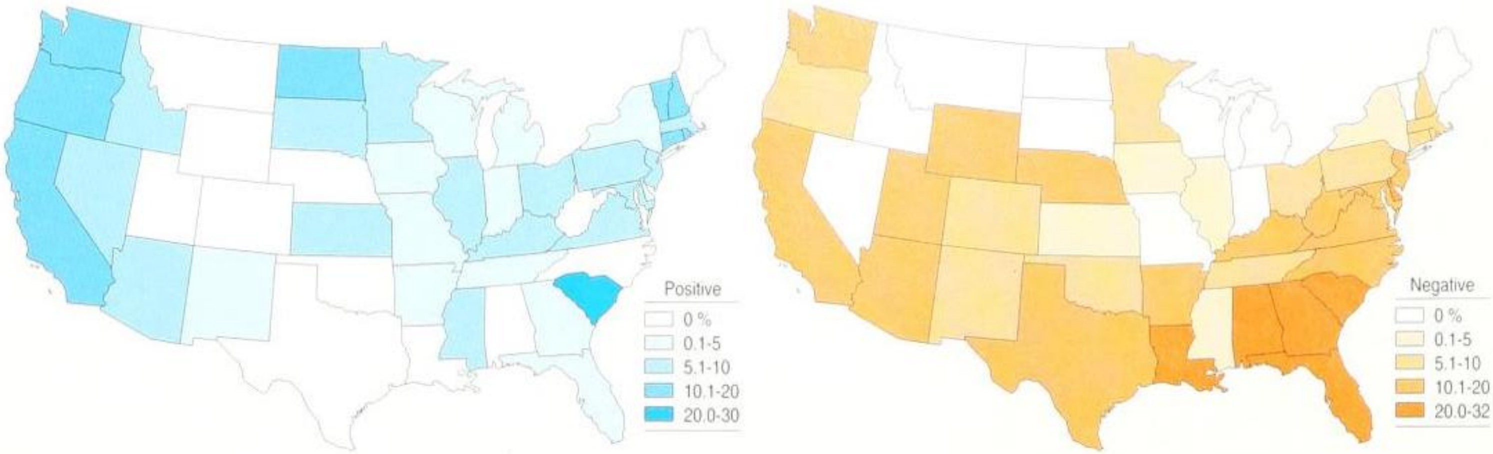

Fig. 3. Percentage of 27 birds showing positive and negative trends.

Great Plains, and the southeastern portion of the conterminous states generally show the greatest declines, though the actual reasons for these population changes will need to be examined in more detail. Certainly, the pattern of extensive declines in most of the southern coastal states is quite alarming.

Additionally, regions of the country that could be particularly influenced by global climatic change are the southern coasts (because of increased storms and degradation of coastal wetlands; IPCC 1990), and the Great Plains (owing to a significant decline in soil moisture; Leatherman 1992). Hence, the populations of birds in these areas need to be closely monitored to ensure preservation actions are taken before the combined effects of population declines and climate change result in extinctions. More studies and monitoring are warranted to understand the possible consequences of these patterns.

The analyses presented here can also be used to investigate population trends of target species across the country. Compare, for instance, the trends by state for the American tree sparrow (*Spizella arborea*; one of the most declining birds examined) and the cedar waxwing (one of the most increasing birds) with maps of their winter range and abundance patterns (Root 1988a). This comparison reveals that significant population trends, whether positive or negative, seem to occur primarily along these species' northern range boundaries and in many coastal states. Such analyses could help target specific regions of the country where population trends of key (e.g., threatened) species need watching.

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For further information:

Terry L. Root
University of Michigan
School of Natural Resources and Environment
430 E. University
Ann Arbor, MI 48109

Breeding Productivity and Adult Survival in Nongame Birds

Populations of many North American landbirds, including forest-inhabiting species that winter in the Neotropics, seem to be declining (Robbins et al. 1989; Terborgh 1989). These declines have been identified through broad-scale, long-term survey programs that identify changes in abundance of species, but provide little information about causes of changes in abundance or the health of specific populations in different geographic locations.

Population health is a measure of a population's ability to sustain itself over time as determined by the balance between birth and death rates. Indices of population size do not always provide an accurate measure of population health because population size can be maintained in unhealthy populations by immigration of recruits from healthy populations (Pulliam 1988). Poor population health across many populations in a species eventually results in the decline of that species. Early detection of population declines allows managers to correct problems before they are critical and widespread.

Demographic data (breeding productivity and adult survival) provide the kind of early warning signal that allows detection of

by
Thomas E. Martin
National Biological Service
David F. DeSante
The Institute for Bird Populations
Charles R. Paine
Montana Cooperative Wildlife Research Unit
Therese Donovan
University of Montana
Randall Dettmers
Ohio Cooperative Research Unit
James Manolis
Minnesota Cooperative Fish and Wildlife Research Unit
Kenneth Burton
The Institute for Bird Populations

unhealthy populations in terms of productivity or survival problems (Martin and Guepel 1993). In addition, demographic data can help determine whether population declines are the result of low breeding productivity or low survival in migration or winter. Breeding productivity data also can help identify habitat conditions associated with successful and failed breeding attempts. Such information is critical for developing habitat- and land-management practices that will maintain healthy bird populations (Martin 1992). Here, we provide examples of the kinds of information that can be obtained by broad-scale demographic studies.

Demographic Programs

The Monitoring Avian Productivity and Survivorship (MAPS) and Breeding Biology Research and Monitoring Database (BBIRD) programs were developed to gather the demographic data needed to provide early and locality-specific warning signals of population problems. MAPS uses large, stationary mistnets to capture and examine young and adult birds for between-year changes and to determine long-term trends in adult population size, productivity, and adult survival. BBIRD locates and monitors bird nests to study changes in nesting success, determine causes of nesting failure (e.g., weather, habitat, nest predation, or nest parasitism), and identify habitat conditions associated with successful reproduction. Though both programs are new, they are growing rapidly. We present example data to demonstrate initial results and burgeoning potential of these programs for the future.

MAPS

Initiated in 1989 and coordinated by The Institute for Bird Populations, MAPS is a cooperative effort among federal and state agencies, private organizations, and bird banders to operate a standardized continent-wide network of mist-netting and banding stations during the breeding season (DeSante 1992; DeSante et al. 1993a, 1993b). A typical MAPS station involves about ten 12-m (39-ft) mistnets over a 20-ha (49-acre) area. All birds captured throughout the breeding season are identified to species, age, and sex, and are banded with U.S. Fish and Wildlife Service bands.

As of 1992, 170 stations were in operation and more than 94,000 captures of more than 200 bird species were recorded. The number of adult birds captured is used as an index of adult population size while the proportion of young provides an index of postfledgling productivity (Baillie et al. 1993).

BBIRD

The BBIRD program, initiated in 1992, provides detailed information on nesting productivity and habitat needs of nongame birds at a national scale. BBIRD is a cooperative effort among biologists studying nesting productivity at local sites across the country. Participants follow a standard field protocol to obtain raw data on nesting productivity, causes of reproductive failure, vegetation measures at several spatial scales, and point counts (bird counts). Data from each local site are overseen by individual independent investigators who can obtain comparative information from other sites. In addition, overview analyses to identify national and regional trends are conducted at the Montana Cooperative Wildlife Research Unit.

BBIRD study sites are in large forested blocks to minimize fragmentation effects and provide baseline information on productivity in undisturbed habitats as well as in auxiliary sites that have no habitat restrictions (e.g., grazed, fragmented, or logged sites). The BBIRD program now includes 23 sites in 17 states. Over 8,000 nests of more than 150 bird species were monitored during the first 2 years of the program.

Variation in Productivity

The data provided by MAPS and BBIRD suggest that weather may be an important influence on population dynamics at large and even continental scales. Prior data from constant-effort mist-netting in scrub habitat on the west coast have suggested that avian productivity may peak during average weather conditions and may be depressed when weather conditions deviate from average (DeSante and Geupel 1987). These facts are especially important because one of the most important ecological results of global climate change may be a greater annual variability in both local and large-scale weather conditions.

Changes in indices of adult population size and postfledging productivity from the first 4 years of MAPS are presented for all species pooled and for each target species caught at 10 or more stations in 1992 in the Northeast and Northwest regions. These data indicate that productivity varied greatly from year to year, presumably a result of large-scale weather conditions (e.g., precipitation and temperature) just before and during the breeding seasons. Productivity was poor across most of North America, but especially in the eastern third of the continent in 1990. Adult population sizes declined significantly in the East in 1991, presumably a result of the poor productivity in 1990. In 1992 productivity was poor again in the East but good in the West. These results suggest that productivity in a given year may influence population sizes and population dynamics in subsequent years for many species over a large area.

BBIRD data likewise suggest that weather may substantially affect nesting productivity. Unusually wet weather conditions were reported at 6 of 14 BBIRD sites in 1992 when nest success of several species, including wood thrush (*Hylocichla mustelina*) and red-eyed vireo (*Vireo olivaceus*), was lower in 1992 than in 1993 (Table 1). These same two species also had reduced breeding productivity based on MAPS data. They produced fewer young per successful nest in 1992 than in 1993, a fact which also may be related to weather; some research suggests that clutch size as well as fledging success can be affected by weather conditions and may even provide a particularly sensitive measure of a species' tolerance to changing climatic conditions (e.g., Rotenberry and Wiens 1989). Further research may show that climatic variability is an important influence on the population trends of species.

Table 1. Wood thrush and red-eyed vireo nest success based on Mayfield (1961, 1975) estimates at midwestern BBIRD sites during 1992 and 1993 (numbers of nests are in parentheses).

State	Wood thrush		Red-eyed vireo	
	1992	1993	1992	1993
Ohio	23.0 (52)	33.1 (194)	6.6 (19)	33.7 (83)
Arkansas	45.6 (11)	58.0 (15)	35.3 (35)	42.1 (36)
Minnesota			19.0 (51)	23.0 (25)

Habitat-specific Differences

Forest fragmentation, where large forest blocks are cut and interspersed with open habitat, is believed to be particularly detrimental for breeding nongame birds. For example, BBIRD data show that fragmentation was associated with lower nest success in several species at midwestern BBIRD sites. Ovenbirds (*Seiurus aurocapillus*) were particularly sensitive to fragmentation effects; their reduced nest success resulted primarily from increased predation, although the parasitism rates of brown-headed cowbird (*Molothrus ater*) were also higher in fragments. No clear effect of fragmentation was noted for red-eyed vireos, although nest success differed substantially among unfragmented sites, potentially reflecting more subtle differences in habitat suitability or landscape-level effects (Table 2).

Table 2. Ovenbird and red-eyed vireo nest success based on Mayfield (1961, 1975) estimates at fragmented and unfragmented midwestern BBIRD sites during 1992 and 1993 (numbers of nests are in parentheses).

State	Ovenbird		Red-eyed vireo	
	Fragmented	Unfragmented	Fragmented	Unfragmented
Ohio	13.7 (35)	33.1 (45)	30.0 (52)	24.6 (50)
Wisconsin	19.8 (30)	42.6 (51)	26.4 (13)	50.8 (13)
Arkansas		51.9 (41)		38.7 (71)
Minnesota		44.5 (159)		21.0 (76)

Adult Survival in Two Eastern Thrushes

Analysis of 3 years (1990-92) of MAPS data for veery (*Catharus fuscescens*) and wood thrush indicated low and substantially different ($P < 0.06$) adult survival probabilities from 1990 to 1991. According to Breeding Bird Survey data, veery populations declined by 1.0% per year between 1966 and 1991, while wood thrush populations showed a statistically greater decline of 2.0% per year (Peterjohn and Sauer 1993). This difference in population declines is mirrored by survival indices; MAPS estimates of wood thrush survival are half that of the veery, possibly because of differences in adult survival over winter. This possibility is especially interesting because wood thrushes winter in Mexico and Central America where a greater proportion of the tropical forests have been cleared than in South America where veeries winter. Differences in estimated survival of the two species, however, could simply reflect different life-history traits (e.g., wood thrushes having lower adult survival associated with higher fertility; Martin in press). Estimated survival differences could also result from differences in breeding-site fidelity, which is related to nest success; a variety of evidence shows that birds disperse more in breeding seasons that follow nesting failure, potentially biasing survival estimates. Further nest-monitoring data from North America and survivorship data from both North America and the Neotropics are needed to identify causes of population declines in these and other Neotropical migratory landbirds.

Trends

Preliminary results from the MAPS and BBIRD programs suggest that population trends of nongame landbirds are influenced by

Courtesy T. Martin, NBS

Monitoring of nests, such as this one belonging to a red-faced warbler (*Cardellina rubrifrons*), provides information on breeding productivity.

weather-induced productivity problems, survival problems during migration or winter, and degradation of breeding habitat. These results emphasize the importance of national programs such as MAPS and BBIRD in providing baseline information on both continental and local habitat-specific processes that influence avian population dynamics. Ultimately, these data on breeding productivity and adult survival and their underlying environmental determinants will provide information critical for managing North American landbirds.

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For further information:

Thomas E. Martin
National Biological Service
Cooperative Wildlife Research Unit
University of Montana
Missoula, MT 59812

Canada Geese in North America

by

Donald H. Rusch
Richard E. Malecki
National Biological Service
Robert Trost
U.S. Fish and Wildlife Service

Canada geese (*Branta canadensis*) are probably more abundant now than at any time in history. They rank first among wildlife watchers and second among harvests of waterfowl species in North America. Canada geese are also the most widely distributed and phenotypically (visible characteristics of the birds) variable species of bird in North America. Breeding populations now exist in every province and territory of Canada and in 49 of the 50 United States. The size of the 12 recognized subspecies ranges from the 1.4-kg (3-lb) cackling Canada goose (*B.c. minima*) to the 5.0-kg (11-lb) giant Canada goose (*B.c. maxima*; Delacour 1954; Bellrose 1976).

Market hunting and poor stewardship led to record low numbers of geese in the early 1900's, but regulated seasons including closures, refuges, and law enforcement led to restoration of most populations. Winter surveys were begun to study population trends and set responsible harvest regulations for these long-lived and diverse birds. Winter surveys begun in 1936-37 probably represent the oldest continuing index of migratory birds in North America.

Surveys

Sporadic counts of migrating and wintering Canada geese from the ground were supplemented by regular tallies from the air in the early 1950's. Winter surveys began because the subarctic and arctic nesting areas of many subspecies were still unknown and aerial surveys of these remote areas were impractical.

The well-designed spring surveys of Canada geese that began in the 1970's with the Eastern Prairie population have now expanded to include several others (Office of Migratory Bird Management 1993). Spring surveys estimate numbers of each population at the time of year when subspecies are reproductively isolated and geographically separated. The smaller subspecies of Canada geese nest farther north (arctic and subarctic regions of Alaska and Canada), and most winter farther south (gulf states and Mexico) than do the larger subspecies.

Status and Trends

Most aggregations of wintering geese were overharvested in the early 1900's. Those