid identification, we compared the new marker set to a previously developed panel of non-diagnostic microsatellite markers. Using genotypes from allopatric individuals, we created a simulated hybrid data set, which was used to compare the statistical power of each marker in identifying hybrid classes. Once validated, the markers were used to calculate a hybrid index for 100 individuals sampled within the overlap zone to assess applicability of the new loci in identifying hybrids within mixed populations. The genetic hybrid index was also compared with a morphological, plumage-based index to evaluate the accuracy of identifying hybrid individuals in the field.

#### **442 Waselik, Grindstaff**

Personality trait development and relationships to learning in Zebra Finches. MATTHEW WASELIK and JENNIFER L. GRINDSTAFF, *Dept. Zool., Oklahoma State Univ., Stillwater, OK.*

Individual consistencies in behavior over time or across contexts, also known as personalities, have been a popular subject of research in animals in recent years. Animal personalities are believed to enhance survival and reproductive success, and thus fitness. However, the developmental basis of personality traits is still not well understood. Exposure to parasites, immune challenges, and other stressors during development has the potential to alter personality expression in adulthood, but previous research has generally not addressed the potential interactive effects between developmental and adult stress exposure on adult personality and behavior. In addition, the potential for personality traits to correlate with learning ability is also not well explored. The objective of this study was to determine the proximate determinants of 2 core aspects of personality (activity and boldness) in a captive population of Zebra Finches (*Taeniopygia guttata*). We used oral dosing with corticosterone (CORT) to simulate natural activation of the stress response and challenge with lipopolysaccharide (LPS) to simulate exposure to a bacterial challenge (which can also activate the stress response). CORT treatment was administered during development and LPS challenge was administered in adulthood. The correlations between activity and boldness and performance on a novel foraging learning task were also quantified. The interaction between developmental CORT treatment and adult LPS challenge significantly affected adult boldness. Additionally, birds exhibited consistent levels of activity and boldness when tested multiple times. No significant relationships between learning and personality traits were found, meaning that activity and boldness are not accurate indicators of learning ability.

#### **443 Watt, Becker, Iberle**

American Goldfinch courtship feeding relationship to male characteristics: do younger males try harder and earlier? DORIS WATT, MARGARET BECKER and JENNA IBERLE, *Saint Mary's Coll., Notre Dame, IN.*

Female American Goldfinches are thought to prefer brighter males with more saturated yellow colored plumage on their breasts. Courtship feeding is also a likely male characteristic that females may "sample" as a predictor of the male's ability and willingness to feed them over the two-week incubation period as well as their aptitude for feeding nestlings. We hypothesized that plumage characteristics and courtship feeding rate should be correlated. Two small social groups of goldfinches were captured in May 2012 and held 1 - 2 d in indoor aviaries. Social interactions including dominance interactions and courtship feedings were observed and compared to physical measures of individual males. Breast and throat color brightness indices were assigned based on Munsell color measurements. The completeness of black crown patch (% black) and crown patch size, the completeness of back and nape molt (% yellow), color index for brightness of the orange bill, as well as unflattened wing chord, body weight and change in weight during captive period were also recorded. Multiple regression of characters as predictors of relative amounts of exhibited courtship feeding did not produce a significant model. However, the character that was most highly correlated to the best model, wing length, alone was a significant predictor of courtship feeding ( $r = -0.60$ ,  $P = 0.04$ ). Age, a correlate to wing length, was associated with courtship feeding; overall, SY males ( $n = 7$ ) had a higher average frequency (0.25) and ASY males ( $n = 5$ ) had a



lower average frequency (0.046) of courtship feedings. In a third group tested 19 Jun, SY males (n = 5) only averaged 0.08 while ASY males (n = 3) averaged 0.20 of the courtship feedings.

#### 444 Wells, Barker

Production of variable microsatellites and application on a species of cooperatively breeding wren. MICHAEL T. WELLS and F. KEITH BARKER, *Dept. Ecol. Evol. & Behav., Univ. Minnesota, St Paul, MN.*

Mating systems in cooperative breeders encompasses a number of genetic mating systems, ranging from genetically monogamous breeding individuals to some of the highest measured levels of promiscuity for any organism. Insight into mating systems, particularly the frequency of extra-pair fertilizations (EPF), has been hypothesized to increase the relatedness of adult offspring to nestlings, providing greater benefits in helping, and setting the stage for the evolution and maintenance of these highly social behaviors. We used next generation Illumina sequencing to produce 4.2 million 260 bp reads of sequence for a cooperatively breeding wren, *Campylorhynchus zonatus*. We then searched for tetra- and penta-nucleotide microsatellite repeats using the program htssr (Jennings, et al. 2011, **Molec. Ecol. Resources** doi: 10.1111/j.1755-0998.2011.03033.x), and designed primers around these fragments using batch primer3. This method yielded 568 unique candidate repeats. Initial application of 11 of these repeats on a population of 37 individuals, with 8 fledglings and nestlings yielded very low levels of promiscuity for most groups, consistent with previous findings in the genus. However, 2 juveniles were found to be unrelated to any sampled past or present members of their natal group, suggesting egg-dumping behaviors may occur in this species.

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Blakesley, J A	217	Buehler, D A	200	Chandler, C R	306
Bloch, N I	s5.7	Buehler, D A	407	Chandler, R	s4.2
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Bloom, D	s10.13	Buehler, D A	s4.15	Chang, B S W	s5.7
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Chevron, Z A	s9.13	Cox, W A	75	Dodge, S	171
Chiavacci, S J	77	Cox, W A	89	Dolan, A C	19
Chilson, P B	226	Cox, W A	341	Dornak, L L	24
Chua, V L	326	Cracraft J L	390	Douglas, D	171
Chutter, C M	19	Cracraft, J	414	Dow, P	316
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Cicero, C	s10.13	Crawford, D L	s4.4	Duchamp, J	s4.10
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Claramunt, S	s10.6	Culbert, P D	90	Duckworth, B	364
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Clarke, J A	144	Curry, R L	13	Dumbacher, J P	325
Clarke, J A	P1	Curry, R L	71	Dumbacher, J P	370
Clarke, J A	s1.1	Curry, R L	338	Dunn, P O	22
Clayton, D H	s7.4	Curry, R L	347	Dunning, J B	362
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Cochran W W	111	Daniel, I J	334	DuVal, E H	66
Cochran, W W	160	Daniel, I J	343	DuVal, E H	122
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Cohen, J B	173	Danner, R M	186	Eaton, M D	53
Cohen, J B	195	Danner, R M	223	Edwards, S V	54
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Cohen, J B	373	Dauphine, N S	s9.2	Edwards, S V	410
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Prevost, S C	407	Riffell, S K	221	Ruiz, M O	165
Price, J J	52	Riffell, S K	335	Ruiz-Sanchez, A	80
Price, J J	53	Rigby, E A	133	Rumble, M A	198
Price, T D	376	Rios, N	s10.13	Rushing, C S	81
Price, T D	s5.7	Rios-Munoz, C A	339	Ruskin, K J	47
Price, T D	s6.4	Risch, T S	129	Russell, L	s10.13
Prince, K	229	Risch, T S	330	Ryder, T B	332
Projecto-Garcia, J	92	Rivera-Caceres, K D	411	Sackinger, N J	413
Proudfoot, G A	320	Rivers, J	s8.4	Sager-Fradkin, K	220
Pruett, M S	18	Rivers, J W	s8.6	Sakaluk, S K	312
Pruett-Jones, S	52	Rochelle M	149	Salgado-Ortiz, J	105
Pruett-Jones, S	99	Rodewald, A	168	Salik, F	s2.3
Prum, R	188	Rodewald, A D	56	Salinas, M A	417
Prum, R O	180	Rodewald, A D	216	Salinas-Melgoza, A	218
Prum, R O	189	Rodrigo, A	436	Salzberg, S L	134
Ptaschinski, J S	343	Rogers, C M	412	Sanchez A E	404
Pugh, S A	s4.4	Rogers, C M	423	Sanchez, C	155
Puiu, D	134	Rohrbaugh, R	s4.15	Sandercock, B K	28
Purdy C	111	Rohrbaugh, R	s4.3	Sandercock, B K	169
Pusch, E A	408	Rohrbaugh, R W	s4.4	Sandercock, B K	170
Pyle, P	333	Rois, L	2	Sandercock, B K	440
Queller, P S	s5.8	Rojas-Soto, O	80	Sandler, A	146
Rabosky, D L	s1.8	Rolland, V	14	Sanin, C	414
Radeloff, V	s3.3	Roman, I	119	Sanin, C	s1.2
Radeloff, V C	29	Rompre, G	s2.2	Santiago-Garcia, S	415
Radeloff, V C	90	Rompre, G	s2.5	Saracco, J F	207
Raedeke, A H	110	Rosenberg, K V	s3.5	Sardell, J M	416
Raherilalao, M J	s6.3	Rosenberg, K V	s4.2	Sardell, R J	182
Raimondi, P	365	Rosenberg, K V	s4.3	Sari, E H R	2
Raipar, M N	s9.4	Ross, E J	206	Sarquis-Adamson, Y	214
Rakhimberdiev, E	316	Ross, J C	353	Saucier, J R	155
Ramarez-Barrera, M	415	Ross, J D	205	Saucier, J R	386
Rand, G J	197	Rota, C T	198	Sauer, J	s3.6
Randall, C A	409	Rotenberry, J	17	Savit, A Z	94
Ratcliffe, L M	20	Rotenberry, J T	105	Sayago, R	417
Reboreda, J C	418	Rotenberry, J T	372	Scardamaglia, R C	418
Reddy, S	323	Roth, A	s4.14	Schmaljohann, H	316
Reddy, S	s6.1	Roth, A	s4.3	Schmidt, K L	102
Redmond, L J	19	Roth, A	s4.4	Schmitt, C J	106
Ree, R	s1.7	Roth, A	s4.5	Schneider, K J	419
Reed, W L	s5.10	Roth, A	s4.7	Schoech, S J	16



Schoech, S J	39	Skrade, P D B	215	Stenger, J M	64
Schoech, S J	309	Skrade, P D B	421	Stevens, M	s5.2
Schoech, S J	313	Slowinski, S	18	Stewart, I R K	86
Schoech, S J	s2.7	Small, D M	332	Stoddard, M C	s5.2
Scholes, E	s10.3	Small, T	313	Stodola, K W	360
Schroeder, J	86	Small, T W	39	Stodola, KW	424
Schwabl, H	38	Small, T W	309	Storz, J	92
Schwagmeyer, P L	86	Small, T W	s2.7	Stouffer, P C	310
Schwartz, S J	s5.6	Smalling, C	s4.5	Stouffer, P C	s9.10
Seavy, N E	316	Smalling, C	s4.6	Stouffer, P C	s9.6
Seddon, N	s10.6	Smalling, C	s4.9	Strager, M P	31
Seeholzer, G F	95	Smalling, C	s4.8	Stratford, J A	425
Sehgal, R	395	Smiley, A	3	Stratford, J A	s9.10
Sehgal, R N M	167	Smit, B E	231	Strausberger, B M	s8.3
Sehgal, R N M	378	Smith, A	s3.4	Strausberger, B M	s8.7
Sekercioglu, C H	s9.1	Smith, B T	143	Strausberger, B M	s8.8
Seo, K	420	Smith, B T	s1.2	Streby, H	YPA1
Shaffer, T L	131	Smith, D R	407	Streby, H M	s4.1
Shah, S S	172	Smith, E K	231	Streby, H M	s4.11
Shapiro, B	134	Smith, N A	s1.4	Streby, H M	s4.12
Shawkey, M D	s5.3	Smith, N D	176	Streby, H M	s4.13
Shawkey, M D	s5.4	Smith, R J	157	Streby, H M	s4.15
Shearer J A	414	Smith, T B	378	Strenger, J M	166
Sheldon F H	93	Smith, V S	s7.2	Stryjewski, K F	s6.5
Sheldon, D	439	Smith-Patten, B D	s9.12	Stutchbury B J M	344
Sheldon, F H	318	Smolinsky, J A	157	Stutchbury, B J M	202
Sheldon, F H	326	Smolinsky, J A	160	Sullivan, B	s3.5
Sherry T W	61	Soencer, C	s10.13	Sullivan, K A	427
Shizuka, D	183	Sofaer, H R	85	Sullivan, S M	219
Shreve, S M	s7.1	Solomon, M	191	Sumner, M D	316
Shriver, W G	161	Soos, C	42	Sutherland, J M	212
Shufflebarger, E F	334	Sorci, G	86	Swan, D	s8.2
Shufflebarger, E F	343	Sorenson, M D	s6.5	Swanson, D L	5
Shultz, A J	54	Sosa-Lopez, J R	100	Swanson, D L	40
Shultz, A J	s10.5	Sousa, B F	199	Swanson, D L	41
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Shustack, D P	7	Specht, H M	422	Swanson, M T	428
Shutler, D	201	Spellman, G M	147	Szabo, I	429
Siefferman, L	211	Spellman, G M	153	Taff, C C	115
Siefferman, L	367	Spellman, G M	374	Takagi, K	400
Siefferman, L M	15	Spellmeyer, A J	423	Takushi, S	430
Sieffermen, L	377	Spicer, G	378	Tarr, N M	431
Sigel, B J	25	Spitzer, M D	65	Tarvin, K A	s5.8
Sigel, B J	322	Spottiswoode, C N	s6.5	Tarwater, C E	187
Sillett, T S	11	Stafford, J D	360	Tarwater, C E	s9.7
Sillett, T S	85	Stager, M	41	Taylor, P D	201
Sillett, T S	178	Stager, M	s10.12	Taylor, R	333
Silva, W R	23	Stanback, M T	46	Taylor, S	74
Silveira, L F	50	Stanback, M T	334	Taylor, S S	310
Silveira, L F	342	Stanback, M T	343	Tedeschi D J	32
Silveira, M B	82	Stanton, R A	57	Tegeler, A K	432
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Skeen, H R	s10.11	Steele, A	s10.13	Terhune, T	s4.5

Terhune, T	s4.8	Vitz, A	432	Wieczorek, J	s10.13
Termignoni, G F	434	Vitz, A	s4.10	Wikelski, M	158
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Thogmartin, W	s4.2	Voss, M A	406	Wilcoxon, T E	s2.3
Thomas, A D	28	Wadleigh, R	356	Wilcoxon, T E	s2.4
Thomas, D B	s10.2	Wagner, G P	180	Wiley, A E	s10.7
Thomas, D B	s5.9	Wagner, S K	196	Wilkerson, J B	407
Thompson, C F	312	Walker, B L	315	Will, T	s4.2
Thompson, F R	57	Walker, E D	165	Will, T	s4.6
Thompson, F R	60	Walsh, J	441	Willard, D	438
Thompson, F R	75	Walters, J R	91	Williams, G	3
Thompson, F R	89	Walters, J R	222	Wilton, P R	410
Thompson, F R	304	Walters, J R	223	Winder, V L	169
Thompson, F R	321	Walther, E L	167	Winder, V L	170
Thompson, F R	350	Wan, D	154	Winger, B	s1.1
Thompson, F R	369	Wang, J M	84	Winger, B	s1.7
Thompson, J	408	Wang, Y	121	Winger, B M	s1.8
Thorpe, P A	44	Ward, M P	77	Wingert, A K	383
Thrimawithana, A H	436	Ward, M P	160	Winkler, D	s10.12
Title, P O	139	Ward, M P	165	Winkler, D W	84
Tobias, J A	s10.6	Ward, MP	424	Winkler, D W	316
Toms, J D	341	Ware, H	34	Winkler, D W	318
Tonra, C M	220	Waselik, M	442	Winn, B	36
Tonra, C M	438	Wassenhove, S J	s2.3	Wisely, S M	169
Toomey, M B	s5.6	Watt, D	443	Wisely, S M	170
Town, C	s5.2	Webb W C	401	Witt C	92
Townsend, A K	230	Webb, E B	110	Witt, C C	3
Tranquillo, K	333	Webb, K	439	Witt, C C	106
Tsai, W	s10.8	Webster, M	s10.1	Witt, C C	164
Tsang, S M	137	Webster, M S	11	Witt, C C	325
Tubaro, P	355	Webster, M S	38	Witt, C C	s10.9
Ueda, K	120	Webster, M S	67	Witt, C C	s5.6
Ueda, K	420	Webster, M S	68	Witt, C C	s7.7
Unitt, P	358	Weckstein, J D	152	Wogan, G O U	185
Uy, J A C	416	Weckstein, J D	s7.2	Wolf B O	308
Vaidya, G	51	Weckstein, J D	s10.11	Wolf, B O	231
Vallender, R	s4.14	Weinzierl, R	158	Wolfenbarger, L L	26
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Valqui, T	s7.2	Weir, J T	s1.9	Woltmann, S	s9.8
Van Doren, B M	439	Weiskerger, C J	125	Wonder, E E	232
Van Wilgenburg, S L	s4.14	Wellicome, T	389	Wood, C	s3.5
Vargas Campos, W	106	Wells, M T	444	Wood, E M	29
Vavrus, S J	s3.3	Westneat, D F	86	Wood, E M	90
Vazquez-Lopez, M	415	Westneat, M W	181	Wood, P B	31
Vazquez-Miranda, H	156	Wheeler, S S	230	Wootton, J T	179
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Vergara, P	119	White, G	s2.2	Worley, S K	407
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Villarruel-Sahagun, L	45	Whitney, B M	141	Wright, S G	347
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Zakaria, M H	s9.4
Zamudio-Beltran, L E	415
Zanette, L	s8.2
Zaya, D N	125
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Zollner, P A	s2.5
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