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Population ecology

North American ornithology in transition

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1. Introduction

There are a large number of ornithological societies in North America, some dating back to the 1880s. Although they differ in part by history, region, scientific approach and taxonomic focus, many of the memberships overlap and the societies are increasingly holding joint meetings. The largest of these is the North American Ornithological Conference (NAOC). Since 1994, NAOCs have convened roughly every 4 years in Missoula, St Louis, New Orleans and Veracruz. The most recent was the 5th North American Ornithological Conference (NAOC-V), a joint meeting of nine ornithological societies from Canada, the USA and Mexico, and the first NAOC to be held in Canada. With nearly 1500 registrants from 25 countries, the conference presented an opportunity for substantial exchange of ideas in research and in how to organize ornithological societies in the coming years. Several unifying elements were apparent throughout the sessions and workshops.

2. Beyond breeding biology: advances in understanding birds over the full annual cycle

NAOC-V highlighted major advances in solving one of the largest gaps in our knowledge of North American birds: what they do outside the breeding season. About 200 species of birds that breed in North America spend most of their lives in the Neotropics, yet the vast majority of research on these migrants has focused on the few months they spend at breeding areas. Although breeding biology is an important component of life history, most mortality occurs outside the breeding season. Consequently, migration and wintering are key stages shaping the evolution and conservation of many species. The endangered Kirtland's warbler (*Dendroica kirtlandii*), for example, suffers 50 per cent of its annual mortality en route to and from the Bahamas. Ornithologists are making major advances in understanding birds over their full annual cycle as a result of long-term datasets from the tropics and exciting technological advances.

It would have been nearly impossible to attend the NAOC-V and not hear a talk using the latest in ornithological technology: 'geolocators'. These tiny devices consist of a clock, light sensor and data logger. Attached to a bird's back via a leg harness, the tag records ambient light levels. When researchers recapture the bird (typically a year after deployment), day length can be used to estimate latitude and sunrise time to estimate longitude for each day of the bird's journey. Although these tracking devices have been used for several years on seabirds, only recently have they been miniaturized sufficiently to study small land birds. Sample sizes are generally small because each $200 tag provides data only if recovered from the bird, and recovery rates are often less than 20 per cent. Nevertheless, geolocator technology came of age at NAOC-V with results moving beyond the novelty stage to the point where enough data have accumulated to start answering important questions in fields from evolution and behaviour to population biology and conservation.

One of the greatest advantages of geolocators is that researchers can track the year-round movements of *individual* birds. Previously, surveys, banding and isotope studies revealed species-level migration routes and wintering locations, but geolocators provide daily details about where and how fast an individual bird goes. For example, new data show that small landbirds can cover huge distances very fast; purple martins (*Progne subis*) can fly more than 6000 km between South and North America in only two weeks. Such data can be combined with physiological studies to test and refine theoretical models of maximum flight ranges based on flight costs and fuel storage. Also, some individual birds occupy more than one discrete wintering area, resulting in three migratory and three sedentary periods during their annual cycle. Veeries (*Catharus fuscescens*) migrate within Amazonia midwinter, and bobolinks (*Dolichonyx oryzivorus*) spend several weeks in Venezuela before continuing to Argentina, paralleling some austral migrations and forcing a critical examination of how we define and differentiate between stopover and wintering ranges.

Some of the most intriguing talks at NAOC-V addressed the timing of migration, with important implications for how migratory birds may adjust to climate change. While isotope studies suggested that circumstances in one season carry over to affect fecundity or survival in another season (often via migration timing), geolocators are revealing remarkable constancy in migration timing within species and individuals. In at least a few species, individuals depart from distant overwintering areas within a few days of each other in a given year, and birds that have been tracked repeatedly for up to three years appear to time their migrations almost identically each year. These results suggest that migration timing may be more 'hard wired' than previously suspected, and birds may not be able to make facultative adjustments to changing climates. If so, we should expect population-level consequences of phenological mismatches between birds and their resources before selection can act to shift endogenous migration programmes. Most isotope and geolocator studies have been carried out on different sets of bird species, and it will be interesting to see how the results from these two approaches are reconciled as our understanding of migrant life histories continues to grow.

The recent advances in primary research on bird migration have important implications for conserving bird habitat. As signatories to the 1916 Migratory Birds Convention, Canada and the USA have strong federal mandates to protect their migratory birds, and a major focus of discussions at NAOC-V was migratory connectivity—the link between breeding and wintering populations. Many species of North American birds consist of distinct eastern and western populations, which we are now learning occupy different wintering areas and use different migratory routes. In purple martins, for example, geolocators revealed that birds breeding in eastern North America spend winter in the Amazon basin, whereas birds from western Canada winter along the southeast coast of Brazil, facing different sets of threats. In Mexico, home to most of North America's threatened bird species, decades of work on avian habitat-use have helped inform forest restoration, Important Bird Area designations and management of 'bird friendly' shade coffee plantations. However, there remain major gaps in applying research to on-the-ground conservation. In combination, long-term breeding season monitoring, new geolocator data and multiple-locus DNA analysis should soon permit us to determine which population declines in North America can be attributed to habitat loss or other disturbance on wintering grounds, along migratory routes or on breeding ranges. With such information, conservation actions can be targeted at regions most effective in conserving North America's birds.

By far the majority of bird species in the Americas, including most of the threatened species, inhabit the Neotropical region year-round. At NAOC-V, the advances in understanding birds over their whole annual cycle extended beyond Nearctic–Neotropical migrants to include these Neotropical residents. A key result was that much of the variation in fecundity and survival in tropical communities is driven by climate, and, at least in seasonally dry areas, decreasing precipitation often results in lower fitness. Because climate change scenarios predict decreases in precipitation for many parts of the Neotropics, we can predict considerable reshuffling of tropical bird communities in coming years.

3. Multiple levels of organization

The great majority of attendees at ornithology meetings come from the fields of ecology, evolution and behaviour. It was clear from the presentations at NAOC-V that research in these disciplines is becoming more integrative, such as by addressing physiological mechanisms for observed traits and by scaling up to regional and global patterns through ecosystem studies and macroecology.

Tools from physiology and neuroscience are providing new insights into some of the long-standing questions in the evolution of life-history traits and behaviour. One of the plenary presentations concerned the links among senescence, cell damage and the trade-off between current and future reproduction. Female blue-footed boobies (*Sula nebouxii*) invest more when breeding with males that have greener feet, a trait that declines in attractiveness with reproductive senescence. Foot colour is an honest signal to females, being associated with levels of oxidative stress and DNA damage to sperm of older birds. Because breeding effort increases oxidative stress, taking a sabbatical from breeding allowed older males to regain their attractive foot-colour and improve their chances of future breeding success. In a second example, non-invasive brain imaging allowed researchers to study the mechanisms underlying social behaviour in wild American crows (*Corvus brachyrhynchos*). Not only do crows remember human faces, they transmit their knowledge to other individual crows and behave differently towards individual humans that they perceive as carers versus threats. Brain imaging revealed which areas of crows' brains become metabolically active when they see humans they associate with neutral or negative experiences. As physiological and neurological tools become more available to ecologists, we can expect an increasing understanding of the mechanisms behind bird behaviours and insights into the evolution of these traits.

Ornithologists are also increasingly scaling up their research to landscape and regional levels, pushed by the need to predict ecological responses to a changing climate. One symposium addressed this point specifically by examining the transmission of avian diseases at scales from the individual to the landscape. It is now clear that individual birds within a population vary widely in their level of viral shedding, such that few individuals are responsible for the

majority of disease transmission. Disease susceptibility also varies widely among species, and at a community level, transmission rates may be affected by introductions and extinctions of bird species. Because climate and habitat are major drivers of pathogen transmission and demography of insect vectors, landscapes also vary widely in the level of avian disease, with some areas acting as population sinks for bird hosts. Understanding the spread of avian disease at individual, community and landscape levels is key for predicting which birds are likely to spread new viruses under scenarios of changing land-use and climate.

4. New phylogenetic hypotheses

One of the most engaging features of birds to both amateurs and professional ornithologists is the high diversity of species. As the tools for collecting DNA data and analysing large sets become more accessible and less costly, the patterns of avian evolution are coming into sharper focus. A comprehensive phylogeny of the wood-warblers (Family Parulidae) was recently completed and one of the plenary talks built upon this framework to gain new insight into their historical patterns of speciation and current distributions. Another exciting development was an unveiling of a tree for all bird species. The tree is not without controversy but this is usually the case for pioneering research. The general consensus among participants was that the authors have developed a reasonable method for incorporating missing taxa into a large phylogeny while also accounting for uncertainty. Moreover, a tree is now available for comparative analyses and can be updated as new systematic data become available. The initial results of this effort are already quite exciting. In a symposium organized around the new tree, it was demonstrated that speciation rates have been much higher on average in the New World than in the Old World, but have not been any higher in the tropics compared with the temperate zone. This suggests that the higher diversity in tropical zones is due to longer residence, not higher rates of speciation.

5. Ornithology going forward

Whereas ornithologists are embracing the research tools and approaches at the forefront of their various broader disciplines of ecology, evolution, systematics, conservation and physiology, the ornithological societies they collectively belong to are having more difficulty agreeing on the best path forward. NAOC-V was a joint meeting of nine ornithological societies but many of the memberships overlap. There has been enthusiasm for holding joint conferences, at least on occasion. A more ambitious proposal for a partial or complete merger of societies has been in development and was the subject of a lively formal discussion scheduled on one of the evenings. There appear to be several pending issues for at least some of the societies, including finding new publishers for the journals, declining memberships and long-term financial planning. Proponents suggested that a larger Society for Ornithology (S.F.O.) would be more financially secure and could speak with a more unified voice in promoting avian science. Critics countered that the same goals could be achieved with a stronger federation model that preserved the traditions and more intimate nature of the smaller society meetings. The issue proved divisive and word came shortly after the meeting that the S.F.O. in the form being proposed was abandoned. Discussions among some of the larger societies are ongoing, however, with the aim of coordinating publications, meetings and other administrative activities.

Ornithology has its roots in the work of amateur naturalists and has always benefitted from the participation of bird-watchers, who are not employed as researchers. Now, advances in online data management and visualization are allowing scientists to use data collected by birders in new ways, to improve monitoring and understanding North America's birds. For many years, volunteer birders have been the mainstay of some of the largest bird surveys in North America, including the Breeding Bird Survey, the Christmas Bird Count and numerous banding efforts. More recently, Internet applications such as e-Bird, a real-time, online checklist programme, capitalize on observations made by birders any time, anywhere. Multiple presentations at NAOC-V demonstrated how data collected by birders could be used to map large-scale migratory movements, understand stop-over ecology, assess population trends, and determine the effects and extent of human impacts such as the Deepwater Horizon oil spill. In future, with advances in communications, it is clear that citizen science will continue to make major contributions to ornithological research.