Contributions by Motus collaborators at the International Ornithological Congress in Vancouver, August, 2018.

1. **Tracking Sanderling (*Calidris alba*) along the Central Flyway: Identifying drivers of migration pace and linkages among key staging sites in a long-distance migrant shorebird**

Authors:
Kristin Bianchini[1], David Newstead[2], Christy Morrissey[1]
1. University of Saskatchewan, Saskatoon, SK, Canada, 2. Coastal Bend Bays & Estuaries Program, Corpus Christi, TX, USA

Abstract *
Long-distance migrants are under strong selective pressure to migrate quickly. This is particularly true in the spring when early arrival at breeding grounds is correlated with greater reproductive performance. However, despite the link between migratory pace and avian fitness, the factors that influence migration timing are not well understood, and research tends to study staging areas in isolation. Therefore, our goal was to investigate the relationship between fuelling, departure and arrival dates, and travel speed in Sanderling (*Calidris alba*), a long-distance migrant shorebird species, at key, latitudinally disparate staging sites along the Central Flyway. Between 2015 and 2017, we captured 121 Sanderling at sites in Gulf of Mexico (GOM) and 118 Sanderling in Chaplin Lake, Saskatchewan. We measured each bird's mass (i.e., fuel load) and attached coded nanotags to track migratory movements using the Motus radio-telemetry array. 95% of Sanderling detected in more northern latitudes were detected in Saskatchewan, suggesting that most Sanderling in the GOM migrate north using the Central Flyway. Fuel loads were negatively correlated with stopover durations and departure dates at all sites, and travel speed was positively correlated with departure dates, suggesting that that Sanderling behave according to a time-minimization migration strategy. Despite these relationships however, many individuals that departed later from the GOM also showed later arrival and departure dates in Chaplin Lake. Our results highlight the potential for carry-over effects during migration and show how proper fuelling at key staging areas along the entire migration route is essential for the conservation of migrant species.

2. **Novel insights into stopover ecology of shorebirds in eastern North America from the MOTUS wildlife tracking network**

Authors:
Charles M. Francis[1], Jamie McLaren[2], Paul A. Smith[2]
1. Canadian Wildlife Service, Environment and Climate Change Canada, Ottawa, ON, Canada, 2. Science and Technology, Environment and Climate Change Canada, Ottawa, ON, Canada

Abstract *
Understanding migration routes, connectivity among stopover locations, and use of stopover locations is important for conservation planning for migratory species. Many shorebirds are believed to rely heavily upon a limited number of key stopover locations, such as Delaware Bay in eastern North America. However, there is uncertainty about the proportion of shorebirds using

these sites and how long they stay. Understanding stopover duration is key to evaluating a site's importance, and also for calibrating migration counts to estimate population trends. We used the MOTUS Wildlife Tracking Network to track migration for several thousand Red Knots *Calidris canutus* and Semipalmated Sandpipers, *Calidris semipalmatus*, and to evaluate their stopover behaviour during spring and autumn migration at several sites in eastern North America. We found that fewer than half the birds tagged at James Bay on southward migration were detected at major known stopover sites on the Atlantic Coast, suggesting significant proportions use smaller locations, or make long-distance migrations to bypass the region. We also found that 'stopover duration' can be challenging to define, as birds often moved among several sites within a region before departing on long-distance flights. We also found that stopover duration at a site tended to be shorter for birds tagged away from the site, than for birds tagged at the site. This could indicate an effect of capture on stopover behaviour, or that each sample represents a different mixture of birds with respect to stopover strategies. Overall, these species have greater diversity of migration strategies than previously recognized.

3. **Post-breeding movements and timing of adult and juvenile Purple martin (*Progne subis*)**

Authors:
Saeedeh Bani Assadi, Kevin C. Fraser
Department of Biological Science, University of Manitoba, Winnipeg, MB, Canada

Abstract *
Improving our understanding of post-breeding movements and habitat selection can help to inform conservation efforts for long-distance migratory aerial insectivores that are currently experiencing steep rates of population decline in North America. We used the Motus Wildlife Tracking Network to determine the post-breeding movements of adult and juvenile Purple Martins (*Progne subis*) at three different breeding colonies in southern Ontario, Canada. We aimed to use the dense array of receiver towers in this region to determine habitat use and movements before the commencement of autumn migration, and whether patterns differed between adults and juveniles as well as between female and male adults. We found movements within the region, from 10s to 100s of kilometers from the deployment sites, sometimes in the opposite direction (northward) to subsequent autumn migration. We report on the spatio-temporal dynamics of post-breeding movements in this system to improve our understanding of this little studied period of the annual cycle for aerial insectivores.

4. **Intrinsic and extrinsic factors driving shorebird migratory strategies and performance from a northern stopover site**

Authors:
Alexandra M. Anderson[1], Erica Nol[1], Paul Smith[2], Christian Friis[3]
1. Trent University, Peterborough, ON, Canada, 2. Environment and Climate Change Canada, Ottawa, ON, Canada, 3. Canadian Wildlife Service, Toronto, ON, Canada
Poster Presentation Day:

Abstract *
Optimal migration theory has guided avian migration research for 30 years, but the ability to track small migratory birds at fine spatial and temporal scales has limited understanding of drivers of migratory behavior of small, long-distance migratory birds. A new technology, automated radio telemetry using the Motus Wildlife Tracking System, has allowed for the collection of high resolution shorebird migration data at and beyond a remote but critical stopover site, the southwestern coast of James Bay, Ontario, Canada. We used this system to determine intrinsic (body condition, refueling rates, and body size) and extrinsic (wind speed and direction, cloud cover, tide levels) factors influencing stopover length, departure, migration speed, wind assistance, subsequent stopover time, and migration routes of five shorebird species using James Bay as a stopover site in 2014-2017. We compared Semipalmated Sandpiper (*Calidris pusilla*), White-rumped Sandpiper (*Calidris fuscicollis*), Least Sandpiper (*Calidris minutilla*), Pectoral Sandpiper (*Calidris melanotos*), and Semipalmated Plover (*Charadrius semipalmatus*) migratory strategies to determine if shorebirds with longer total migration distances were more time-constrained during sound-bound migration. We expect to see the most extreme long-distance migrants (White-rumped Sandpiper and Pectoral Sandpiper) exhibit time-minimizing migration strategies (refueling rates and mass associated with initial flight distance from James Bay, fewer stopovers, longer-distance flights, higher flight speeds, and less compensation for wind drift) compared to the other shorebird species that migrate shorter distances and may act as energy-minimizers. This research expands knowledge of drivers of migration strategies in long-distance migrant shorebirds at an under-studied but important stopover site.

5. Tracking the effects of a neonicotinoid insecticide in migratory songbirds

Authors:
Margaret L. Eng[1], Bridget J. Stutchbury[2], Christy A. Morrissey[1]
1. University of Saskatchewan, Saskatoon, SK, Canada, 2. York University, Toronto, ON, Canada

Abstract *
Neonicotinoids are neurotoxic insecticides commonly used as seed treatments in a wide variety of crops. Consumption of treated seeds by migratory birds using cropland as stopover sites could have consequences for migratory fueling or orientation behavior; however, the influence of neonicotinoids on migratory ability is poorly understood. We combined captive and field manipulations in migrating White-crowned Sparrows (*Zonotrichia leucophrys*) to assess effects of imidacloprid on migration in seed-eating passerines. In a captive study, birds exposed to environmentally relevant concentrations of imidacloprid experienced significant mass loss and stopped orienting correctly, whereas control birds maintained body mass and a seasonally appropriate northward orientation. To corroborate results from captive trials at an ecologically relevant scale, we conducted a study in free-living White-crowned Sparrows. Birds were caught during spring migratory stopover and given a single oral dose of a vehicle control or imidacloprid at either 1.2 or 3.9 mg/kg-bw. Birds were held for 6 hours to monitor body mass and food intake, then tagged with uniquely coded transmitters and released into into an array of automated telemetry towers (Motus) to track movements on a landscape scale. Imidacloprid exposed birds reduced food consumption and lost a significant amount of mass relative to controls, and birds with the longest stopover durations were in the imidacloprid treated groups.

Visual assessment of telemetry tracks suggests that dosed birds avoided risky flights (e.g. over major waterbodies), while control birds took a more direct route. Effects on speed and direction of migratory movements based on telemetry data will be presented.

6. The Motus Wildlife Tracking System: working collaboratively to cover more ground

Authors:
Tara L. Crewe[1], Philip D. Taylor[2], Stuart A. Mackenzie[1]
1. Bird Studies Canada, Port Rowan, ON, Canada, 2. Acadia University, Wolfville, NS, Canada

Abstract *
Automated radio-telemetry was conceived in the 1960s to monitor the local movement of animals with greater temporal precision than was possible using manual tracking. Today, radio-telemetry remains the primary means to track small animals with high spatial and temporal precision. A desire to apply the technology to the study of movement behavior at broader spatial scales led to the concept of a collaborative, open source network of receivers operating on a single radio frequency, allowing tags to be 'recaptured' by any receiver in the network. What began as a collaborative network of receivers on the Atlantic coast of North America has now grown into the Motus Wildlife Tracking System, a network with over 150 collaborators and over 400 receivers across the Americas, Europe, and soon Australia. Researchers collaborating in the network benefit from detections of their tags at towers maintained by others, and from the data upload, processing, management, visualization, and analytical tools currently being developed by Motus for its users. In complement to other tracking technologies, Motus is allowing researchers to work together to answer important ecological questions about the movement behavior of small animals. For example, data from six projects using Motus, geolocators, and banding studies are together unraveling the continental-scale movement patterns of the Blackpoll Warbler, *Setophaga striata*. Going forward, we envision an open-source platform that allows interoperability with alternative technologies and data portals (e.g., ICARUS, MoveBank), and where users can contribute to the development of Motus through technology and analytical tool development.

7. Post-breeding movements and timing of adult and juvenile Purple martin (*Progne subis*)

Authors:
Saeedeh Bani Assadi, Kevin C. Fraser
Department of Biological Science, University of Manitoba, Winnipeg, MB, Canada
Poster Presentation Day:
Wednesday August 22
e-poster Presentation Time:
15:30 - 16:00
e-poster Station:
Station 11

Abstract *

Improving our understanding of post-breeding movements and habitat selection can help to inform conservation efforts for long-distance migratory aerial insectivores that are currently experiencing steep rates of population decline in North America. We used the Motus Wildlife Tracking Network to determine the post-breeding movements of adult and juvenile Purple Martins (*Progne subis*) at three different breeding colonies in southern Ontario, Canada. We aimed to use the dense array of receiver towers in this region to determine habitat use and movements before the commencement of autumn migration, and whether patterns differed between adults and juveniles as well as between female and male adults. We found movements within the region, from 10s to 100s of kilometers from the deployment sites, sometimes in the opposite direction (northward) to subsequent autumn migration. We report on the spatio-temporal dynamics of post-breeding movements in this system to improve our understanding of this little studied period of the annual cycle for aerial insectivores.

8. Modeling the many horizons of tower and turbine collision risk for migratory birds

Authors:
Jeremy D. Ross, Eli S. Bridge
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Abstract *
In the era of ever-crowding skies migratory birds are faced with greater numbers of structures projecting into the aerosphere. These obstacles are known to cause direct mortality by collision but may also hold the potential to elicit avoidance behaviors. Over thousands of kilometers of travel the many horizons of seemingly "open" airspace are effectively compressed by movement into one aggregated risk profile across the entire migratory pathway. The sum effect on the individual or the species depends on the distribution and abundance of obstacles, as well as the relative risk each structure type presents. To model this, we have compiled and cross-referenced records for towers, buildings, and wind turbines registered with the US Federal Communications Commission and Federal Aviation Administration, determining for each structure its timeline of existence and configuration (i.e., height, lighting, guyed, etc.) From these data we produced maps of obstacles across the contiguous US for each year from 1973 to 2017 with associated configuration data for each tower in each respective year. We then plotted across this landscape a collection of migratory bird pathways, both precise (satellite/GSM) or interpolated (geolocator/motus) and examined how collision risk along these migration pathways has changed over time. We also examined a series of realistic migratory pathways for a hypothetical small songbird using an agent-based modeling approach to determine entire which migratory corridors may have become disproportionately affected by increased obstacle development into the aerosphere. Our findings highlight the accelerating pace with which obstacles to bird flight are crowding the skies.

9. Tracking changes in the microbiome of Kirtland's Warblers on their wintering and breeding grounds

Authors:
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1. University of Chicago, Chicago, IL, USA, 2. Field Museum of Natural History, Chicago, IL,

USA, 3. Migratory Bird Center, Smithsonian Conservation Biology institute, Washington, DC, USA

Abstract *
Each individual animal is host to a complex microbial community composed of millions of microorganisms, collectively known as the microbiome. The microbiome is quickly becoming recognized as a highly influential aspect of the host. In this study, the fecal microbiome of an endangered species, Kirtland's Warbler (*Setophaga kirtlandii*), is quantified and compared using specific individuals tracked with coded radio tags and Motus towers from their wintering grounds on Cat Island, Bahamas through to their breeding grounds in lower Michigan, thereby significantly advancing our understanding of birds throughout their annual cycle. Using metagenomics sequencing and multi-level comparisons of microbial diversity, the changes, similarities, and differences between individual warblers and populations will be identified and analyzed. This microbiome data joins a rich matrix of information on these birds, including fecundity, age, diet, weight, and migration dates, as well as breeding and wintering territories. The composition of the microbiome is relatively understudied in wild animals, especially in migratory birds. Identifying changes that occur during different stages of migration will lead to a more integrative understanding of the biological changes that occur when a bird travels long distances between dramatically different habitats.

10. Using eBird Citizen Science data to choose the best big birds to track smaller ones: "communications ecology" takes flight

Authors:
David W. Winkler[1], Mattia Pancerasa[2], Tricia Miller[3], Michael Lanzone[4]
1. Cornell University, Ithaca, NY, USA, 2. Politecnico di Milano, Milan, Italy, 3. Conservation Science Global, West Cape May, NJ, USA, 4. Cellular Tracking Technologies, Rio Grande, NJ, USA

Abstract *

With the development of LifeTags small enough to track birds less than 20g in mass over their entire life-times, there is increasing need to place receivers in the paths of small migrating passerines. In the Americas, the Motus wildlife tracking system is beginning to have regional impact and is still growing, but there are many places that small birds travel where Motus may never reach. We are exploring the possibility of using species of birds large enough to carry a receiver that listens for tags on smaller species to dramatically increase the odds of repeatedly encountering smaller target species. The larger species would serve as an "air station", migrating and moving through its habitat and passively encountering the smaller tagged species. Every time a signal is received, it would be time- and GPS-stamped, and the encounter sent back to a central server via the cell phone network. We use eBird data to combine information on the annual movements and patterns of co-occurrence of target and potential air station species to help choose among them. We think this is a promising method in the new science of "communications ecology," using larger species as mobile sensing platforms that can gather information on the environment much more efficiently than can any purely human-manufactured sensor platforms. The method should increase greatly the chances of gathering registrations of

the target species, either throughout the annual cycle or in designated times of year when information on movements is particularly sparse.

11. New York City is an urban migratory stopover site for Semipalmated Sandpipers *Calidris pusilla*

Authors:
Susan B. Elbin, Debra L. Kriensky, Kaitlyn L. Parkins, Emilio T. Garcia
New York City Audubon, New York, NY, USA

Abstract *
Shorebirds undertake a long-distance annual round-trip migration with stopover sites along the way. Jamaica Bay Wildlife Refuge, New York City, NY, USA, is a 21,000-acre urban estuary that lies within the Atlantic Flyway and in the most densely populated city in the United States. Habitat loss is the greatest threat to Atlantic Flyway shorebirds and may lead to increased use of urban sites. Do these sites provide nutrients and shelter needed by shorebirds during their migration? We begin addressing this question by looking at local and long-distance movement. To document habitat use, we conducted citizen science surveys to produce maps of shorebird hotspots. In 2018 we ground-tracked tagged birds. Long-distance movements were mapped using NanoTag data. NanoTags are small radio transmitters (0.67 grams) that emit signals stored on towers in the Motus Wildlife Tracking System. We banded and tagged birds at three stopover sites in Jamaica Bay during their spring (n = 19 in 2017; n = 10 in 2018) and fall (n=5 in 2016) migrations. All birds were detected upon release. Nineteen birds were detected at least one point along their spring migration, including Gulf of St. Lawrence and James Bay. Seven birds were detected during the fall migration. We are waiting for results from the 2018 stations. Results to date indicate that birds stopping in Jamaica Bay continue to points north during the breeding season, and the resources they find NY need to be high quality.

12. Post-fledging survival of Barn Swallows (*Hirundo rustica*): New insights from an automated telemetry approach

Authors:
Dean R. Evans[1], Keith A. Hobson[1, 2], Jackson W. Kusack[1], Mike D. Cadman[3], Kaelyn H. Bumelis[1], Greg W. Mitchell[2]
1. University of Western Ontario, London, ON, Canada, 2. Environment and Climate Change Canada, Ottawa, ON, Canada, 3. Canadian Wildlife Service, Environment and Climate Change Canada, Burlington, ON, Canada

Abstract *
The post-fledging period is one of the most important but least understood stages of the annual cycle for migratory songbirds. After fledging, juveniles face high rates of mortality as they learn to forage independently and evade predators. Due to the difficulty of tracking songbirds after fledging there are very few estimates of post-fledging survival for songbirds and almost none that exceed two to three weeks in length. Here we present the results of a two-year (2016/2017) study on the post-fledging survival of Barn Swallows (*Hirundo rustica*) in southern Ontario using automated radio telemetry (The Motus Wildlife Tracking System). We radio tagged 221 juveniles just prior to fledging and tracked them for approximately 42 days prior to migration.

Using Motus tower detections we created individual encounter histories for survival analysis using RMark. Survival was lowest during the first two weeks post-fledging, resulting in a mortality rate of approximately 30% in each year. Following this, daily survival increased to about 98-99% which resulted in a cumulative survival probability of 35% in 2016 and 48% in 2017 for the entire tracking period. We also found that condition at fledging in 2017 could impact survival by as much as 20% with better quality individuals having higher overall survival rates. Our results support previous studies indicating that the first few weeks post fledging is a critical window for survival, but also further suggests that cumulative post-fledging survival prior to fall migration may represent a critical population bottleneck for this species.

13. Over-winter movement patterns of the endangered Red Knot (*Calidris canutus rufa*) at Bahia Lomas, Chile

Authors:
Stuart A. Mackenzie[1], Zoe Crysler[1], Peter Davidson[1], Amanda Dey[2], Carmen Espoz[3], Stephanie Feigin[4], Gabriela Garrido[5], Paul A. Smith[7], Lawrence J. Niles[6]
1. Bird Studies Canada, Port Rowan, ON, Canada, 2. New Jersey Department of Environmental Protection, Greenwich, NJ, USA, 3. Universidad Santo Tomas, Santiago, Chile, 4. Conserve Wildlife Foundation of New Jersey, Trenton, NJ, USA, 5. Centro Bahia Lomas - Centros de Investigacion UST, Punta Arenas, Chile, 6. Environment and Climate Change Canada, Ottawa, ON, Canada, 7. LJ NIles Associates LLC, Greenwich, NJ, USA
Display Days:
Thursday/Saturday
Poster Presentation Day:
Saturday August 25

Abstract *
Bahia Lomas, Terra del Fuego, Chile is one of the most important wintering locations for the endangered Red Knot (*Calidris canutus rufa*), and another species of concern, the Hudsonian Godwit (*Limosa hemastica*), for both of which we lack basic information about winter ecology and behaviour. In January 2018, we outfitted 79 knots and 7 godwit with radio transmitters, and used five automated radio telemetry stations strategically positioned around Bahia Lomas to measure movement patterns and habitat use. Knots and godwits were monitored for an average of 41.5 and 58 days resulting in 886,939 and 157,687 detections, respectively. Knots travelled a minimum of 5 km, and up to 57 km per day as they moved between roost and foraging sites. Roosting and movement patterns appear to be driven largely by daily and seasonal tide cycles. The amount of time individuals spent at the primary roosting/capture site also declined as the season progressed suggesting seasonal shifts in habitat use, or a gradual departure of individuals from the site. Most birds appear to depart by mid-March. Five birds were detected elsewhere in the hemisphere during spring migration suggesting a minimum migration time back to North American staging areas (~10,000+ km) of ~15 days. These preliminary findings greatly increase our understanding of the winter ecology of these two species and improve our ability to predict and respond to potential environmental or anthropogenic threats. Further study is needed in order to quantify and compare the relative importance of staging and wintering sites across their range.

14. Population connectivity of Snowy Plovers (*Charadrius nivosus*) on the southern Great Plains of Texas, New Mexico and Oklahoma

Authors:
Kristen M. Heath[1], Warren C. Conway[1], Clint W. Boal[2]
1. Texas Tech University, Lubbock, TX, USA, 2. USGS Texas Cooperative Fish and Wildlife Research Unit, Lubbock, TX, USA

Within-season dispersal events are rarely studied, and further investigation is required to elucidate spatiotemporal aspects of metapopulation dynamics. This is particularly germane for Snowy Plovers (*Charadrius nivosus*), which are listed as Species of Greatest Conservation Need throughout their range in the Southern Great Plains (SGP). To date, no within-breeding season movements have been quantified in Snowy Plovers on the SGP, where Snowy Plover breeding habitat can be <1 km, to as great as >600 km apart. This variable and discrete distribution of breeding habitat patches, coupled with weather stochasticity and low plover densities at sites in Texas and New Mexico, increases risk of extirpation. Moreover, an estimated 5.8-10 hatchlings per adult per year are needed to maintain populations on the SGP barring immigration. Considering well-documented habitat degradation and population declines (>75% in some regions) regional persistence probability is low. In our study, we used the Motus Wildlife Tracking Network to determine population connectivity of adult Snowy Plovers across the SGP of Texas, New Mexico and Oklahoma. In 2017 we erected six receiver stations at active breeding sites across the SGP and attached 31 avian nanotags to adult Snowy Plovers. We detected regional movement between discrete habitats >12 km apart, and 5 plovers were detected and resighted on the Gulf Coast during fall and winter 2017. We plan to tag >100 plovers in 2018 to obtain more detailed information on midcontinental Snowy Plover population connectivity, which will be crucial to inform conservation strategies rangewide.

15. Tracking the effects of cold weather on Barn Swallow (*Hirundo rustica*) movements and survival

Authors:
Michael D. Cadman, Jeffrey Costa
Canadian Wildlife Service, Burlington, ON, Canada

Abstract *
Periods of cold weather are potentially important stressors of aerial insectivores. We used radio transmitters on Barn Swallows in early May of 2016 (n=40) and 2017 (n=31) and the MOTUS network in Southern Ontario to assess how movements and mortality varied with temperature during the pre- and early-breeding season. Daily high temperature dropped below 11°C for two consecutive days in 2016, and for five consecutive days in 2017. In both years, regardless of temperature, birds were detected primarily near their breeding site, though a drop in detections during cold weather suggests that activity was reduced. Seventeen birds (42%) in 2016 and 15 (48%) in 2017 were detected away from their breeding sites during cold snaps; of these, 14 (82%) and 11 (73%) birds, respectively, were detected in the vicinity of two lakes up to 20 km from their breeding sites, suggesting that certain waterbodies provide valuable foraging opportunities during harsh conditions. In both years, 5 birds were detected further afield during the cold snaps at distances of 27 to 70 km from breeding sites, but detections suggest that all birds returned to their breeding site to roost overnight. The two day cold snap of 2016 caused no mortality. Although 13% of birds were not detected following the five day cold snap of 2017, the difference was not conclusive due to lower capture probabilities. Our results suggest a strong

attachment to breeding sites, even before nesting commences, but are inconclusive regarding the effects of cold snaps on Barn Swallow mortality.

16. Integrating migratory behaviour and physiology: adrenocorticoid activity, aerobic capacity and fuel load determine ecological barrier crossing in free-flying songbirds

Authors:
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CMEC, Copenhagen, Denmark

Abstract *
Long distance migrants frequently encounter topographical features, such as obligate water crossings, which can elicit observed changes in behaviour. While it has been established that overall, migratory flights are orchestrated by predictable seasonal rhythms, intrinsic factors specific to the individual, or perturbations in external variables: few studies have attempted to investigate the physiological integration between cues and fine scale behaviour in free-flying birds. Utilizing an array of automated radiotelemetry receivers we tested the role of adrenocorticoid activity and a suit of body-condition metrics in migratory decisions at the individual level, of adult European robins *Erithacus rubecula* at the periphery of the Baltic Sea, Southern Scandinavia. We find that multiple intrinsic and physiological parameters influence complex migratory behaviour in this passerine. Circulatory corticosterone, stress-induced corticosterone, body size, fuel load and haematocrit combined, best predicted departure direction. This demonstrates a flexible strategy in response to condition, presumably to optimise survival prospects when confronted with an ecological barrier.

17. Exposure to Malaria, not Necessarily Infection Itself, Can Affect Migratory Behaviour of Songbirds: Evidence from Captive and Field-Based Experiments

Authors:
Tosha R. Kelly[1, 2], Simon J. Bonner[1, 3], Ben D. Rubin[1], Scott A. MacDougall-Shackleton[2, 4], Elizabeth A. MacDougall-Shackleton[4]
1. Department of Biology, University of Western Ontario, London, ON, Canada, 2. Advanced Facility for Avian Research, University of Western Ontario, London, ON, Canada, 3. Department of Statistical and Actuarial Sciences, University of Western Ontario, London, ON, Canada, 4. Department of Psychology, University of Western Ontario, London, ON, Canada

Abstract *
Seasonal migration exposes animals to a variety of habitats and parasites giving infected migrants the potential to transport infectious diseases long distances. To determine whether parasitic infection can alter or interfere with songbird migration timing, we conducted both lab- (spring migration) and field-based (fall migration) experiments with white-throated sparrows (*Zonotrichia albicollis*) and song sparrows (*Melospiza melodia*), respectively, inoculated with malarial parasites (*Plasmodium* spp.). In captivity, we assessed infection success, parasite loads, nocturnal migratory restlessness (Zugunruhe), and body composition (fat mass, lean mass, and hematocrit) of white-throated sparrows for the duration of the infection. While there were no differences between groups in body composition, resistant (exposed to malaria, but did not become infected) and infected birds appear to differ in Zugunruhe: resistant birds decreased

Zugunruhe immediately after inoculation during the acute phase and infected birds decreased Zugunruhe during the recovery phase. In the second experiment, we assessed infection success and body composition of song sparrows in captivity until the end of the acute phase. Birds were then released and monitored for fall migration departure using radio-telemetry. Resistant song sparrows had reduced lean mass in comparison to controls prior to release, but we could not detect differences in departure date. These findings suggest that exposure to malaria can affect migratory schedules and body condition of songbirds. Models of disease spread depend on knowing whether infection affects migratory behaviour, making studies such as these crucial to understanding future host/pathogen dynamics in our changing climate.

18. Movement ecology of long-and medium-distance songbird migrants - results of a tracking study

Authors:
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1. Institute for Biology and Environmental Sciences, Carl von Ossietzky University Oldenburg, Oldenburg, Germany, 2. Institute of Avian Research "Vogelwarte Helgoland", Wilhelmshaven, Germany

Abstract *
Birds can be distinguished between residents and facultative, and obligate migrants. Within the Palaearctic-African migration system, migrants are separated into trans-Saharan migrants, which show longer seasonal migration periods, and those that winter farther north. The latter are usually termed “medium-distance migrants”, whereas the former are named “long-distance migrants”. The migratory periods are shorter and the speed of migration is lower in medium- than in long-distance migrants. Optimal migration theory predicts that medium-distance migrants have more time for their seasonal travels and organize migration to minimize energy expenditure. In contrast, long-distance migrants probably maximize the speed of migration at the expense of higher energy costs. It was therefore hypothesized that resting until flow assistance improves pays off in terms of minimizing the energy costs of transport but not in terms of minimizing the time spent on migration because lying in wait costs time. Hence, based on theoretical reasoning long-distance migrants are thought to organize their migration to minimize the time spent on migration, whereas the migration behaviour of medium-distance migrants is thought to minimize the energy costs of migration. Yet, no study has investigated potential differences in their migration behaviour by jointly considering species of both groups simultaneously under free-flying conditions. To do so, radio-tracking data of a large-scale automated radio telemetry array will be analyzed. Special emphasis will be given to the different adaptations formed by natural selection in long- and short-distance migrants in terms of both their migration behavior and their range of reaction norms to environmental variation.

19. Breeding productivity, phenology and habitat use of two co-occurring aerial insectivores

Authors:
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1. Simon Fraser University, Burnaby, BC, Canada, 2. Environment and Climate Change Canada, Edmonton, AB, Canada

Abstract *
Aerial insectivores have been declining across North America for several decades, but the main causes of these declines remains unclear. Furthermore, very little research has been conducted to compare interspecies variation in causes of declines or to examine the critical post-fledging stage. Therefore, we directly compared variation in breeding phenology and productivity in co-occurring populations of Barn Swallows (*Hirundo rustica*) and Tree Swallows (*Tachycineta bicolor*), and examined the post-fledging survival and habitat use of Barn Swallows. We monitored Barn Swallow and Tree Swallow nests from 2013-2016 across three different habitat types and tracked post-fledgling Barn Swallows using radio telemetry from 2015-2016 in the lower mainland, BC, Canada. Tree Swallows had larger clutches, and earlier average lay dates, but Barn Swallows were double-brooded and both species initiated laying only 1-2 days apart over the four years. In addition, both species responded similarly to warmer spring temperatures, and interspecies differences were largely independent of habitat type. Barn Swallows had low post-fledgling survival rates, which could negatively impact population dynamics of the species in this region. Barn Swallows preferentially selected crop habitat, but not pasture habitat, which is commonly used by breeding adults. Overall, our results indicate there are only minor interspecies differences on the breeding grounds between Barn Swallows and Tree Swallows and therefore factors related to variation in species' trends may be occurring during the post-fledging stage, migration or on the wintering grounds.

20. Small scale movements of passerine migrants at the German North Sea coast

Authors:
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Abstract *
Migrating land birds regularly encounter ecological barriers such as the open sea. Arriving at the coast, each bird has to decide on its individual flyway, eventually crossing the open water or following the coastline. Our study site, the German Bight, poses such a barrier and covers 320 km of coastline and several islands. While general flight trajectories of species are well studied in this area, knowledge on individual routing decisions is scare, especially regarding passerines. To track individual flights, we used a network of automated radio telemetry receivers. During autumn 2017, 169 passerine birds (Eurasian blackbird, song thrush, redwing, Eurasian blackcap, dunnock and European robin) were equipped with light-weight radio tags. Relative to the general NE–SW migration direction during autumn, birds were tagged before they reached the coast. About 60 percent of tagged birds were detected by at least one receiving station. Single birds could be detected at up to 11 different stations and 250 kilometers. Tracks of birds reveal a variety of small-scale movement patterns, including crossings of the sea and reverse movements. As expected, routes differed between groups of species. While tracks of thrushes generally covered the whole area of the German Bight, blackcaps and dunnocks, in particular, seemed to rather follow the coastline. Combining these data with weather conditions at departure and individual parameters like age, sex and fuel loads of birds, bears the unique potential to better understand the causes of individual routing decisions of migrating birds at an ecological barrier.

21. Evaluating the impact of overnight en route weather over the Gulf of Mexico on lean mass of spring migrants

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Abstract *
During long migratory flights, birds use fat deposits for energy, but they also burn lean tissue resulting in significant reductions in muscle and organ masses which can impose physiological limitations that prolong stopover. In wind-tunnel experiments, hotter or drier conditions lead to greater depletion of lean mass in flying birds. Therefore, warming temperatures experienced *en route* may directly impact body condition, migration rate, and ultimately breeding success of migratory songbirds. Here we test the hypothesis that higher temperatures and/or drier conditions experienced *en route* by spring trans-Gulf of Mexico migrants will result in reduced lean mass upon arrival in the Northern Gulf coast. In spring 2016-2018 we banded songbirds on a barrier island in Apalachicola Bay, Florida. We used plasma metabolite profiling and Quantitative Magnetic Resonance body composition analysis to accurately and non-invasively measure body condition of spring migrants on arrival. Select species were tracked using automated radio-telemetry to determine stopover duration and migratory behavior. For six focal species, body fat averages were all under 9%, indicating birds had recently arrived from trans-Gulf flight. We found no inter-annual difference in fat mass or refueling rate. Northern Waterthrush (*Parkesia noveboracensis*) had significantly lower lean mass in 2016 than in 2017, but we did not find inter-annual lean mass differences for the other species. Overnight temperature and humidity data prior to capture will be correlated against size-corrected lean and fat masses to determine how climate impacts fuel use in flight and arrival condition in passerine Neotropical migrants.

22. Big data, big challenges: new Movebank tools for avian telemetry

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The growing resolution and temporal record of on-animal sensor data is moving ecologists towards advanced tools for management, analysis and collaboration. At the same time, to understand and mitigate risk to animals caused by ongoing anthropogenic changes, in particular for migratory birds, wildlife biologists must minimize the time between data collection and data-informed management decisions. To meet these challenges, Movebank (movebank.org) offers free tools that are accessible across geographic, administrative and taxonomic boundaries and can be integrated with use of R, GIS and other applications. Access and sharing options support communication between researchers, collaborators and the public, while allowing sensitive data to remain private. As of April 2018, Movebank hosts over 700 million locations and 1.2 billion other sensor measurements (primarily from geolocators and accelerometers) describing 778 taxa

and stored in over 4,500 user-created studies. In addition to providing automated data feeds for more than ten manufacturers, Movebank is now the data access portal for ICARUS, a new satellite tracking system for small animals enabled through the International Space Station and currently in its testing phase. In addition, the Environmental Data Automated Track Annotation (EnvDATA) System now connects to new global satellite products and provides an improved user interface for annotating hundreds of environmental variables to animal movement tracks, geographic regions and generic time-location records, enabling efficient data exploration, hypothesis testing and model building. Finally, we are working with the International Bio-Logging Society to make published data discoverable across the biodiversity and life sciences communities.

23. Migration of Piping Plovers in the U.S. Atlantic: timing, routes, and atmospheric conditions

Authors:
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Abstract *
Information on offshore movements of species listed under the Endangered Species Act is needed for assessments of offshore wind energy areas. Our specific objectives were to track federally-threatened Atlantic Coast Piping Plovers (*Charadrius melodus*) to determine: 1) fall migration routes; 2) temporal and demographic variation in offshore movements; and 3) atmospheric conditions during offshore flights. From 2015 to 2017, we attached 1.0 g digitally-coded VHF transmitters to 150 adult Piping Plovers nesting in Rhode Island and Massachusetts, USA and tracked their movements using 35 automated radio telemetry stations along the U.S. Atlantic Coast. Tagged plovers initiated migration from mid-July through early September, with failed breeders departing earlier than successful breeders. Piping Plovers migrated at flight speeds ranging from 50 to 80 km/hr on evenings with predominately southwest winds, above average air temperatures, high visibility and little to no precipitation. Piping Plovers from Cape Cod, Massachusetts departed within six hours prior to local sunset, and primarily used an offshore route across the mid-Atlantic Bight. In contrast, plovers from Rhode Island departed within four hours prior to local sunset, and either followed a coastal route or took an offshore route south of Long Island, New York. Individuals used stopover sites along the U.S. mid-Atlantic coast during migration, with nocturnal migratory flights spanning distances of over 600 km. These results reveal new insights into the migration ecology of Piping Plovers and will be used in assessments of exposure to offshore wind energy areas throughout the U.S. Atlantic Outer Continental Shelf.

24. Dietary antioxidants and food availability alter stopover decisions in passerines: a field experiment

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Abstract *
During migration, birds must decide many times when to travel and these decisions are likely contingent on their fuel stores and antioxidant capacity. We manipulated the condition of migrating birds on an offshore stopover site (Rhode Island: 41°130N, 71°330W) to test the hypothesis that birds with greater fuel stores and antioxidant capacity have shorter stopovers than lean birds with low antioxidant capacity. We used a 2 X 2 factorial experiment (high or low food availability, dietary anthocyanins or no anthocyanins) in four species of birds that differed in migration strategy: Myrtle Warblers (*Setophaga coronata coronata*, n = 32), Hermit Thrushes (*Catharus guttatus*, n = 32), Red-eyed Vireos (*Vireo olivaceus*, n = 16), and Blackpoll Warblers (*Setophaga striata*, n = 16). We then attached Avian NanoTags (Lotek Wireless) to assess stopover duration. Oxidative damage was high when birds arrived on stopover, and birds given anthocyanins were able to reduce oxidative damage during captivity more than birds not given anthocyanins. Birds fed *ad libitum* with anthocyanins were able to increase their antioxidant capacity more than those not given anthocyanins. Stopover was shorter for Hermit Thrushes, Red-eyed Vireos and Blackpoll Warblers fed *ad libitum* as compared to maintenance food (GLMM , F= 7.52, P = 0.01; F= 2.96, P= 0.09; F= 18.01, P= 0.004 respectively), but not for Myrtle Warblers (GLMM, F= 0.69, P= 0.41). These findings indicate that fat stores and oxidative status can influence the time passerines spend on stopover, and those condition-dependent movements are influenced by a bird's migration ecology.

Workshop:

Motus Wildlife Tracking System: data management and analysis

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Abstract *
The Motus Wildlife Tracking System is a collaborative research network that uses coordinated automated radio-telemetry arrays to study movements of small animals. Online tools allow Motus users to upload raw receiver data for processing, and manage tag and receiver metadata. Motus R packages allow users to download processed detections data by project or receiver, while the companion online Motus R Book instructs users how to manage, filter, explore, and analyze Motus detections using the R statistical programming language. The purpose of this workshop is to provide a practical demonstration of the online Motus tools for uploading and managing Motus detections data and tag/receiver metadata, and of the use of the Motus R packages to import, filter, explore, and analyze the data. The primary aim will therefore be to provide users with the tools and confidence they need to successfully manage their own project data. Following the formal demonstration, there will be an opportunity for feedback and discussion on software performance, analysis requirements and future directions. The workshop will be used to develop a series of future webinars on data management and analysis, which will be made available on the Motus website at https://motus.org.