Hubbard Brook Research Foundation

Why Study Neotropical Migratory Birds?

A description of avian research findings at Hubbard Brook

Least Flycatcher/Robert Royse

The spring arrival of Neotropical migratory birds to the temperate and boreal forests of the northern hemisphere is among the great wonders in nature. Travelling immense distances, risking starvation, exhaustion, and countless hazards, migratory birds leave the tropical regions to come north, where they feed on the great abundance of insects that multiply in the long days of the northern summer and carry out their breeding activities. Birds in the northern hemisphere have undertaken this annual rite—of flying long distances, selecting breeding areas, singing, nesting, and rearing young—since at least the last ice age. These fascinating characteristics of birds have long attracted attention from professional scientists and the general public alike. Recently, scientists studying bird populations have documented a significant decline in the abundance of Neotropical migratory birds. This creates concern for several reasons, including the facts that birds provide many valuable ecosystem services such as pollination, seed dispersal, insect and rodent control, and that they serve as indicator species that can signify problems elsewhere in the ecosystem. Understanding the causes of population change in migratory birds, and what they imply for bird conservation, adds a new chapter to the history of humans' fascination with birds and bird ecology.

Indeed, birds in the forests of New England face a host of threats from both natural and human-caused environmental challenges. For thousands of years, birds have contended with recurring disturbances such

as hurricanes and ice storms, predation, pathogens, and disease. In addition to these natural hazards are those created by humans—habitat loss from residential development, atmospheric pollutants, and most recently, accelerated climate change. Scientists face the daunting task of understanding how these natural and human-caused environmental challenges interact and impact successful migration, breeding, and survival of birds. Moreover, this is made more difficult because environmental threats differ for these species in their breeding grounds, in wintering areas, and along their migration routes.

Evaluating the impacts of such challenges to birds requires an understanding of their ecology, how they respond to their environments, and what factors influence their populations. At the Hubbard Brook Experimental Forest, researchers have investigated these topics using long-term measurements of bird abundance and distribution at local and landscape scales; intensive field studies of habitat use, feeding behavior, fecundity, survival, and behavior of individually marked birds; and simultaneous monitoring of food availability, predators, vegetation and other environmental conditions. Through these investigations, Hubbard Brook scientists have assembled one of the world's most extensive long-term records on the ecology of birds that breed in temperate forests. This resource is used internationally by other scientists, students, and teachers.

Avian Research Findings at Hubbard Brook

In 1969, two avian ecologists, Richard Holmes and Frank Sturges, began studying birds that occupy the Hubbard Brook Experimental Forest in central New Hampshire. Since that time the project has grown to include scientists and students from many institutions. While Hubbard Brook is perhaps best known for its pioneering use of small watersheds for studying water and nutrient cycling, the bird population research conducted there stands out for its insights into the complex mechanisms that govern bird abundance and behavior. This research has intensively examined how birds use habitats, how they feed, find mates and nest, respond to predators, and react to a host of other natural environmental conditions. Studies lasting this long are rare in the world of science and the work performed at Hubbard Brook has allowed scientists to understand the factors that affect the distributions and abundances of forest birds. These baseline data are particularly valuable because until scientists understand how bird populations fluctuate in undisturbed mature forest conditions, they won't be able to predict how environmental impacts, especially those caused by humans, will affect birds in the future.

The major site for these investigations has been the Hubbard Brook Experimental Forest, a 3,157 hectare (7,800 acre) sector of the White Mountain National Forest in north central New Hampshire. The forest has not been logged since the early 1900s, and consists mainly of relatively mature sugar maple, American beech, and yellow birch, with more spruce and fir at the higher elevations. Approximately 80 species of birds have been recorded in the Hubbard Brook valley, about half of which breed there. Two species in particular, the black-throated blue warbler and the American redstart, have been the subject of the most intensive research effort by the Hubbard Brook investigators.

One major finding from this decades-long record of research is that bird abundances fluctuate, in some cases dramatically, even

though their habitat of mature undisturbed forest appears relatively stable to an untrained human eye. The general trend shows that the total numbers of birds at Hubbard Brook peaked at over 200 individuals per 10 hectares (25 acres) in the early 1970s, declined throughout the 1980s, and finally stabilized at around 80–100 individuals since the early 1990's. Within this overall decreasing trend, researchers discovered that populations of some species have declined quite sharply, while many have remained relatively stable, and a few have actually increased in abundance. These findings indicate that each species responds differently to its environment and that the many factors involved in determining the abundance of these forest birds differ markedly among species.

Another important result comes from long-term study of songbird population dynamics, primarily that of the black-throated blue warbler. It was found that the number of one-year old males that established breeding territories in a given year was related to the total number of offspring produced in the preceding summer. For example, high reproductive success in one summer resulted in a larger number of one-year old birds in the population in the subsequent summer, resulting in a higher breeding population. This relationship occurred despite the fact that these young birds had migrated thousands of miles to a distant winter site and returned, along with all the hazards incumbant to their survival over the course of the non-breeding period (see below). This important finding indicates that the factors in the breeding grounds that determine reproductive success (which at Hubbard Brook are food abundance, weather, nest predation, and density-dependent processes), drive population dynamics in these species. The research has therefore clearly demonstrated the importance of habitat quality in the breeding area in maintaining the overall abundance of these migrant bird populations.

Research at Hubbard Brook has also focused on how birds select and use habitats—namely how they distribute themselves in the forest, how they decide where to nest, how they find and capture food items, etc. Each species of bird has its own habitat preferences, but how does a first-time breeder know where to settle and nest? Hubbard Brook researchers have discovered that in at least some cases these year-old birds use social cues from other members of their own species to determine where to nest. In this case, they settle near where they have 'observed' other members of their own species reproducing successfully. This discovery complements previous studies that show that birds often seek out habitats with the best food and nesting opportunities.

Research at Hubbard Brook has also shown that birds often forage for insects preferentially among different tree species, i.e., they spend more time and forage more efficiently in some tree species compared with others. Yellow birch, in particular, is the species that birds forage in most often at Hubbard Brook. This differential use of tree species by foraging birds was found to be due in part to differences in insect densities, but also to differences in plant architecture (e.g., in leaf size, shape, and positioning in relation to branch structure), which affect the ability of birds to see and capture insects most efficiently. Thus, the tree species composition of a forest can influence which kinds of birds occur there and how successful they are in capturing prey, a finding relevant to forest management.

Finally, unlike many studies of temperate forest birds, Hubbard Brook researchers have also investigated the ecology of these

migrant species on their Caribbean wintering grounds. The researchers considered this essential to understanding the ecology of these species, as what happens to birds during the non-breeding time of the year affects populations in our temperate forests as well. The results provide a rare glimpse at the entire year-long ecology of migratory species, from their wintering grounds, through migration, to their breeding grounds. Two very important findings emerged from this phase of the research. First, using a newly developed method involving stable isotopes as markers*, the researchers discovered that the habitat(s) occupied by migrant birds during the non-breeding season affected their body condition, departure time from winter areas, and arrival time in the breeding areas. Subsequent study has shown that delayed arrival to the breeding grounds can even influence reproductive success in that summer. This carryover effect from winter to summer shows the importance of the winter grounds to the overall ecology of these migratory species. The second major finding from this research was when and where most mortality occurs. The results showed that more birds die during migration than during the other phases of the annual cycle. Indeed, the mortality rates of these migrants during migration was at least 15 times higher than it was during the breeding or overwintering periods, indicating how important the migratory stopover sites might be to successful migration and overall bird abundances.

In summary, research at Hubbard Brook has identified many of the factors influencing bird abundances and distribution in the northern hardwood forests. These findings will be helpful in evaluating the impact of future environmental changes. Currently, researchers are investigating the role of climate change on birds, seeking to understand how a projected rise in temperatures in central New Hampshire will affect bird survival and reproduction. Other future environmental impacts that threaten birds—residential development, pollution from acid rain and mercury, new pathogens such as West Nile virus, and forest pests such as birch bark disease and emerald ash borer—await future study. As researchers design experiments to understand the overlapping effects of these emerging threats, they will rely on Hubbard Brook's long-term data and continue to lay a foundation of observation that will assist the next generation of scientists to understand and protect our region's rich diversity of bird life.

* How do stable isotopes help determine the locality of a birds' habitat?

An isotope is a form of an element that has the same number of protons but a different number of neutrons as that element. Carbon13 (an isotope of carbon12) and deuterium (an isotope of hydrogen) occur naturally in nature. The ratio of carbon13 to carbon12 and the ratio of deuterium to hydrogen differ around the globe- each area and in some cases, each habitat, has its own "isotopic signature." When birds live in an area for a period of time, they 'pick up' the isotope signature through the food chain and incorporate the locally occurring isotope into their tissues. Thus when feathers, blood samples, or other body tissues of a songbird are sampled and analyzed, the isotopic ratio can help to reveal the approximate location and/or habitat in which the bird resided at particular times of year.

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