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Monitoring Landbirds in National Parks: Understanding Populations, Migratory Connectivity, and Climate Change

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Abstract

Identifying the proximate causes of avian population change is important in developing effective conservation goals and strategies. To address this need, in 1989 The Institute for Bird Populations (IBP) created the Monitoring Avian Productivity and Survivorship (MAPS) Program to measure and monitor the demographics of North America's landbirds. The national park system has been an integral partner in this program: 83 MAPS stations have operated in 36 national park sites, with an additional 563 stations on other public lands. Overall the program has collected more than two million capture records from over 1,300 stations in nearly every state and Canadian Province. Demographic monitoring provides insight into the life history stages at which population change is taking place. MAPS data from parks and protected areas have also contributed to recent studies of avian response to climate change and migratory connectivity. Both areas of study will likely continue to be important elements of conservation planning inside and outside of national parks throughout the coming decades.

Introduction

Twenty-five years ago, during the Yosemite Centennial Symposium on the University of California, Berkeley campus, IBP described the results from the first season of a new kind of avian monitoring program (DeSante 1990). The fledgling initiative, MAPS, was intended to examine the key demographic parameters ("vital rates") that regulate bird populations and to identify, where possible, the factors responsible for species declines. The program began with sixteen stations spread across several regions of the USA and, the following year, initiated a long and fruitful relationship with the National Park Service (NPS), with the first station on NPS land established in Yosemite National Park (Table 1).

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Table 1. Units of the National Park Service with past or current MAPS Stations	
Acadia National Park	Kobuk Valley National Park
Amistad National Recreation Area	Lake Mead National Recreation Area
Big Thicket National Preserve	Lassen Volcanic National Park
Cabrillo National Monument	Mammoth Cave National Park
Cape Cod National Seashore	Mesa Verde National Park
Capital Reef National Park	New River Gorge National River
Chiricahua National Monument	Noatak National Preserve
Congaree National Park	Oregon Caves National Monument
Coronado National Monument	Organ Pipe Cactus National Monument
Denali National Park	Point Reyes National Seashore
Devils Postpile National Monument	Redwood National Park
Fort Bowie National Historic Site	Sequoia National Park
Gateway National Recreation Area	Shenandoah National Park
Grand Teton National Park	Tumacacori National Historical Park
Grant-Kohrs Ranch National Historic Site	Valles Caldera National Preserve
Great Smoky Mountains National Park	Vicksburg National Historical Park
Indiana Dunes National Lakeshore	Yosemite National Park
Kings Canyon National Park	

A quarter of a century later, MAPS is a thriving network of bird monitoring stations that has comprised more than 1,300 stations (about 350 of which operate per year) in nearly every U.S. state and Canadian province. Although IBP administers the program and operates some stations, the vast majority of stations are staffed and supported by a wide variety of by federal, state, and other agencies or volunteers, and staff from non-governmental organizations. MAPS data have been used to further avian conservation efforts in many ways, and the program has helped train hundreds of cooperators, from professional ecologists to volunteers and interns, in the concepts and methods of bird banding, demographic monitoring, and conservation.

MAPS uses a standardized protocol with a system of fine-mesh mist-nets operated at fixed locations to capture birds during the summer nesting season. A typical station is comprised of 10 nets spread over 20 hectares. MAPS operators band the birds and collect information on their age, sex, body condition, and reproductive status. Captured birds are given a lightweight, numbered aluminum leg band and released unharmed. Birds that are subsequently recaptured provide especially valuable information on survival rates.

Why monitor birds?

Birds are important components of the environment, providing ecosystem services such as pollination, seed dispersal, and insect and rodent control. Birds are also useful indicators of environmental change. Before the "canary in the coal mine" was a cliché, miners really did use canaries, goldfinches, and other species to detect toxic gases such as carbon monoxide, carbon dioxide, or methane before they reached levels that were fatal to humans (see, for example, Burrell and Seibert 1916). Bird population declines in the 1960s and 1970s, such as peregrine falcon (*Falco peregrinus*) and bald eagle (*Haliaeetus leucocephalus*), provided some of the first indications of the dangers of DDE, DDT, and other environmental contaminants. Today, birds are being used in many areas of research to monitor the local and global effects of habitat loss, drought, and climate change (Both et al. 2004; Tingley et al. 2012).

Relative to other taxa, several factors make birds excellent barometers of ecosystem integrity:

- Abundance: birds are relatively diverse and common, and present in nearly every ecosystem in the world, from arid deserts to humid tropical forests and frigid arctic and Antarctic regions.
- Observability: birds are often brightly colored, highly visible, vocal, and usually diurnal, which makes detecting, identifying, and tallying them easier than many other types of animals.
- Rapid metabolism and high trophic position: many bird species, being secondary consumers (i.e., they eat other animals, including other birds, rodents, or insects) may bio-accumulate compounds, including toxins, that are present in the organisms they eat. This was the case with DDE and DDT for many birds of prey.
- Broad appeal to the public: this aspect of the potential utility of birds to scientific inquiry should not be underestimated. Citizen science programs such as the National Audubon Society Christmas Bird Count (which has been operating since 1900), the Breeding Bird Survey (BBS), and e-bird (www.ebird.org) tap into the great love of the public for birds with much success. Every year, tens of millions of records are submitted to these long-term datasets by volunteers and professionals. There are few similar programs for other types of animals, and certainly none as widespread and long-lasting.

Recently, bird populations and their distribution, habitat, and diet have been shown to be effective barometers of climate change and habitat alteration (Gregory and Strien 2010).

What is gained from demographic monitoring?

The MAPS program utilizes demographic monitoring, which uses capture and recapture data from a population to estimate or index key demographic parameters (often referred to as "vital rates") such as productivity, survivorship, and recruitment. These vital rates are the proximate causes of population change. Once vital rates are understood, researchers can link proximate causes of population change to ultimate ones, such as habitat loss, weather, or climate to make more informed conservation and management decisions.

MAPS and the NPS

Strengths of MAPS data include the length of data collection (some stations have been continuously operating for more than 25 years); the breadth of the program, which has operated in nearly every state and Canadian Province; the continental standardization of procedures and protocols; and the size of the dataset which exceeds two million avian capture records. MAPS has operated stations in 36 units of the NPS where the program has captured more than 240,000 individual birds of 335 species. IBP researchers and independent MAPS operators have published nearly 100 peer-reviewed and other papers and technical reports using data collected exclusively or partially at national parks.

At the scale of the individual national park, Yosemite National Park provides an example of how MAPS can help park managers fulfill important monitoring, management, and outreach goals. Yosemite's MAPS stations, which have been running continuously since 1990, documented the local extirpation of a California state-endangered species, the willow flycatcher (*Empidonax trailii*) as a breeding species in the park, providing important information for understanding the species' decline across the Sierra Nevada region (Siegel, Wilkerson, and DeSante 2008) and stimulating possible restoration efforts within the park and elsewhere in the region. Other products of Yosemite's MAPS program have included documenting range-wide longevity records

for several species of wild birds (Rowan et al. 2014), assessing long-term population trends and demographics for dozens of bird species within the park, and a current effort to understand the effects of annual weather variation and climate change in the park on productivity of nesting songbirds. The program has also yielded a hugely popular and successful outreach program involving the training of young ornithologists and on-site interpretive bird banding demonstrations that provide visitors, youth, and park staff opportunities to experience "science in action."

At larger spatial scales, MAPS stations in the national parks contribute data to regional and continent-wide efforts to better understand landbird ecology and inform scientifically sound conservation efforts. Understanding migratory connectivity—identifying where, within a species' overall wintering range, a particular breeding population actually spends the winter—has been a major challenge, impeding bird conservation efforts. Data and feather samples from MAPS stations in Denali National Park, Yosemite National Park, Mount Lassen National Park, Sequoia and Kings Canyon National Parks, and Point Reyes National Seashore (in addition to several National Wildlife Refuges and National Forests) contributed to two recent studies that pioneered the integration of genetic and stable-isotope data (Rundell at al. 2013) and the use of high-resolution genetic markers (Ruegg et al. 2014) to identify genetically distinct groups of a migratory bird, the Wilson's warbler (*Cardellina pusilla*), and to link its breeding and wintering populations (Figure 1).

MAPS data from the national parks have also contributed greatly to ongoing efforts by IBP researchers to analyze the vital rates of more than 150 species from data gathered during the first fifteen years of the MAPS Program. In many cases these analyses yielded information regarding the demographic causes of population declines, and thus indicated whether conservation efforts would best be focused on the breeding or non-breeding grounds, or both. Several interesting patterns have emerged from these analyses. First, low survival of adult and first-year birds is often as or more important than low productivity in driving observed population declines, a pattern that highlights the importance of conserving migratory birds' wintering grounds and migration routes. Second, conditions on wintering grounds and migration routes affect survival rates and can even affect birds' reproductive output the following summer. This is known as a "carry-over effect" (Norris et al. 2004). Many of the results from previous avian demographic studies are already publicly available, and can help national park managers and researchers see the results of their participation in the larger MAPS Program.

Another important aspect of MAPS in national parks is that, with the exception of fire management, there is relatively little intentional alteration of the landscape by park policies. Compared to national forests, Bureau of Land Management landholdings, and Department of Defense, national parks are relatively pristine areas that can serve as controls for monitoring demographic rates of landbirds and comparing those rates to the rates on other federal areas that are being more intensively managed, for example, for timber production, livestock grazing, or military training. National parks can be very important for understanding the effects of these actions.

The MAPS Program provides an efficient, cost-effective, collaborative, and scientifically-rigorous basis for decision-making that can inform bird conservation and land management in national parks and elsewhere across North America. MAPS is a powerful tool for identifying factors that drive bird populations, and providing insight into where and when in the annual life-cycle conservation efforts are likely to be most effective. In addition, MAPS enables national park managers and scientists to understand how global forces such as climate change and habitat loss contribute to avian population change, and what can be done to reverse declines.

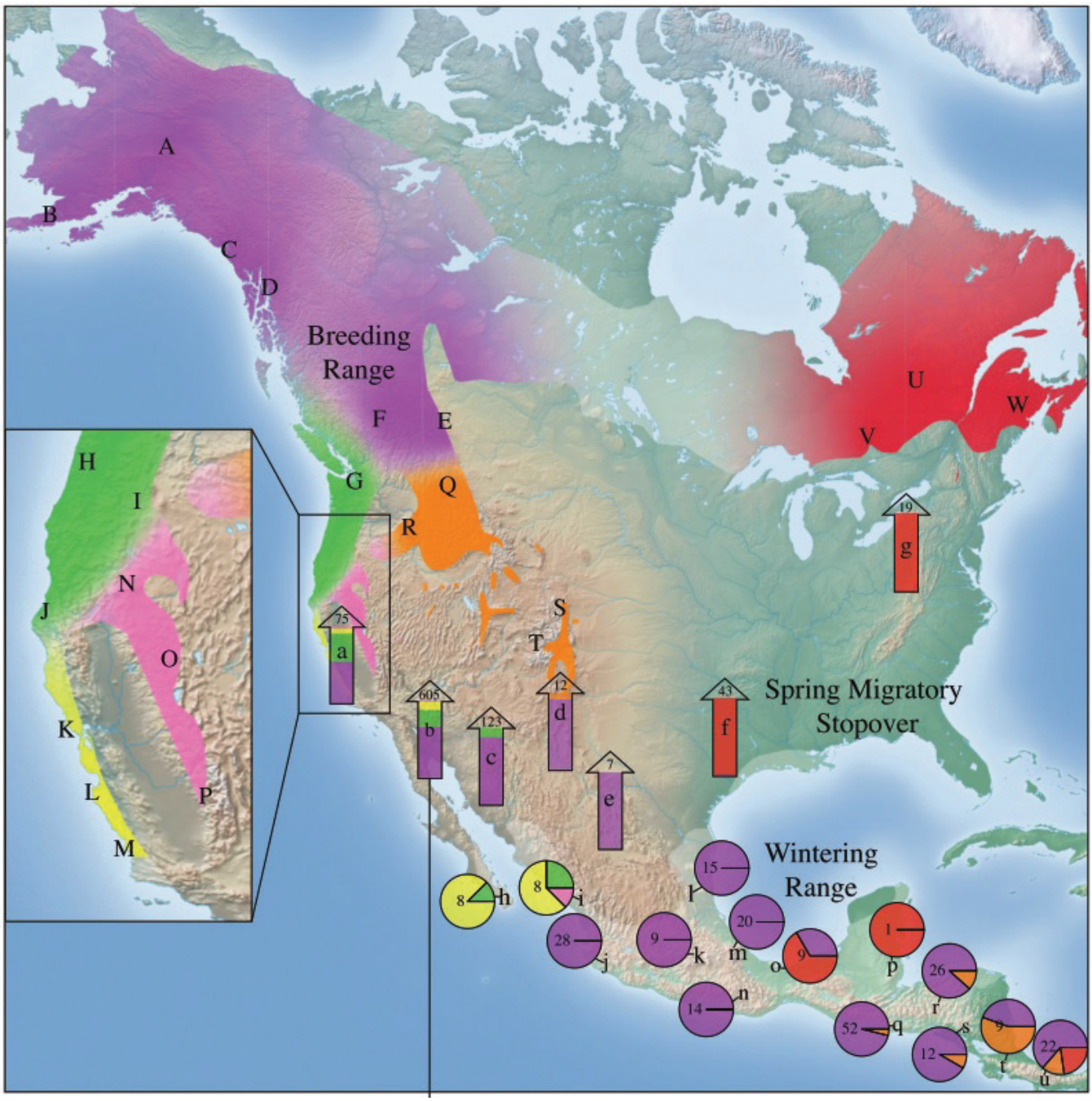

Figure 1. IBP scientists and colleagues from several disciplines recently showed how high-resolution genetic markers can be used to identify distinct groups of Wilson's warbler and assess regional drivers of demographic trends. The figure shows distinct subpopulations (different colors) and migratory routes and timetables of spring migration. The MAPS and MoSI Programs, including MAPS stations from at least six national park units, played a critical role by providing coordinated sample collection at many geographically diverse sites. This promising use of new genetic techniques may revolutionize our understanding of migratory connectivity (figure courtesy of Kristen Ruegg et al. 2014).

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