SPRING ARRIVAL DATES OF MAINE MIGRATORY BREEDING BIRDS: 1994-1997 VS. 1899-1911

W. Herbert Wilson, Jr., Daniel Kipervaser, and Scott A. Lilley [1]

ABSTRACT - We compared the mean spring arrival dates of 80 species of Maine migratory breeding birds between the interval 1899-1911 and the interval 1994-1997. Arrival dates for the earlier interval were extracted from records in the *Journal of the Maine Ornithological Society*. Dates for the latter interval were collected by volunteers across the state of Maine. Our prediction of a trend toward earlier arrival as a function of global warming was rejected. Of the 29 species that showed significant changes in arrival date, 20 (69.0%) arrived earlier in 1899-1911 than in 1994-1997. Spring arrival dates do not at present provide any signal of the effects of global warming in the state of Maine.

INTRODUCTION

Human activities fundamentally affect the spatial and temporal distribution of birds. Varied spatial effects have been well documented. For instance, clearing of eastern forests has allowed the eastward expansion of Brown-headed Cowbirds (*Molothrus ater*) (Mayfield 1988, 1989). Cutting of old-growth forests threatens Marbled Murrelets (*Brachyramphus marmoratus*), Spotted Owls (*Strix occidentalis*), and Red-cockaded Woodpeckers (*Picoides borealis*) (Conner et al. 1995, Dawson et al. 1987, Marshall 1988). The proliferation of feeding stations has been implicated in the northern range expansion of Tufted Titmice (*Baeolophus bicolor*), Northern Cardinals (*Cardinalis cardinalis*), and eastern House Finches (*Carpodacus mexicanus*) (Kricher 1981; Wilson 1994, 1999).

Changes in temporal components of avian distribution have received less attention but will become increasingly important in the face of global warming. Mean surface temperature of the earth has increased by 0.5° C in the past century and models predict an additional rise of 1.5° to 5° C by the year 2100 (Mahlman 1997). Twenty species of British birds show trends of earlier egg laying over the period 1971-1995; the average shift in egg laying was 8.8 days (Crick et al. 1997). The authors attribute this shift to global warming. An increase in mean temperature has been implicated in changes in plant physiology. The active growing season of northern European plants has increased by eight days over the past 11 years (Myneni et al. 1997). Earlier leaf-out and resumption of photosynthesis may result in earlier emergence of leaf folivores and other animals taken as prey by birds. We know that early breeders usually produce the greatest number of offspring (Perrins 1970), placing a premium on early arrival on their breeding grounds for migratory birds. It is reasonable

[1] Department of Biology, Colby College, Waterville, ME 04901, USA

therefore to expect that the spring arrival of migratory breeding birds will occur earlier as global temperatures increase.

In this contribution, we compare the mean arrival dates of Maine migratory breeding birds in two time intervals, separated by nearly a century. If global warming has proceeded far enough to date to influence avian distributions in Maine, the comparison of arrival dates could be a measure of such effects. Our expectation is that most species that show a significant difference in arrival date in modern time compared to 1899-1911 will arrive earlier now.

MATERIALS AND METHODS

In 1994, the senior author initiated a project to determine the arrival dates of 141 species of migratory breeding birds in the state of Maine (Wilson et al. 1997). Volunteer observers were enlisted across the state to record the first spring sighting of any migratory breeding species along with location data. This continuing project has resulted in the accumulation of over 15,000 arrival date records from more than 100 different observers, spanning the length and breadth of the state.

Between the years of 1899 and 1911, the Maine Ornithological Society published the quarterly *Journal of the Maine Ornithological Society*. In addition to articles on nesting behavior, surveys of local areas and range extensions, detailed tables of migration data were published. These tables provided data, taken by individual observers, on the arrival and departure dates of migratory breeding birds as well as arrival and departure dates for migratory wintering birds. Sighting data included the location of each observation.

Regrettably, the Maine Ornithological Society disbanded in 1915. However, the migration records in their Journal provide comparisons for the arrival data we have been collecting for four recent springs. We combined all of the data for 1899-1911 into one dataset and combined the 1994-1997 data into a second. All data for the extreme northern portion of Maine [Biophysical Regions 1-4 (McMahon 1991)] were excluded because some species arrive significantly later there than in the rest of Maine (Wilson et al. 1997). Within central and southern Maine, the arrival dates of nearly all species of migratory breeding birds do not vary statistically (Wilson et al. 1997). Dates were converted to day of the year; for example, April 10 was entered as the 100th day of the year. Differences in mean arrival dates for the two data sets were tested by Mann-Whitney U-tests with a significance level of $\alpha = 0.05$. Arrival dates are reported as averages for the two time periods.

RESULTS

We had sufficient data to analyze the arrival dates of 80 species of Maine migratory breeding birds. Of those 80 species, 51 species showed spring arrivals that did not differ between the 1899-1911 interval and the 1994-1997 interval (Table 1). Of the remaining 29 species, only nine

species arrived earlier in 1994-1997 compared to 1899-1911 (Table 2). Contrary to our expectation, 20 species were detected on the breeding grounds earlier in the spring in the 1899-1911 interval (Table 3).

DISCUSSION

Assessing the strengths of impacts of global warming is contentious (Hasselman 1997). Although there can be no denying that earth surface temperatures have increased in the past 100 years (Mahlman 1998) and that the quantities of carbon dioxide, the most important greenhouse gas, continue to increase (Vitousek et al. 1997), the detection of biological reactions to these changes is difficult. High interannual variance in temperature and large-scale climatic events such as the El Niño/Southern Oscillation may obfuscate actual differences in biological processes that are occurring. Furthermore, modulation of effects by biogeochemical feedbacks may mask effects as well (Braswell et al. 1997).

We gathered data in this study to yield insight into the possible effects of climate change on the phenology of bird migration. The data from the *Journal of the Maine Ornithological Society* provide a baseline for the spring arrival dates of Maine migratory breeding birds. Using recent data, we can gauge any changes that have taken place, predicting that most of the significant changes will involve earlier current arrival dates.

Comparisons between intervals separated by nearly a century must be made cautiously. The amount of forested land has increased significantly in the past century (Hagan 1993, Irland 1997). We have no quantitative information for the changes, if any, in bird populations between 1899-1911 and 1994-1997. If there are differences in abundance, a first arrival is more likely to be detected earlier for a population that is more abundant.

Differences in approach to field identification exist between the two ends of the 20th century. Although it is apparent from reading the *Journal of the Maine Ornithological Society* that those observers had well developed aural identification skills, the use of high-quality binoculars to identify birds did not occur until the 1930s (Davis 1994). With the proliferation of field guides, optics designed for birders and general interest in birding, we expected that modern birders would be more proficient in sighting first arrivals.

The most commonly observed pattern was no change in mean arrival date between the two intervals (Table 1); 51 of the 80 species analyzed (63.8%) did not show any significant difference in arrival time. Perusal of Table 1 shows that these 51 species are found in a variety of habitats: old-growth forests, open countryside, marshes, bogs, and early successional habitats.

Of the 29 species that showed significant changes in arrival dates over the two intervals, 20 (25.0% of the total species, 69.0% of the species that showed significant changes) arrived earlier in the period 1899-1911 compared to 1994-1997. Like the species in Table 1, the species in Table 2 come from a variety of habitats. It is possible that earlier observers spent

Table 1. Species whose average spring arrival dates are not statistically different ($p > 0.05$ in Mann-Whitney U-tests) between the interval 1899-1911 and 1994-1997. The number of observations is given in parentheses for each date. Species are arranged in the order given in the American Ornithologists' Union Check-list (1998).

SPECIES	Average Arrival Date (1899-1911)	Average Arrival Date (1994-1997)
American Bittern (*Botaurus lentiginosus*)	7 May (21)	30 Apr (80)
Wood Duck (*Aix sponsa*)	15 Apr (7)	14 Apr (130)
Broad-winged Hawk (*Buteo platypterus*)	25 Apr (23)	27 Apr (161)
Spotted Sandpiper (*Actitis macularia*)	10 May (42)	13 May (133)
Common Snipe (*Gallinago gallinago*)	22 Apr (2)	24 Apr (82)
Black-billed Cuckoo (*Coccyzus erythopthalmus*)	25 May (35)	30 May (44)
Belted Kingfisher (*Ceryle alcyon*)	26 Apr (51)	21 Apr (188)
Yellow-bellied Sapsucker (*Sphyrapicus varius*)	24 Apr (21)	26 Apr (119)
Olive-sided Flycatcher (*Contopus cooperi*)	22 May (26)	24 May (59)
Eastern Wood-Pewee (*Contopus virens*)	24 May (55)	23 May (143)
Yellow-bellied Flycatcher (*Empidonax flaviventris)*	26 May (13)	23 May (55)
Great Crested Flycatcher (*Myiarchus crinitus*)	15 May (28)	17 May (149)
Eastern Kingbird (*Tyrannus tyrannus*)	13 May (71)	15 May (183)
Blue-headed Vireo (*Vireo solitarius*)	8 May (11)	5 May (168)
Warbling Vireo (*Vireo gilvus*)	17 May (31)	18 May (79)
Philadelphia Vireo (*Vireo philadelphicus*)	25 May (5)	22 May (27)
Red-eyed Vireo (*Vireo olivaceus*)	22 May (63)	21 May (152)
Purple Martin (*Progne subis*)	5 May (41)	12 May (30)
Tree Swallow (*Tachycineta bicolor*)	21 Apr (61)	18 Apr (254)
Bank Swallow (*Riparia riparia*)	13 May (29)	14 May (67)
Cliff Swallow (*Petrochelidon pyrrhonota*)	10 May (52)	11 May (87)
Winter Wren (*Troglodytes troglodytes*)	16 Apr (13)	25 Apr (82)
Ruby-crowned Kinglet (*Regulus calendula*)	25 Apr (32)	24 Apr (158)
Veery (*Catharus fuscescens*)	13 May (38)	15 May (159)
American Robin (*Turdus migratorius*)	29 Mar (68)	26 Mar (175)
Gray Catbird (*Dumetella carolinensis*)	14 May (58)	12 May (202)
Brown Thrasher (*Toxostoma rufum*)	11 May (48)	12 May (99)
Nashville Warbler (*Vermivora ruficapilla*)	10 May (45)	11 May (144)
Northern Parula (*Parula americana*)	12 May (47)	11 May (177)
Yellow Warbler (*Dendroica petechia*)	14 May (63)	12 May (205)
Chestnut-sided Warbler (*Dendroica pensylvanica*)	16 May (58)	14 May (181)
Black-throated Blue Warbler (*Dendroica caerulescens*)	14 May (37)	15 May (135)
Yellow-rumped Warbler (*Dendroica coronata*)	27 Apr (5)	28 Apr (221)
Black-throated Green Warbler (*Dendroica virens*)	8 May (54)	9 May (192)
Pine Warbler (*Dendroica pinus*)	27 Apr (37)	26 Apr (124)
Bay-breasted Warbler (*Dendroica castanea*)	19 May (19)	18 May (83)
Blackpoll Warbler (*Dendroica striata*)	19 May (38)	19 May (101)
Black-and-white Warbler (*Mniotilta varia*)	8 May (60)	6 May (201)
Ovenbird (*Seiurus aurocapillus*)	12 May (59)	11 May (195)
Northern Waterthrush (*Seiurus noveboracensis*)	12 May (23)	12 May (117)
Mourning Warbler (*Oporornis philadelphia*)	26 May (11)	26 May (49)
Common Yellowthroat (*Geothlypis trichas*)	14 May (47)	14 May (190)
Wilson's Warbler (*Wilsonia pusilla*)	19 May (26)	18 May (95)
Canada Warbler (*Wilsonia canadensis*)	18 May (38)	20 May (113)
Scarlet Tanager (*Piranga olivacea*)	20 May (29)	20 May (133)
Eastern Towhee (*Pipilo erythrophthalmus*)	30 Apr (4)	4 May (110)
Chipping Sparrow (*Spizella passerina*)	23 Apr (64)	25 Apr (204)
Fox Sparrow (*Passerella iliaca*)	3 Apr (46)	5 Apr (66)
Swamp Sparrow (*Melospiza georgiana*)	23 Apr (29)	30 Apr (113)
Rusty Blackbird (*Euphagus carolinus*)	3 Apr (22)	9 Apr (77)
Baltimore Oriole (*Icterus galbula*)	15 May (207)	13 May (64)

more time in rural, less developed habitats. Modern observers may also have been more likely to make observations on weekends, a bias that would tend to cause modern arrival dates to be later than earlier ones. It is possible that 1899-1911 observers were keener or more diligent than modern observers, diametrically opposed to our expectations that modern observers are more skilled. Despite these potential biases, we believe that these differences in arrival dates are real.

Only nine of the 80 species (11.2%) showed a shift in arrival date (earlier arrivals in 1994-1997) consistent with the effects of global

Table 2. Species whose average spring arrival dates over the interval 1899-1911 are significantly later than arrival dates over the interval 1994-1997 ($p < 0.05$ in Mann-Whitney U-tests). The number of observations is given in parentheses for each date. Species are arranged in the order given in the American Ornithologists' Union Check-list (1998).

SPECIES	Average Arrival Date (1899-1911)	Average Arrival Date (1994-1997)
Common Loon (*Gavia immer*)	8 May (18)	25 Apr (77)
Great Blue Heron (*Ardea herodias*)	23 Apr (26)	13 Apr (211)
American Woodcock (*Scolopax minor*)	12 Apr (29)	4 Apr (150)
Ruby-throated Hummingbird (*Archilochus colubris*)	19 May (54)	15 May (203)
Tennessee Warbler (*Vermivora peregrina*)	27 May (9)	20 May (73)
White-throated Sparrow (*Zonotrichia albicollis*)	27 Apr (70)	19 Apr (212)
Rose-breasted Grosbeak (*Pheucticus ludovicianus*)	16 May (47)	13 May (203)
Indigo Bunting (*Passerina cyanea*)	24 May (34)	20 May (104)
Red-winged Blackbird (*Agelaius phoeniceus*)	4 Apr (54)	26 Mar (242)

Table 3. Species whose average spring arrival dates over the interval 1899-1911 are significantly earlier than arrival dates over the interval 1994-1997 ($p < 0.05$ in Mann-Whitney U-tests). The number of observations is given in parentheses for each date. Species are arranged in the order given in the American Ornithologists' Union Check-list (1998).

SPECIES	Average Arrival Date (1899-1911)	Average Arrival Date (1994-1997)
Common Tern (*Sterna hirundo*)	24 Apr (2)	24 May (42)
Black-billed Cuckoo (*Coccyzus erythopthalmus*)	25 May (35)	30 May (44)
Common Nighthawk (*Chordeiles minor*)	19 May (59)	25 May (58)
Whip-poor-will (*Caprimulgus vociferus*)	11 May (48)	19 May (41)
Chimney Swift (*Chaetura pelagica*)	10 May (71)	14 May (120)
Northern Flicker (*Colaptes auratus*)	13 Apr (31)	18 Apr (227)
Alder Flycatcher (*Empidonax alnorum*)	20 May (30)	26 May (85)
Least Flycatcher (*Empidonax minimus*)	8 May (38)	18 May (133)
Eastern Phoebe (*Sayornis phoebe*)	6 Apr (64)	12 Apr (181)
Barn Swallow (*Hirundo rustica*)	1 May (72)	6 May (182)
Eastern Bluebird (*Sialia sialis*)	24 Mar (66)	13 Apr (157)
Hermit Thrush (*Catharus guttatus*)	19 Apr (67)	27 Apr (184)
Magnolia Warbler (*Dendroica magnolia*)	14 May (47)	16 May (152)
Blackburnian Warbler (*Dendroica fusca*)	14 May (36)	19 May (136)
American Redstart (*Setophaga ruticilla*)	13 May (58)	17 May (182)
Field Sparrow (*Spizella pusilla*)	29 Apr (40)	5 May (62)
Vesper Sparrow (*Pooecetes gramineus*)	17 Apr (57)	1 May (51)
Savannah Sparrow (*Passerculus sandwichensis*)	19 Apr (48)	27 Apr (138)
Song Sparrow (*Melospiza melodia*)	25 Mar (69)	30 Mar (139)
Bobolink (*Dolichonyx oryzivorus*)	14 May (54)	17 May (192)

warming. We must conclude that either effects of temperature increases on bird migration are not present at this stage of global warming or that birds provide a muddled signal that cannot be detected with the present precision of the data. Nevertheless, the two datasets described here provide a baseline for assessment of changes in arrival date of Maine migratory breeding birds in the 21st century.

LITERATURE CITED

BRASWELL, B.H., D.S. SCHIMEL, E. LINDER, and B. MOORE III. 1997. The response of global terrestrial ecosystems to interannual temperature variability. Science 278: 870-872.

CONNER, R.N., D.C. RUDOLPH, and L.H. BONER. 1995. Red-cockaded Woodpecker population trends and management on Texas National Forests. J. Field Ornith. 66: 140-151.

CRICK, H.Q.P., C. DUDLEY, D.E. GLUE, and D.L. THOMSON. 1997. UK birds are laying eggs earlier. Nature 388: 526.

DAVIS, W.E. 1994. Dean of the Birdwatchers: a Biography of Ludlow Griscom. Smithsonian Inst. Press, Washington, DC.

DAWSON, W.R., J.D. LIGON, J.R. MURPHY, J.P. MYERS, D. SIMBERLOFF, and J. VERNER. 1987. Report of the scientific advisory panel on the Spotted Owl. Condor 89: 205-229.

HAGAN, III, J.M. 1993. Decline of the Rufous-sided Towhee in the eastern United States. Auk 110: 863-874.

HASSELMAN, K. 1997. Are we seeing global warming? Science 276: 914-915.

IRLAND, L.C. 1997. Maine's forest vegetation regions: selected maps 1858-1993. Northeast. Natur. 4: 241-260.

KRICHER, J.C. 1981. Range expansion of the Tufted Titmouse (*Parus bicolor*), in Massachusetts. Amer. Birds 35: 750-753.

MAHLMANN, J.D. 1997. Uncertainties in projections of human-caused climate warming. Science 278: 1416-1417.

MARSHALL, D.B. 1988. The Marbled Murrelet joins the old-growth forest conflict. Amer. Birds 42: 202-211.

MAYFIELD, H.F. 1988. Changes in bird life at the western end of Lake Erie. Amer. Birds 42: 393-398.

MAYFIELD, H.F. 1989. Changes in bird life at the western end of Lake Erie. Part III of III. Amer. Birds 43: 46-49.

McMAHON, J.S. 1991. Benchmarks in a changing landscape. Ecological reserves: a missing link in Maine's conservation agenda. Habitat 8: 16-21.

MYNENI, R.B., C.D. KEELING, and C.J. TUCKER. 1997. Increased plant growth in the northern high latitudes from 1981 to 1991. Nature 386: 698-702.

PERRINS, C.M. 1970. The timing of birds' breeding seasons. Ibis 112: 242-255.

VITOUSEK, P.M., H.A. MOONEY, J. LUBCHENCO, and J.M. MELILLO. 1997. Human domination of earth's ecosystems. Science 277: 494-499.

WILSON, Jr., W.H. 1994. The distribution of wintering birds in central Maine: the interactive effects of landscape and bird feeders. J. Field Ornith. 65: 512-519.

WILSON, Jr., W.H. 1999. The northward expansion of the Tufted Titmouse in Maine. North. Natur. 6: 231-237.

WILSON, Jr., W.H., A. SAVAGE, and R. ZIERZOW. 1997. Arrival dates of migratory breeding birds in Maine: results from a volunteer network. North. Natur. 4: 83-92.