



# Abstract Book

## **Honored Speakers**

Plenary Speakers	1
Young Professional Award Speakers	2-3

## **Symposia**

Hummingbird Conservation Symposium (S01)	4-7
Biological Invasions: Consequences For Native Birds In a Changing World (S02)	8-9
Conservation Biology and Evolutionary Genetics of Aphelocoma Jays (S03)	10-13
Climate Change: Consequences For Birds (S04)	14-17
Current Conservation Issues For Birds of Semi-Arid Regions (S05)	18-19

## **Topical Sessions**

Behavior (G01)	20-22
Breeding Biology (G02)	23-26
Conservation (G03)	27-30
Community Ecology (G04)	31-33
Habitat Relationships (G05)	34-38
Migration (G06)	39-42
Molt/Morphology (G07)	43-44
Physiology (G08)	45
Population Ecology (G09)	46-48
Systematics/Evolution (G10)	49-51
Tropical (G11)	52
Ornithological Profession (G12)	53

**Posters**

Behavior (G01)	54-55
Breeding Biology (G02)	55-57
Conservation (G03)	58-60
Community Ecology (G04)	60
Habitat Relationships (G05)	60-63
Physiology (G08)	63
Population Ecology (G09)	64
Systematics/Evolution (G10)	65-67
Tropical (G11)	68

**Author Index**

69-70



## Plenary Speakers

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### NEW PERSPECTIVES IN EVOLUTIONARY ORNITHOLOGY

Avian diversity has fascinated biologists for thousands of years and the search for the mechanisms behind the origination, modification, and historical persistence of this diversity has fueled major breakthroughs in evolutionary and life history theory. Now, in the post-genomic era, 150 years since Darwin's theory of natural selection, birds, and ornithologists, are again on the forefront of a new evolutionary synthesis. New empirical advances enable us, for the first time, to resolve such long-standing conceptual problems as the link between adaptation and adaptability, between development and inheritance, and between within-generation plasticity and evolutionary change. I will highlight empirical studies of the ecology and evolution of avian maternal effects and plumage coloration to illustrate the promise of this new approach and to suggest that it brings us closer to a more realistic understanding of avian diversity and its evolution.

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### ARE SOME MANIRAPTORANS BIRDS RATHER THAN DINOSAURS?



## Young Professional Award Speakers

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### INTERPLAY BETWEEN SEASONAL CHANGES IN STRESS PHYSIOLOGY, ENVIRONMENTAL CUES AND MIGRATORY BEHAVIOR IN AN IRRUPTIVE NOMAD, THE RED CROSSBILL

Nomadic and opportunistic species specialize on resources that are unpredictably distributed and typically display a higher degree of behavioral flexibility than seasonal migrants. Here we evaluate hypotheses regarding stress physiology and behavior that have been generated in the seasonal breeder and migrant literature using data collected from captive and free-living red crossbills (*Loxia curvirostra*), a nomadic migrant and opportunistic breeder. Our data reveal some interesting and very different seasonal patterns. For example corticosterone levels are highest during molt in red crossbills. This result challenges the current hypothesis that HPA-axis suppression protects protein stores during feather formation. However, response to reduced food supply in captive red crossbills was similar to that seen in seasonal breeders. Reduced food availability resulted in increased baseline corticosterone and activity levels. Interestingly, this effect could be enhanced or attenuated by allowing visual and acoustic access to a neighbor with reduced food availability or ad libitum food, respectively. These data suggest that mechanisms for group coordination of irruptive migration, or at least for increasing accuracy of food assessment, exist and may act through an endocrine pathway.

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### SEASONAL DECLINE IN AVIAN CLUTCH SIZE: A TEST OF FOUR ALTERNATIVE HYPOTHESES

Average clutch size typically changes as the breeding season progresses in many taxa, including insects, fish, reptiles, mammals, and birds. In birds, individuals that reproduce early in the breeding season tend to lay larger clutches than those that breed later. Despite the ubiquity of this pattern and extensive research on the topic, we still do not understand the underlying causes of why avian clutch size declines seasonally. Here, we simultaneously evaluated four commonly cited hypotheses: food availability for egg production, food availability for nestlings, nest predation, and female age. We failed to find support for the nest predation hypothesis. Instead, our results suggest that seasonal changes in age of breeding females and the availability of food for nestlings cause seasonal declines in clutch size. We emphasize the importance of examining multiple hypotheses simultaneously to elucidate the ecological processes that impose the strongest selection on commonly observed life history traits.

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## WHERE SHOULD WE PLACE THE NORTHERN BOUNDARY OF THE SOUTHWESTERN WILLOW FLYCATCHER?

The northern boundary of the endangered Southwestern Willow Flycatcher (*Empidonax traillii extimus*) is approximately located in southern Colorado and Utah, but a more precise estimate of the location is needed. To help better define the location of the boundary, I evaluated the geographic distribution of molecular genetic markers sampled from 25 breeding sites across Arizona, Colorado, New Mexico, and Utah. I found breeding sites clustered into two major groups, generally consistent with the current boundary; however, delineating a precise boundary between the two subspecies was proved difficult because 1) I found evidence for a region of intergradation across the boundary area, implying the boundary is not a discreet line, and 2) the boundary region is sparsely populated, with few extant breeding populations to help fix a boundary. I overcome these difficulties by modeling the geographic distribution of genetic markers as a function of latitude and elevation. The model was brought into a GIS environment to create multiple candidate boundaries, with the strength of each candidate boundary evaluated on the basis of how much genetic variation it separated.



## Hummingbird Conservation Symposium (S01)

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### ORIGIN AND EVOLUTION OF HUMMINGBIRDS: BIOGEOGRAPHY AND ADAPTATIONS TO LIFE AT HIGH ELEVATIONS

The hummingbirds are among the most species rich families of birds and although restricted to the western hemisphere, have colonized diverse and challenging habitats including islands, deserts, and high elevations. We have recently published a phylogenetic tree for 151 of approximately 330 species based on two protein-coding mitochondrial genes (ND2 and ND4), flanking tRNAs, and two nuclear introns (AK1 and BFib). In the context of our well-resolved and well-supported phylogenetic estimate, we are examining the origin and diversification of the family, and the aerodynamic and physiological adaptations for flight at high elevations. Concerning the historical biogeography, we have found that the basal hummingbird assemblages originated in the lowlands of South America. In addition, most of the principle clades of hummingbirds originated on this continent, but there have been at least 30 independent invasions of other primary landmasses, especially Central America. Hummingbirds that live at high elevation exhibit numerous adaptations including altered hemoglobin protein structure, and changes in body mass and wing size that allow for remarkably efficient locomotion despite the high costs of flight in hypobaric air.

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### FEEDING ECOLOGY AND FORAGING STRATEGIES IN MEXICAN HUMMINGBIRDS.

The hummingbird-plant interaction can be considered as key process for biodiversity conservation. We addressed the resources used by hummingbirds in different regions of Mexico, evaluating the timing and abundance of both groups. 64 hummingbird species live in Mexico, are more diverse and abundant in highlands of all mountain chains of the country, and many species (both residents and migrants) move altitudinally searching floral resources. Plant species such as *Salvia*, *Lobellia*, *Erythrina*, *Hamelia* are important nectar sources for hummingbirds. Floral availability changes a lot seasonally as hummingbird communities also do. Resource availability can be correlated with foraging strategy, and this can change with the species, sex and age of the individuals, affecting community structure. Plant and hummingbird phenologies should be tightly coupled over time, and uncoupling phenologies as a result of, for example climate change, can cause disruptions and severe changes in hummingbird community structure. The precise understanding of both feeding ecology and foraging strategies can help in proposing management solutions to ensure conservation.

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#### THE USFS AND CONSERVATION OF WESTERN HUMMINGBIRDS

We discuss the role of the US Forest Service (USFS) in hummingbird conservation and identify needs to promote hummingbird conservation. The mission of the USFS is to sustain the health, diversity, and productivity of the Nation's forests and grasslands to meet the needs of present and future generations. Therefore, the USFS is a critical link for integrating current science into land management actions toward the protection and enhancement of western hummingbirds and their habitats through monitoring, research, education, and habitat management and improvement on National Forest System lands and, through partnerships, on private lands in the US and throughout the breeding, migration, and winter range of the birds. In order for the USFS to successfully achieve hummingbird conservation, specific information and tools are required, including information on habitat needs of breeding, migrating, and wintering hummingbirds; identification of important habitat components for which to manage; identification and prioritization of habitat improvement needs; effective monitoring techniques to assess population trends and management success; identification of information gaps for focused research; and identification of education needs and methods.

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#### CONSERVATION GENETICS OF HUMMINGBIRDS: STATE OF THE SCIENCE AND PRIORITIES FOR RESEARCH

Genetics has recently emerged as an essential element in the toolkit of the avian biologist and natural resources manager. From DNA information scientists can identify individuals, sex, parentage, pedigrees, population assignment, landscape-scale population structure, and genetic diversity. While model organisms and some groups of vertebrates have received significant genetic research attention, hummingbirds have received very little. This paucity of information may be attributed to factors including historical lack of laboratory tools, limited opportunities to handle hummingbirds in hand, and challenges of collecting sufficient genetic samples noninvasively from such small animals. With the advent of polymerase chain reaction (PCR)-based trace DNA analysis and versatile molecular genetic markers such as mitochondrial DNA, microsatellites, and SNPs (single nucleotide polymorphisms), previously cryptic and intractable biological relationships can be revealed. My goal is to present a plain-language summary of the molecular tools, opportunities, challenges, and priorities that lie ahead in the path of application of genetics for hummingbird biology and conservation.

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#### BREEDING BIOLOGY OF HUMMINGBIRDS: WHAT WE KNOW AND WHAT WE DON'T

Despite the fact that, among Neotropical birds, hummingbirds are among the best studied groups, our knowledge of their reproduction is far from complete. Using the hummingbird fauna of Ecuador, one of South America's most trochilid-rich countries, I examine the relative levels of knowledge of the reproductive ecology of hummingbirds. I will discuss aspects of reproduction which are most poorly known and point to future directions which will likely be most valuable for ecologists and conservationists.

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#### A STABLE ISOTOPE STUDY OF MIGRATORY CONNECTIVITY IN RUFOUS HUMMINGBIRDS

We present preliminary results of a study of migratory connectivity in the Rufous hummingbird (*Selasphorus rufus*), using deuterium analysis of feather material.

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#### HUMMINGBIRDS: ENERGY, WATER, AND PHYSIOLOGICAL DESIGN

The small size, high water intake, and unique mode of flight that is characteristic of hummingbirds has necessitated physiological adaptations designed to facilitate energy and water budget management. The high daily energy expenditure (DEE) of hummingbirds is driven by their small size and high cost of hovering flight (10X BMR). Metabolic demand is fueled by sugar consumed with nectar that by volume dominates their diet. Sugars are processed at an impressive rate minimizing oxidation of stored fat needed for nocturnal metabolism. If energy intake is below DEE hummingbirds have the ability to use nocturnal hypothermia (torpor) to reduce DEE. Emerging evidence suggests that hypothermia is not physiologically restorative so is likely avoided when possible. A byproduct of nectar consumption is high daily water intake. Hummingbirds consume up to 5X their body mass in water. This likely frees them from concerns of the high evaporation rates characteristic of small animals allowing them to thermoregulate even at extreme temperatures. Thus both the water and sugar content of nectar were likely selective forces in crafting hummingbird design.

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#### GLOBAL CHANGE AND HUMMINGBIRDS.

Destruction of natural habitats, invasive species, and climate change are dramatically modifying our world. In this talk, I conduct a brief review of the effects that the different components of global change could have on hummingbirds. The loss of natural habitats has had negative effects on some forest-dwelling species. For others, areas modified by human activities and under secondary succession may lead to increased areas where hummingbird nectar plants grow and thus could play an important role for maintaining large populations of several hummingbird species in North America. The presence of invasive plant species that disrupt ecological processes along migratory routes may also be an important threat for long distance migratory species. Changes in temperature and humidity could generate important mismatches between plant phenology and hummingbird biology, including an immediate change in the amount of nectar produced. There is a potential synergism among habitat loss, invasive species and climate change that could affect the ecology of most North American species of hummingbirds.

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#### DISEASES AND POPULATION HEALTH OF HUMMINGBIRDS: STATE OF CURRENT KNOWLEDGE AND PRIORITIES FOR RESEARCH

Avian disease research has evolved in recent decades and provides valuable information about bird biology. Given their foraging behavior, migratory nature, and vast geographic distribution, hummingbirds are sentinels for environmental impacts of pollutants and pesticides. Identification of disease conditions that affect hummingbirds will establish indications of general health, provide key parameters necessary for population viability analyses and environmental risk assessments, and assist conservation efforts. While other avian groups have received significant research attention, hummingbirds have received very little. This paucity of information may be attributed to factors including the historical lack of bird-in-hand opportunities and challenges of collecting disease information from such small animals. Our goal was to evaluate existing scientific information on diseases of hummingbirds and provide recommendations for future efforts. We conducted a literature search for bacterial, viral, fungal, and parasitic infections and toxicologic conditions. We will describe our findings and outline a course for systematic evaluation of health parameters and diseases. Identification of diseases impacting hummingbird populations is an essential step toward evaluating environmental and health challenges that impact fertility, behavior, population dynamics, and future population viability.

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#### HUMMINGBIRDS AND THEIR FLOWERS: NEW PERSPECTIVES AND IMPLICATIONS FOR CONSERVATION

Hummingbirds participate in an ecological interaction involving almost one-third of described species, that between flowering plants and animal pollinators. The interaction is mutually beneficial but not cooperative: plants seek sexual services whereas pollinators seek reward, usually food. As a result, many pollinators, including the flame-throated hummingbirds of North America, are opportunistic in flower use, and classical typologies such as “hummingbird flowers” (and “pollination syndromes” more broadly) fail to adequately capture the mutualism. Instead, communities of plants and pollinators are joined in webs of interaction, with specialists usually connected to generalists rather than other specialists. This asymmetry tends to buffer a pollination web, including opportunists such as hummingbirds, from extinction of component species. But opportunism requires opportunity, and hummingbirds—especially migratory species—may encounter few nectar sources in parts of their annual cycles. If anthropogenic insults such as climate and habitat change stretch these already-weak links, the cycles may be broken. This appears to me a place for future focus in research and conservation.

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#### HUMMINGBIRD MIGRATION: A REVIEW OF MOVEMENT PATTERNS AND MECHANISMS

Migration routes and movements patterns for hummingbirds are poorly known. Most hummingbird species, particularly tropical species, are not long distance migrants, but are involved in local movement patterns, such as altitudinal migration. Long distance hummingbird migrants occur mainly in the temperate regions of the Americas. In western North America, the most studied area, these routes are described for only a few species, but mechanisms underlying these movement patterns have not been studied. In this talk, I will review characteristics of hummingbird movement patterns and provide examples. Additionally, I will review mechanisms influencing migration of other bird families and, using phylogenetic reasoning, suggest which mechanisms might apply to hummingbirds. Techniques used to study migration will also be reviewed and evaluated for use in the study of hummingbird migration.



## Biological Invasions: Consequences For Native Birds In a Changing World (S02)

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### RED IMPORTED FIRE ANTS CAN DECREASE SONGBIRD NEST SURVIVAL

Red imported fire ants (*Solenopsis invicta*) are known predators of songbird nests. We conducted a replicated manipulative experiment to quantify the decrease in nest survival caused by *S. invicta*. We also quantified the frequency of *S. invicta* foraging near songbird nests and factors associated with the susceptibility of songbird nests to *S. invicta* predation. We monitored 45 black-capped vireo (*Vireo atricapilla*), 67 white-eyed vireo (*V. griseus*), and 123 northern cardinal (*Cardinalis cardinalis*) nests in 9 shrubland patches of 36–103 ha each in central Texas, USA in 2006–2007. Preventing *S. invicta* from preying on songbird nests increased nest survival by 21% (from 10 to 31%) for white eyed vireos (n = 44) and 6% (from 7 to 13%) for black-capped vireos (n = 27). We detected *S. invicta* on the ground near 60% of songbird nests and 1 m high in vegetation near 7% of nests (n = 122). Nests <2 m high and <4 m from an edge were more susceptible to *S. invicta* predation indicating potential threshold conditions, below which songbird nests may be more susceptible.

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### INTRODUCED BIRDS ARE THE GREATEST THREAT TO HAWAIIAN FOREST BIRDS

Several introduced bird species in Hawaii have invaded native forests. During a study from 1987-2006 at Hakalau Forest National Wildlife Refuge on Hawaii Island, the Japanese white-eye, a generalist that overlaps multiple foraging substrates with each native species, increased in numbers beginning 2000. All native species became food limited. The white-eye is most similar morphologically and ecologically to the endangered Hawaii akepa, and is replacing the akepa in the sites of the increase, as well as causing declines in numerous other species. The white-eye increase had to be sustained by immigration because juvenile survival during the increase became null, even though white-eye fledglings were in good condition. The increase was associated with forest restoration in pastures above our study site that was initially colonized by white-eyes. This is a nightmarish problem for Hawaiian birds, because forest restoration at high elevation is essential to establish refugia from mosquito-borne disease. Paradoxically, there will be few birds left to inhabit these restoration forests because the white-eyes produced in these forests are invading the old-growth forests and competing with native birds.

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### SPATIO-TEMPORAL DRIVERS OF WEST NILE VIRUS IMPACT IN AVIAN HOSTS

Emerging infectious diseases present a formidable challenge to the conservation of native species. However, identifying the impacts of an introduced pathogen and distinguishing it from other forces that influence population dynamics is complex. Here, twenty potential avian hosts are examined for West Nile virus (WNV) impact across their North American population ranges. Significant changes in population trajectories, including dramatic declines, are demonstrated for seven species from four families and are consistent with a priori predictions and pathogen dispersal. Spatial and temporal heterogeneity in West Nile virus impact suggest important interactions among pathogen amplification, human land use and climate. These findings illustrate the potential consequences of pathogen emergence for a diverse faunal assemblage across broad geographic scales and underscore the complexity of subsequent community response.

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#### INVASION OF AN EXOTIC FORB IMPACTS REPRODUCTIVE SUCCESS, SITE FIDELITY, AND SONG IN A MIGRATORY PASSERINE

Exotic plants are likely to impact higher trophic levels when they overrun native plant communities, but few studies have examined the specific nature of these effects. We studied chipping sparrows breeding in savannas that were either dominated by native vegetation or invaded by spotted knapweed, an exotic forb that substantially reduces prevalence of native plants. We found that grasshoppers, an important prey resource, were substantially reduced at knapweed versus native sites. In addition, initiation of first nests was delayed at knapweed versus native sites, an effect frequently associated with low food availability, and breeding delays translated to reduced estimates of seasonal fecundity. Site fidelity of breeding adults and the proportion of older versus yearling males were also reduced in knapweed compared to native habitats. These differences may further affect song structure because yearling males adopt their one signature song from their neighbors in their first breeding season. Accordingly, we found lower song similarity among males at knapweed compared to native sites. Our results strongly suggest that knapweed invasion can have complex effects on chipping sparrow populations by reducing food availability.

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#### BIOLOGICAL INVASIONS AND AVIAN SPECIES: IMPACTS, IMPLICATIONS FOR NATIVE COMMUNITIES, AND MANAGEMENT.

Research on biological invasions has increased dramatically in the past two decades. However, most ecological work has focused on plant invasions and their impacts on native vegetation, and far less is known about the ecology of biological invasions as it relates to higher trophic levels. A brief survey of the literature indicates that avian species can be affected in a range of ways by a great variety of biological invaders including plants, invertebrates, mammals, birds, and pathogens. Although most documented effects of invasions on avian biology are negative, invasions can sometimes benefit birds, particularly when they generate new concentrated food resources. Both positive and negative direct effects on birds can translate to strong negative indirect effects on non-avian species and ecosystem processes, though such outcomes are understudied. There is evidence that some birds can adapt to invaders over time, but this subject is also understudied. Managing to mitigate invader impacts on birds and other native species has proven challenging and sometimes backfires due to complicated community interactions. Additional research is necessary to understand and manage invader impacts on avian species.

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#### WHY SALT CEDAR MATTERS AS BIRD HABITAT IN THE SOUTHWEST

In the southwestern United States, there are extensive efforts underway to control exotic saltcedar (*Tamarix ramosissima*, *T. chinensis*, or hybrid). Although saltcedar habitat tends to support fewer species and individual birds than does native habitat, many riparian-dependent species use saltcedar in the southwest. Some of these have the potential to be negatively affected by widespread saltcedar control in at least part of their range. Furthermore, there is surprisingly little data showing that birds breeding in saltcedar are actually suffering negative effects. Therefore, saltcedar control could have unintended consequences. Overall, we contend that a) saltcedar dominated woodlands are important to southwestern riparian bird species, especially where native habitat can no longer exist, and b) saltcedar control and restoration projects that do not replace saltcedar with higher quality native riparian habitat can actually result in a net habitat loss for riparian obligate birds.



## Conservation Biology and Evolutionary Genetics of *Aphelocoma* Jays (S03)

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### EPISODIC DISEASE AND THE POPULATION DYNAMICS OF FLORIDA SCRUB-JAYS

Four epidemics have occurred over the 39-year span of our study. These appear cyclic, occurring every 9-10 years. The magnitude of each has varied as have the ecological conditions during each occurrence. Circumstantial evidence suggests arboviruses, specifically encephalitis viruses, are the likely disease agent(s). Antibody screening has revealed that as much as 25% of the population has been previously exposed to one or more of these viruses. During epidemic years, mortality rates can be more than twice that of non-epidemic years. Mortality appears highest among youngest and oldest members of the population, with carry-over effects on age structure that may persist for several years. Elevated mortality typically begins in July and extends into the fall, but duration may vary with patterns of rainfall and temperature that influence the abundance of the putative vector, mosquitoes. Our large and intact population of Florida Scrub-Jays appears resilient to disease, but impacts to other populations may vary with their size and isolation. The ecology and pathology of disease also may vary among the different social systems within the genus *Aphelocoma*.

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### ECOLOGICAL CORRELATES OF REPRODUCTIVE SUCCESS IN THE ISLAND SCRUB-JAY (*APHELOCOMA INSULARIS*)

Predicting species' responses to environmental change requires an understanding of how habitat structure influences reproductive success. Such data are especially needed for rare species in rapidly changing environments. The Island Scrub-Jay, North America's sole island-endemic bird species, lives only on Santa Cruz Island, California. Beginning in the mid-1800s, woody vegetation on the island was denuded by feral sheep, cows, and pigs. Removal of non-native herbivores over the past twenty years has allowed the vegetation to recover; these changes are expected to be beneficial to the jays. However, little research has been conducted on the jay's habitat requirements. In 2008, we initiated a reproductive ecology study to measure habitat-specific reproductive success, quantify parental breeding behavior, and map jay territories. We found 112 nests on 47 territories, fifteen of which (32%) successfully fledged young. Our first year's data suggest that nest survival probabilities, and hence reproductive output, are strongly correlated with territory size and quality. Small territories with relatively high oak cover per unit area had the lowest nest predation rates. We discuss possible ecological mechanisms that could explain this pattern.

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#### EFFECTS OF LANDSCAPE CHANGES ON GENE FLOW IN FLORIDA SCRUB JAYS

The habitat of the Florida Scrub-Jay has been dramatically destroyed and fragmented in the past decades. As a result the populations of this specialist species have dramatically declined throughout its range and it is urgent to understand what measures have to be taken to save the Florida Scrub-Jay. Using microsatellite genotypes we performed analyses to understand how those landscape changes affect gene flow, and hence dispersal movement, in this species. We tested more specifically the hypothesis that habitat gaps impede gene flow among groups of individuals; we also inferred the effects of increasing levels of habitat fragmentation on gene flow levels within populations. Our results show that dispersal movements of Florida Scrub Jay are affected by habitat fragmentation, which decreases gene flow levels within and between populations. To maintain the genetic diversity and structure of the species, and to avoid the other risks associated with reduced levels of dispersal (e.g. increased levels of inbreeding and extinction risks due to a lack of immigration), we recommend the protection and restoration of habitat corridors within the genetically differentiated groups constituting the species.

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#### GENETIC DIVERGENCE WITHIN WESTERN SCRUB-JAYS

Western Scrub-Jays (*Aphelocoma californica*) exhibit substantial geographic variation in morphology and behavior. Western Scrub-Jays are a polytypic species complex with three distinct groups (“californica”, “woodhouseii”, and “sumichrasti”) associated with geography and distinguished by morphology, genetics, and behavior. We analyzed mitochondrial DNA sequences (control region I) to assess phylogenetic relationships within Western Scrub-Jays. Our genetic results reveal that the interior “woodhouseii” group, which contains the “sumichrasti” subclade, and the coastal “californica” group have had a long and independent evolutionary history. Island Scrub-Jays evolved from the coastal “californica”, which makes Western Scrub-Jays paraphyletic with respect to Island Scrub-Jays. The phylogenetic pattern we found may be associated with environmental variability across Western North America. We used maximum entropy modeling and environmental data to predict the geographic distribution of Western Scrub-Jay groups. The resulting ecological niche model is then compared to our phylogenetic results. To more accurately define the diversity that exists within Western Scrub-Jays, we suggest splitting Western Scrub-Jays into two or three species, California Scrub-Jay (*A. californica*), Woodhouse's Scrub-Jay (*A. woodhouseii*), and, potentially, Sumichrast's Scrub-Jay (*A. sumichrasti*).

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#### TWO SOURCES OF DEMOGRAPHIC INSTABILITY AMONG POPULATIONS OF FLORIDA SCRUB JAYS (*APHELOCOMA COERULESCENS*).

Florida Scrub-Jays are confined to oak scrub typically maintained low and open by wildfire. We describe a 19-year experiment at Archbold Biological Station in which an overgrown tract of scrub was thoroughly burned, followed by complete fire suppression. Jay density increased during years 1-6, remained stable in years 7-9, then declined steadily to near-zero by year 19, revealing the first fully documented fire-cycle for this species. Maximum density was 4.5 pairs per 40 ha. Density increased mainly via immigration, while the decline involved both lower reproductive success and increased breeder mortality, corroborating that this species exhibits rapid demographic shift toward instability under fire-suppressed conditions. A different population, studied from 1991 to 2007 in Sarasota County, FL, revealed a similarly sharp demographic shift even in fire-maintained habitat. Here, the problem appears to be super-saturation by immigrating jays attracted to this uniquely optimal habitat preserve. Density-dependent reproductive success and breeder survival produced demographic instability in excess of 4.5 pairs per 40 ha, exactly the same density reached in the experimental tract at Archbold.

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#### A MULTILOCUS PHYLOGENY AND BIOGEOGRAPHIC HISTORY OF *APHELOCOMA*

The genus *Aphelocoma* has provided a model system for the study of behavioral evolution and ecological diversification. Despite previous research on the genetics of *Aphelocoma*, certain relationships within the genus have remained elusive, preventing a robust phylogenetic perspective on such exciting topics as the evolution of cooperative breeding and niche shifts during speciation. The speciation order among Mexican jays, scrub jays, and unicolored jays has been particularly elusive, likely because these lineages experienced a rapid and ancient diversification. With genetic data from 2 mtDNA genes and 11 nuclear genes, we attempt to resolve the speciation order within *Aphelocoma* using new phylogenetic methods that incorporate mutational and coalescent stochasticity among gene trees to provide a best estimate of the species tree. Our broad sampling scheme uncovers previously unrecognized genetic structure in all parts of the *Aphelocoma* phylogeny. Recent hybridization among coastal and interior clades appears to have played a large role in the current genetic make-up of the western scrub-jay, whereas footprints of ancient hybridization are revealed within Mexican jays.

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#### ISLAND SCRUB-JAY: A NEW LOOK AT THREATS AND STRATEGIES TO ABATE THEM

The Island Scrub-Jay occurs only on Santa Cruz Island, California. Although the species has no state or federal listed status, the species faces a number of novel threats to long-term viability, perhaps especially the risk of epidemic disease. West Nile Virus arrived in California in 2003 and has been attributed to the decline of a number of mainland bird populations, with mortality most pronounced among corvids. We sampled hundreds of passerines during fall 2007 and 2008 and found no evidence that West Nile is yet present on Santa Cruz Island. With regional temperatures increasing as global climates change, and with increasing prevalence of the disease on the mainland -- ca 30 km offshore of the island -- it is likely only a matter of time before the virus establishes on the island. Strategy options to abate this and other risks are few, but include vaccinating a portion of the wild population, preparing for captive breeding, and establishing a second population. We provide an overview of the planning, monitoring, research, and management underway to reduce extinction risk of this species.

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#### REVISING SPECIES LIMITS AND IMPLICATIONS FOR CONSERVATION OF ENDEMIC MEXICAN APHELOCOMA JAYS

Molecular genetic studies of *Aphelocoma* jays have revealed greater phylogenetic diversity than had been appreciated, which should be recognized as several additional species in the genus. As species limits change, so also must conservation assessments: I analyze the conservation status of each Mexican species of *Aphelocoma*, taking into account basic distributional restriction, habitat preferences, land use change, climate change, and climate change-mediated marine intrusion. The result is a synthetic view of threats to the species in the genus that result from diverse factors, permitting identification of key areas for conservation.

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#### PRELIMINARY ESTIMATE OF RANGEWIDE POPULATION SIZE AND HABITAT-SPECIFIC ABUNDANCE OF THE ISLAND SCRUB-JAY (*APHELOCOMA INSULARIS*)

The Island Scrub-Jay is North America's sole island endemic bird species and exists only on Santa Cruz Island, California. This jay's tiny range and resulting small population size make it especially vulnerable to natural disasters such as catastrophic fire, disease, and habitat alteration due to climate change. Concerns about the viability of *A. insularis* became acute in 2006 when researchers noticed an apparent negative population trend on their long-term study plot in the island's central valley. However, no rigorous population size data existed for the species. Therefore, we conducted island-wide surveys in October 2008 to estimate: 1) population size and 2) habitat-specific abundance. We used a distance sampling to survey 308 randomly selected points throughout the island. Using a hierarchical model to accommodate point-level abundance covariates, we estimated that total population size was considerably lower than previously published estimates of 10,000 – 18,000. Jays were most abundant in low to mid-elevation forest and chaparral habitats with extensive oak canopy cover.



## Climate Change: Consequences For Birds (S04)

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### DEVELOPING A TOOL TO PREDICT SPECIES' VULNERABILITY TO CLIMATE CHANGE

Climate change has the potential to affect species around the world within a very short time frame. While some effects are already apparent, particularly for birds, the complexity of natural systems and the magnitude of projected changes mean that we can only speculate on many future effects. Our task is to integrate science into management strategies and reduce a complex problem to a set of predictive factors. Identified factors that affect survival or fecundity and that potentially will be altered by changes in climate include habitat, phenology, physiology, and interspecific interactions. The goals of our project are 1) create a tool for managers to assess species' vulnerability to climate change, 2) propose a method for setting management priorities, and 3) identify vulnerabilities where actions will potentially be most effective. The proposed tool is purposely flexible so it can be updated with new information as it becomes available. This is one step towards initiating effective and anticipatory management actions to assist species.

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### OVERVIEW OF CLIMATE CHANGE EFFECTS ON BIRDS.

Climate patterns throughout the world are changing, as evidenced by increases in average global temperature and in the annual variability of weather conditions. The responses of bird populations to climate change are not well studied. This overview evaluates recently published studies and models assessing demographic patterns in apparent response to climate change. A substantial amount of evidence indicates changes in the phenology of birds, particularly of the timing of migration and of nesting. Both adult survival and the production of young of some species may be positively correlated with the Southern Oscillation Index. The study of climatically induced distributional change is currently at a predictive modeling stage, and methods will need to be developed for testing predictions. According to some models, plains and desert bird species appear more heavily influenced by climate change than montane species, with drastic area reductions and spatial movements of habitats. We review tools and methods for facilitating adaptation of bird species and discuss factors that may inhibit adaptation to climate change.

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#### THE INFLUENCE OF TREE PHENOLOGY ON AVIAN MIGRATION PATTERNS AND THE POTENTIAL ROLE OF CLIMATE CHANGE

In western North America, migration patterns of Neotropical land birds evolved in a landscape of heterogeneous environments. Migration routes and stop-over habitats of western migrant land birds appear to be assessed at four major scales; 1) corridor selection; 2) large-scale landscape features; 3) vegetation patches; and, 4) microhabitat selection within a vegetation patch. Along the major river drainages in southwestern North America, these scales are variously influenced by long-term climate, regional weather, vegetation, and insect prey base. Among the migrants that we examined, arrival date and numbers were variable among years but were largely influenced by plant phenology which serves as a key to food availability. Plant phenological cycles are related to local climate and elevation, which influences avian species arrival dates and stop-over duration. Our results suggest that large scale landscape features and long-term climate patterns drive plant phenology and associated insect abundance, and ultimately influence spring migration patterns in southwestern North America.

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#### CLIMATE-DRIVEN SHIFTS IN TIMING AFFECT POPULATION SIZES: WHAT IS HAPPENING AND THE ROLE OF THE USA NATIONAL PHENOLOGY NETWORK IN MANAGING THE CONSEQUENCES

Shifts in phenology, such as bird migrations and breeding, are among the best-documented biological responses to climate change. Species vary, however, in the magnitude of their responses. For example, some birds are migrating much earlier than in the past, some slightly earlier, while others are not changing at all or are even migrating later. Similar variation exists at all trophic levels and has the potential to greatly alter time-sensitive ecological interactions, such as those between plants and pollinators and predators and prey. Recent evidence suggests shifts in timing are already affecting population sizes. Here I will discuss recent results from my own research and that of others, focusing on the conservation and management implications of recent changes in bird phenology. I will also highlight the role that the USA National Phenology Network ([www.usanpn.org](http://www.usanpn.org)) can play in understanding the effects of climate change on birds and in developing appropriate strategies manage populations in the context of climate change.

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#### PREDICTING SPECIES RANGE SHIFTS IN RESPONSE TO ALTERED CLIMATE: IMPORTANCE OF CONSIDERING SPECIES INTERACTIONS AND LOCAL ADAPTATION

We evaluated local adaptation and biotic interactions in predicting range shifts of California Gnatcatcher to changing climate in southern California. We compared niche models calibrated from northern subspecies range (local) to models calibrated from entire species range (species). California Gnatcatchers occur along Baja Peninsula, with increasing aridity and temperatures proceeding south. The northern subspecies is restricted to coastal scrub, whereas southerly subspecies occur in several arid scrub types. Outputs of vegetation models were included as biotic variables in the dataset used for gnatcatcher models. We modeled vegetation in northern subspecies' range for local models and modeled vegetation from throughout the Peninsula for species models. We compared models under altered climates, varying temperature (+0.6°C, +1.7°C, +2.8°C) and precipitation (50%, 90%, 100%, 110%, 150%) relative to current conditions. Local models predicted habitat reductions in all altered climates, particularly when biotic variables were included. Species models predicted less habitat reduction. Local models predicted large-scale habitat loss because coastal scrub is not adapted to desert conditions. Impacts of climate change to gnatcatchers in California may depend on whether they remain restricted to coastal scrub.

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#### ADDRESSING THE CONSEQUENCES: HOW DO WE ADAPT BIRD CONSERVATION TO CLIMATE CHANGE?

It is increasingly apparent that climate change poses major challenges to resource management and bird conservation. As part of a new initiative, PRBO Conservation Science is working at the interface of resource management, climate change, and avian science to develop new tools for conservation. This initiative focuses on 1) describing climate-bird interactions, 2) using these interactions to project conditions under future climate scenarios, 3) adapting bird conservation strategies to include future conditions, and 4) monitoring changes with the explicit goal of detecting climate-related changes and validating model projections. Our initial results of these efforts suggest that while projecting changes in bird communities may be relatively straight forward logistically, translating these changes and their associated uncertainty into conservation recommendations is challenging. However, the very real need for these recommendations within the conservation community makes it imperative that we continue to address these challenges.

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#### CLIMATE CHANGE AND SOUTHWESTERN RIPARIAN-NESTING BIRDS: LESSONS FROM THE MIDDLE RIO GRANDE

Southwestern riparian forests harbor the region's highest densities and diversities of nesting birds, including several threatened or endangered species. Under predicted climate change scenarios, frequency, intensity, and timing of groundwater fluctuation, flood, and wildfire will be altered, resulting in changes to the nesting habitat of riparian birds. Using the Middle Rio Grande riparian forests of New Mexico as an example, we predict consequences of climate change to populations of southwestern riparian-nesting birds. Results from our studies of riparian habitat during periods of drought, wildfire, and floods suggest that climate change will accelerate the loss of cottonwood (*Populus* spp.) canopy cover, resulting in decreased availability of resources for canopy nesting, riparian obligate birds. Populations of generalist, shrub nesting species are less likely to be affected by climate change and may benefit from increased density of exotic and upland vegetation in riparian zones. Management plans involving flood and fire disturbance must incorporate climate change scenarios in order to maintain diversity and productivity of riparian-nesting birds.

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#### CONNECTING PHYSIOLOGY AND CLIMATE CHANGE: TEMPERATURE MATTERS.

Avian energy metabolism demonstrates a tight coupling with elements of climate, especially temperature, in both field and laboratory. Although ambient temperature is vitally important to understanding climate change, it is exquisitely difficult to measure accurately in an ecological context in part because it is sensitive to both an animal's physical traits and behavior. Tight coupling between thermal environment and physiology implies birds may be sensitive to the thermal consequences of climate change. Yet thermal constraints can also affect behavior, especially time available for foraging. My presentation reviews how physiological ecologists assess temperature in the field and examines temperature's effect on behavior and physiology. In 21 studies of small birds (<110 g) in which field metabolic rate (FMR) was measured with doubly labeled water, temperature accounted for a significant fraction of the interindividual variation in FMR (mean  $\pm$  SD;  $34 \pm 20\%$ , range 5-85 %), with the best agreement between FMR and standard operative temperature. Operative temperature measurements (taxidermic mounts) of open-habitat, Panamanian seedeaters link behavior and physiology, revealing a mere 1°C rise in temperature constrains time available for foraging.



## **Current Conservation Issues For Birds of Semi-Arid Regions (S05)**

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### **THE NEW NEVADA BIRD CONSERVATION PLAN: TECHNIQUES AND STRATEGIES**

With 87% of Nevada's lands managed by the government and its human population being one of the fastest-growing in the nation, bird conservation in the state offers unique challenges and opportunities. Nevada has historically been overlooked in large-scale bird inventories. However, in the last two decades, several major inventory and monitoring efforts have been undertaken, including the Nevada Breeding Bird Atlas, the Nevada Bird Count (a long-term landbird monitoring program), and several species- or taxon-specific inventories. Most recently, a Nevada Bird Conservation Plan is being assembled, with publication anticipated in December 2009. This paper presents preliminary results and insights from this effort to summarize relevant data for all taxa of conservation priority birds. Examples of how integrated data sets are applied to derive guidelines for habitat management, to resolve conflicting conservation goals, and to set priorities based on threats will be discussed. By providing the most biologically effective solutions for bird conservation in our region, the plan will aid Nevada's stakeholders who are faced with the often-difficult task of integrating conservation objectives with economic and public demands on the resource.

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### **LARGE-SCALE RIPARIAN BIRD MONITORING ALONG THE LOWER COLORADO RIVER: CHALLENGES AND SOLUTIONS**

Riparian birds are poorly sampled by the Breeding Bird Survey (BBS) because riparian areas cover a small fraction of the landscape. Furthermore, large-scale programs like the BBS usually lack the flexibility to address special needs through more intensive sampling or collection of auxiliary data in specific areas. We addressed these problems on the Lower Colorado River where status monitoring is a legal requirement and management issues, such as determining effects of habitat alteration, arise frequently. The study area extends >400 miles from Lake Mead to the US-Mexico border. Strata were defined based on region and habitat. Surveys were conducted on 160 plots. Detection rates were determined on a subset of plots through intensive work. The method yields unbiased estimates of density and population size as long as estimates from the intensive plots are unbiased. Estimated population sizes will be presented and compared to past work, and we will discuss ways of using the method to address short-term management issues.

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#### RESPONSE OF RIPARIAN-NESTING BIRDS TO WILDFIRE IN THE SOUTHWESTERN UNITED STATES

Wildfires occur with increasing frequency in southwestern riparian forests, yet little is known about the effects of this disturbance on populations of breeding birds. To address this information need, we monitored riparian vegetation and birds in unburned and wildfire sites along the Middle Rio Grande, New Mexico. Rio Grande cottonwood (*Populus deltoides var wislizenii*), an important resource for nesting birds, recovered from fire at some sites, but density was reduced at others due to variation in fire intensity, hydrology, and other factors. Analysis of point counts revealed that widespread, generalist species were most abundant in post-wildfire sites, while rarer riparian-specialists were more abundant in unburned sites. Nest monitoring results indicate that wildfire removed potential nest sites in the forest canopy, but increased nest site availability in the understory. Although wildfire alters forest structure and composition, nest survival did not vary between wildfire and unburned sites for any of the species examined. Our results show that response to wildfire is mixed among riparian-nesting birds and post-fire habitat quality is dependent on recovery of cottonwood and other woody species.

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#### RESPONSES OF BIRDS TO PINYON-JUNIPER REMOVAL IN ARIZONA GRASSLAND HABITATS

In regions of the semi-arid west pinyon-juniper woodlands are presently expanding into grassland habitats. Management challenges associated with 'chaining' and prescribed fire have resulted in more instances where mechanical thinning of pinyon-juniper woodlands is being utilized. Our 2005-2006 study examined responses of breeding birds to the mechanical reduction of pinyon-juniper woodlands across control and treatment plots within GSENM, Utah. We surveyed birds within 20 plots prior to and following pinyon-juniper mechanical reduction treatments. Thinning in April 2006 removed a mean of 92% (SE=6.4%) of the live trees from treatment plots. The avian guild most greatly influenced by mechanical thinning was pinyon-juniper obligate species. Those species eliminated following mechanical thinning were the Gray Vireo and Brown-headed Cowbird, while Chipping Sparrow numbers were significantly reduced. Birds in the shrub-nesting guild, including the sagebrush specialist Brewer's Sparrow, and habitat generalists such as the Bushtit increased in relative abundance following treatment. We conclude that mechanical thinning in pinyon-juniper vegetation communities has the potential for natural area managers to tailor treatments that can influence both pinyon-juniper and sagebrush- steppe avian species within the intermountain west.



## Behavior (G01)

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### FACTORS INFLUENCING FLAP RATE OF TURKEY VULTURES IN FALKLAND ISLANDS

Individual foraging Turkey Vultures (N=965) were observed in flight throughout East and West Falkland Islands for a period of thirty seconds and the number of flaps, date and time, weather variables, and landscape variables were recorded. Turkey Vultures exhibit great variation in flap rate and typically flap from 0 to 40 times per thirty seconds. These preliminary data strongly suggest flap rate is affected by terrain, temperature, wind speed, and season. Additional findings show variation in flap rate among seasons when temperature, wind speed, and landscape effects are controlled, which may suggest Turkey Vultures modify their flap rate in response to other factors (e.g. seasonal food availability). Such plasticity in flight behavior could partially account for the species' abundance and widespread distribution in the New World.

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### INDIVIDUAL RECOGNITION OF PEOPLE BY AMERICAN CROWS

We demonstrate experimentally that a cognitively advanced, social bird, the American crow (*Corvus brachyrhynchos*), learns to recognize the face of a dangerous person and continues to do so for at least 2.7 years. We exposed wild crows to a novel "dangerous face" by wearing a unique face mask as we trapped, banded, and released 7 - 15 birds at 5 sites near Seattle, WA. After trapping, crows consistently used harsh vocalizations to scold and mob people of different sizes, ages, and genders who wore the dangerous mask, even when they were in crowds. To determine if young crows learn from their parents about dangerous people, we quantified the ontogeny of scolding behavior in response to masks previously used for trapping. At 3-5 weeks of age, we banded and radio tagged the young of four pairs of crows who consistently scolded the masks. After observing their parents' response to the dangerous mask, the young independently scolded without their parents present. We suggest that conditioned and observational learning of specific threats may allow local bird behaviors to include aversions to individual people.

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### LEVELS OF VARIATION IN DUETS OF THE YELLOW-NAPED AMAZON: RELATIVE CONSERVATION OF SYNTAX, NOTE COMPOSITION AND PHONOLOGY.

Complex vocal signals composed of multiple notes may vary in a number of features such as the rules by which notes are ordered (syntax), the relative number and types of different notes (note composition), and the acoustic structure of notes (phonology). Research in songbirds typically shows greater conservation of syntax than phonology. Here we investigated whether these patterns of geographic variation are also found in parrot duets, by examining pair duets of yellow-naped amazons, *Amazona auropalliata*, at five sites within one vocal dialect. We also examined variation at several levels of social organization, including within pairs, among pairs and among sites. Variation was present for all levels and for all of the duet factors, but was highest at the within-pair level. We hypothesize that variation at the among-site level allows duets to indicate site membership, while variation at the within-pair level allows pairs to tailor their duets so that they function in a variety of circumstances. Note composition also exhibited more variability than syntax and phonology, potentially indicating that duets can be effective despite inconsistencies in note composition.

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#### GEOGRAPHIC VARIATION IN TYPE I SONGS OF BLACK-THROATED GRAY WARBLERS AND A COMPARISON WITH THE DIALECTS OF HERMIT WARBLERS.

Black-throated Gray Warblers (*Dendroica nigrescens*) occupy a fragmented landscape in southwestern Oregon and northern California. Twelve distinct song variants of type I songs were distributed in a complex geographic pattern across 18,300 km<sup>2</sup> of the region. The geographic extent of Black-throated Gray Warbler song variants differed widely. Several song variants occurred in well-defined areas and differed from neighboring variants while others overlapped adjacent song variants or graded from one form to another across a narrow zone. Song variants occurring in the most limited area and having the most fragmented distribution showed the least consistent structure among individuals both within local populations and across the range of the variant. While dialects could be identified, the pattern of distribution throughout the region does not describe a clear system of dialects. Instead it suggests a dynamic system with changes in song occurring in isolated segments of the population and distributional changes occurring by gradual infiltration and local extinctions in addition to moving dialect boundaries. This contrasts with the clear system of dialects of type I songs displayed by Hermit Warblers in the region.

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#### COERCION OF PEOPLE BY CROWS: ARE GIFTS INTENTIONAL OR INCIDENTAL?

Members of the family Corvidae are known for their intriguing behaviors such as tool use, vocal mimicry, and intentional play. The close association of corvids with people may favor other novelties including adaptable nest placement, discrimination among individual people, and memory of persecution. Given these abilities and settings it is not surprising that people and corvids have a long history of strong and reciprocal interaction. I report on a new aspect of this ongoing mutual interaction, gifting. Citizen scientists have reported to me seven cases of corvids (6 *Corvus brachyrhynchos*, 1 *Pica pica*) leaving objects, typically in exchange for food. The typical case involves a person who regularly feeds crows finding a shiny object (metal butterfly, key, candy heart, marble, glass) in the feeder after the food has been eaten. But crows have been observed leaving objects while taking food and leaving objects without food involved. I consider hypotheses for gifting that include incidental and purposeful mechanisms and conclude that a likely explanation for gifting is that corvids are intentionally leaving gifts to reinforce or coerce adaptive human behavior.

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#### FATAL BATTLES AMONG MALE LOONS LEAD TO LONG BREEDING QUEUES AMONG FEMALES

In common loons (*Gavia immer*), usurpation is the most common mode of territory acquisition, and both sexes engage in fierce physical contests for territory ownership. Males, however, often fight to the death, while females rarely do so. Hence the population of floaters is strongly female-biased, containing many females that have survived displacement and seek a new breeding position. Females, therefore, take much longer than males to find a first breeding position and endure longer waits than do males between loss of one territory and acquisition of another. On the other hand, body condition remains roughly stable throughout the lifetimes of females. While male loons are able to evict an established male from his territory only while in the prime of life (6-11 years of age), females retain the ability to usurp high-quality territories throughout their lives.

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#### SONG RATE AND RISK OF COWBIRD PARASITISM: A TEST OF ALTERNATIVE HYPOTHESES IN BELL'S VIREOS

Song rate in hosts of the Brown-headed cowbird (*Molothrus ater*) has been shown to be positively correlated with brood parasitism in many studies. However, this relationship has not been observed in Bell's vireo (*Vireo bellii*), a frequent cowbird host that suffers high costs of parasitism. We tested 3 alternative hypotheses to explain why increased song rate does not increase parasitism risk in this species. These hypotheses assume different underlying causal pathways between song rate and parasitism. Hypotheses addressed potential roles of nest concealment, nest attentiveness, and energetic requirements in mediating the relationship between song rate and parasitism. The relationship between song rate and parasitism differed among stages of the nesting cycle, with unparasitized birds singing more frequently than parasitized birds during the building and incubation stages. Nest concealment was positively correlated with song rate, suggesting that vireos with well-concealed nests can sing frequently without increasing parasitism risk. We recommend that future studies control for both nesting stage and parasitism status in order to further elucidate relationships between host behavior and risk of cowbird parasitism.

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#### HAMILTON MEETS CASWELL: HOW SHOULD WE QUANTIFY INDIRECT FITNESS?

Understanding the proximate causes underlying the evolution of cooperative breeding has been a goal of ornithologists for at least the past century. Many competing hypotheses have been proffered in an attempt to explain why complex mating strategies have evolved. Individuals that engage in helping behavior gain indirect fitness benefits, as proposed by Hamilton, by helping raise non-descendant kin. Using Acorn Woodpeckers (*Melanarpes formicivorus*) as an example, we illustrate how previous use of lifetime reproductive success as a fitness currency is flawed and introduce a matrix method that quantifies both the timing and effort of reproduction. By comparing individuals whose reproductive history was known for at least nine consecutive years, we illustrate that individuals that helped for at least one season had 24% less direct fitness than those that did not engage in helping behavior. When indirect fitness was added to direct fitness, however, individuals that helped accrued 64% more inclusive fitness than those that did not. This analysis provides a potential evolutionary explanation for why Acorn Woodpeckers engage in helping behavior.

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#### ANALYZING THE COSTS AND BENEFITS OF VOCAL MATCHING IN BUDGERIGARS

In budgerigars (*Melopsittacus undulatus*), vocal matching of an immigrant bird's contact call to that of its new flock has been experimentally demonstrated, but the costs and benefits of this matching behavior have not been investigated. We simulated immigration in captive flocks of budgerigars to determine 1) if there is a social cost to immigrant birds, which do not share the flock call, in the form of aggression and exclusion, and 2) if these costs are alleviated once the immigrant can imitate the call of the flock. We've recorded contact calls and behavior in flocks of captive budgerigars, and analyzed glucocorticoid metabolites in feces as an indicator of stress levels. Transfer to a new group appears to cause transitory stress in immigrants, but contrary to predictions of the password hypothesis, stress hormones return to baseline levels before vocal matching occurs, and transfer recruits are not subject to more flock aggression than control recruits. This finding calls into question the assumptions underlying the password hypothesis, namely that group membership is exclusive and costly.



## Breeding Biology (G02)

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### ECOLOGICAL CAUSES OF LIFE HISTORY VARIATION TESTED BY COMPARATIVE BROOD SIZE MANIPULATIONS

Resource limitation and age-specific extrinsic mortality are hypothesized to alternatively or interactively explain among-species variation in reproductive strategies. Brood size manipulations played a central role in the development and testing of these hypotheses yet provided ambiguous support for either. We suggest this is because past tests focused on increasing brood sizes outside of natural ranges, which exposes parents and offspring to novel situations in which their responses are unlikely to be adaptive. To redress this issue and provide a clear test of alternative explanations, we tested these two hypotheses by experimentally reducing broods by approximately half in 7 passerine bird species with divergent life histories. Nests with reduced broods showed increased per-nestling provisioning and nestling growth, and the magnitude of these effects varied among species. We suggest food limitation explains increased per-nestling provisioning and growth in reduced broods. However, the magnitude of manipulation effect appeared to increase with adult mortality among species, suggesting species with low mortality reduce reproductive effort with reduced broods. This suggests ecological factors play interacting roles at alternative levels in determining expression of life history traits.

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### METAPOPULATION BIOLOGY OF BLACK AND VIRGINIA RAILS: UNCOVERING DYNAMICS OF CRYPTIC SPECIES WITH OCCUPANCY MODELS

Black and Virginia Rails are highly secretive marsh birds with patchy distributions and unknown population biology. We use multiple-season occupancy models to examine population dynamics and correlates of extinction and colonization in metapopulations of Black (BLRA) and Virginia (VIRA) Rails inhabiting small wetlands in the foothills of the Sierra Nevada. We conducted playback surveys from 2002-2008 at 232 sites. Detection modeling suggested little effect of visit covariates for BLRA, although year and visit number influenced VIRA detections. Site-specific detection was 0.94-0.99 for BLRA and 0.61-0.88 for VIRA. Turnover occurred frequently, differed little among years, and was balanced from 2002-2006. Both extinction (0.25 vs. 0.19) and colonization (0.28 vs. 0.16) were higher for VIRA than BLRA, respectively. Biogeographic characteristics of patches had a greater influence on turnover than matrix conditions, and habitat quality for both species. Extinction was negatively related to area, however, patch isolation exerted the most influence on both extinction and colonization, suggesting an important role of rescue effects. A major extinction event in 2007 was apparently due to West Nile Virus, and little recovery occurred in 2008.

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#### VARIATION IN PRE-LAYING AMBIENT TEMPERATURE AND THE TIMING AND SUCCESS OF REPRODUCTION

Ambient temperature exerts a strong influence on reproductive behavior and reproductive success in birds. We evaluated among-year differences in various reproductive parameters relative to pre-breeding temperature in a cavity-nesting bird, the Mountain Chickadee (*Poecile gambeli*). The population of chickadees we studied bred in nestboxes in the Sierra Nevada of California. Among the three years of our study, in the year with the earliest increase in springtime temperatures chickadees initiated breeding the earliest. However, pairs produced fewer young and lower-quality young in the year when breeding occurred the earliest. Mean clutch size and mean nestling mass were the lowest, as was the number of nestlings fledged. The results of our study are contrary to studies of other species where earlier-than-average lay initiation dates were associated with larger clutch sizes. In two of the three years, we also evaluated to what extent variation in temperature among nestboxes was associated with among-pair differences in reproduction. The relationship between nestbox temperature and lay initiation date differed in each year.

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#### LOCATION, LOCATION, LOCATION: WHAT PEREGRINE FALCONS LOOK FOR IN REAL ESTATE

The Peregrine Falcon (*Falco peregrinus*) population in eastern North America has grown significantly over the past three decades, especially in urban areas. We compiled and analyzed all documented nesting attempts from southern Quebec, southern Ontario, Pennsylvania, New Jersey, and Massachusetts from 1980 through 2006 to evaluate nest site selection and factors affecting productivity. Of 801 nesting attempts, 663 were successful, producing 1613 young. Peregrines nesting in quarries or on buildings had higher productivity than those using marsh towers or bridges, but productivity did not differ overall between urban and rural sites. Nests with overhead cover had higher productivity than those without, as did nests in trays or boxes compared to sites without any human-provided nesting aids. Peregrines favored nest sites facing east to south, but productivity did not vary significantly with direction. Of over 350 identified breeders, just five females and males accounted for 8% and 9% of all young fledged, respectively; all of these were at urban locations. While peregrines have been thriving in eastern cities, continued management may be required for them to maintain their level of success.

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#### DETERMINANTS OF HIGH PRODUCTIVITY IN THE ENDANGERED LEAST BELL'S VIREO

Understanding the factors influencing productivity of endangered species is important to recovery-oriented management. In 2008, we documented exceptionally high productivity in the Least Bell's Vireo, an endangered riparian obligate, with per pair production of young exceeding that observed at any of our multiple study sites over the last 22 years. Pairs in two large vireo populations in coastal San Diego county, CA, fledged an average of >4 young in 2008, 62-83% higher than the number fledged since 2005. This high productivity resulted primarily from a high incidence of double-brooding, which is typically infrequent in our study populations; over one-third of pairs in 2008 fledged two broods, in contrast to 3-12% of pairs in previous years. Three factors contributed to the high incidence of double-brooding: 1) earlier onset of nesting, with the median lay date of first nests in 2008 2-4 weeks earlier than in past years; 2) higher success rate of first nests (approximately 60% vs 26-45%), and 3) a greater likelihood of re-nesting among successful pairs (67-77%), only 23-50% of which typically re-nest following a successful initial attempt. These findings establish a link between timing of breeding and components of seasonal productivity that can be used to predict responses to projected climate change.

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#### NEST SITE SELECTION AND PREDATION RISK: TESTING AN "ADAPTIVE PEAK" HYPOTHESIS

Nest predation is a major limitation to avian fitness, so birds should select nest sites that minimize predation risk. However, many empirical studies fail to find significant relationships between natural variation in predation risk and preferred nest habitat features. Such findings may be explained if birds occupy "adaptive peaks." Birds may select exclusively minimal-predation habitats, such that predation risk would be relatively homogenous among natural habitats, although predation risk would still be higher outside the natural habitat range. I tested this "adaptive peak hypothesis" with respect to nest concealment for a breeding population of Yellow Warblers near Mono Lake, CA. In 2006-2007, predation rates for both natural and experimental nests were not significantly different among natural concealment levels, but experimental predation rates were much higher in extremely exposed sites. In addition, data collected in a non-experimental year provided evidence for a shift in this adaptive peak; the natural concealment-predation relationship became strongly positive and Yellow Warblers responded by increasing concealment of their nests. Finally, I used clay egg bite data to identify specific predator types contributing to observed concealment-predation patterns.

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#### EVIDENCE FROM SPATIAL POINT-PATTERN ANALYSES OF TERRITORIALITY AND INTER-SPECIFIC INTERACTIONS AMONG SYMPATRICALLY NESTING CANADA GEESE AND LESSER SNOW GEESE

Quantifying the spatial patterns of avian nests and nest fate provides insights into processes influencing a species' distribution. At Cape Churchill, Manitoba, Canada, local declines in breeding Eastern Prairie Population (EPP) Canada geese (*Branta canadensis interior*) has coincided with increasing populations of nesting lesser snow geese (*Chen caerulescens caerulescens*). We employed nest distribution data (2001 – 2007) and spatial point-pattern analyses to assess (1) whether nesting Canada geese exhibited territoriality, (2) whether current spatial patterns of Canada goose nest distribution were evolutionarily stable, and (3) whether spatial patterns of Canada goose nest fate were associated with the density of nesting snow geese. Our results suggested that (1) nesting EPP Canada geese were territorial at the scale of nearest neighbors, but were aggregated when considering overall density of conspecifics at slightly broader spatial scales, (2) spatial distribution of nest fates indicated that current patterns of nest distribution represent evolutionarily stable nesting strategies, however (3) changes in snow goose nest proximity and density may influence Canada goose nest fate.

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#### CORTICOSTERONE ELEVATION IN BREEDING COMMON MURRES (*URIA AALGE*): STRESS OR ADAPTIVE RESPONSE?

Corticosterone levels were measured in Common Murres in two breeding seasons that differed in prey availability. In the first year, spawning capelin, the main forage fish, arrived inshore before chick hatching (prey match year). In the second year, capelin did not move inshore until a week after chick hatching (prey mismatch year). Overall, corticosterone levels were higher in the prey mismatch year than in the match year. However, there was an opposite relationship between elevated corticosterone levels and behavioral profiles in the two years. Birds with higher corticosterone levels in the prey match year provisioned their chicks less often and frequently attempted to get their partner to forage more, compared to birds with lower levels. In contrast, in the prey mismatch year, birds with higher corticosterone levels fed their chicks more often and made fewer attempts to increase partners' workloads. These results suggest that pair interactions affecting how partners share parental duties are behavioral-endocrine responses to variation in environmental conditions. Further, whether we consider corticosterone elevation as a stress or an adaptive response depends on the environmental conditions at testing.



## Conservation (G03)

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### CALIFORNIA GULLS IN SAN FRANCISCO BAY: IMPLICATIONS FOR THE SOUTH BAY SALT POND RESTORATION PROJECT

Breeding populations of California Gulls have increased over the past two decades in San Francisco Bay, from less than 200 breeding birds in 1982 to over 46,000 in 2008. This increase may be closely related to their use of landfills and other anthropogenic sources of food, and may have negative effects on other ground-nesting waterbirds through harassment, encroachment on nesting sites, and predation on eggs and chicks. Furthermore, the South Bay Salt Pond Restoration Project may cause a portion of the 46,000 breeding gulls to move to new nesting sites, displacing other breeding waterbirds and potentially increasing predation rates. We conducted surveys to determine the extent of landfill use by California Gulls, radio-marked California Gulls to examine their current distribution and movements in the bay, and are initiating a study to determine gull predation rates on threatened and endangered species. Our current results indicate that California Gulls heavily use local landfills and habitats that support other breeding waterbirds. This expanding gull population may negatively impact other breeding waterbirds, threatening the success of the South Bay Salt Pond Restoration.

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### ABUNDANCE AND VARIETY OF BIRDS AT POINT SOURCES OF WATER IN SOUTHWESTERN NEW MEXICO

Desert birds may be able to live without drinking water, but nevertheless still use it when it is available. We counted birds along five matched pairs of 600-m transects in southwestern New Mexico, half of which were centered on livestock feeder tanks. Bird numbers on transects with water were triple those on transects without water, while species richness per transect was more than 1.5 times higher. Birds responding positively to water availability included quail, doves, finches, some flycatchers, and especially flocks of wintering sparrows. Most of the increased detections on experimental versus control transects occurred within 50-m of the water sources. This result suggests the hypothesis (yet to be tested) that water had relatively little impact on overall bird density in a landscape, but that the tanks served as oases that birds came from considerable distances to visit temporarily, perhaps because of increased survivorship and/or reproduction.

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#### NEST PREDATION BY COMMON RAVENS ON GREATER SAGE-GROUSE IN RELATION TO LAND COVER IN WESTERN WYOMING

Human populations are growing in western Wyoming due to increased oil exploration and high levels of tourism. As towns expand, they subsidize some wildlife species, such as the Common Raven, while negatively impacting others, such as the Greater Sage-grouse. In 2007-2008, we surveyed for raven activity at 166 random locations and 249 locations near grouse nests/broods in Pinedale and Jackson, Wyoming, using 20-minute point counts. We used observed densities in our analyses because detectability did not vary by landcover. Raven abundance varied significantly by landcover. The highest densities occurred within towns, supporting the hypothesis that increased human populations increased raven populations. Occupancy was highest at city, road, and oil points. Avian predation accounted for 3% of known grouse nest failures. Observed raven densities near grouse nests/broods were not significantly greater than predictions based on landcover, and densities near failed grouse nests/broods were not significantly greater than at successful nests/broods. We conclude that ravens are subsidized by human activity, but are not attracted to areas with high levels of grouse reproductive activity and do not significantly negatively impact grouse reproductive success.

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#### THE IMPORTANCE OF CRAYFISH IN THE DIET OF NESTING COMMON BLACK HAWKS IN THE VERDE RIVER DRAINAGE, CENTRAL ARIZONA.

The majority of the geographic range of Common Black-Hawks (*Buteogallus anthracinus*) is south of the United States, but these birds have traditionally bred in riparian forests of Arizona. Black-Hawks are considered a priority species of concern in lowland riparian habitats of the state and populations are thought to be self-sustaining but highly unstable. Beyond general threats to habitat, another threat is how prey availability and composition has changed as a result of the introduction of exotic crayfish and other invasives. Diet of Black Hawks studied in Arizona in the 1980's and 1990's showed that amphibians were an important component of the diet (up to 32%), while aquatic invertebrates were rarely noted (less than 10%). Preliminary data collected over two years on prey brought to seven Black Hawk nests revealed an opposite pattern: amphibians were never recorded among the eight different prey items identified, while crayfish comprised a significant proportion of prey at several nests (up to 90% with a mean of 44%). This difference may suggest a significant shift in overall prey availability and use since these earlier studies.

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#### AVOIDANCE OF WIND GENERATORS BY BREEDING GRASSLAND BIRDS

Wind power is considered a desirable source of renewable energy. Potential consequences to certain wildlife, particularly birds and bats, are of major concern, however. The Central and Northern Plains with their strong wind resources are favored locations for wind development. More specifically, ridgetops in the Plains are the most preferred. Coincidentally, many of those ridgetops, because of their inaccessibility to plows, support much of what of little native prairie remains. Since 2003 the USGS Northern Prairie Wildlife Research Center has been investigating potential avoidance of wind generators by breeding grassland birds. Study sites in North and South Dakota have provided information on breeding-bird use both before and after wind generators were constructed. Nearby control sites permit an evaluation of annual variation, which facilitates interpretation of the results. Early results indicate that some bird species appear indifferent to the presence of wind generators, whereas other species avoid them. Replicating studies in different areas with different avifaunas will be needed to gain a more complete understanding of the consequences of wind energy development.

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#### INVASIONS OF NON-NATIVE EARTHWORMS IN NORTHERN HARDWOOD FORESTS: IMPACTS ON NATIVE GROUND-NESTING SONGBIRDS

Non-native earthworms are invading previously earthworm-free hardwood forests of the northern U.S., causing significant detrimental effects to soil structure and plant assemblages. Effects to vertebrates remain mostly unstudied. Earthworm-mediated changes to understory plant and invertebrate communities may increase susceptibility of ground nesting songbirds to nest predation or result in food shortages for ground foraging birds. We conducted avian surveys and nest searching at sites representing a progression of earthworm invasion in the Chequamegon-Nicolet National Forest, Wisconsin. Preliminary results suggest that Ovenbirds and Hermit Thrushes, common ground-nesters in the region, may indeed be negatively impacted by earthworm invasions. Densities of these species were significantly lower in invaded forest stands compared to earthworm-free stands. Furthermore, habitat characteristics at nests of these species differed between worm-free and invaded sites, with significantly more bare ground and thinner litter depth at nests in invaded sites. Our results suggest that these ground nesting species are declining locally in response to earthworm invasion. Further research is needed to clarify the mechanisms for this decline and whether invasions of non-native earthworms pose a significant regional threat to forest songbirds.

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#### SURVEY OF PARASITES AND WEST NILE VIRUS IN THE GREATER SAGE-GROUSE IN WESTERN NATRONA COUNTY, WYOMING

Fecal samples, blood smears, and ectoparasite samples of male and female greater sage-grouse (*Centrocercus urophasianus*) were examined for parasites to determine potential pathogens that may impact stressed individuals and populations and to establish base-line data of parasite frequency in central Wyoming. Samples were collected from birds captured, radio-collared, and released in western Natrona County, Wyoming (USA). Diseased collared birds found in the field were tested for West Nile virus. Low parasite prevalence was reflected in the fecal (N=66) and blood (N=61) samples. Ectoparasites were not found on any of the birds (N=14). One female tested positive for West Nile virus (N=2). With the potential for being listed under the Endangered Species Act, the habitat loss the grouse are experiencing, and the effects of climate change, the pathogen survey on this population of sage-grouse is on-going.

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## CATASTROPHIC AVIAN MORTALITY DURING HEAT WAVES AND DROUGHT: THE ROLE OF CLIMATE CHANGE AND EXTREME EVENTS

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. 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 mechanisms underlying avian mortality associated with heat stress and the lack of water. We develop a physiological model that predicts rates of evaporative water loss and survival times as a function of body mass and dehydration tolerance. Current and historical accounts already document catastrophic mortality caused by hyperthermia or through dehydration. Our projections suggest that increasing global temperatures, combined with increased frequency and intensity of heat waves and drought, will result in more frequent catastrophic mortality, and could depopulate regional bird communities.



## Community Ecology (G04)

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### THE VULNERABILITY OF HAWAIIAN FOREST BIRD FEEDING SPECIALISTS TO FOOD WEB DISRUPTION AND OTHER ENVIRONMENTAL DISTURBANCE

Populations of Hawaiian forest bird species that evolved specialized bills and feeding behaviors suffered the greatest rates of extinction in the both the prehistoric and historic periods. The extreme bills, narrow diets, and relatively heavy bodies of specialists were liabilities as habitats and food webs were disrupted by human activities and invasive species. Specialists were also disadvantaged by having smaller clutches and slower development, probably due to energetic constraints imposed by their narrower foraging niches and by greater challenges in provisioning their young. Caterpillars were premier foods of all forest bird species. They could be readily captured by birds with extreme bills, and they were vital to nestlings. However, caterpillars have become relatively scarce in low- and mid-elevation habitats due to greater threats from parasitoid wasps and other invasive species. The relative abundance of caterpillars at higher elevations partially explains the persistence of specialist birds there, despite caterpillar parasitism rates of 25% by alien wasps even in prime habitat. Also influencing the distributions of birds are massive habitat disturbance and introduced disease vectors and predators, especially in lowland forests.

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### COMPETITION WITH AN INTRODUCED BIRD STUNTS GROWTH THROUGHOUT A NATIVE BIRD COMMUNITY

The Japanese white-eye, introduced to Hawaii, may be an avian weed, defined as an organism that negatively impacts most or all similar organisms in a community. It overlaps multiple foraging substrates with each native bird species. When the white-eye increased in numbers on Hakalau Forest National Wildlife Refuge in 2000, juveniles of all seven native passerines (with sufficient data) had lower mass and shorter bills than before 2000. At the same time, in the site with fewest white-eyes, juveniles had normal mass and bill length. There was a correlation between extent of stunting and similarity of bill length to that of the white-eye. The temporal, spatial, and morphological comparisons strongly support exploitative competition with the white-eye as the cause of the stunting. Lower mass resulted in lower juvenile survival, and shorter bills in second year birds resulted in mortality by stabilizing selection. Such selection persisted in adult birds since adult birds captured after 2000, which were initially captured before 2000, survived better than adult birds captured after 2000. Control of white-eyes is essential for conservation of Hawaiian forest birds.

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#### MANAGEMENT FOR GRASSLAND HETEROGENEITY WITH IMPLICATIONS FOR THE GRASSLAND BIRD COMMUNITY

Rare and common grassland birds continue to decline even though extensive conversion of grasslands to agriculture has long ceased and remaining consumptive uses leave grasslands intact. Tallgrass prairie of the Flint Hills Region of Eastern Kansas and Northeastern Oklahoma are traditionally managed for cattle grazing with annual spring burning to increase grass production and reduce forbs and shrubs. We compared bird use and productivity between traditional grazing methods and patch-burn grazing. Patch-burning rotates burning among a portion (a patch) of a pasture, which results in a heterogeneous pasture made up of several seral stages. These seral patches within a pasture are relatively homogeneous, but the pasture as a whole is a mosaic of patches that shift through time initiated by burning and cattle preferences to graze the most recently burned patch. Bird diversity and productivity increased in the patch-burn treatment compared to the traditional treatment. This study provides recommendations on providing habitat for both rare species of concern and common species of the tallgrass prairie by creating habitats for the entire grassland bird community.

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#### TRANSIENT DYNAMICS OF INVASIVE COMPETITION: BARRED OWLS, SPOTTED OWLS AND THE DEMONS OF COMPETITION PRESENT

The recent range expansion of barred owl (*Strix varia*) into the Pacific Northwest where it now co-occurs with the endemic northern spotted owl (*Strix occidentalis caurina*) provided a unique opportunity to investigate potential competition between these two species. Models of occupancy dynamics with colonization and extinction probabilities allowed us to address the competitive process directly rather than inferring past processes through patterns in present species' distributions. Within the context of forest habitat characteristics, we used single-species, multi-season, occupancy models and covariates quantifying barred owl detections to determine the effect of barred owls on spotted owl occupancy dynamics. Extinction rates increased most in response to decreased amounts of old forest at the territory core. While colonization rates were higher when old forest habitat was less fragmented, we also observed strong, negative effects of barred owls on the colonization rates of owl pairs. This strong barred owl effect on colonization rates provided evidence of currently occurring interference competition, but these interactions will pose a serious challenge to spotted owl conservation.

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#### THE DISTRIBUTION OF WOODLAND-SAGEBRUSH AVIAN COMMUNITIES IN THE INTERMOUNTAIN WEST.

Little is known about the geographical range of birds using sagebrush-woodland ecotones in the Intermountain West and the environmental gradients that influence their distributions. We investigated avian communities in interface regions between sagebrush and Utah juniper, pinyon-pine, and western juniper at 14 sites using point counts (n = 466). Preliminary analyses suggest that species richness, evenness, and densities did not differ among sites. We used NMS to determine similarity of species composition (n/ha) among sites and then related environmental gradients (location, elevation, and 19 land cover types) to community composition. Preliminary results suggest that avian communities consisted of four species shared among all regions, six species unique to either the western juniper or the Utah juniper region, and four shared species between pinyon-pine and one of the other regions. Sites clustered by region, except one site in Utah juniper woodlands. Latitude, elevation, and five land cover types correlated strongly with ordination axes. Our study is the first to document spatial changes in woodland-sagebrush avian communities across regional scales and provides important information on factors influencing the distributions of these species.

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#### HUMMINGBIRD FORAGING STRATEGIES DURING THE WINTER SEASON IN A HIGHLAND COMMUNITY IN WESTERN MEXICO

We described the foraging behavior of a hummingbird community inhabiting a highland forest in Jalisco (Mexico). We tested the hypothesis that both the composition of the hummingbird community, and the abundance of floral resources modify the foraging strategies of the hummingbirds. The community we studied was composed of 11 species (4 residents, 3 latitudinal migrants, 3 altitudinal migrants, 1 occasional), that exhibited large differences in their dominance status and foraging strategies. We found all the possible combinations of these characteristics, from highly dominant territorial species to subordinates trapliners. These differences in the dominance status and resource use were principally related with the species, sex and age of the individuals, the number of flowers in the area, and the abundance of the migratory species. The aggressive species preferred the places with more flowers, and started the majority of the fights, attacking even birds that did not visit the flowers; the subordinate hummingbirds did not start fights, and these happened during their visits to the territorial hummingbird's flowers. The relationship between dominance status and foraging behavior could affect the role of the different hummingbird species as pollinators.



## Habitat Relationships (G05)

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### FACTORS AFFECTING SIZE AND PLACEMENT OF FLORIDA GRASSHOPPER SPARROW TERRITORIES

Temperate grasslands face habitat degradation as a result of infringing human development. Therefore, maintaining breeding habitat is imperative for the preservation of taxa within managed grasslands. We investigated whether habitat characteristics or arthropod availability could explain the size and placement of breeding territories for the Florida Grasshopper Sparrow, an endangered subspecies endemic to the Florida dry prairie. We mapped territories, sampled arthropods, and surveyed habitat composition within territories and unoccupied areas twice during the 2008 breeding season. The density of males decreased from 14 in the early season to 8 in the late season, which may explain the seasonal increase in male territory size ( $p < 0.001$ ). Similarly, the sparrows displayed habitat preferences in the early season but relaxed these preferences in the late season. Prey abundance did not appear to affect territory size. However, in the late season prey abundance was lower within territories than within unoccupied areas suggesting depletion of prey within territories as the season progressed. These results imply that territory placement in the Florida Grasshopper Sparrow may be based on habitat preferences and not food availability.

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### COMPARATIVE ANALYSIS UNCOVERS THE TRUE EFFECTS OF NEST CONCEALMENT ON AVIAN NESTING SUCCESS

Dense foliage surrounding a nest is often assumed to reduce nest predation. However, studies examining this relationship have produced inconsistent results. To determine the cause of these equivocal results, we reviewed studies that examined foliage density and nest predation in North American passerines. Surprisingly, 76% of past studies ( $n = 109$ ) reported that increased foliage density was not associated with reduced nest predation. Equivocal results of past studies can be explained, in part, by differences in nesting ecology among species and differences in methodologies across studies. For example, foliage density was 62% more likely to be associated with reduced predation in ground-nesting compared to shrub-nesting species. Methodological differences among studies such as methods employed, spatial scale, and timing of measurements also affected the relationship between foliage density and nest predation. Studies that measured foliage density using more quantitative methods were 24% more likely to show that foliage density was associated with reduced nest predation. Moreover, 41% more studies reported that foliage density was associated with reduced nest predation when they measured foliage density at a larger ( $>5$  m) spatial scale.

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#### NDVI MODELS AS AN INDEX OF AVIAN BREEDING DIVERSITY ALONG DESERT RIPARIAN HABITATS

Monitoring breeding bird communities is challenging and expensive. The development of remote-sensing habitat models that predict community composition may facilitate management actions. Here we assess the applicability of a habitat model designed to predict nesting habitat of the Southwestern Willow Flycatcher (SWFL) to model breeding bird community diversity more generally. Using avian point counts, vegetation surveys, and remote-sensing data from three breeding seasons on approximately 40 miles of the San Pedro River, we found that the SWFL model only weakly correlates with avian abundance, species richness, or species of conservation concern. However, NDVI, the SWFL model's main component, showed a stronger relationship, suggesting NDVI alone is a better metric for monitoring birds than the SWFL model. The acquisition of global NDVI imagery can be simple and inexpensive to obtain, making NDVI a potentially valuable tool for land managers.

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#### TRACKING WATER RESOURCE USE BY MIGRANT AND RESIDENT BIRDS IN THE SONORAN DESERT USING STABLE ISOTOPES

Water is a limited resource in desert ecosystems therefore animals must rely on water found in food (i.e. insects, fruit and seeds) or drink from a permanent source of water. In the Sonoran Desert of Arizona, the Department of Game and Fish maintains permanent water tanks as a resource for big-game. We were interested in the reliance of migratory and resident birds on these water resources during the spring and summer. We enriched the water in tanks on the Kofa National Wildlife Refuge with deuterium and sampled blood from the bird community to track the use of these water resources. Because deuterium is found in low abundance in the environment, birds that use tanks will have elevated levels of deuterium in plasma. We sampled 802 birds of 50 species (25 sp residents and 25 migrants) at distances from the water holes ranging from 2 to 900m. We found that tanks were used by doves and quail, and some resident passerines. Neotropical migrants, in contrast, largely ignored this resource during spring migration.

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#### “INTERIOR” FLOODPLAIN FOREST : A BIRD’S EYE VIEW

The concept of “interior” forest on the Upper Mississippi River (UMR) seems strange because historic floodplain forests were naturally highly fragmented. However, at least 50% of the pre lock and dam floodplain forest has been lost through inundation, and only 4-7% of current UMR forest areas are greater than 100m from any edge. In a previous study of breeding birds at random points there was no evidence of community differences related to distance from forest edge. In 2008 I conducted a breeding bird study designed to investigate community differences among interior patches, associated edge, and random areas not in or within 100m of an interior patch. The community in interior and associated edge did not differ but in random areas the community was slightly different. Species of conservation need and Brown-headed Cowbirds were not among the species contributing to the difference, however. Floodplain forest configuration rather than edge its self may play a role in shaping the breeding bird community.

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#### RESPONSE TO HABITAT RESTORATION BY AN ENDANGERED BIRD SPECIES, THE LEAST BELL'S VIREO (*VIREO BELLII PUSILLUS*)

The endangered least Bell's vireo is a migratory songbird that breeds in riparian habitat in southern California. Causes for its decline include habitat loss exacerbated by introduction of exotic plants, such as giant reed (*Arundo donax*), into riparian systems. Resource managers at Marine Corps Base Camp Pendleton, in northwestern San Diego County, have been mechanically and chemically removing giant reed from the Santa Margarita River since 1996. Areas recently treated for giant reed may represent temporary degradation in vireo habitat from loss of understory vegetation. From 2005-2008, we monitored breeding activity of 10 vireo pairs in each of four study plots, two where giant reed was removed between 2000 and 2002 (treatment plots) and two reference plots. We censused vireos and used previous censuses to calculate population density from 1997-2008 within our study plots. We found non-significant trends toward higher nest success and lower number of fledglings/pair at treatment sites, except in 2008, when vireos had more fledglings/pair at treatment sites. Since 1997, vireo density has been consistently higher at treatment sites, except during and immediately following treatment. We conclude that giant reed removal at our sites has had no negative effect on vireo productivity and only a temporary negative effect on population density.

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#### SMITH'S LONGSPUR DENSITY AND DISTRIBUTION IN THE BROOKS RANGE, ALASKA

Smith's Longspur (*Calcarius pictus*) has been identified as a species of concern, yet few studies have been conducted on their breeding grounds in Alaska. To develop effective conservation measures we need an understanding of population abundance and distribution. We conducted point count surveys for breeding Smith's Longspur at six sites in the Brooks Range in 2006, 2007, and 2008. Our main objectives were to document density, distribution, and habitat associations for Smith's Longspurs and to use this information to develop predictive models for their distribution across northern Alaska. Density estimates ranged from 0.07 - 0.47 birds/sq ha. We created distribution models from presence information and environmental variables using TreeNet. Our first distribution model produced a high (91-94%) predictive accuracy and suggested Smith's Longspurs occur farther west than currently known. Important environmental variables included slope, elevation, distance to river, and landcover. Additional sites will be surveyed in 2009 to further test and refine the accuracy of the distribution model.

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#### NEST SITE BEHAVIOR AND TIME BUDGETS OF FERRUGINOUS HAWKS IN SOUTH-CENTRAL WYOMING.

The Ferruginous Hawk historically nested extensively on the ground, small rock outcroppings, and pilings of bison bones. During the 20 years, Artificial Nest Structures (ANSs) have become the most prominent nesting substrate utilized by Ferruginous Hawks within the south-central Wyoming study area. Between 2000 and 2004, I monitored 50 Ferruginous Hawk nests to evaluate potential differences in nest attendance, prey deliveries, and hunting attempts. Hawks nesting on inaccessible nests, primarily ANSs, spent significantly more minutes attending, delivered more prey items, made more proximate hunting attempts, and flushed from the nest less than pairs nesting at sites that were accessible to mammalian predators. Accessibility was the only consistent predictor of minutes attended, hunting attempts, and prey deliveries; however, seasonal period was the most significant predictor of minutes attended, and time of day was another significant predictor of total prey deliveries ( $P < 0.001$ ). This may indicate a simultaneous strategic response involving the interplay of a nest site's accessibility to mammalian predators and proximity to concentrated prey resources help explain the diversity of nest sites utilized by this long-lived raptor species.

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#### AVIAN BIODIVERSITY IN MIDWESTERN BIOFUEL CROPPING SYSTEMS

Increasing demand for energy coupled with reduced oil availability has spurred increased interest in the development of biofuels as alternative fuel sources. Cellulosic ethanol production from perennial crops such as switchgrass (*Panicum virgatum*) promises greatly increased energy efficiency and enhanced ecological sustainability, yet there is limited published information available linking changes in biodiversity to agricultural land-use associated with biofuel crops. We examined the abundance and diversity of birds exploiting contemporary (corn) and second generation cellulosic feedstocks (switchgrass and mixed-grass prairie) as breeding habitat in southern Michigan. Results illustrate switchgrass fields will support an avian community richer than that associated with corn-based ethanol, but less diverse than that of native prairie. We demonstrate area-sensitivity in grassland birds in both prairie and switchgrass patches and show that avian species richness in these crops increases with patch size, while it declines with patch size in corn. While widespread conversion of corn to switchgrass acreage may have benefits for some grassland birds, our results suggest it will be relatively unimportant to the maintenance of populations of rare and declining grassland bird species in this region.

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#### BIRD-HABITAT RELATIONSHIPS IN THE CHIHUAHUAN DESERT GRASSLANDS OF MEXICO

North American grassland birds are experiencing the most widespread population declines of any avian ecological guild. Wintering habitat needs rank among the most important and least studied aspects of conservation efforts. We obtained avian population densities in the Chihuahuan Desert grasslands of Mexico in January and February of 2008. We established 497 randomly located one kilometer transects across 22,619 square kilometers of grassland. Percent cover of Grass, Shrubs, and Other were derived from occupied line segments and averaged within transects. Dominant grassland type was a categorical parameter obtained from GIS land use data. Horned Lark, Sprague's Pipit, Chestnut-collared Longspur and seven species of sparrows were included in the analyses. Models were built into a generalized linear model framework and detections of independent flocks operated as the response variable. Quadratic transformations of Grass and Other were included to allow negative coefficients to illustrate thresholds of tolerance. Shrubs had a positive relationship for three species and a negative relationship for five. Grass had a positive relationship for all but one species. These results will help inform avian conservation and land management decisions.

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#### THE INFLUENCE OF HABITAT CHARACTERISTICS ON BROOD PARASITISM AND NEST PREDATION RATES FOR THE SOUTHWESTERN WILLOW FLYCATCHER

Nest predation and brood parasitism account for the majority of nest failures for cup-nesting passerines and may negatively impact reproductive success. Habitat characteristics at multiple scales may influence rates of parasitism and predation, yet few studies have examined the effects on each concurrently. We quantified habitat characteristics and determined nest fate at 348 nests of the endangered Southwestern Willow Flycatcher at six sites from 2003-2008. Model selection using Akaike's Information Criterion (AIC) yielded conflicting results for nest-site and territory-scale features important for predation and parasitism. No models performed better than the null model for parasitism, which may indicate that brood parasites use cues other than habitat to locate nests. Models of nest predation that included site and distance to edge performed the best, indicating that predator composition or abundance likely differs among sites, but edge effects are important at all sites. Inclusion of unmeasured factors, including matrix type or degree of fragmentation, may improve our ability to predict predation and parasitism rates.

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#### GRASSLAND BIRD HABITAT USE IN NORTHWEST ILLINOIS: EFFECTS OF PLANT SPECIES DIVERSITY, VEGETATION STRUCTURE, AND LANDSCAPE VARIABLES.

We censused birds and plants at 30 sites in Carroll and Jo Davies counties, Illinois to test the idea that vegetation structure is more important than plant species diversity for grassland bird habitat use. We also examined the influence of landscape variables on grassland bird occurrence at the 30 sites. The sites included remnant prairies, prairie restorations, warm season plantings, cool season grasslands, and abandoned pastures. Landscape variables were more important than either vegetation structure or plant diversity variables for predicting bird occurrence. Vegetation structure and plant species diversity did not have easily distinguishable effects on bird occurrence in multivariate analyses. Results suggest that while warm season grass plantings and restorations approximate some features of native prairies important for grassland birds most restorations and plantings in this area are far too small and/or far from other grasslands to support grassland bird species most in need of conservation efforts.



## Migration (G06)

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### CAPTURE RATES AND CONDITION OF AUTUMN MIGRANT BLACKPOLL WARBLERS IN THE BRITISH VIRGIN ISLANDS

Blackpoll Warblers undergo an autumn migration that includes an approximately 3,000 km flight over the Atlantic Ocean from the northeastern United States to the east Caribbean and South America. This may require up to 88 hours of energetically taxing nonstop flight. Little information is available for condition, age ratios, or ecological factors associated with stop-over fallouts in the eastern Caribbean Islands. I examined condition, age ratios, and timing of Blackpoll Warblers arriving on Guana Island, British Virgin Islands, each October from 2003 to 2008. I captured a total of 438 Blackpoll Warblers ( $73 \pm 27/\text{yr}$ ) at a rate of 0.19 ( $\pm 0.06$ ) birds per net hour. Average mass of first capture warblers was 11.1g, but there were significant differences between years ( $P < 0.0001$ ) with annual averages ranging from 9.6g to 11.5g. Within year, there were no correlations between day of capture and average mass except during 2005, and there was no statistical difference in numbers of AHY and HY warblers. We also assess fat loads, muscle condition, and meteorological association with timing of fallout.

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### MESIC MOVERS AND XERIC SQUATTERS: MULTIPLE MOLT-MIGRATION STRATEGIES IN WESTERN PAINTED BUNTINGS.

Painted Buntings (PABU) exist as two geographically isolated breeding populations with distinct molt-migration strategies. PABUs breeding along the East Coast of the US undergo prebasic molt on the breeding grounds followed by fall migration to southern Florida and the Caribbean. In contrast, PABUs breeding in the South Central and Southwestern US molt on the wintering grounds in Mexico and Central America or on separate molting grounds after they leave the breeding area. Analyses of feather isotopes from birds captured in southwestern Oklahoma evince two distinct molt-migration strategies. Some birds are 'mesic movers' that consume primarily C3 carbon sources and undergo significant geographical movement during molt. Others are 'xeric squatters' that consume mostly C4 carbon and remain stationary during molt. Divergent molt-migration strategies within a single population are rare, probably because the combined effects of gene flow and competition limit intraspecific variation in migration behavior. In relating our current and future studies of this rare phenomenon we discuss possible explanations for different migration strategies in the same population as well as mechanisms that may allow them to persist.

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#### IS AVIAN MIGRATION IN THE AMERICAN SOUTHWEST FUELED BY NECTAR OF COLUMNAR CACTI?

Saguaro cacti produce a predictable crop of nectar- and pollen-rich flowers that geographically and temporally overlaps with spring migration in the Southwest. We hypothesize that cactus nectar may provide energy to migratory birds that may even time their flights to take advantage of this resource. We measured carbon isotopes of breath and blood samples collected from birds in Southern Arizona in May and June. Because isotope ratios of cacti are very distinct from those of other resources available at this time of the year ( $-12.8\text{‰}$  vs.  $-24.9\text{‰}$  VPDB), and because turnover rates in breath, plasma and red blood cells vary, we can determine the relative importance of CAM-resources for a time frame from very recently (breath) to several weeks ago (red blood cells). This allows us to model the temporal utilization of this short-lived but abundant food resource and to infer the degree to which migration may be fueled by columnar cactus bloom.

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#### COMPARATIVE EQUILIBRATION METHODS AND ESTIMATED $\delta D$ VALUES OF FEATHERS.

Hydrogen stable isotope ratios of bird feathers have become a common way to assess long distance movement of individuals. One complication of this approach is equilibrium exchange of H between feathers and water vapor. This problem is minimized by estimating the H isotope ratios ( $\delta D$ ) of the non-exchangeable fraction of H in birds' feathers through comparison of known standards with unknown samples; a process called comparative equilibration. We evaluated  $\delta D$  values calculated from two comparative equilibrations. The 1st equilibration used relatively light standards alone ( $-108$ ,  $-147$ , and  $-187$   $\delta D$  per mil) and the second used both light and heavy standards ( $-75$  and  $-58$  per mil). We found that the difference in estimated  $\delta D$  values from the two comparative equilibrations was negligible ( $< 2$  per mil) for feathers with  $\delta D$  values within the range of the light standards ( $< -108$  per mil), but substantial ( $> 3$  per mil) for feathers with heavier  $\delta D$  values ( $> -100$   $\delta D$  per mil). We suggest that standards used for comparative equilibration should bracket the expected  $\delta D$  values of unknown samples; however, limited availability of known keratin standards is a real concern.

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#### HAVE BURROWING OWLS THAT FORMERLY BRED IN CANADA AND THE U.S. ALTERED THEIR MIGRATORY BEHAVIOR IN RESPONSE TO LAND-USE CHANGES IN MEXICO?

Identifying the factors that limit the abundance and distribution of organisms is the ultimate puzzle in ecology. This task is especially relevant in migratory birds which have distinct breeding and wintering distributions. Shifts in either the breeding or wintering distribution can provide insights into the factors that limit species' abundance and promote the evolution of migratory behavior. The Burrowing Owl has undergone recent distributional changes: a contraction of the northern limit of its breeding distribution and a southern expansion of its breeding range deeper into northern Mexico. We suggest that these changes are the result of formerly migrant burrowing owls from northern latitudes becoming resident breeders in northern Mexico, where irrigated agriculture has created conditions suitable for year-round residency. To test this hypothesis, we used microsatellite DNA markers to determine the genetic structure of Burrowing Owl populations throughout North America. We also conducted stable isotope analyses on feathers to track the extent of annual breeding dispersal among populations in North America. We did not find support for our hypothesis. Preliminary microsatellite data suggest that owl populations are not genetically differentiated within their current breeding range, suggesting high connectivity among all populations. Preliminary stable isotope data did not reveal connectivity between northern migratory populations and populations in northern Mexico.

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#### CARBON ISOTOPE TURNOVER AS A MEASURE OF ARRIVAL TIME IN MIGRATORY BIRDS

Arrival time on breeding areas is of interest in studies exploring fitness consequences of migratory schedules. However, arrival time of unmarked individuals is difficult to assess in the field. Here we use carbon isotope turnover in avian blood as a technique to estimate arrival time for birds switching from one environment to another. Stable carbon isotope ratios in blood assimilate to a new equilibrium following a diet switch according to an exponential function. This relationship can be used to determine the time the diet switch occurred if  $\delta^{13}\text{C}$  of both the old and new diet are known. We explored the utility of this technique for King Eiders (*Somateria spectabilis*) arriving on terrestrial breeding grounds after migration at sea. We estimated arrival time of King Eiders on breeding grounds in northern Alaska from red blood cell  $\delta^{13}\text{C}$  turnover to be 3 – 8 June. This time window overlapped with arrival time of eiders from the same site tracked with satellite transmitters (5 – 12 June). We conclude that this method can be used to assess arrival time of birds in an isotopically distinct environment.

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#### EXTENDING NOCTURNAL MIGRATORY RESTLESSNESS ALTERS THE DIEL PATTERN OF CORTICOSTERONE

Research on bird migration has marveled at the endurance capacities of migrants for long distance flight. Field studies have shown that birds caught either preparing for or during migratory flight have elevated levels of baseline corticosterone and attributed this to the eventual and actual demand for energy associated with flight. Previous studies of captive birds have shown that baseline levels increase when birds express nocturnal migratory restlessness in comparisons with non-migratory stages. We tested the correlation of migratory restlessness and baseline corticosterone in order to confirm that the energy-demanding activities of migration may affect diel patterns of corticosterone in captive White-crowned Sparrows. Periods of migratory restlessness were extended by prolonging the dark or scotophase of the 18L:6D photoperiod by 2, 26 and 48 h in independent studies. Baseline corticosterone remained elevated without escalating further as long as birds continued to express migratory restlessness. Thus, spring migrants may meet the energetic demands of flight with elevated levels of corticosterone that, in turn, can influence other metabolic processes to promote availability of fuels and support long-distance flight.

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#### MIGRATORY DOUBLE BREEDING IN NEOTROPICAL MIGRANT BIRDS

Neotropical migratory songbirds typically breed in temperate regions and then travel long distances to spend the majority of the annual cycle in tropical wintering areas. Using stable-isotope methodology, we provide the first quantitative evidence of migratory double breeding for five species of Neotropical migrants. Each is well known to have a Neotropical winter range and a breeding range in the USA and Canada. However, following their first bout of breeding, some individuals migrate hundreds to thousands of kilometers in mid summer to breed again in coastal Sinaloa and Baja California Sur, Mexico. After breeding again in west Mexico they undertake a second bout of “fall” migration to their final wintering areas in the Neotropics. Our discovery of migratory double breeding reveals a hitherto unrealized flexibility in resource exploitation in long-distance migrants and emphasizes that demographic models and conservation planning for these several species need to consider this phenomenon.



## Molt/Morphology (G07)

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### PATTERNS OF SEXUAL SHAPE DIMORPHISM IN TWO HUMMINGBIRD SPECIES.

Sexual dimorphism is widespread in birds; however the majority of research to date has examined plumage coloration and size dimorphism. However, despite the clear ecological importance of bill dimensions for successful foraging, patterns of sexual shape dimorphism in bill shape have received considerably less attention. I conducted a shape analysis of male and female hummingbird bills to understand patterns of sexual shape dimorphism as characteristics related to feeding. Using geometric morphometric methods, I found significant sexual shape dimorphism in both Ruby-throated and Black-chinned Hummingbirds, with Ruby-throated Hummingbirds exhibiting 50% greater sexual shape dimorphism as compared to Black-chinned Hummingbirds. Additionally, I found that the amount and pattern of sexual shape dimorphism was population specific, such that populations of hummingbirds in different geographic localities exhibited different degrees of sexual shape dimorphism. Given the importance of bill shape for foraging, the latter suggests the possibility of regional trophic specialization. This hypothesis and other implications of these findings will be discussed.

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### MORPHOLOGICAL PLASTICITY IN RESPONSE TO STRESS DURING DEVELOPMENT AFFECTS PREDICTED FLEDGING TIME IN MOURNING DOVES

Developmental plasticity has been increasingly recognized to play an integral role in adapting organisms to their environment. Plasticity is likely to be particularly important for short term adaptation of individuals to stressors during ontogeny where cues are relatively accurate and selective pressure high. I examined the relationship of morphological plasticity in response to brood size manipulations to the predicted fledging time of mourning dove juveniles. I found that weight gain and overall structural growth of nestlings slowed as the number of siblings in the brood increased and relative allocation to different body parts differed among brood size manipulations. Total wing area was the best predictor of fledging age and individuals from larger broods had larger wings relative to overall body size. Nestlings from larger broods fledged at later ages. However, differential allocation to wing growth mediated this effect by decreasing the delay by ~ 2 d relative to if plasticity among body parts had not occurred. This study demonstrates that morphological plasticity during development can have important near-term effects on life history transitions during ontogeny of birds.

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#### POPULATION DYNAMICS AND HABITAT SELECTION FOR MOLT-MIGRANT PASSERINES IN THE MEXICAN MONSOON REGION OF ARIZONA, SONORA, AND SINALOA

Adults of several species of western North American passerines migrate to the Mexican Monsoon Region following breeding, where they stop and undergo molt in July-October before migrating to wintering grounds in the Neotropics. To investigate the biology, habitat selection, and conservation requirements of molting birds we established 13 capture stations and conducted widespread area-search surveys during the monsoon seasons of 2007 and 2008 in southeastern Arizona, Sonora, and Sinaloa. Nine known and nine newly documented molt-migrant species showed variation in geographical distribution and habitat selection for molt. Significantly higher proportions of molting adults were captured in 2007 (a dry monsoon year) than in 2008 (a wet monsoon year), suggesting that molting birds concentrate in riparian habitats during dry years but can select more diverse habitats to molt during wetter years. Virtually no site fidelity to molting locations was recorded between the two years. Our results suggest that molt migration is a stochastic process, with individuals making annual choices where and when to molt based on breeding-season dynamics, climate variables, and nutrient-resource availability on both breeding and molting grounds.



## Physiology (G08)

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### HEAT PRODUCTION FROM FORAGING ACTIVITY CONTRIBUTES TO THERMOREGULATION IN SEASONALLY ACCLIMATIZED DOWNY WOODPECKERS.

We measured metabolic heat production of perching and foraging Downy Woodpeckers (*Picoides pubescens*) to determine if the heat produced during foraging activity could replace thermoregulatory heat production requirements. Heat production and activity of woodpeckers were measured in summer and winter at temperatures ranging from -10 to 15°C. Heat production was measured using open-circuit respirometry for birds that were either perching or foraging inside metabolic chambers. Heat production did not vary significantly between perching and foraging birds, indicating that heat produced during foraging does substitute for heat produced by shivering for thermoregulation. In addition, body temperature and thermal conductance did not vary significantly between perching and foraging woodpeckers in either summer or winter. These results suggest that heat produced from locomotor muscles during foraging activity substitutes for thermoregulatory requirements in glean foraging species, such as woodpeckers in both summer and winter.

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### DO GROUP SIZE AND LAYING ORDER INFLUENCE MATERNAL DEPOSITION OF TESTOSTERONE IN SMOOTH-BILLED ANI EGGS?

The avian egg contains maternal hormones that affect behavior, growth, and offspring survival. Patterns of yolk androgen deposition could provide females with a means to manipulate sibling competition and increase female fitness. We examined yolk testosterone (T) concentrations in eggs of the smooth-billed ani (*Crotophaga ani*) to understand patterns of androgen deposition in eggs of this plural-breeding joint-nesting species. We tested the hatching asynchrony adjustment hypothesis, which states that increases in yolk androgen levels over the laying sequence function to mitigate the disadvantage of being a later-hatched chick in species without adaptive brood reduction. In both single- and multi-female groups as yolk testosterone levels increased from early- to late-laid eggs. This suggests that ani females can influence nestling competition and chick survival by within-clutch differential T allocation. We did not observe an effect of group size on yolk T deposition. Yolk testosterone concentrations may not be a mere reflection of a female's hormonal status as female plasma circulating levels of T did not vary in the same direction as yolk T levels. Results of this study support the idea that females may adaptively manipulate chick behavior through hormonal deposition in eggs.



## Population Ecology (G09)

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### CLIMATE-INDUCED CHANGES TO THE POPULATION DYNAMICS OF PINYON JAYS

Pinyon jays (*Gymnorhinus cyanocephalus*) depend on food and habitat resources provided by pinyon (*Pinus edulis* and *P. monophylla*) and Ponderosa (*P. ponderosa*) pines. Both pines experienced significant mortality in Northern Arizona in 2002-2003 during a severe drought. Pine mortality had cascading effects on the flock demographics and population structure of pinyon jays. Two hypotheses were generated to explain these effects. The first hypothesis suggests that changes in reproductive behavior affected the relative fitness of individuals in certain flocks. The second hypothesis suggests that changes in dispersal patterns caused a source/sink dynamic to form among flocks. Both hypotheses are supported by observational analysis of relative fitness, and by observational and genotypic analysis of dispersal behavior. Changes in relative fitness and dispersal rates affected the age and population structure of flocks, causing them to become ecological sources and sinks. Changing flock organization suggests adaptive changes to social organization in response to a selective event.

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### ELEVATED BREEDING SUCCESS OF BLACK-THROATED SPARROWS AT A DISTRIBUTION MARGIN: WILL CLIMATE CHANGE CAUSE A RANGE SHIFT (OR NOT)?

If the breeding distribution of a species is limited by a gradient of biotic or abiotic environmental factors, then reduced breeding success is expected at distribution margins. We measured breeding success of Black-throated Sparrows (*Amphispiza bilineata*) along an elevation gradient between the Peninsular Mountains and Colorado Desert (San Diego County, California) over a three-year period. We compared breeding success at marginal locations (higher-elevation sites) to those at central locations with more typical habitat (lower-elevation sites). Breeding success was measured at the nest-level, territory-level, and population-level. At lower-elevation sites in more typical habitat, Black-throated Sparrows had 100% reproductive failure during the two dry years of our study (2006-2007), but did relatively well at higher-elevation sites at the distribution margins. Only in the wetter year (2008) was breeding success slightly greater at lower-elevation sites. If the climate continues to become warmer and drier in this system, then the distribution boundary of this species is expected to track upward in elevation; however, there has been little evidence of an upward shift.

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#### DEMOGRAPHY OF THE SOUTHWESTERN WILLOW FLYCATCHER ALONG THE LOWER COLORADO RIVER AND TRIBUTARIES, 1997–2007

The southwestern willow flycatcher (*Empidonax traillii extimus*) is a migratory passerine that breeds in dense, mesic, riparian areas in the southwestern U.S. It was declared an endangered species in 1995, and color-banding and monitoring of willow flycatchers at multiple study areas in the lower Colorado River (LCR) area began in 1997. We used multi-state models in Program MARK to examine how survival, detection, and transition probabilities of southwestern willow flycatchers were influenced by age, time, geographic area, and gender in 1997–2007. The best-supported model showed that survival varied by year and geographic area, with higher survival rates shown by adults vs. juveniles and males vs. females. Detection rates were influenced by time period and age, with adults having higher probability of detection than juveniles. Pradel models combined with nest monitoring results suggest that while all geographic areas had per capita population growth rates  $\geq 1$ , the relative contributions of adult survival, on-site juvenile recruitment, and immigration to population growth varied among areas, with some areas depending on immigration to sustain the population.

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#### POPULATION TRENDS OF BREEDING BIRDS IN THE WESTERN GREAT LAKES -1991 TO 2008

We counted birds in over 1200 survey points in more than 400 stands in the Chequamegon National Forest, Wisconsin, and the Chippewa and Superior National Forests, Minnesota each year from 1991 to 2008. Trends in relative abundance were calculated for over 70 breeding bird species within each National Forest and 41 species were combined for all three national forests. Of the 166 species trends possible, 72 (43%) were significant ( $P < 0.05$ ) including 32 species that have increased and 21 species have decreased in at least one National Forest. A total of 13 species have increased and 7 have decreased for the combined National Forest data over the 18 years of study. The most consistent pattern observed thus far has been a significant decline in birds that nest on the ground, including Winter Wren, Veery, Hermit Thrush, Ovenbird, and White-throated Sparrow. A detailed analysis of detection probability and overdispersion was also recently completed on sixteen species of varied abundance and detectability and will be briefly summarized.

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#### PROXIMATE CAUSES OF POPULATION TRENDS IN MIGRATORY LANDBIRDS

We assessed demographic contributions to BCR-scale spatial variation in MAPS population trends for 28 species of migratory landbirds. We estimated trends (time-constant  $\lambda$ ), adult apparent survival rates, and recruitment rates from capture-recapture models; and indexed productivity from constant-effort mist-netting data. Productivity appeared to be important in driving recruitment and trend for just 9 species, while recruitment appeared to be the major driver of trends for 25 species, implicating the major importance of first-year survival. Adult survival appeared to be important for driving trends for 9 species. Species for which first-year survival was important in explaining spatial variation in trends tended to have declining populations, species for which adult survival was important tended to have stable trends, and species for which productivity was important tended to have stable or positive trends. Results indicate that (1) enhancing survival (especially first-year) will be important for slowing declines and stabilizing populations, (2) enhancing productivity may be necessary to recover populations whose declines have been arrested, and (3) identifying relationships between vital rates and winter habitat and weather will be critical for migratory bird conservation.

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#### USING GENETIC MARKERS TO DETERMINE CONSERVATION UNITS IN ALEUTIAN ROCK PTARMIGAN

Studying birds that breed in the Aleutian Islands of Alaska provides an opportunity to examine how geographic isolation affects high-latitude populations and to identify conservation units. The Rock Ptarmigan, *Lagopus muta*, is a member of the grouse family that lives on this island chain as well as on the mainland of Alaska and has numerous subspecies described within this area. This study focused on six populations in various regions of Alaska and the Aleutian Island chain that represent four subspecies. We sought to determine whether subspecies and genetics were concordant, infer levels of gene flow among populations, and assess each population's genetic diversity. We genotyped six microsatellite loci and found very high genetic divergence between all six populations. There was strong concordance between subspecies and genotype and many island populations had low genetic diversity. Isolated populations, that exhibit little or no gene flow, along with unique genetic lineages suggest that these groups can be labeled as individual management units (MUs). We propose that these unique, isolated units be targeted for conservation efforts in order to preserve their genetic lineages.



## Systematics/Evolution (G10)

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### REVISITING THE EVOLUTION OF COOPERATIVE BREEDING IN *APHELOCOMA* JAYS

Cooperative breeding occurs when nonbreeding helpers assist breeding individuals in raising their offspring. This breeding strategy may be explained as a way for non-breeders to increase their inclusive fitness by promoting the survival of non-descendant kin. However, the number of non-breeding helpers that assist in raising unrelated young may be underestimated. Cooperative breeding has been shown to occur nonrandomly within certain phylogenetic lineages. Peterson and Burt (1992) mapped cooperative breeding onto a phylogeny constructed using allozyme data, which suggested that plural cooperative breeding was the ancestral trait in *Aphelocoma*, and that cooperative breeding has been reduced in some lineages to singular or no cooperative breeding. Recent analysis using the ND2 gene has changed the proposed phylogeny of *Aphelocoma* jays. Therefore, I revisited the social evolution of *Aphelocoma* based on this new phylogeny. Plural cooperative breeding does not appear to be the ancestral trait in *Aphelocoma*, but is a derived character in the Mexican Jay clade. These new findings may allow researchers to investigate the factors that influence the loss and gain of social complexity in *Aphelocoma* jays.

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### THE REPEATED EVOLUTION OF FUSED THORACIC VERTEBRAE IN SONGBIRDS

A notarium is a column of fused thoracic and sometimes cervicothoracic vertebrae that are independent of the synsacrum. Although the bone was thought to be absent in the Passeriformes, I surveyed oscine passerine skeletons and found a notarium with fully-fused vertebrae in Chabert's Vanga, certain woodswallows and shrikes, the Willie Wagtail, the Phainopepla, the penduline tits including the Verdin, various larks, the Common Starling, the sickle-billed thrashers, and the crossbills. Mapping of character evolution on a supertree suggests that a fully-fused notarium has evolved independently at least 12 times in the oscines. Phenotypic expression of a notarium is fixed in some species but variable in others. Ontogenetically, the fully-fused notarium forms when the bird is immature. Among the systematic implications of my survey are additional support for placement of the Verdin (*Auriparus flaviceps*) in the Remizidae and for the monophyly of a group of western thrashers (*Toxostoma* spp.) with strongly decurved bills. I speculate on the genomic and functional basis for the evolution of notaria in birds.

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### POPULATION GENETICS AND EVOLUTIONARY HISTORY OF THE FLAMMULATED OWL (*OTUS FLAMMEOLUS*)

Distributions of Nearctic vertebrate taxa and their population structures have been shaped by glacial cycles during the late Pleistocene. Vertebrate taxa and their habitats underwent major shifts throughout the landscape of temperate North America. The Flammulated Owl is a Neotropical migrant breeding in western mountain ranges from Mexico to British Columbia. Sedentary populations are found in central and southern Mexico. Between 2002 and 2008, we gathered 163 samples from breeding populations of both migrants and non-migrants throughout most of their range. Population genetic analyses of the mitochondrial markers ATPase 6&8 reveal 29 unique haplotypes and weak geographic structure. We find evidence for a recent range shift from Mexico to the United States and Canada based on evidence from ecological niche models. Asymmetric patterns of gene flow at high rates between northern and Mexican populations are observed. Sedentary birds from southwestern Mexico exhibit low genetic variation. This may be due to a recent expansion from a refugium into this area. Current habitat destruction in the species' southern ranges may keep such diversity indices low in the future.

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#### AVIAN-LIKE CHARACTERS IN THE TRIASSIC *ARCHOSAUR LONGISQUAMA INSIGNIS*.

A common theme in the literature supporting the hypothesis that birds are maniraptoran theropods (the “BMT hypothesis”) is that there are no important morphological similarities between birds and non-dinosaurian archosaurs. However, at least one incompletely preserved Triassic archosaur, *Longisquama insignis*, possesses avian-like characters in both the skeleton and integument. The osteological characters include similarities in the dentition (conical teeth with swollen roots and constrictions between crowns and roots), the cranial (expanded braincase), and postcranial skeleton (grooved furcula and strap-like scapula). *Longisquama* also possesses elongate integumentary appendages. Recent fossil discoveries of birds from the early Cretaceous of China have uncovered integumentary structures similar to those of *Longisquama*. Regardless of whether the integumentary structures in *Longisquama* are homologous with the feathers of birds, these discoveries show that the integuments of *Longisquama* and birds share important characters. *Longisquama* is an example of a non-dinosaurian archosaur from the Triassic that possesses important morphological similarities with birds. The avian-like characters of *Longisquama* demonstrate that potential non-dinosaurian sister-taxa of Aves can be identified.

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#### AVIAN DIVERSIFICATION AND THE GREAT AMERICAN BIOTIC INTERCHANGE

Approximately 3.5 million years ago, the continents of North and South America became connected by the Panamanian Isthmus, which initiated a phenomenon known as the Great American Biotic Interchange. Our fundamental understanding of the Great American Biotic Interchange has been driven almost entirely by the rich mammalian fossil record; which shows the emergence of new immigrant taxa on each continent in the late Pliocene. For other groups of organisms, such as birds, incomplete and sparse fossils have led to speculation on how much faunawide participation occurred in the Great American Biotic Interchange. Here we show, the first summary of the overall participation of avifauna in the Great American Biotic Interchange, by assembling 131 time-calibrated diversification events between North and South America from mitochondrial DNA. Our data show that despite birds’ ability to fly, the highest frequency of diversification coincided with the completion of the Panamanian land bridge. Overall, the impact the Great American Biotic Interchange had on each continent is strongly linked to asymmetric phylogenetic niche conservatism among temperate Northern lineages and Southern tropical lineages.

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#### CONVEYOR BELT SPECIATION IN HAWAII'S FLYCATCHERS: MOLECULAR DIVERGENCE SUPPORTS NEW ISLAND ENDEMICS WITHIN THE ELEPAIO

The elepaio (*Chasiempis sandwichensis*), a monarch flycatcher endemic to Hawaii, varies in morphology among and within islands, and five subspecies are currently recognized. We investigated phylogeography and population structure of elepaio using mitochondrial and nuclear loci and microsatellites. Elepaio on each island formed distinct, reciprocally monophyletic clades, with Kauai basal. Sequence divergence between islands (3.08-2.21%) was similar to that in other avian sibling species. Divergence times estimated with relaxed molecular clock models indicated elepaio colonized Kauai 0.83 million years ago, Oahu 0.49 myr ago, and Hawaii 0.44 myr ago. Within Hawaii, AMOVA showed some structure at ND2, but microsatellites showed no population structure. Genetic, morphological, and behavioral evidence supports splitting elepaio into three species, one on each island, but does not support recognition of subspecies within Hawaii or other islands. Morphological variation in elepaio has evolved at small geographic scales within islands due to short dispersal distances and steep climatic gradients. Divergence within islands has been limited by lack of dispersal barriers, but anthropogenic habitat fragmentation and population declines are likely to decrease gene flow and accelerate differentiation.



## Tropical (G11)

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### AVIAN DIVERSITY ACROSS TROPICAL AGROECOSYSTEMS OF JAMAICA

Agroecosystems dominate a vast and expanding proportion of the tropical landscape. However, significant assemblages of regional biodiversity can be retained under some production systems. Intensification of farming practices aimed at increasing production are degrading agricultural habitats and compromising species assemblages. We assessed avian diversity across five agroecosystems on the island of Jamaica: Coffee, coconut, cacao, citrus, and pimento. These agricultural commodities are produced at various elevations and under different intensities of cultivation throughout the island. We found diverse assemblages of endemic and migratory birds within agroecosystems that maintained structural diversity of vegetation cover and retained patches of non-crop habitat within the matrix of the farm landscape. Bird species showed differential response to habitat complexity and fragmentation. Neotropical migrant species occurred within areas under greater production intensities than most endemic species which require more diverse forest-like habitat structure, while some common resident species were abundant within the most intensive farming landscapes. Maintaining avian diversity within tropical agricultural regions will require consideration of the crop and non-crop diversity, structure, and complexity of habitats at a landscape level.



## Ornithological Profession (G12)

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### LIFE AFTER GRADUATE SCHOOL FOR ORNITHOLOGISTS

Low retention rates for student members of the AOU, COS and WOS are often blamed on easy access to electronic journals. But, a demographic analysis of these three societies indicates that retention rates have declined for over 20 years and are related to employment prospects. We interviewed 74 attendees of ornithological meetings and 159 attendees of an ESA meeting to understand the transition from student to professional scientist. We interviewed finishing Ph.D. students, post docs, temporary job holders and those who recently obtained a permanent job. The ideal job for most applicants is a tenure-track position at a research university. Permanent job holders tended to have applied interests, quantitative skills, were highly mobile, and did not have a partner in the same field. Differences in the retention rates of male and female student members appear to be a function of women being more likely to have a partner in the same field and to accommodate their partner's career. Early career ornithologists had surprising low reproductive success. We offer unorthodox advice on obtaining an ideal job and balancing career and family.



## Posters

### Behavior (G01)

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#### ENERGETIC CONSEQUENCES OF EPISODIC LIKE MEMORY IN FREE-LIVING HUMMINGBIRDS

Episodic memory has been described as the ability to recall personal past events, involving what, where and when an event has been experienced. It must be flexible to the acquisition of new information in novel situations. Nectar, the primary food of hummingbirds, is dispersed in hundred of flowers and it varies in concentration and renewal rate, therefore a hummingbird should remember what, where and when the nectar will be available in order to improve the energy intake when compared to random. We carried out a field experiment with green-backed firecrown hummingbirds (*Sephanooides sephaniodes*) (n=10). We evaluated the ability to recall, in novel situations, the location, nectar quality and renewal rate of the best rewarding flowers among several less rewarding flowers with identical visual cues. Hummingbirds were able to remember best nectar sources, flowers' position and to adjust their visits to nectar renewal rate. Cognitive performance varied among individuals implying differences up to 1.5 times the energy gained. Our results strongly suggest that hummingbirds use cognitive abilities to exploit nectar sources efficiently and therefore, are potentially tied to the survival probability.

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#### POSSIBLE ROLES OF ORNAMENTAL TRAITS IN ROCKHOPPER PENGUINS, EUDYPTES CHRYSOCOME.

Animals use various techniques to increase their fitness via sexual selection, including production of colorful plumage ornaments. Unlike the well-studied feather ornaments of passerine birds, ornamental traits of any sort are relatively unstudied in seabirds. Plumage ornaments may be especially revealing in penguins because the birds have no opportunity to feed during molt. Therefore, elaboration of ornamental patches depends on food available at the beginning of molt. We studied the elaboration of ornaments in rockhopper penguins (*Eudyptes chrysocome*) at a study site in the Falkland Islands, specifically looking at the length of head plumes in males and females, and in juveniles and adults. There was no difference between males and females in condition (mass corrected for body size;  $t < 0.001$ ,  $df = 26$ ,  $p = 1.0$ ) or plume length ( $t = -0.55$ ,  $df = 26$ ,  $p1\text{-tail} = 0.29$ ). However, plume length is significantly related to condition ( $r^2 = 0.24$ ,  $df = 26$ ,  $p = 0.008$ ), and adults had significantly longer plumes than juveniles ( $p < 0.01$ ) suggesting that plume length may be valuable as a sexually selected signal.

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#### SEX DIFFERENCES IN CORTICOSTERONE LEVELS OF ATLANTIC PUFFINS

We investigated the effects of sex, varying foraging conditions, and time during season on corticosterone (CORT) levels in Atlantic Puffins (*Fratercula arctica*) nesting in the Witless Bay Ecological Reserve, Newfoundland, Canada. CORT concentrations were extracted from blood samples from 1998-2000. Overall, female puffins demonstrated higher CORT levels and this difference was most pronounced post-hatching, congruent with behavioural observations that females feed chicks more often than males. There were no differences between early and late chick rearing or among years with varying foraging conditions. These results contrast with findings for a related alcid the Common Murre (*Uria aalge*) for the same years, where there was no sex difference in CORT levels but birds had higher levels in years with difficult foraging conditions. Puffins feed chicks a more variable diet than do Murres, and burrow nesting allows both parents to forage simultaneously. In addition, puffin chick development takes place more slowly over a longer period of time. These species differences likely mediate stress reactions during poor foraging conditions, as timing of prey spawning is not as critical for puffins as for murres.

## Breeding Biology (G02)

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#### AVIAN PARENTAL CARE STRATEGIES IN DIVERSE NEST PREDATOR ENVIRONMENTS

Avian parental care activities in the vicinity of nests can attract enemies such as nest predators. Parent birds therefore often tailor parental care strategies to the perceived risk to offspring. In diverse nest predator environments, however, assessing potential nest predation risk may be difficult or impossible. In such cases, parents may rely on direct experience with nest predation in order to gauge optimal behavior in subsequent nest attempts. We tested this hypothesis using the Brewer's sparrow (*Spizella breweri*), a multi-brooded passerine exposed to a taxonomically- and behaviorally-diverse suite of nest predators. Brewer's sparrows did not alter parental care behaviors (incubation or nestling feeding rhythms) according to ambient nest predation risk. However, pairs whose nests failed during previous attempts increased incubation on- and off-bout lengths and decreased nestling feeding rates in subsequent attempts, which resulted in fewer nest trips. Our results suggest that birds that are not able to assess ambient nest predation risk may rely on direct experience with nest predation in order to modify parental care strategies.

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#### NEST PREDATORS IN MIDWESTERN FORESTS

We used a vendor-built and an inexpensive custom-built video surveillance system to document the cause of failure for 86 songbird nests at eight sites in Missouri and Illinois. Avian predators such as hawks, owls, and Blue Jays were the most important contributors to overall predation rates. Some predators (e.g. raccoons, snakes) appear to be disproportionately more important for shrub-nesting species than for those that nest in trees. Preliminary analysis suggests that heavily forested landscapes reduce the probability of predation by snakes. Future analysis will incorporate variables at additional spatial scales (e.g. nest site, patch) and will integrate data from both filmed and unfiled nests into our nest survival models.

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#### FACTORS AFFECTING SURVIVAL OF SONGBIRD NESTS IN MIXED-GRASS PRAIRIE

We estimated nesting success of a grassland songbird assemblage at Bowdoin National Wildlife Refuge, Montana. We explored the association between daily survival rates (DSR) of nests and the following covariates: bird species, site, year, clutch size, time-of-season, and nest age. The study was conducted in native mixed-grass prairie on five permanent sites (26-59 ha); DSR was estimated using the survival model in program MARK. DSR did not differ markedly among bird species or spatially among sites. However, DSR did vary substantially among years, suggesting a decreasing trend during the period of study ( $b = -0.002$ ). Clutch size was also an important predictor, although the effect varied among years (odds ratio range = 0.9–1.4). Of greater importance, DSR varied with time-of-season, although the effect varied with both year and bird species. Nest age was clearly the best predictor of DSR. The relationship between nest age and DSR varied among bird species during incubation, with DSR improving for some species as incubation progressed. However, DSR during the nestling stage decreased in a similar manner across all bird species.

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#### EVALUATING THE INFLUENCE OF INCREASING LESSER SNOW GOOSE NESTS ON SURVIVAL OF CANADA GOOSE NESTS IN NORTHERN MANITOBA

Nesting Mid-Continent Population lesser snow geese (*Chen caerulescens caerulescens*) have expanded their distribution in northern Manitoba, Canada; increasing in abundance in areas where they did not previously occur and were traditionally used allopatrically by nesting Eastern Prairie Population (EPP) Canada geese (*Branta canadensis interior*). We employed logistic-exposure models to evaluate factors influencing within- and among-year variation in the probability of nest survival for Canada goose nests from 2005 – 2007. We considered variables from 6 distinct components of Canada goose nest survival including inter- and intra-specific interactions, predator pressure and behavior, the defensive capabilities of nesting geese, and the abundance of alternative-prey for potential nest predators. Specifically, we tested the apparent competition hypothesis and the nesting association hypothesis as mechanisms to describe interactions between nesting Canada geese and snow geese in this ecosystem. Our data did not support the apparent-competition or nesting-association hypotheses as mechanisms governing interactions among nesting Canada geese and snow geese. However, our analysis further supported for the importance of arctic fox (*Alopex lagopus*) and lemmings (*Dicrostonyx* spp.) in the population dynamics of Canada geese in this region.

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#### APPARENT ANNUAL SURVIVAL AND PHILOPATRY RATES OF SHRUBLAND BIRDS IN CONSERVATION-MANAGED FIELDS IN CONNECTICUT.

Loss of shrubland habitat has caused successional birds to decline at 1-3% per year in eastern United States, but shrubland management has rarely been implemented in areas of decline. We banded 228 adults and 173 nestlings in Connecticut from 2004-2008 in conservation-managed fields or actively-maintained shrublands and estimated annual survival ( $\Phi$ ), capture probability ( $p$ ) and philopatry rates for Prairie Warbler (*Dendroica discolor*), Blue-winged Warbler (*Vermivora pinus*), Indigo Bunting (*Passerina cyanea*), and Field Sparrow (*Spizella pusilla*). Probabilities were estimated using open population models with time constant, linear and quadratic time effects in Program Mark. Model selection was based on Akaike's Information Criterion (AICc). Models with sex effects were estimated for species with disproportionate sex ratios of returning birds. Survival was highest for Prairie Warbler (males-  $0.75 \pm 0.17$  to  $0.82 \pm 0.12$ , females-  $0.60 \pm 0.24$  to  $0.69 \pm 0.22$ ) and Blue-winged Warbler ( $0.24 \pm 0.22$  to  $0.81 \pm 0.24$ ). Philopatry (return of young) was only 2.3%, and occurred only in Prairie Warbler and Field Sparrow. High survival of adult Prairie and Blue-winged warblers on conservation-managed shrublands showed positive effects of current management practices, but there was very low local recruitment for two species and none for the other two.

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#### BANK SWALLOW ABUNDANCE AND DISTRIBUTION IN NEW MEXICO: RESULTS OF THE FIRST YEAR OF SURVEYS

The Bank Swallow (*Riparia riparia*) nests colonially on vertical banks and bluffs with friable soils in lowland riparian, lacustrine, and coastal areas. It also can nest away from water and in human-made sites. Little is known about the swallow's abundance and distribution in New Mexico: only a single colony, located in an arroyo near Albuquerque, Bernalillo County, was known to be active in 2007. The state's first systematic swallow surveys were completed May – August 2008. We surveyed 9 of the 33 counties and located 17 active colonies. Most colonies had >500 burrows and the population was estimated at 1,497 pairs. Nearly all colonies were in urban areas of a single county (Sandoval), were distant from water (2.96 mi), and were in tall (6.56 m), long banks (42.37 m) of arroyos with friable soils. 2008 survey results indicate that a higher number of active Bank Swallow colonies currently exist in New Mexico than previously known. However, as most occur in a single county that is undergoing rapid development, conservation and management action is needed to prevent population declines in this species.

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#### DOES GARBAGE MAKE MORE GLAUCOUS GULLS?

Glaucous Gulls (*Larus hyperboreus*) are abundant predators in northern Alaska and are believed to benefit from garbage as a supplemental food source. This may be causing gull populations to increase in developed areas. In summer 2008, we studied Glaucous Gull diet and reproduction at eight breeding colonies in northern Alaska. Across all colonies, garbage made up 0-64% of gull diet and the number of chicks fledged per pair was 0-2.88. By colony, there was a significant positive logistic correlation between the amount of garbage consumed and the number of chicks fledged per pair ( $R\text{-sq} = 0.91$ ,  $p < 0.001$ ). Additional data from summer 2009 will further elucidate this relationship. These results suggest that Glaucous Gull reproductive output may be enhanced by the garbage available at some human developments in northern Alaska. This may be allowing gull populations to increase, which could have implications for the gulls' natural prey species, including shorebirds and waterfowl. This effect could be exacerbated if more garbage becomes available to gulls as oil and gas development continues in northern Alaska.

## Conservation (G03)

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### EFFECT OF PRESCRIBED BURNING FOR MANAGEMENT OF THE RED-COCKADED WOODPECKER ON THE AVIAN COMMUNITY IN THE SAM HOUSTON NATIONAL FOREST.

In the past century there has been a drastic change in vegetation due to fire suppression in the southern pine ecosystem, which has had negative impacts on many avian species. In particular, the red-cockaded woodpecker (*Picoides borealis*) was affected so severely it was placed on the endangered species list. The U.S. Forest Service actively manages red-cockaded woodpecker habitat in the Sam Houston National Forest by prescribed burning and mechanical removal of understory. I am investigating the effects of three prescribed burning regimes on the avian community. Avian species richness, diversity and abundance will be documented in areas burned every 1 to 3 years, 5 to 10 years and in areas not burned for well over 10 years, through year-round point count surveys. I will document how burning impacts the community and the significance of these habitats for resident and migrant species.

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### LEWIS' WOODPECKER AND EUROPEAN STARLING INTERACTIONS AND NEST SUCCESS AT FORT SIMCOE STATE PARK, WASHINGTON: CITIZEN SCIENCE IN ACTION.

We analyzed data collected by Washington State Parks staff and Audubon Society volunteers over a three-year period at Fort Simcoe State Park, Washington, to investigate concerns that European Starling (*Sturnus vulgaris*) competition for nest cavities is negatively impacting the breeding success of Lewis' Woodpecker (*Melanerpes lewis*), a State Candidate for listing. Although the two species used similar nest cavities, we found minimal temporal overlap in their nesting phenology. Most starlings nest from mid-April to mid-June, on average 3-5 weeks earlier than Lewis' Woodpeckers, which nest from late May to mid-July (Mann-Whitney test,  $U=20.5$ ,  $p < 0.001$ ). Furthermore, the data indicate that Lewis' Woodpeckers dominated interactions at nest sites more often than starlings, and that Lewis' Woodpeckers had higher breeding success than starlings on average (59.9% vs. 50.3%). Given limited evidence that starlings are negatively impacting Lewis' Woodpeckers at Fort Simcoe, we recommend that park management a) focus on maintaining and/or improving suitable habitat for Lewis' Woodpeckers; b) continue monitoring species interactions during the breeding season; and c) limit resources allocated to starling control.

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#### PREDATION ON ARTIFICIAL NESTS IN URBAN AND NATURAL ENVIRONMENTS

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Nest predation is the leading cause of reproductive failure in songbird species. Urbanization may result in higher nest predation due to the loss of nesting habitat, as well as an increase in urban-adapted predators. We studied nest predation on artificial nests in two habitats in east Texas using time-lapse infrared video camera systems. One habitat was a residential neighborhood consisting of large yards with many older trees and shrubs in the city of Huntsville, Walker County, Texas, while the other was a 100 ha tract of pines and hardwood forest adjacent to the Sam Houston National Forest. We hypothesized that predator species would differ in the two habitat types and that depredation would occur at a higher rate in the urban area than in the natural area. We found a significantly higher predation rate in the urban habitat as predicted. Via video surveillance, several taxa of nest predators were identified visiting depredated nests. Knowledge of how nest predation varies according to region and habitat is important to the conservation of songbird species.

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#### ESTABLISHMENT OF PARENTAGE RELATIONSHIPS IN A CAPTIVE POPULATION OF MILITARY MACAW (*ARA MILITARIS*) USING MOLECULAR MARKERS AS A CONSERVATION STRATEGY

The Military Macaw (*Ara militaris*) is an endangered species threatened by habitat loss and by trade in the pet market. In México, one conservation strategy has been the reproduction of captive individuals and the registration of their chicks using closed bands. Nevertheless, it has been not enough to avoid that wild individuals can be commercialized as “captive-born macaws” because at this time, there is no way to prove their source. Genetic analyses can be used as an alternative to demonstrate the paternities of captive-born individuals. I used blood samples of a Military Macaws obtained from a captive population where the parentage relationships were known, and using molecular markers to accept or reject their registered relationships. By means of both, exclusion and maximum-likelihood parentage tests, I was able to confirm 70% of the born captive macaws’ paternities, representing the whole sample of individuals where mother and father information was available. This methodology can be useful to issue a certificate that would be employed by governmental authorities to certify the legal precedence of the Macaws available for sale in pet stores and captive-breeding places.

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#### FIRST RECORDS OF NEST BOX USE BY THE CRITICALLY ENDANGERED MASAFUERA RAYADITO

The Masafuera Rayadito (*Aphrastura masafuerae*) is a little known, critically endangered, endemic bird species of Alexander Selkirk Island, Juan Fernandez Archipelago, Chile. The species population may have declined because of habitat loss and degradation and potentially, due to lack of nest sites. The four nests that have been described are over the tree line only. No information on nesting materials, structure or egg characteristics have ever been reported. To study the breeding ecology, we installed 81 nest boxes in three groups in 2006. We found no occupation on the central and northern group. Seven out of 42 boxes were occupied on the southern group: three complete and four incomplete nests. Complete nests had a canelo and tree-fern rootlet structure that supported a cup made out of petrel feathers. We also found an unhatched egg. The probability of occupation was not affected by tree diameter or box height. Empty, partially used, or used nest boxes entrance was uniformly oriented. These results, although incipient, suggest that nest boxes can be used in the restoration of the Masafuera Rayadito habitat.

## Community Ecology (G04)

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#### HUMMINGBIRD NICHES: PHYSIOLOGICAL AND COMPETITIVE LIMITS.

A hummingbird's niche comprises those factors that allow an individual to maintain a positive energy balance. In this study we asked whether these niche factors can be identified using large-scale climate and environmental variables. We used breeding bird survey data of black-chinned (*Archilochus alexandri*) and broad-tailed (*Selasphorus platycercus*) hummingbirds to indicate areas of allopatry and sympatry and overlaid these locations with remotely sensed climate and habitat data, on-the-ground measures of nectar availability and spatially interpolated climate data. While it is well known that the two species separate along an elevation axis, we found an additional and independent effect of nectar availability. We also found that the species distributions indicate inclusive niches whereby black-chins are distributed over a broader range of values for some niche factors than broad-tails. Theory predicts that broad-tails are physiologically limited to the most environmentally benign portion of the niche and through competitive exclusion limit black-chins to the severe part of the niche. We identify the possible ways in which elevation, climate and resources physiologically limit broad-tails but make them a superior competitor to black-chins.

## Habitat Relationships (G05)

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#### AMERICAN THREE-TOED WOODPECKERS' BREEDING HOME RANGE SIZE IN THE BLACK HILLS, SOUTH DAKOTA

The American Three-toed Woodpecker is a quiet, sedentary and elusive species that prefers spruce habitat in old-growth forests. A permanent population that exists in white spruce forests in the Black Hills of South Dakota is listed as a USDA sensitive species and is of conservation concern due to its rarity and isolation from other populations in the Rocky Mountains. I conducted a radio telemetry study during the breeding seasons 2005-2008 to determine the home range size and core areas using fixed kernel and minimum convex polygon (MCP) methods for 11 radiotagged birds. Mean home-range estimates calculated by 95% fixed kernel were  $90.85 \pm 30.27SE$  ha, versus 100% MCP  $62.75 \pm 18.49 SE$  ha. Core area (50%) means for fixed kernel were  $21.90 \pm 8.32 SE$  ha versus  $16 \pm 7.74 SE$  ha for MCP. These results provide preliminary data for future research assessing the relationship between home range area and landscape-level characteristics.

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#### ABUNDANCE AND HABITAT USE OF RIPARIAN BIRDS IN RELATION TO BURN SEVERITY IN SAN DIEGO COUNTY, CALIFORNIA.

We used the 2007 catastrophic wildfire season in southern California as an opportunity to collect baseline data on the response of riparian bird communities to wildfire at four drainages (three burned, one unburned) in San Diego County. Specifically, our goals were to 1) assess the effects of burn severity on bird species abundance, and 2) quantify habitat use in burned riparian of Common Yellowthroat (*Geothlypis trichas*), Least Bell's Vireo (*Vireo bellii pusillus*), Song Sparrow (*Melospiza melodia*), Yellow-breasted Chat (*Icteria virens*), and Yellow Warbler (*Dendroica petechia*). We counted birds at 24-40 points per drainage to calculate bird species abundance and recorded percent cover by height of vegetation along transects (N=100) centered on points. Species abundance differed significantly ( $P < 0.10$ ) by burn severity, expressed as an index of low, moderate, and high severity, for 10 of 23 species. Logistic regression models revealed that burn severity was less important than habitat structure in describing bird-habitat relationships.

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#### SHIFTS IN NEST-SITE CHARACTERISTICS OF SOUTHWESTERN WILLOW FLYCATCHERS OVER 20 YEARS IN THE KERN RIVER VALLEY, CA.

Habitat characteristics can play a key role in limiting the distribution and density of breeding bird populations. Once a common breeder, the Southwestern Willow Flycatcher (*Empidonax traillii extimus*) is now rare throughout much of its breeding range and this is largely attributed to the loss and degradation of riparian habitats. We monitored a population of breeding Southwestern Willow Flycatchers in the Kern River Valley, California continuously since 1989. We used six features of Willow Flycatcher nest sites to examine if there have been shifts in these characteristics over the last 20 years. We found significant increases in nest height, canopy height at the nest site, distance to forest edge, and distance to nearest water. We found a significant decrease in amount of nest cover and no change in overall canopy cover and distance to canopy edge. Overall, these shifts in nest-site characteristics may be evidence of a change in available Willow Flycatcher habitat due to natural forest succession (aging).

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#### CAVITY-NESTING BIRDS AND ASPEN STAND COMPOSITION IN NORTHERN YELLOWSTONE NATIONAL PARK

Aspen stands within northern Yellowstone National Park (YNP) have experienced considerable decline over the last several decades. Various hypotheses have been proposed for this decline, including high herbivory by elk in the absence of their main predator, wolves. However, human elk hunting just north of the park border has occurred for several decades. The relatively lower herbivory of aspen outside the park appears to be reflected in differing habitat composition of aspen stands inside and outside the park, particularly among young recruiting stems and large diameter ( $\geq 20$ cm) snags. Similarly, cavity-nesting birds associated with aspen-snag habitat appear to reflect this difference. Data collected during breeding season 2001-2003 show similar species richness and occurrence in aspen stands inside and outside YNP, but differences in aspen stand composition (recruiting stems and relative large snag abundance), and greater abundance of 6 of 11 species within YNP stands. The higher relative large-diameter snag abundance and open stand/canopy conditions of YNP stands currently appear to provide more desirable habitat for many cavity-nesting bird species that respond to such conditions. However, future YNP stand conditions may not be favorable as large-diameter snags are lost without new recruits.

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#### ECOLOGICAL TRADE-OFFS OF DIFFERENT FIRE CONDITIONS FOR AVIAN COMMUNITIES OF DRY CONIFEROUS FORESTS IN THE WESTERN UNITED STATES

Lower elevation, dry coniferous forests of western North America evolved under the influence of wildfire. Nevertheless, for nearly a century, land managers implemented the policy of widespread fire exclusion in these forests. Such practices altered fire regimes and ecological conditions in many areas, resulting in changes to habitat and populations of avian species. We examine avian abundance, and in some cases nesting survival, among three fire conditions in dry coniferous forests: fire exclusion, low-severity fire, and moderate-to-high severity fire. We evaluate the ecological trade-offs of these conditions in three regions of the western United States: Interior Northwest, California, and American Southwest. Historical fire regimes of dry coniferous forests in the recent past (150-200 years ago) were typically frequent, low severity burns and vegetation attributes were similar among the regions. To examine bird population responses, we selected species common across regions that represented different nesting strategies and forest strata: ground/shrub-nesting, canopy-nesting, and cavity-nesting species. Bird responses to different fire conditions were largely consistent across regions, suggesting that similar management actions might be appropriate for maintaining habitat of individual species within dry coniferous forests.

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#### A COMPARISON OF MULTI-SCALE HABITAT MODELS FOR BLACK TERNS

Black Terns are a species of concern due to habitat loss and population declines. They nest in freshwater wetlands and often forage in surrounding uplands and wetlands, indicating habitat selection at multiple spatial scales. To look at the relative importance of local and landscape variables in explaining presence, density, and breeding, we conducted surveys at 125 wetlands in North and South Dakota, then created multi-scale habitat models using Random Forests, a classification and regression tree technique. We also explored varying the definition of landscape by creating models using landcover within radii of 1, 2, and 4 kms. The most important predictor variable overall was the amount of nesting substrate in the breeding wetland. Wetland basin size, while important in the presence/absence models, did not explain density of Black Terns, suggesting passive sampling precautions are necessary. The 1-km models generally did not perform as well as the 2- and 4-km models. Our results demonstrate the importance of response variable and landscape scale choice in multi-scale habitat models for Black Terns, and contribute to generalizing and predicting Black Tern habitat information.

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#### AVIAN SURVEYS IN THE EVERGLADES AGRICULTURAL AREA

From April 2007 through April 2008 avian surveys were conducted on a 648 ha parcel of active agricultural land (predominately sugar cane) in the Everglades Agricultural Area (EAA) of West Palm Beach County, Florida. The site abuts the Arthur R. Marshall Loxahatchee National Wildlife Refuge. The study encompassed the completion of two surveys per month using a 20 point grid system based on the existing gravel roads. Survey points were located at approximately 0.5 km increments and established with the use of a GPS unit. Survey methods were developed for the actual surveys based on techniques used by Partners in Flight. All survey data were incorporated into a comprehensive database. During the survey a total of 77 species, with an average of 24 species identified per survey, were documented. A total of ten state-listed and two federally-listed species were identified. This survey method provided an effective and efficient way to gather avian use data over the course of an entire year.

## Physiology (G08)

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#### DO SEX AND AGE AFFECT IMMUNITY IN LEACH'S STORM-PETRELS?

Investment in immunity may be influenced by sex and age. We measured two components of the immune system in Leach's storm-petrels (*Oceanodroma leucorhoa*). Petrels are monomorphic, monogamous, long-lived (>30 yr) seabirds that lay single-egg clutches and exhibit very slow post-natal growth. For both nestlings and adults, we used a hemolysis-hemagglutination assay that measures the strength of natural antibodies and complement-mediated lysis. For nestlings only, we used the phytohemagglutinin test that measures cell-mediated immune response. We collected data on 97 individuals (54 adults and 43 nestlings) in summer 2008 on Bon Portage Island, Nova Scotia, Canada. Results confirm our predictions that immune response is un-biased between sexes, and that immune function strengthens with age.

## Population Ecology (G09)

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### POPULATION TRENDS OF BREEDING BIRDS IN THE WESTERN GREAT LAKES -1991 TO 2008

We counted birds in over 1200 survey points in more than 400 stands in the Chequamegon National Forest, Wisconsin, and the Chippewa and Superior National Forests, Minnesota each year from 1991 to 2008. Trends in relative abundance were calculated for over 70 breeding bird species within each National Forest and 41 species were combined for all three national forests. Of the 166 species trends possible, 72 (43%) were significant ( $P < 0.05$ ) including 32 species that have increased and 21 species have decreased in at least one National Forest. A total of 13 species have increased and 7 have decreased for the combined National Forest data over the 18 years of study. The most consistent pattern observed thus far has been a significant decline in birds that nest on the ground, including Winter Wren, Veery, Hermit Thrush, Ovenbird, and White-throated Sparrow. A detailed analysis of detection probability and overdispersion was also recently completed on sixteen species of varied abundance and detectability and will be briefly summarized.

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### USING GENETIC MARKERS TO DETERMINE CONSERVATION UNITS IN ALEUTIAN ROCK PTARMIGAN

Studying birds that breed in the Aleutian Islands of Alaska provides an opportunity to examine how geographic isolation affects high-latitude populations and to identify conservation units. The Rock Ptarmigan, *Lagopus muta*, is a member of the grouse family that lives on this island chain as well as on the mainland of Alaska and has numerous subspecies described within this area. This study focused on six populations in various regions of Alaska and the Aleutian Island chain that represent four subspecies. We sought to determine whether subspecies and genetics were concordant, infer levels of gene flow among populations, and assess each population's genetic diversity. We genotyped six microsatellite loci and found very high genetic divergence between all six populations. There was strong concordance between subspecies and genotype and many island populations had low genetic diversity. Isolated populations, that exhibit little or no gene flow, along with unique genetic lineages suggest that these groups can be labeled as individual management units (MUs). We propose that these unique, isolated units be targeted for conservation efforts in order to preserve their genetic lineages.

## Systematics/Evolution (G10)

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### SPECIES AND DIVERSIFICATION HISTORY OF THE NORTH AMERICAN ROSEFINCHES (GENUS *CARPODACUS*): INFERRED FROM MULTI-LOCUS DATA

The North American rosefinches (genus *Carpodacus*) encompass three species, which collectively are distributed throughout the United States and Mexico. Previous work has suggested that the North American rosefinches are monophyletic and represent a separate radiation from the Old World members of the genus *Carpodacus*. Presently, phylogenetic relationships among the North American rosefinches, *C. cassinii*, *C. purpureus*, and *C. mexicanus*, are unknown. To investigate species relationships within the rosefinches, we used a multi-locus (mitochondrial and nuclear DNA) approach along with geographic sampling of each species. The mitochondrial gene tree suggests that there are four distinct lineages within the group. We generated five additional gene trees from nuclear loci, to infer a species tree. Furthermore, we used the species tree to examine the timing of the rosefinch radiation in North America.

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### DEFINITION OF PARALLEL NORTH AMERICAN CARDUELIS SPECIES EVOLUTIVE RADIATIONS

Genus *Carduelis* is composed of different and separate evolutive species radiations, being the oldest group appeared on Earth about 9 MYA on Miocene Epoch (Eurasian greenfinches). Cyt-b molecular phylogenies by using maximum likelihood and Bayesian inference and linearized trees show that North American *Carduelis* species probably stem from Eurasian siskin (*C. spinus*) or an extinct related ancestor.

Pine siskin is a sister species Eurasian siskin, Antillan (La Hispaniola Island pine forests) and black-capped siskin (Mexico and Guatemala Highlands). American goldfinch evolutive radiation comprises the habitat-restricted Lawrence's goldfinch (Southern USA "spots") and *Carduelis psaltria* (dark-backed goldfinch), which has reached northern Peru in a large southwards habitat extension. Finally, the extant parental species of the South American siskin radiation is a North American siskin: *Carduelis notata* (black-headed siskin which thrives in Mexican tropical forest borders). The questions about time of appearance of these radiations in relation to climate and geology (after Miocene Epoch), distribution, and why the American *Carduelis* species' ancestor, Eurasian siskin, is not now thriving in America are addressed.

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#### MORPHOLOGICAL AND PLUMAGE VARIATION IN GRAY-HEADED CHICKADEES ACROSS BERINGIA

The Bering Strait, located between Alaska and Russia forms an ecological barrier for many taxa. The Gray-headed Chickadee (*Poecile cincta*) is a sedentary species and the only member of the family Paridae found in both the Old and New Worlds. The isolated New World subspecies (*P. c. lathamii*) occurs in northern Alaska, and northwestern Canada. *P. c. lathamii* has been disjunct from the founding population in eastern Russia since the end of the Wisconsin glaciation, approximately 10,000 years ago. We investigated plumage and morphological differences between *P. c. lathamii* and populations of *P. cincta* in the eastern Russia. Plumage variation was measured using reflectance spectrophotometry on nine specimens from Alaska and Canada and nine specimens from eastern Russia. Morphological measurements were taken on 10 specimens from Alaska and Canada and 13 specimens from eastern Russia. Four of 15 plumage variables and four of 10 morphological variables were significantly different between New World and eastern Russian specimens. Thus, substantial divergence has occurred between the source population in eastern Russia and the isolated New World population in a relatively brief time.

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#### IS TURNAGRA A BOWERBIRD?

Previous morphological and mitochondrial DNA evidence suggested that the piopios of New Zealand (*Turnagra capensis* and *Turnagra tanagra*) were bowerbirds. I extracted DNA from toe pads from one specimen of each Turnagra species, obtained from the American Museum of Natural History, and PCR amplified and obtained both mitochondrial and nuclear DNA sequences for each species. Turnagra RAG1 sequences were aligned to a large RAG1 dataset of passeriform species downloaded from Genbank. Phylogenetic analyses of this dataset robustly reveal that Turnagra is not allied with the bowerbird/treecreeper clade. Rather, analyses indicate that the lineage falls within the classic Corvida. There is moderate support for the Turnagra species to be nested within a clade that includes the oriolids (e.g., figbirds of Australasia and Old World orioles), and the pachycephalids (e.g., Australasian pitohuis, shrike thrushes and whistlers). Thus, based on these results, Turnagra probably had an Australasian origin, but not because it is a bowerbird. In addition, the two Turnagra taxa are diverged to an extent that indicates they are likely distinct species, but additional specimens are needed to confirm this.

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#### COMPLEX BIOGEOGRAPHIC HISTORY OF LANIUS SPP. SHRIKES AND ITS IMPLICATIONS FOR THE EVOLUTION OF HOST DEFENSES AGAINST AVIAN BROOD PARASITISM

We constructed a phylogeny of the *Lanius excubitor meridionalis* superspecies and relatives using portions of three mitochondrial genes to resolve the systematic relationships and to explain the pattern of egg rejection behavior in shrikes. The New World Northern Shrike *L. excubitor* and the Old World Southern Grey Shrike *L. meridionalis* were sister taxa, while the Old World Northern Shrike was considerably diverged from both New World species. The Chinese Grey Shrike *L. sphenocercus* was sister to the New World clade, and closer to the New World Northern Shrike and the Loggerhead Shrike than to the Old World Northern Shrike. The paraphyly and sequence divergence between New World and Old World Northern Shrikes suggests that they represent distinct species. When rejection behavior was mapped onto the phylogeny it suggests that rejection is deeply rooted in the shrikes. Rejection in Loggerhead Shrikes may have been retained in excess of 2 million years since they split from the Old World shrikes. These results suggest hosts are becoming increasingly resistant to brood parasitism, which will force parasites to specialize on a few host species.

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#### EVALUATION OF THE INTRODUCED EURASIAN TREE SPARROW (*PASSER MONTANUS*) FOR A POPULATION BOTTLENECK.

Twenty Eurasian Tree Sparrows (*Passer montanus*) were released in St. Louis, Missouri in 1870 from Germany in a single introduction event. Unlike the House Sparrow (*Passer domesticus*), which was introduced several times and spread throughout North America, the Eurasian Tree Sparrow has not spread far beyond the St. Louis area. Due to this well documented introduction and small number of founding birds, the Eurasian Tree Sparrow provides a unique opportunity to study a potential genetic bottleneck. Thirty three birds were sampled from western Illinois. Two of the nine microsatellite loci were monomorphic, but the other seven possessed as many as eleven alleles per locus. This suggests that a genetic bottleneck is unlikely to have affected dispersal in the Eurasian Tree Sparrows.

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#### MITOCHONDRIAL DNA PHYLOGENETIC DEFINITION OF A GROUP

Birds included within the Carduelini tribe (genera *Rhodopechys*, *Carpodacus* and *Leucosticte*) apparently belong to the same evolutive radiation according to molecular phylogenetic analyses. Our phylogenetic analyses based on nucleotide sequences of the cytochrome b gene (cyt-b) indicate that some of these birds (*Rhodopechys mongolica*, *R. githaginea* and *Carpodacus nipalensis*) do cluster together, but not with their respective phenetically defined allies. This new group of birds thrives in both hot and cold arid zones (including North America, *Leucosticte*) and are phenetically distinct, probably because of their adaptation to different extreme environments. Both maximum likelihood and Bayesian inference methods support the existence of this new evolutionary basal group among finches which might have originated about 14 million years ago. Eurasian *Leucosticte* expansion to North America is discussed on paleoclimatic and geological changes bases.

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#### EVOLUTION OF EGGSHELL ARCHITECTURE ACCOMPANYING RAPID RANGE EXPANSION IN A PASSERINE BIRD

Environmental factors such as temperature and humidity can affect avian egg shell structure because gas exchange across shell must allow a sufficient amount of water loss while preventing dehydration of the embryo. Alternatively, behavioral adaptations such as incubation attendance can compensate for variation in environmental factors, especially in species colonizing novel environments. The relative importance of morphological and behavioral adaptations related to egg shell permeability is poorly known. Here, we examined changes in egg shell architecture that accompanied rapid expansion of house finch (*Carpodacus mexicanus*) range across North America. We analysed eggs from three widely ecologically distinct populations in most north-western, south-eastern, and south-western edges of the species' current distribution. For each population, we measured egg shell thickness and pore density and distribution. In addition to establishing whether range expansion has resulted in rapid evolution of eggshell morphology, this study sheds light on the adaptive value of egg shell structure and provides insights into selective pressures associated with colonizing novel environments.

## Tropical (G11)

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### COMPOSITION AND DIVERSITY OF *RAMPHASTOS* TOUCAN FORAGING FLOCKS AT LA SELVA, COSTA RICA

We evaluated the temporal and spatial relationships between *Ramphastos* toucan foraging flock composition and fruit availability at La Selva Biological Station, Costa Rica. We hypothesized that fruit density affects species composition of frugivorous flocks and that flock composition and diversity would fluctuate as fruit abundance changed in the tree crown. Foraging observations of the Chestnut-mandibled Toucan (*R. swainsonii*) and Keel-billed Toucan (*R. sulfuratus*) were recorded from 4-29 July 2008 and 5-17 January 2009 (N=320); observations included determining species and abundance of other frugivores foraging in the focal tree. Fruit abundance data from focal trees were recorded to illustrate changes within a single tree over the study period. Toucans were observed in 18 focal trees during the 2008 study period and 11 during the 2009 study period. We found that fruiting phenology of individual trees and interspecies interactions of tropical frugivores determine composition of foraging flocks in this dynamic system.



## A

Ackerman, J. T. – 27  
Africa, L. A. – 65  
Allen, M. F. – 16  
Aldredge, J. N. – 34  
Aldredge, R. A. – 49  
Altshuler, D. L. – 4  
Arnaiz-Villena, A. – 65, 67  
Ammon, E. M. – 18  
Andersen, D. E. – 26, 56  
Andrews, S. – 32  
Angeloni, L. M. – 10  
Anthony, R. G. – 32  
Arizmendi, M. C. – 4, 33, 59  
Avilez T., F. – 44

## B

Badyaev, A. – 1, 67  
Bagne, K. E. – 14, 14, 62  
Bakian, A. V. – 53  
Banko, P. C. – 31  
Banko, W. E. – 31  
Barritt, A. M. – 63  
Bart, J. – 18  
Barton, D. C. – 23  
Bedrosian, B. – 28  
Beissinger, S. R. – 23  
Benford, R. – 46  
Bentley, G. E. – 42  
Berns, C. M. – 43  
Bird, D. M. – 24  
Birks, S. – 66  
Blair, R. B. – 29  
Block, W. – 62  
Bluso-Demers, J. – 27  
Boal, C. W. – 39  
Bock, C. E. – 27  
Bock, J. H. – 27  
Borgmann, K. L. – 34  
Boughton, R. K. – 10  
Bowman, R. – 10, 11, 12  
Boyce, W. M. – 12  
Bozinovic, F. – 54  
Brauning, D. – 24

Breen, B. M. – 20  
Breuner, C. W. – 2  
Bridge, E. S. – 39, 40  
Brodrick, M. J. – 58  
Brown, B. V. – 63  
Bruner, M. – 63  
Bui, T. D. – 28

## C

Caldwell, L. – 10  
Callahan, R. E. – 68  
Campomizzi, A. J. – 8  
Campos Contreras, J. E. – 59  
Cann, R. L. – 8, 31  
Carlson, D. B. – 51  
Carrothers, C. A. – 5  
Chalfoun, A. D. – 55  
Chambers, M. K. – 44  
Churchwell, R. T. – 32  
Clark, K. E. – 24  
Coe, S. J. – 24  
Conway, C. J. – 2, 22, 34, 41  
Cooper, S. J. – 45  
Cornelius, J. M. – 2  
Cornell, H. N. – 20  
Coulon, A. – 11  
Cousineau, C. – 45  
Cox, W. A. – 55  
Craig, D. L. – 5  
Culver, M. – 41

## D

Dahlin, C. R. – 20  
Danz, N. – 47, 64  
Darden, A. – 54  
Davis, C. A. – 32  
DeCicco, L. – 66  
Decker, K. L. – 2  
Delaney, K. S. – 11, 12  
DeSante, D. F. – 48  
Dieni, J. S. – 56  
Doran, P. – 37  
Dudley, R. – 4  
Dugger, K. M. – 32

## E

Eagles-Smith, C. – 27  
Engle, D. M. – 32  
Engel, S. – 40  
Ernest, H. B. – 5, 7  
Ervin, A. M. – 60

Estades, C. F. – 60  
Etterson, M. – 47, 64  
Etzel, K. E. – 28

## F

Faaborg, J. – 55  
Farwell, L. S. – 58  
Feldman, R. E. – 60  
Ferree, K. – 25, 61  
Fimbel, R. – 58  
Finch, D. M. – 14, 14, 17, 19  
Fitzpatrick, J. W. – 10, 11, 12  
Fleischer, R. C. – 66, 66  
Fontaine, J. J. – 15  
Freed, L. A. – 8, 31  
French, T. – 24  
Friggens, M. M. – 14, 14  
Fudickar, A. M. – 39, 40  
Fuhlendorf, S. D. – 32

## G

Gahbauer, M. A. – 24  
Gomez L. E. – 44  
Gomez-Prieto, P. – 65, 67  
Gonzalez-Gomez, P. L. – 54  
Greene, E. – 9  
Greeney, H. F. – 5

## H-I

Hahn, B. – 62  
Hahn, T. P. – 2  
Hargrove, L. – 14, 46  
Harrell, W. C. – 32  
Harvey, T. M. – 35  
Hawkins, L. R. – 67  
Henneman, C. – 61  
Ho, J. Z. – 58  
Hobson, K. A. – 42  
Hodum, P. J. – 60  
Hollenbeck, J. – 61  
Holmes, J. – 28  
Huettmann, F. – 36  
Hyde, T. C. – 35, 40

## J

James, F. – 1, 50  
James, H. F. – 49  
Janes, S. W. – 21

Johnson, D. H. – 29  
Johnson, M. D. – 52  
Johnson, M. J. – 28  
Jones, S. L. – 56

## K

Kellermann, J. L. – 52  
Kelly, J. F. – 19, 39, 40  
Kendall, S. – 36  
Kirsch, E. M. – 35  
Klicka, J. – 49, 50, 65  
Knick, S. T. – 33  
Knowles, L. L. – 12  
Koenig, W. D. – 22  
Koronkiewicz, T. J. – 38, 47  
Kozma, J. – 58  
Kus, B. E. – 25, 36, 61

## L

LaDeau, S. L. – 8  
Latif, Q. S. – 25  
Lehmkuhl, J. – 62  
Leitner, W. A. – 44  
Leu, M. – 33  
Levandoski, G. – 38  
Lim, M. – 65  
Loss, S. R. – 29  
Lovette, I. J. – 11  
Lozano A., L. – 44  
Lynn, S. – 25, 36

## M

Macias-Duarte, A. – 41  
Mandich, C. A. – 29  
Martin, T. E. – 23, 55  
Marzluff, J. M. – 20, 21, 28  
Maslowski, H. – 54  
McCormack, J. E. – 12  
McGuire, J. A. – 4  
McIntosh, C. E. – 66  
McKay, D. W. – 26, 55  
McKechnie, A. E. – 30  
McLeod, M. A. – 38, 47  
McGill, B. J. – 60  
McMillan, T. – 36  
McMorris, F. A. – 24

McNeil, G. V. -- 63  
Menendez, R. J. -- 63  
Mika, M. -- 49  
Miller, D. A. -- 43  
Miller-Rushing, A. J. -- 15  
Mockford, S. -- 66  
Moffat, J. -- 42  
Moran, J. -- 6  
Morrison, M. -- 63  
Morrison, S. A. -- 10, 12, 13

## **N**

Neal, M. C. -- 37  
Neudorf, D. L. -- 58, 59  
Niemi, G. J. -- 47, 64  
Nolan, P. -- 54  
Noss, R. F. -- 34

## **O**

Oh, K. P. -- 67  
Oppel, S. -- 41

## **P**

Panjabi, A. -- 38  
Parga, C. -- 65, 67  
Patten, M. A. -- 68  
Paxton, E. H. -- 3, 9  
Pearson, D. E. -- 9, 9  
Peck, R. W. -- 31  
Peer, B. D. -- 66, 67  
Peterson, A. -- 12, 13, 47, 64  
Piper, W. H. -- 21  
Pourtless IV, J. A. -- 50  
Powell, A. -- 36, 41, 57, 62  
Powers, D. R. -- 6  
Preston, K. L. -- 15  
Prouty, A. -- 59  
Pruett, C. L. -- 48, 64  
Purcell, K. -- 62  
Pyle, P. -- 44, 48

## **Q**

Quinn, J. S. -- 45

## **R**

Ramenofsky, M. -- 42  
Rector, M. E. -- 55  
Reguera, R. -- 65, 67  
Reiter, M. E. -- 26, 56

Repp, R. -- 58  
Richmond, O. -- 23  
Risk, B. -- 23  
Roberts, M. T. -- 67  
Robertson, B. A. -- 37  
Robinson, C. -- 27  
Rodriguez Estrella, R. -- 16  
Rodriguez-Flores, C. -- 4, 33  
Romano, M. A. -- 67  
Rotenberry, J. T. -- 16, 24, 46  
Rothstein, S. I. -- 66  
Rohwer, S. -- 42,  
Rohwer, V. G. -- 42  
Royle, J. A. -- 13  
Ruiz-del-Valle, V. -- 65, 67  
Russell, R. -- 62  
Ryker, L. -- 21

## **S**

Saab, V. A. -- 62  
Saracco, J. F. -- 48  
Schemske, D. A. -- 37  
Schmaltz, G. -- 45  
Schoech, S. J. -- 45  
Schondube, J. E. -- 6  
Seavy, N. E. -- 16  
Serrano-Vela, I. -- 67  
Seville, R. S. -- 29  
Sferra, S. J. -- 9  
Shaffer, J. A. -- 29  
Shutler, D. -- 63, 66  
Sillett, T. S. -- 10, 12, 13  
Skagen, S. -- 15  
Slay, C. M. -- 57  
Smith, B. T. -- 50, 65  
Smith, D. M. -- 17, 19  
Smith, K. G. -- 57  
Soberanes-Gonzalez, C. A. -- 59  
Sogge, M. K. -- 9  
Sparks, R. -- 38  
Steckler, S. E. -- 22  
Steen, V. A. -- 62  
Stein, L. R. -- 67  
Storey, A. E. -- 26, 55  
Strong, C. -- 27  
Stumpf, K. J. -- 38  
Sullivan, K. A. -- 53  
Swanson, H. -- 44

## **T-U**

Takahashi, L. S. -- 26  
Takekawa, J. Y. -- 27  
Tecklin, J. -- 23  
Tell, L. A. -- 7  
Theimer, T. C. -- 28, 38  
Thompson III, F. R. -- 55  
Tomasevic, J. A. -- 54, 58, 60  
Turner, T. N. -- 48, 64

## **V**

VanderWerf, E. A. -- 51  
van Riper, C. -- 15, 19, 35  
Vasquez, R. A. -- 54  
Villa, C. -- 36

## **W-X**

Wade, M. C. -- 63  
Walker, H. A. -- 57  
Walsh, C. J. -- 26, 55  
Walters, E. L. -- 22  
Wassenaar, L.I. -- 40  
Waser, N. M. -- 7  
Wayne, R. K. -- 11  
Weathers, W. W. -- 17  
Weiser, E. L. -- 57  
Wellik, M. J. -- 61  
Wenny, D. G. -- 38  
Wethington, S. M. -- 7  
Wilhelm, S. I. -- 26  
Winker, K. -- 48, 64  
Witt, C. C. -- 4  
Wolf, B. O. -- 30, 35, 40  
Wright, T. F. -- 20, 22

## **Y-Z**

Yeung, N. W. -- 51  
Young, A. M. -- 22  
Young, L. C. -- 51