Spring Arrivals of Maine Migratory Breeding Birds: Response to an Extraordinarily Warm Spring

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Abstract - This paper documents the median spring arrival date of 101 species of Maine migratory breeding birds in 2010 compared to their normal arrival from 1994–2011. The spring of 2010 was uniformly warmer for March, April, and May (monthly departures of 2.0 to 4.0 ºC above the mean value). The 101 species showed a strong response to the warm spring, with 86 species arriving earlier, only 12 arriving later, and 3 showing no difference in arrival date from the 17-year median. The strongest response was by leaf-gleaning birds; all 30 species arrived earlier in 2010.

Introduction

Monitoring the arrival of migratory birds has become an important tool in assessing the strength and impacts of climate change (Dunn and Winkler 1999, Ledneva et al. 2004, Marra et al. 2005, Mason 1995, Mills 2005). The logic is that warmer spring temperatures accelerate the resumption of growth in plants, leading to earlier appearances of insects and other organisms that birds depend upon. Data from observations of first arrivals in spring and from captures of birds at banding stations yield abundant evidence that many migratory breeding birds are arriving on the breeding grounds earlier (reviewed in Cox 2010).

Since 1994, I have been coordinating a volunteer effort across the state of Maine to monitor the first arrivals of over 100 species of migratory breeding birds. Observers are asked to note their first detection of each species and identify their location in the state. The data have been useful in documenting the nature of migration across the state (Wilson et al. 1997), in comparing contemporary arrival dates with dates from about a century ago (Wilson et al. 2000), and in detecting a relationship of foraging style with intra-annual variability in arrival dates (Wilson 2009).

I used the data to examine the impact of springtime temperature and North Atlantic oscillation (a driver of hemispheric climatic variation [Huppop and Huppop 2003, Vähatalo et al. 2004]) and found weak but statistically significant effects of these climatic variables for 60% of the species analyzed (Wilson 2007). The muddled signal may have arisen in part because of the complex pattern of variation in spring weather in Maine. An abnormally cold March may be followed by a warmer than normal April but a cold May (Wilson 2007). However, the spring of 2010 is unique among the 18 years of the study to date in that March, April, and May all had substantially warmer temperatures than average. This year provides an opportunity to test for earlier spring arrivals without the confounding effects of warm and cold spells during the migration season.

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Methods

The dataset on arrival dates has over 44,000 records for 105 species. Four species were excluded because of low sample sizes. For each year, I determined the median arrival date for each species. Medians were used rather than means because some observers reported very late first arrivals. Occasionally, extremely early but accurate first arrivals were reported. Such atypical records may have a strong effect on the mean but less of an effect on the median. For each species, I determined the grand median of the 18 yearly medians to determine the typical arrival date over the 18-year study period. I then determined the difference between the grand median and the 2010 median. While it is true that the 2010 median, based on a single year's data, is being compared to a grand median derived from 18 years of data, the median for 2010 is based on at least 10 records for each species and sometimes as many as 50 records. I have found that the median stabilizes after 8–10 records are randomly drawn from a species with many records (e.g., *Scoloplax minor* [American Woodcock], *Sayornis phoebe* [Eastern Phoebe], and *Aegelaius phoeniceus* [Red-winged Blackbird]).

I compared the number of species for which the 2010 arrival date was earlier to the number of species that showed a later arrival date for 2010. I used this simple non-parametric test rather than calculating z-scores or performing other parametric tests because the distribution of medians did not always conform to a normal distribution. A chi-square test was used to test the null hypothesis of no difference in the number of species with earlier arrivals compared to those with late arrivals.

I classified each species into one of 8 foraging modes: aquatic (including both herbivores like ducks and predators like *Gavia immer* [Common Loon] and *Megaceryle torquata* [Belted Kingfisher]), aerial insectivores, granivores, ground-feeding predators (like thrushes or *Charadrius vociferus* [Killdeer]), leaf-gleaning predators, nectarivores, raptors, and scansorial (foraging on tree trunks) feeders (Ehrlich et al. 1988). Patterns of early arrivals were examined for each foraging class.

Results

The average difference between the 18-year mean monthly temperature and the corresponding 2010 data (hereafter, temperature departure) for Maine was 4.0 ºC for March, 3.0 ºC for April and 1.9 ºC for May (data from National Climatic Data Center records). The monthly spring departures from the average were a mixed pattern of negative and positive departures (Table 1; Wilson 2007) except for 1999 and 2006, when all 3 months had positive departures from the mean. However, the departures were modest (1.0–1.7 ºC) compared to the warm 2010 spring.

Table 1 presents arrival data comparing the median arrival date for 2010 with the median of all the 18 years of the study to date. Eighty-six species had earlier median arrival dates in 2010 compared to the grand median, with only 12 species arriving later. Three species showed no difference in the arrival date. A chi-square test with alpha = 0.05 under the null expectation of equal

Table 1. Trophic group, median arrival date (grand median of 18 annual medians (1994–2011), 2010 median and the difference (in days) between the two medians. Positive differences represent earlier arrivals, and negative differences represent later arrivals.

Species	Trophic group	Median Grand	Median 2010	Difference
Aix sponsa L. (Wood Duck)	Aquatic	4/9	4/4	5
Anas discors (L.) (Blue-winged Teal)	Aquatic	4/23	4/11	12
Aythya collaris (Donovan) (Ring-necked Duck)	Aquatic	4/8	4/7	1
Gavia immer (Brünnich) (Common Loon)	Aquatic	4/19	4/16	3
Podilymbus podiceps (L.) (Pied-billed Grebe)	Aquatic	4/17	4/25	-8
Botaurus lentiginosus (L.) (American Bittern)	Aquatic	5/1	5/4	-3
Ardea herodias (Rackett) (Great Blue Heron)	Aquatic	4/13	4/11	2
Butorides virescens L. (Green Heron)	Aquatic	5/13	5/8	5
Plegadis falcinellus (L.) (Glossy Ibis)	Aquatic	4/22	4/18	4
Cathartes aura (L.) (Turkey Vulture)	Scavenger	1/28	3/24	4
Pandion haliaetus (L.) (Osprey)	Raptor	4/16	4/14	2
Circus cyaneus (L.) (Northern Harrier)	Raptor	4/8	4/5	3
Buteo platypterus Viellot) (Broad-winged Hawk)	Raptor	4/25	4/21	4
Falco sparverius L. (American Kestrel)	Raptor	4/7	4/5	2
Rallus limicola Viellot (Virginia Rail)	Aquatic	5/9	5/7	2
Porzana carolina (L.) (Sora)	Aquatic	5/12	5/13	-1
Charadrius vociferus L. (Killdeer)	Ground predator	4/2	3/28	5
Actitis macularius (L.) (Spotted Sandpiper)	Ground predator	5/13	5/13	0
Tringa semipalmata (Gmelin) (Willet)	Ground predator	5/7	5/5	2
Bartramia longicauda (Bechstein) (Upland Sandpiper)	Ground predator	5/11	5/19	-8
Gallinago delicata Ord (Wilson's Snipe)	Ground predator	4/22	4/19	3
Scoloplax minor Gmelin (American Woodcock)	Ground predator	3/31	3/30	1
Coccyzus erythropthalmus (Wilson) (Black-billed Cuckoo)	Leaf gleaner	5/30	5/21	9
Chordeiles minor (Forster) (Common Nighthawk)	Aerial	5/26	5/26	0
Chaetura pelagica (L.) (Chimney Swift)	Aerial	5/13	5/14	-1
Archilochus colubris (L.) (Ruby-throated Hummingbird)	Nectarivore	5/12	5/13	-1
Megaceryle torquata (L.) (Belted Kingfisher)	Aquatic	4/18	4/10	8
Sphyrapicus varius (L.) (Yellow-bellied Sapsucker)	Scansorial	4/22	4/11	11
Colaptes auratus (L.) (Northern Flicker)	Scansorial	4/14	4/6	8
Contopus cooperi (Nuttall) (Olive-sided Flycatcher)	Aerial	5/24	5/21	3
C. virens (L.) (Eastern Wood-Pewee)	Aerial	5/23	5/19	4
Empidonax alnorum Brewster (Alder Flycatcher)	Aerial	5/26	5/20	6
E. minimus (Baird and Baird) (Least Flycatcher)	Aerial	5/15	5/14	1
Sayornis phoebe (Latham) (Eastern Phoebe)	Aerial	4/9	4/4	5
Myiarchus crinitus (L.) (Great Crested Flycatcher)	Aerial	5/16	5/5	11
Tyrannus tyrannus (L.) (Eastern Kingbird)	Aerial	5/13	5/12	1
Vireo solitarius (Wilson) (Blue-headed Vireo)	Leaf gleaner	5/4	5/2	2
V. gilvus Viellot (Warbling Vireo)	Leaf gleaner	5/14	5/8	6
V. olivaceus (L.) (Red-eyed Vireo)	Leaf gleaner	5/20	5/15	5
Tachycineta bicolor (Viellot) (Tree Swallow)	Aerial	4/17	4/18	-1
Stelgidopteryx serripennis (Audubon) (Northern Rough-winged Swallow)	Aerial	5/6	5/8	-2
Riparia riparia (L.) (Bank Swallow)	Aerial	5/16	5/11	5
Petrochelidon pyrrhonata Viellot (Cliff Swallow)	Aerial	5/14	5/10	4
Hirundo rustica L. (Barn Swallow)	Aerial	5/5	5/5	0
Troglodytes aedon Viellot (House Wren)	Ground predator	5/11	5/5	6
Cisthothorus palustris (Wilson) (Marsh Wren)	Ground predator	5/17	5/16	1

Table 1, continued.

Species	Trophic group	Median		Difference
		Grand	2010	
Regulus calendula (L.) (Ruby-crowned Kinglet)	Leaf gleaner	4/24	4/19	5
Sialia sialis (L.) (Eastern Bluebird)	Ground predator	4/12	4/13	-1
Catharus fuscescens (Stephens) (Veery)	Ground predator	5/16	5/16	0
C. ustulatus (Nuttall) (Swainson's Thrush)	Ground predator	5/19	5/14	5
C. guttatus (Pallas) (Hermit Thrush)	Ground predator	4/24	4/18	6
Hylocichla mustelina (Gmelin) (Wood Thrush)	Ground predator	5/12	5/6	6
Dumetella carolinensis (L.) (Gray Catbird)	Ground predator	5/11	5/9	2
Toxostoma rufum (L.) (Brown Thrasher)	Ground predator	5/8	5/7	1
Seiurus aurocapilla (L.) (Ovenbird)	Leaf gleaner	5/10	5/6	4
Parkesia novaeboracensis (Gmelin) (Northern Waterthrush)	Leaf gleaner	5/10	5/7	3
Mniotilta varia (L.) (Black-and-white Warbler)	Leaf gleaner	5/7	5/1	6
Oreothlypis ruficapilla (Wilson) (Nashville Warbler)	Leaf gleaner	5/10	5/6	4
Geothlypis philadelphia (Wilson) (Mourning Warbler)	Leaf gleaner	5/25	5/24	1
G. trichas (L.) (Common Yellowthroat)	Leaf gleaner	5/13	5/10	3
Setophaga ruticilla (L.) (American Redstart)	Leaf gleaner	5/16	5/11	5
S. tigrina (Gmelin) (Cape May Warbler)	Leaf gleaner	5/17	5/16	1
S. americana (L.) (Northern Parula)	Leaf gleaner	5/10	5/5	5
S. magnolia (Wilson) (Magnolia Warbler)	Leaf gleaner	5/15	5/11	4
S. castanea (Wilson) (Bay-breasted Warbler)	Leaf gleaner	5/18	5/12	6
S. fusca (Forster) (Blackburnian Warbler)	Leaf gleaner	5/17	5/13	4
S. petechia (L.) (Yellow Warbler)	Leaf gleaner	5/12	5/8	4
S. pensylvanica (L.) (Chestnut-sided Warbler)	Leaf gleaner	5/16	5/12	4
S. striata (Müller) (Blackpoll Warbler)	Leaf gleaner	5/21	5/16	5
S. caerulescens (Gmelin) (Black-throated Blue Warbler)	Leaf gleaner	5/14	5/11	3
S. palmarum (Wilson) (Palm Warbler)	Leaf gleaner	4/22	4/20	2
S. pinus (Wilson) (Pine Warbler)	Leaf gleaner	4/24	4/21	3
S. coronata (L.) (Yellow-rumped Warbler)	Leaf gleaner	4/28	4/25	3
S. discolor (Wilson) (Prairie Warbler)	Leaf gleaner	5/14	5/9	5
S. virens (Gmelin) (Black-throated Green Warbler)	Leaf gleaner	5/8	5/5	3
Cardellina canadensis (L.) (Canada Warbler)	Leaf gleaner	5/20	5/18	2
C. pusilla (Wilson) (Wilson's Warbler)	Leaf gleaner	5/17	5/15	2
Pipilo erythrophthalmus (L.) (Eastern Towhee)	Granivore	5/4	5/2	2
Spizella passerina (Bechstein) (Chipping Sparrow)	Granivore	4/23	4/15	8
S. pusilla (Wilson) (Field Sparrow)	Granivore	5/4	5/7	-3
Passerculus sandwichensis (Gmelin) (Savannah Sparrow)	Granivore	4/25	4/28	-3
Passerella iliaca (Merren) (Fox Sparrow)	Granivore	3/12	3/20	8
Melospiza melodia (Wilson) (Song Sparrow)	Granivore	3/25	3/16	9
M. georgiana (Latham) (Swamp Sparrow)				
Zonotrichia albicollis (Gmelin) (White-throated Sparrow)	Granivore	4/15	4/7	8
Piranga olivacea (Gmelin) (Scarlet Tanager)	Leaf gleaner	5/18	5/15	3
Pheucticus ludovicianus (L.) (Rose-breasted Grosbeak)	Granivore	5/12	5/9	3
Passerina cyanea (L.) (Indigo Bunting)	Granivore	5/21	5/15	6
Dolichonyx oryzivorus (L.) (Bobolink)	Ground predator	5/16	5/13	3
Aegelaius phoeniceus (Müller) (Red-winged Blackbird)	Ground predator	3/21	3/20	1
Sturnella magna (L.) (Eastern Meadowlark)	Ground predator	4/23	4/22	1
Euphagus carolinus (Müller) (Rusty Blackbird)	Ground predator	4/10	4/3	7
Quisculus quiscala (L.) (Common Grackle)	Ground predator	3/24	3/23	-1
Icterus galbula (L.) (Baltimore Oriole)	Leaf gleaner	5/11	5/7	4

numbers of early and late arrivals for 2010 rejected the null hypothesis (χ^2 = 55.88, $P < 0.001$).

A more conservative approach is to require that a difference of at least two days must occur to claim an earlier or later arrival data. Sixteen species (ten arriving one day earlier and six arriving one day later) under this criterion are considered to show no meaningful difference in arrival data. The remaining species (with at least two days difference between the two medians) include 76 species with earlier arrivals in 2010 and only 7 with later arrivals in 2010. A chi-square test rejects the null hypothesis of equal numbers of early and late median arrivals for 2010 (χ^2 = 57.36, $P < 0.001$).

The trophic group with the strongest response was the leaf gleaners. All 30 species showed earlier arrivals in 2010. Nine of 12 aquatic species arrived earlier. All 4 raptors arrived earlier as did the 2 scansorial species. For ground predators, 15 of 18 arrived earlier. The only nectarivore (*Archilochus colubris* [Ruby-throated Hummingbird]) arrived a day late. For granivorous species, 7 of 9 showed earlier arrivals in 2010. Aerial insectivores showed a similar pattern with 9 of 12 species arriving earlier.

Discussion

Abundant evidence exists that bird migration is responsive to temperature (Cotton 2003, Crick 2004, Hubálek 2004, Peñuelas et al. 2002, Sparks and Carey 1995). Most of this evidence has been recently marshaled as investigators test springtime arrival dates for migratory birds through the lens of global climate change. Such temperature-dependent migration has been documented in the northeastern United States. Butler (2003) used birding records from bird clubs in the Ithaca, NY and Worcester, MA areas to document nearly universal earlier arrival dates for contemporary populations compared to birds from 50 years ago or longer. Vitale and Schlesinger (2011) showed similar patterns in springtime arrivals of breeding birds in Duchess County, NY.

My students and I have found much weaker patterns of temperature-dependence of spring migration in Maine (Wilson 2009, Wilson et al. 2000). Comparing contemporary data with birding records from 1891–1910, we found no strong pattern of earlier arrival in modern times. The most common result was no change in arrival dates (47 species) across the ends of the century. Only nine of 86 species are arriving earlier now and 22 species are arriving later. Using arrival data for the periods of 1994 through 2005, Wilson (2007) showed that 60% of the species showed weak but significant responses to either springtime temperature or to the North Atlantic Oscillation, a hemispheric determinant of climate.

Often, the exceptional case can be more informative than the average case. I argue that situation arises here. The spring of 2010 caused arrivals of 87% of the bird species to be earlier than normal. This pattern brings Maine birds into line with the patterns seen by workers in New York and Massachusetts, where earlier arrivals are nearly universal. I suggest that the more northerly location of Maine may moderate the annual fluctuations of temperature in the spring compared to New York and Massachusetts, hence leading to a more muddled relationship between temperature and arrival date for most years.

I showed that intra-specific variance in arrival dates was least for leaf-gleaning birds in Maine (Wilson 2009). These birds depend on the insect herbivores that feed on deciduous leaves. Hence, leaf-gleaners must not arrive before leaf-out occurs. There is strong directional selection against birds that arrive too early. On the other hand, delaying arrival until well after leaf-out may place birds at a competitive disadvantage for procuring breeding sites. This interpretation is consistent with the present data where every leaf-gleaning species arrived early (3–6 days in most cases; Table 1).

Granivores and ground-predators did not have as striking a response, with 2 of 9 granivores and 3 of 18 ground-predators arriving later. One presumes these birds can find food once the ground thaws. Of the 14 aerial insectivores, only 9 arrived earlier in 2010. Perhaps the emergence of the flying insects on which these species depend is not as strongly temperature-dependent as leaf-out.

In summary, the uniformly warm spring of 2010 provided an extraordinary event to test for the response of earlier arrivals by Maine migratory birds. The magnitude of the temperature departure produced a much stronger impact on arrivals than has been documented through historical comparisons (Wilson et al. 2000) and through contemporary inter-annual comparisons (Wilson 2007).

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