ABSTRACTS

In alphabetical order of presenting author (by surname)

Effect of chronic anthropogenic noise on extra-pair paternity rate and mate choice of Chestnut-collared Longspurs

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Prairies are among the most threatened ecosystems in North America due to habitat loss and alterations from human activities, such as oil and gas extraction. As the oil and gas industry continues to expand, this may present a growing threat to biodiversity reliant on prairies. Grassland birds are of special concern since most obligate grassland species have suffered from significant declines in population size over the last half of the century, and many are now classified as threatened or vulnerable.

Our focal species, the Chestnut-collared Longspur (*Calcarius ornatus*) is a threatened prairie obligate. Oil infrastructure fragments the landscape and produces chronic low-amplitude noise, consequently altering the soundscape. Since acoustic signals play major roles in avian communication, birds are susceptible to such changes in the soundscape. Anthropogenic noise has the potential to alter perception and reception of acoustic signals that regulate mating systems leading to changes in preferences for social and extra-pair mates and, therefore, extra-pair paternity rates. This study isolated effects of noise from associated disturbances (e.g. physical structure, roads, traffic) by broadcasting high-fidelity playback oil-well noise in mixed-grass prairies of Southern Alberta from May to August 2016. Each solar-powered playback system played continuously during the breeding season. During this period, 119 adults and 253 nestlings Chestnut-collared Longspurs were captured, and a total of 82 nests were sampled. We collected blood samples for genetic analyses and a series of morphometric measurements (e.g. bill length, wing cord, body fat and pectoral muscle indices). Adults and nestlings were genotyped at 8 microsatellite loci to assess parentage. Using body condition indices, we evaluated differences in quality between socially paired individuals. The use of both genetic and physiological measures allowed us to assess impacts of oil infrastructure and isolated effects of noise on extra-pair behaviours and social-pair mate choice.

Marie-Ève Cyr is a Master of Natural Resources Management student at the University of Manitoba. Her interest in animal behavior and conservation lead her to focus her research on the anthropogenic threats faced by grassland songbirds and recently broaden to look at avian vocalizations in a tropical ecosystem.

ABSTRACTS

Corticosterone suggests mother longspurs increase parental effort to mitigate the effects of anthropogenic disturbance on nestlings

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Corticosterone (CORT) provides an opportunity to examine whether human disturbances lead to non-lethal but potentially negative impacts on wildlife by revealing signs of physiological responses to challenging environments. The mixed-grass prairie region of Canada has recently undergone rapid conventional oil development, which fragments habitat, introduces novel physical and acoustic features onto the landscape, and may contribute to the drastic declines seen in grassland bird populations. We measured basal and peak induced (acute stress response) plasma CORT of adult female and nestling chestnut-collared longspurs (*Calcarius ornatus*). We sampled nests at sites with oil wells, and sites with solar-powered playback units broadcasting recordings of oil wells, to isolate effects of noise from the associated infrastructure. Females closer to both oil wells and playback units had higher basal, but not peak induced CORT. In contrast, nestlings showed lower basal and peak induced CORT near oil wells but not the playback units, demonstrating that effects were caused by the presence of infrastructure and not its noise. Nestlings with lower CORT levels were also heavier, suggesting that they were of good quality and that their low CORT was not a result of hypocorticism. There was no significant relationship between nestling CORT and CORT levels of their mothers. The opposite trend in adult and nestling CORT suggests that different mechanisms affect CORT levels of nestlings and adults. Females near oil wells may need to spend more energy raising their young, resulting in higher basal CORT; our results suggest this behaviour may effectively compensate for negative impacts of infrastructure on nestlings, resulting in healthy offspring. Further research is needed to understand the complex physiological responses of birds to anthropogenic development.

Paulson Des Brisay is a master's student at the University of Manitoba. His current research is focused on applying methods from conservation physiology to determine why similar species may react differently to disturbance by linking settlement patterns, body condition, and glucocorticoids in grassland songbirds exposed to oil development.

ABSTRACTS

Intermountain grassland songbird responses to bison grazing on the National Bison Range and Yellowstone National Park

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Intermountain grasslands of the Rocky Mountain region in North America are composed of a blend of prairie grasslands and shrublands that host grassland obligate, facultative grassland, shrub associate, and sagebrush obligate avian species. Grassland obligate birds are known to respond to differences in grass vegetation structure, with some species having preferences for short, sparse grasses, and others preferring taller, denser grasses. On the other hand, facultative grassland, shrub associate, and sagebrush obligate species responses to vegetation structure are weaker and less consistent. Grazing by large ungulates is a key ecological process that maintains and creates the structure of grass vegetation in intermountain grasslands.

Bison are suggested to be ecosystem engineers that modify habitat and create a spectrum of vegetative structures to which songbirds respond. Historically, plains bison (*Bison bison*) were a major grazer throughout North America. Today, bison are restricted to smaller spatial scales, altering their forage and movement behavior. Recent conservation efforts focus on reintroduction of bison to sites within their historic range. However, little is known about whether contemporary bison grazing fulfils the same ecological process as it once did, and how it influences avian species.

We investigate intermountain grassland songbird occupancy and abundance in relation to bison grazing intensity to understand songbird habitat selection. We use bird surveys and bison grazing surveys to study the effect of bison grazing intensity on the occupancy and abundance of multiple avian species. We present results from the 2016 and 2017 field seasons at the US Fish and Wildlife Service - National Bison Range and US National Park Service - Yellowstone National Park, showing both avian species-specific and community responses to bison grazing. We conclude that bison grazing intensity may be one of many components of songbird habitat selection. Our results inform songbird conservation, bison reintroduction efforts, and current bison management.

Danielle Fagre is a graduate student in the Wildlife Biology program at the University of Montana. She is a member of the Avian Science Center and is interested in research that promotes conservation outcomes.

ABSTRACTS

KEYNOTE

Conservation management of breeding waders on wet grasslands

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Breeding wader populations across western Europe have been in sharp decline in recent decades, largely as a result of agricultural intensification and associated drainage of wetlands. Many of these populations are increasingly restricted to nature reserves, where management is generally focussed on providing habitat conditions that are attractive to breeding waders, through management of water levels and grazing. However, high levels of predation of eggs and chicks means that such management is typically not sufficient to maintain sustainable populations. By contrast, wader populations on grasslands at the subarctic latitudes of Iceland remain large and productive.

In this talk, we will discuss the management strategies that have been used to provide breeding resources for waders and reduce predator impacts on temperate lowland grasslands. In particular, using our studies of temperate and subarctic grassland-breeding wader populations, we will consider the types of local- and landscape-scale actions that are likely to be needed to maintain and recover breeding wader populations on wet grasslands.

Jennifer Gill is Professor of Applied Ecology at the University of East Anglia (UEA). Her research focusses on the ecology and conservation of migratory birds and she works on breeding waders in Iceland and, in collaboration with Jen Smart (RSPB & UEA) on lowland wet grasslands in the UK.

ABSTRACTS

The effects of bison reintroduction on grassland nesting birds in tallgrass prairie

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Agriculture conversion of tallgrass prairie has severely fragmented the landscape and many grassland birds are now in decline due to this loss of habitat. Restoration projects have sought to increase the quality and size of prairie fragments, hypothetically increasing breeding habitat for these birds. Bison are now being reintroduced to prairie restorations as a management tool to increase habitat heterogeneity. The goal of our study was to understand how the immediate impact of bison influences nest survivorship of all grassland nesting birds at Nachusa Grasslands in Illinois. We hypothesized that Daily Survivorship Rate (DSR) would be lower in areas with bison grazing, because of increased trampling, dislodging, decreased vegetation height, and potential increase in nest parasitism. We measured nest survivorship, parasitism, fire frequency, and vegetation characteristics around nests at six sites from 2014-2017. We found 210 nests of fourteen different species. DSR was calculated for all species and for Field Sparrows using RMark and compared using AICc for 16 different variables that could affect nest survivorship. We found that bison presence and parasitism did not influence survivorship of nests. Vegetation density around the nest was the only variable that explained DSR for all species, but none explained DSR of Field Sparrow nests. Three years post reintroduction may be too soon to see an influence of bison grazing in a tallgrass prairie restoration site. However, any decrease in the vegetation density at this site by bison grazing and trampling may indirectly decrease the DSR of these nesting birds in the future.

Heather Herakovich is an ecologist with a main research focus on grassland bird response to management, currently obtaining a PhD at Northern Illinois University. She is particularly interested in how restoration is impacting higher trophic levels and if we can assess differences using remote sensing technology.

ABSTRACTS

Testing experimental habitat management of grass-heath for breeding Woodlark (*Lullula arborea*)

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Woodlark (*Lullula arborea*) is a Species of European Conservation Concern protected under Annex 1 of the EC Birds Directive (EC 1979) due to historic declines across their European range. In the UK, most breed on lowland heath and dry grasslands, where they utilise a mosaic of microhabitats including bare-open areas for foraging. However, it is currently unclear whether creating additional foraging habitat through mechanical ground disturbance will facilitate population recovery, and if so which prescriptions deliver the best outcome. Here we examined the response of breeding Woodlark to four prescriptions plus controls, over a three-year period (2015-2017) in an extensively replicated landscape-scale experiment across the UK's largest remaining extent of grass heath. Prescriptions differed in treatment (discing vs ploughing) and complexity ('homogenous plots' vs 'complex mosaic plots', comprised of overlapping subplots of different fallow ages). As replicated treatments were stratified across different grassland types and ages, results inform management across a range of lowland habitats used by the species. Breeding Woodlark numbers increased through the study period, and responded positively to both ploughed and disced complex mosaic (not homogenous) plots across all studied grassland types. Within complex mosaic plots, Woodlark preferred recently disturbed subplots, which were characterised by shorter turf and a greater extent of bare substrate. Our results support the conclusion that Woodlark will benefit from dynamic mechanical ground disturbance that creates a combination of freshly disturbed areas and older fallows within lowland heathland and grassland habitats.

Robert Hawkes is a PhD student at the University of East Anglia, UK. His research investigates outcomes of management to support avian figurehead species for other diverse taxonomic groups (plants, beetles, true bugs, ants, bees, wasps and spiders), utilising one of the largest replicated landscape-scale experiments in Europe.

ABSTRACTS

Grassland bird responses to 25 years of land-use change across the steppes of Kazakhstan and Russia

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The Eurasian steppe belt stretches from Ukraine in the West to the Altai mountains. In Kazakhstan alone, 10% of the world's near-natural grasslands remain. The steppes host a number of globally threatened and biome-restricted bird species, such as Sociable Lapwing, Steppe Eagle, or Black Lark. Furthermore, they harbour large populations of 'farmland birds' such as Skylark that have been declining dramatically elsewhere in Europe.

The steppes of Kazakhstan remained largely untouched until the 1960s, when 25 million hectares grassland were ploughed in Nikita Khrushchev's 'Virgin Lands campaign', leading to a pronounced loss of steppe biodiversity. However, after the collapse of the Soviet Union in 1991, a reverse trend was observed, and millions of hectares of arable land were abandoned – with positive responses of steppe birds. More recently, new trends to intensify agriculture and recultivate abandoned land are obvious. Apart from the changes in crop systems, the quantity and distribution of livestock also underwent large changes over the past 25 years. Due to the collapse of the Soviet state farms and impoverishment of the rural population, livestock is currently concentrated near human habitation. At the same time, massive expanses of steppe remain ungrazed. This leads to local overgrazing, but an accumulation of biomass where livestock is absent. The latter process fuels larger and hotter wildfires that have significantly changed steppe vegetation.

Over the past 10 years, we have studied the effects of land use change on steppe bird distributions, abundance, habitat selection and reproductive performance in Kazakhstan and neighbouring Western Siberia. We will present a synthesis of the state-of-the-art knowledge and describe the use of our results for conservation planning and management. Finally, we will illustrate future steps to use our approaches to improve bird monitoring in Kazakhstan, e.g. through incorporating our data into the new European breeding bird atlas EBBA2.

Johannes Kamp, Ruslan Urazaliev and Ingrid Stirnemann are ecologists and conservation scientists. They are interested in land-use change effects on biodiversity, sustainable land management, socio-ecological systems and animal migration.

ABSTRACTS

Noise decouples perceived and actual habitat quality for grassland songbirds

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Anthropogenic noise impacts behaviour of different species in different ways, and thus we might expect that effects of noise on habitat selection by birds might differ from effects of noise on prey search behaviour of nest predators. This may decouple birds' perception of habitat quality from behaviour of predators searching for or encountering nests, resulting in ecological traps. We conducted a large-scale manipulative experiment in Alberta, Canada, in which we played recordings of oil well and drilling noise in sites without these activities to evaluate effects of noise on grassland songbirds and their predators. Savannah sparrows and chestnut-collared longspurs avoided drilling noise, which is loud and inconsistent and thus difficult to adapt to. Sprague's pipits avoided all anthropogenic features, regardless of noise. Effects of noise on nesting success differed from effects on abundance for three of our four focal species, and occurred at a broader spatial scale, consistent with the larger home ranges of nest predators compared with grassland birds. This suggests that anthropogenic noise decouples perceived from actual habitat quality for grassland birds, potentially leading to inefficient nest site selection and high depredation rates.

Nicola Koper is a Professor of Conservation Biology at the Natural Resources Institute of the University of Manitoba. Her research interests focus on mechanisms that explain effects of landscape structure and anthropogenic development on avian ecology.

Integrating environmental and behavioural drivers of nest predation in grassland management strategies for breeding waders

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In Western Europe, one of the greatest current conservation challenges is identifying means of reducing the very high levels of predation preventing population recovery in many ground-nesting birds. This is exemplified by many breeding wader populations which are declining rapidly and which, as ground nesters, are inherently vulnerable to a wide range of generalist predators of eggs and chicks. Management for

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breeding waders has historically focused on providing suitable nesting habitats, but land management to reduce predator impacts, and the contexts within which such actions can be effective, have received much less attention.
I will present findings of our recent studies of wet grassland-breeding waders which suggest that land management can potentially reduce nest predation rates, but only when highly targeted in areas of high wader breeding density. This targetting is likely to be effective because of the interaction of management effects with the positive density-dependent effects of anti-predator vigilance and mobbing. Integrating such density-dependent drivers of local productivity into conservation strategies may therefore provide a means of improving their effectiveness. In this presentation, I will use these findings to explore (1) the management actions that can potentially influence wader nest predation rates and (2) the potential benefits of targetting such actions to exploit evolved behavioural responses to predators by identifying the spatial and temporal drivers of these density-dependent responses. Through a greater understanding of these environmental and behavioural processes we can aim to optimise our abilities to manage grasslands to maintain sustainable ground-nesting bird populations.

Becky Laidlaw is a post-doctoral researcher at the University of East Anglia, whose research is concentrated on developing conservation solutions that aim to reduce the impacts of predators on breeding waders through landscape-scale habitat management.

Oil and natural gas development influence nest-site selection and nest survival of upland-nesting waterfowl and shorebirds

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Native grasslands provide important breeding habitat for many upland-nesting waterfowl and shorebirds. However, recent increases in oil and gas development in native grassland may alter the quantity and quality of this globally threatened habitat. Oil and natural gas development involves construction of roads, trails, and wells; often facilitating invasion by exotic vegetation. Our objectives were to determine 1) whether nest placement by upland-nesting waterfowl and shorebirds varied with proximity to oil and gas infrastructure; and 2) the extent to which nest survival was influenced by proximity to wells, roads, and trails, as well as percent cover of the exotic crested wheatgrass in southeastern Alberta, Canada, 2010–2011. Mallard (*Anas platyrhynchos*) and blue-winged teal (*Spatula discors*) nests were located within 100 m of wells more than expected by chance, and northern shoveler (*Spatula clypeata*) and northern pintail (*Anas acuta*) tended to nest more frequently within 200 m of wells. In contrast, more shorebird nests were located farther from wells than expected. Mallards and blue-winged teal were also more likely to place their nests near roads.

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Shorebirds tended to place their nests either close to roads or far from these structures more often than expected by chance. The proportion of mallard nests located in close proximity to trails was greater than expected, but fewer blue-winged teal nests were located near trails than expected by chance. The top-ranked models explaining variation in daily nest survival rates of northern shoveler, mallard, and shorebirds included distance to infrastructure variables, although these relationships were weak. Northern shovelers appear to benefit from placing nests closer to trails; daily nest survival rate increased with proximity to trails. However, trails may act as an ecological sink for shorebirds; they were more likely to place nests near trails but daily survival rates were lower near trails.

Sarah Ludlow is a conservation science coordinator with the Nature Conservancy of Canada with a main research focus on grassland birds and conservation. Her graduate work investigated the effects of oil and gas development on prairie birds. Following this, she worked on multiple projects related to conservation of grassland songbirds.

Comparing grassland bird population trends between a large, intact native prairie and Breeding Bird Survey data at multiple spatial scales

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The steep decline of North American grassland bird populations is of conservation concern. Recent work using BBS trends suggests that declines are driven by breeding ground agricultural intensification. While the conversion of native grasslands to crops on the breeding grounds is undoubtedly a major factor, it is unclear whether factors in migration and wintering areas or changes in climate and weather patterns are contributing. One way to explore these varied influences is to compare population trends between areas that have become dominated by intensive agriculture with those that remain in native prairie condition.

We compared grassland bird population trends between BBS routes at three spatial scales and a large, intact native mixed-grass prairie site, the Suffield National Wildlife Area, in Alberta, Canada. Suffield (459 km^2) is one of the largest remaining intact mixed-grass prairie sites in Canada, in a region dominated by cropped agriculture. We predicted that if on-going agricultural intensification is driving trends, then BBS data will show steeper declines compared to Suffield. Conversely, if trends are similar to BBS at Suffield, then other factors may be contributing. Using point count data collected at Suffield from 1994-2016, we estimated trends for 16 passerine and shorebird species and compared those trends to BBS trends at

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regional, national and North America-wide scales. Almost all species with declining trends according to BBS are stable or increasing at Suffield. The notable exception is Horned Lark is declining in all strata.

These results suggest that on-going agricultural activities which dominate breeding areas of North American grassland birds are indeed responsible for population declines for most species. If migration and/or wintering ground habitat or climate change impacts were major contributors to trends we would expect similar trends at Suffield where agriculture is absent. We highlight the critical importance of conserving large, intact native prairie habitat.

Nancy Mahony is a research biologist whose research focuses on declining populations of grassland songbirds and aerial insectivores. She is particularly interested in understanding the demographic causes of population declines in relation to habitat change, anthropogenic threats and climate change in order to develop conservation and management strategies.

Grassland resource use by parasitic Common Cuckoo nestlings via provisioning from host Meadow Pipit pairs

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Identifying key food and habitat resources for breeding species is a vital area of conservation and ecology research. In brood-parasitic birds, adult and nestling resource use are separate: Nestlings are raised by host species pairs at their nest (provisioning them mistakenly as their own offspring) while adults play no role in parental care. The Common Cuckoo *Cuculus canorus* has declined in most recorded breeding habitats in the UK, but is stable or increasing in population in semi-natural grassland and heathland. This contrast suggests Cuckoo declines may be driven by variation in breeding ground resource availability. Despite the potential importance of grasslands in supporting Cuckoo, the species has been little-studied in these habitats. To identify prey and habitats of importance during the Cuckoo nestling stage, and assess whether resource use (food, habitat, 'parental' time budgeting) differs between parasite and host nestlings; we observed foraging behaviour of Meadow Pipit *Anthus pratensis* pairs raising a Cuckoo nestling or their own young in a semi-natural grassland study area. We measured rate of provisioning visits; size of food items brought to the nest; and distances from the nest of plots used for foraging by Pipit pairs. Vegetation structure and composition of foraging plots was characterised, as was the habitat in a 100m radius around each nest. To the authors' knowledge, this constitutes the first study comparing the foraging behaviour of host parents provisioning a brood parasite nestling and those feeding their own young. Diet of Meadow Pipit nestlings was identified by molecular analysis of prey DNA 'barcodes' in faecal samples. Here we will

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show how resource-use in the nestling Cuckoo is satisfied in semi-natural grassland, and discuss the implications for nestling survival and conservation at a cross-habitat level.

Lowell Mills is a doctoral student in Biosciences whose main research interests are avian diet and foraging behaviour in the context of conservation ecology. His PhD project studies variation with land-use in breeding Common Cuckoo resource availability (food, habitat structure, hosts).

KEYNOTE

Applying population ecology to conserve red-billed choughs in agricultural grasslands

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Theoretical and empirical understanding of population dynamic responses to environmental variation has advanced dramatically over recent years, such that effects of demographic covariation, structure and stochasticity on population growth rate, and on effective population size and resulting inbreeding, are now well known. Investment in such fundamental population science is commonly justified by the overarching objective of informing management strategies for wild populations of conservation or economic value. Yet, in practice, our ability to apply such complex principles to populations of conservation concern is often severely limited by a lack of detailed demographic and ecological data.

We used 35 years of data from a small Scottish population of red-billed choughs (*Pyrrhocorax pyrrhocorax*) inhabiting low-intensity agricultural grasslands to identify demographic and ecological constraints on population growth rate and effective size, and thereby design and implement appropriate management strategies. Initial analyses identified low first-year survival associated with food shortage as the primary constraint on population growth rate, and identified locations that produced fledglings that survived poorly. Grassland management aimed at improving foraging conditions were consequently implemented. Meanwhile, first-year survival decreased to rates that threatened short-term population viability, and further analyses identified acute food shortage in late summer as the likely cause. An emergency programme of supplementary feeding was consequently implemented. Meanwhile, evidence of the

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expression of a lethal recessive allele, and detailed demographic analyses that estimated a critically small effective population size, highlighted inbreeding as a possible further constraint on population growth rate. Translocations to alleviate inbreeding are now being considered, yet must be accompanied by appropriate management of agricultural grasslands and livestock.

Through this case study, we showcase an iterative process that bridges the gap between complex population science and applied population management, and highlight the benefits and challenges of linking the two worlds.

Jane Reid is a population and evolutionary ecologist interested in understanding how environmental, genetic and demographic variation combine to influence population dynamics and evolution. She uses long-term data from wild bird populations and sophisticated statistical and simulation models to understand population dynamics and the evolutionary causes and consequences of polyandry, inbreeding and partial migration.

KEYNOTE

Identifying demographic bottlenecks in the annual cycles of grassland birds

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Conservation of grassland birds requires a better understanding of demographic bottlenecks at different stages of the annual cycle. Seasonal patterns of survival can help to identify ecological factors that limit population numbers, and regulatory mechanisms that drive population dynamics. The *compensatory mortality hypothesis* predicts that mortality should be highest overwinter due to density-dependent competition for resources. Conversely, the *additive mortality hypothesis* predicts high anthropogenic losses to harvest, collision or increased predation risk, with greater impacts when timing of loss follows seasonal peaks in natural mortality.

What are the seasonal patterns of mortality for grassland birds breeding in managed rangelands? For eight populations of prairie-chickens (*Tympanuchus* spp.) in the Great Plains, I used time-to-event models to examine seasonal changes in hazard rates and demographic value of radio-marked females. Prairie chickens had 0 to 2 peaks in the seasonal hazard rates, and most mortality was due to predation or collisions. Mortality rates were highest during the nesting and brood-rearing periods, but relatively low during the nonbreeding season. In Upland Sandpipers (*Bartramia longicauda*), I used mark-recapture

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models to estimate annual rates of apparent survival, and time-to-event models to estimate seasonal survival during breeding seasons in Kansas and nonbreeding seasons in Uruguay. Mortality rates of sandpipers were highest during migration, with no mortality events observed during the nonbreeding season.

Seasonal patterns of mortality in grassland birds do not support the compensatory mortality hypothesis. In both species, anthropogenic mortality during the nonbreeding season is likely to be additive because natural mortality is low and the demographic value of surviving birds remains high. Migration was a risky period in sandpipers, which is consistent with reports of mass mortality events that regularly occur in the Andes. Baseline data on seasonal patterns of mortality risk will help to target conservation actions during key stages of the annual cycle.

Brett K. Sandercock is a terrestrial ecologist with research interests in population biology and wildlife ecology. He is a Senior Research Scientist at the Norwegian Institute for Nature Research, where he is involved with long-term research and monitoring projects for grouse, migratory shorebirds, and species of conservation concern in Scandinavia.

KEYNOTE

Assessing and mitigating the effects of wind-energy development on grassland and wetland birds in the U.S. Northern Great Plains

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Wind-energy facilities continue to proliferate across the natural landscapes of the U.S. Great Plains, yet implementation of mitigation tools to ameliorate the direct loss of habitats or indirect effects on wildlife from wind-facility construction are rarely applied. Three published research studies conducted in the northern Great Plains by the U.S. Geological Survey and U.S. Fish and Wildlife Service have established the displacement impact on grassland and wetland birds. Results for each study will be discussed, including one study that employed the rarely implemented Before-After Control-Impact methodology. These studies have led to the development of methods for quantifying displacement rates and the amount of grasslands and wetlands needed to support displaced pairs; the calculations required for each will be explained. Case examples will be provided where mitigation measures could be applied to the protection of grassland and wetland habitats. In addition, spatial tools that identify important areas for protection against development and potential areas for conservation offsets of mitigation will be discussed.

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Jill Shaffer is an ecologist with a research focus on grassland-bird ecology and conservation. She has evaluated the impacts of wind facilities on grassland birds and is working on a series of species accounts that will be compiled in a Compendium of the Effects of Management Practices on Grassland Birds.