THE 1980 SPRING WARBLER MIGRATION STUDY: AN EXPERIMENT IN COOPERATIVE DATA COLLECTION

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For many Massachusetts birders the spring warbler migration is one of the high points of the birding year. Mild weather and a parade of colorful singing birds entice more observers into the field than at any other time of year. One might think that this birding enthusiasm would yield a flood of field reports which would support quantitative monitoring of the abundances of migrants. But, in reality, deficiencies in the data reporting and compilation processes usually erode the value of published records and leave us with surprisingly little birding data which is useful in the quantitative study of migration. Consider for instance a simple question such as the following: Has the number of Bay-breasted Warblers migrating through Massachusetts increased or decreased in the last 10 years? If one consults the records published in BOEM or in the Massachusetts Audubon Field Notes, one finds primarily early records, late records, and extreme high counts. Generally, the reports of high counts are difficult to evaluate since they fail to detail the time afield or the area covered in generating the count. Nor do they discuss unusual weather conditions that might have caused a peak.

The authors have long felt that the field reports of birders can be made much more useful than is currently the case. For this reason a migration monitoring study was organized in the spring of 1980. The goal of the study was to observe and record the migration of warblers in a manner that would produce migrant abundance data of long-term usefulness. The study also sought to detect site-to-site differences in the migrant counts. These differences would help to determine whether intensive coverage of one site (Mt. Auburn Cemetery, say) can be considered a substitute for more widespread coverage.

Methodology

In devising a methodology for the study, it was immediately apparent that the familiar Christmas Bird Count approach was inappropriate. The CBC is a single-day census and thus suitable only for the counting of sedentary populations. Since the numbers of migrant landbirds vary greatly from day to day, a single-day census could be quite atypical of the season as a whole. It was decided that the study must take place over several weeks during the migration. Daily coverage for such a period was out of the question for most participating observers. Hence data analysis techniques that could accommodate intermittent coverage were developed.

The study focused upon warblers for several reasons. First, warblers constitute a family containing a moderate number of species, many of

TABLE 1. SUMMARY OF WARBLER MIGRATION STUDY DATA

SITE NO.	CODE	LOCATION	NO. VISITS	NO. HOURS	TOTAL COUNT	MIGRANT COUNT	NO. SPECIES	MIGRANTS PER HR.	OBSERVER
1	PLUM	Plum Island (Hellcat Swamp)	12	12.5	316	163	18	13.0	M. Schoene
2	MTA1	Cambridge (Mt. Auburn Cemetery)	12	19.0	604	594	21	31.3	S. Zendeh
3	MTA2	Cambridge (Mt. Auburn Cemetery)	12	15.4	420	409	21	26.6	C. Jackson
4	WINC	Winchester/Medford ("Army Camp")	19	27.8	945	840	24	30.2	G. Gove
5	LEX	Lexington (Whipple Hill)	21	23.9	264	214	20	8.9	J. Andrews
6	WEST	Weston (Linwood Cemetery)	13	22.3	369	272	21	12.2	L. Robinson
7	CONC	Concord (GMNWR)	18	35.3	799	255	19	7.2	L. Taylor
8	WAYL	Wayland (Heard's Pond)	14	7.1	385	304	18	42.8	R. Forster
		TOTALS	121	163.3	4102	3051	20.2 (ag.)	18.7 (ag.)	

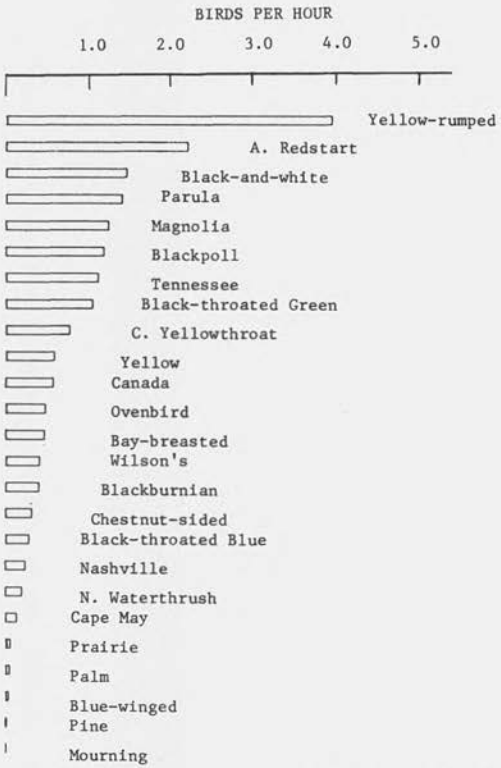

FIGURE 1. Abundance of Migrant Warblers Obtained by Combining Data from All Sites

which can be found in substantial numbers in almost any town or city in the area. Second, they present few identification problems in spring plumages (autumn is another story!). Finally, most of the warblers seen in eastern Massachusetts during May are migrants. This somewhat alleviates the problem of distinguishing migrants from resident individuals.

During the month of May, eight observers covered fixed routes at their chosen sites and recorded the numbers of all warbler species observed. Both sight and voice records were accepted. The particular dates of the visits were at the discretion of the observers, but participants were asked to conduct the census at least once every three days. Previous experience had indicated that less frequent visits could miss migration peaks for particular species and result in undercounts for the migration period.

In addition to keeping weather counts, observers filled out a daily visit log that indicated the amount of time spent on the census, the weather conditions, and the overall level of migratory activity observed. Finally, a site description form, describing the topology, vegetation, and land use at the site, was completed.

All counts were taken in terms of the number of bird-days. Thus, if one individual was seen on two consecutive days, that individual contributed two bird-days to the count. No attempt was made to convert these counts to the actual numbers of individuals visiting the site over a period of time. It is felt that bird-day counts are meaningful indicators of abundance and that any attempt to convert these counts to actual numbers of visitors could only introduce more uncertainty into the significance of the data.

Overview of Results

Table 1 provides an overview of the eight sets of data that were submitted. A total of 4102 bird-days was recorded. Of this total, 1051 bird-days were attributed to residents rather than migrants, leaving 3051 migrant records for analysis. The correction for each resident species was determined by analyzing trends in the daily counts and by having the observers submit estimates of the resident populations at their sites.

Figure 1 provides a summary of the abundances of each of the 25 warbler species recorded during the study. The abundances are expressed in terms of birds per hour (multiply by 163 hours to get the total number of birds recorded). The most abundant migrant was the Yellow-rumped Warbler, which accounted for approximately 21% of the migrant records.[1] The second most abundant migrant was the American Redstart, which

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[1] The census was conducted only during the month of May. If April records had been included, certain early migrants such as Yellow-rumped, Pine, and Palm Warbler would probably increase in relation to other species.

TABLE 2. BIRDS-PER-HOUR VALUES FOR MIGRANT WARBLERS

	1 PLUM	2 MTA1	3 MTA2	4 WINC	5 LEX	6 WEST	7 CONC	8 WAYL	
YRMP	1.28	5.00	6.49	3.85	2.22	2.56	1.98	21.05	3.963
RDST	2.16	3.47	1.49	5.61	1.30	0.85	0.71	2.12	2.217
B&W	0.96	2.84	1.69	2.63	0.92	1.48	0.48	0.42	1.470
PARU	1.28	2.53	1.82	3.35	0.38	0.72	0.54	0.28	1.415
MAGN	1.44	2.16	1.56	2.34	0.59	1.26	0.25	0.71	1.249
BPLL	0.08	2.95	1.88	1.22	0.21	0.81	0.65	3.95	1.188
TENN	0.0	2.74	2.47	1.91	0.25	0.72	0.25	1.27	1.121
BTG	0.56	2.63	2.27	1.62	0.46	0.63	0.20	0.42	1.053
YTHR	0.80	0.16	1.17	0.97	0.25	0.49	0.54	4.66	0.778
YEL	0.72	0.89	1.43	0.07	0.04	0.09	0.62	2.82	0.582
CNDA	0.56	0.53	0.58	1.58	0.29	0.27	0.11	0.85	0.570
OVEN	0.08	0.32	0.45	1.04	0.59	0.72	0.11	0.14	0.478
BAYB	0.0	0.79	0.91	0.83	0.04	0.58	0.03	1.27	0.465
WILS	2.00	0.63	0.71	0.22	0.0	0.0	0.28	0.42	0.410
BBUR	0.08	0.95	0.32	0.79	0.17	0.31	0.06	0.99	0.404
CHES	0.08	0.74	0.32	0.79	0.29	0.09	0.03	0.0	0.318
BTBL	0.40	0.79	0.32	0.50	0.13	0.04	0.08	0.0	0.282
NASH	0.0	0.53	0.06	0.29	0.38	0.31	0.0	0.56	0.239
NWAT	0.24	0.05	0.26	0.32	0.0	0.04	0.25	0.71	0.196
CMAY	0.16	0.53	0.26	0.11	0.0	0.09	0.0	0.0	0.129
PRIE	0.0	0.05	0.0	0.07	0.25	0.0	0.0	0.0	0.055
PALM	0.16	0.0	0.0	0.04	0.13	0.0	0.0	0.28	0.049
BWNG	0.0	0.0	0.06	0.04	0.08	0.04	0.03	0.0	0.037
PINE	0.0	0.0	0.0	0.0	0.0	0.09	0.0	0.0	0.012
MOUR	0.0	0.0	0.0	0.04	0.0	0.0	0.0	0.0	0.006

NOTE: BPH abundance for each species is expressed as birds per hour afield. The final column provides the BPH values resulting from combining data from all sites.

TABLE 3. RELATIVE ABUNDANCE OF MIGRANTS

	1 PLUM	2 MTA1	3 MTA2	4 WINC	5 LEX	6 WEST	7 CONC	8 WAYL	
YRMP	9.82	15.99	24.45	12.74	24.77	20.96	27.45	49.01	21.206
RDST	16.56	11.11	5.62	18.57	14.49	6.99	9.80	4.93	11.865
B&W	7.36	9.09	6.36	8.69	10.28	12.13	6.67	0.99	7.866
PARU	9.82	8.08	6.85	11.07	4.21	5.88	7.45	0.66	7.571
MAGN	11.04	6.90	5.87	7.74	6.54	10.29	3.53	1.64	6.686
BPLL	0.61	9.43	7.09	4.05	2.34	6.62	9.02	9.21	6.359
TENN	0.0	8.75	9.29	6.31	2.80	5.88	3.53	2.96	5.998
BTG	4.29	8.42	8.56	5.36	5.14	5.15	2.75	0.99	5.637
YTHR	6.13	0.51	4.40	3.21	2.80	4.04	7.45	10.86	4.163
YEL	5.52	2.86	5.38	0.24	0.47	0.74	8.63	6.58	3.114
CNDA	4.29	1.68	2.20	5.24	3.27	2.21	1.57	1.97	3.048
OVEN	0.61	1.01	1.71	3.45	6.54	5.88	1.57	0.33	2.557
BAYB	0.0	2.53	3.42	2.74	0.47	4.78	0.39	2.96	2.491
WILS	15.34	2.02	2.69	0.71	0.0	0.0	3.92	0.99	2.196
BBUR	0.61	3.03	1.22	2.62	1.87	2.57	0.78	2.30	2.163
CHES	0.61	2.36	1.22	2.62	3.27	0.74	0.39	0.0	1.704
BTBL	3.07	2.53	1.22	1.67	1.40	0.37	1.18	0.0	1.508
NASH	0.0	1.68	0.24	0.95	4.21	2.57	0.0	1.32	1.278
NWAT	1.84	0.17	0.98	1.07	0.0	0.37	3.53	1.64	1.049
CMAY	1.23	1.68	0.98	0.36	0.0	0.74	0.0	0.0	0.688
PRIE	0.0	0.17	0.0	0.24	2.80	0.0	0.0	0.0	0.295
PALM	1.23	0.0	0.0	0.12	1.40	0.0	0.0	0.66	0.262
BWNG	0.0	0.0	0.24	0.12	0.93	0.37	0.39	0.0	0.197
PINE	0.0	0.0	0.0	0.0	0.0	0.74	0.0	0.0	0.066
MOUR	0.0	0.0	0.0	0.12	0.0	0.0	0.0	0.0	0.033

NOTE: The relative abundance of each species is expressed as a percentage of total migrant warblers at the site. The final column provides the relative abundance that results from combining data from all sites.

accounted for almost 12% of the migrant records. Twelve species were recorded at all sites. Two were recorded only at single sites (Pine Warbler at Weston and Mourning Warbler at Winchester). The greatest number of species at a single site was 24 in Winchester.

Nine species of warblers were recorded as breeding. They were Black-and-White (Lexington), Blue-winged (Weston), Nashville (Lexington), Yellow (3 sites), Black-throated Green (Weston), Ovenbird (Winchester and Weston), Northern Waterthrush (Winchester), Common Yellowthroat (all sites), and American Redstart (Weston).

It is worth noting that most observers visited their sites in the early morning (before the workday started). They covered their chosen routes at a rate of about one mile per hour and averaged 25.2 warblers per hour (18.7 migrant warblers per hour).

Site Differences in Birds Per Hour Values

To make a meaningful comparison of counts from different sites, the data must be normalized to remove the effect of "level of effort" factors such as the size of the area covered or the duration of the visits. A simple and often effective normalization is achieved by expressing the counts in terms of birds per hour (BPH). Robinson (Reference 1) has argued that BPH normalization is a useful tool for analyzing population trends of residents. If so, it should also be considered for the analysis of migrant data. In Table 2, BPH values for migrant warblers are presented for each site in the study. A glance at this table shows that there are wide differences in the BPH values for the same species at different sites.

Values for the two sets of Mount Auburn data vary somewhat but are generally consistent. A statistical test (chi-squared test applied pairwise) shows that these two sets are statistically more similar than any other two sets in the data base. This consistency lends some support to the view that site differences, not differences in observers, are responsible for the bulk of the variation between sites.

Site Difference in Relative Abundance

Because of the striking site-to-site variation in the BPH values, a second method of normalization was attempted. This method is called relative-abundance analysis. It expresses the abundance of each species as a fraction of the total count at the site (see Reference 2). Relative-abundance values are, in a sense, "more normalized" than the BPH values. Relative abundance is not directly affected by speed of coverage, conservatism in estimating numbers, conspicuity factors, or the overall tendency of a site to concentrate migrants.

Table 3 presents relative-abundance values in the same format at the BPH values presented earlier. The relative-abundance values seem to show somewhat less variation from site to site than the BPH values,

but significant variations nevertheless exist.[2] As with the BPH analysis, the relative-abundance analysis indicates that the observers at the different sites are not seeing the same population mix of warblers.

Significance of Site Characteristics

A possible explanation of site-to-site variations in relative abundance is that some sites have characteristics that attract particular species more than others. The data reveals several instances of this. For example, the Plum Island count is notable in having a very high count for Wilson's Warbler (2.0 BPH) while having no Tennessee or Bay-breasted Warblers. An obvious explanation is that the Wilson's Warbler was attracted to the wet shrubby areas it prefers, while the Tennessee and Bay-breasted Warblers shunned the site because of its lack of taller trees.

In order to investigate the significance of site characteristics quantitatively, the linear correlation coefficient between BPH and several of the principal site parameters was calculated.[3] The strongest correlations that resulted are shown in Table 4.

In several instances, the abundance of the species is correlated with site characteristics most typical of the preferred breeding habitat - even though the species does not breed in the census area.

Time/Series Analysis

To examine the manner in which migrant counts varied with the time of the month, it was necessary to develop normalization criteria that could take into account both the variations in numbers between sites and the random dates of coverage at the various sites. The first step in this process was to compute for each site the average number of migrants seen per visit. The count on each particular day was then divided by the site average to give a measure of the magnitude of the count on each day. For example, if 163 warblers were recorded in 12 visits to a site, then the average count for the site would be

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[2] As shown in Reference 2, the standard deviation of the sampling error is readily computed. For an observer who counted 400 total birds, the standard error associated with a relative abundance of 0.05 is approximately 0.011. The variations in Table 3 greatly exceed this level, hence they are not attributable to statistical fluctuation produced by the inherent randomness of the sampling process.

[3] The linear correlation coefficient is a standard statistical measure of how closely changes in one quantity follow changes in another quantity. Its value may lie anywhere between -1 and +1. Positive values indicate that when one quantity increases, the other tends to increase also. Negative values indicate that when one quantity increases, the other tends to decrease.

TABLE 4. CORRELATION OF BPH ABUNDANCE WITH SELECTED SITE PARAMETERS.

SITE PARAMETER	SPECIES AND CORRELATION COEFFICIENT: MOST POSITIVELY CORRELATED	MOST NEGATIVELY CORRELATED
Distance from Coast	Yellow-rumped (0.608) C.Yellowthroat (0.590) Yellow (0.470) Blackpoll (0.445)	Black-throated Blue (-0.607) Magnolia (-0.538) Parula (-0.512) Wilson's (-0.497) Black & White (-0.462)
Maximum Elevation Less Minimum of Elevation (A Measure of Hilliness)	Prairie Warbler (0.680) Ovenbird (0.604) Blue-winged (0.495) Chestnut-sided (0.351)	Wilson's (-0.563) Yellow (-0.426)
% Forest Greater than 30 Feet Height	Pine (0.567) Nashville (0.551) Bay-breasted (0.408)	Wilson's (-0.670) Black-throated Blue (-0.464) Parula (-0.303)
% Open Vegetated Area	Parula (0.494) Black-thr. Green (0.460) Black & White (0.449) Chestnut-sided (0.452) Black-thr. Blue (0.410)	Palm (-0.758) C.Yellowthroat (-0.516) Yellow-rumped (-0.445)

NOTE: Only those species with the strongest correlations (either positive or negative) are displayed. See FF. 3 for explanation of correlation coefficient.

163/12 = 13.6 birds. If 19 birds were recorded on May 12 at that site, then the normalized count magnitude for that day would be 19/13.6 = 1.40, i.e., 40% above normal.

For each day in the study, a combined migration-magnitude value was derived from the counts of all sites that reported on that day. This number was calculated as follows. First, the total number of birds observed on the date was computed by summing the totals for all reporting sites. Then the number that would have been observed if each reporting site had reported its daily average was computed (i.e., the daily averages for all reporting sites were summed). The ratio of these two numbers gives the combined migration magnitude for the day.

Figure 2 is a plot of the results of the above analysis. Fluctuations in combined migration magnitude are shown by the solid line. The general trend of this curve reveals an early peak on May 5, caused primarily by large counts of Yellow-rumped Warblers. It also reveals the main migration peak around May 14. Superimposed on this general curve are a number of "spikes" that fall with surprising regularity at intervals of three or four days. Such cyclical abundance cycles have been noted before (Reference 2), and it has been speculated that they are related to the spacing between weather fronts.

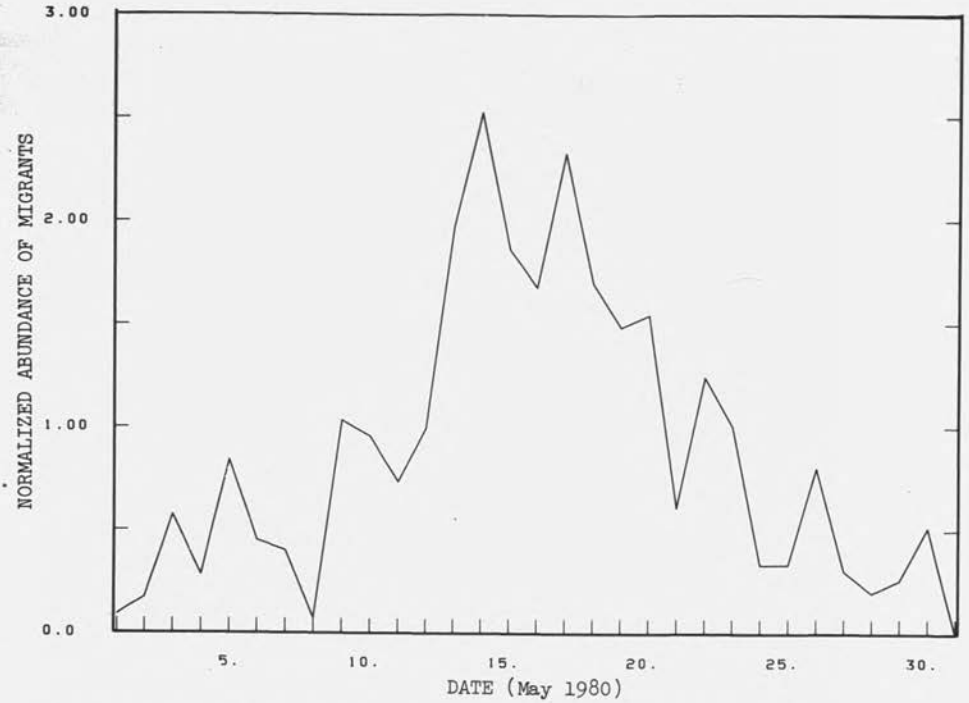

FIGURE 2. Normalized Abundance of Migrants for Each Date. (A Value of 1.00 Corresponds to an Average Count of Migrants: See Text.)

Conclusions

Analysis of the data reveals large site-to-site variations in the BPH values and in the relative abundances of the various warbler species. These variations do not resemble the variations one would expect if each site's data were a random sample from one general distribution of species abundance.

Site characteristics appear to influence the local abundance of certain species. A tendency for migrants to select their preferred breeding habitat types as migration stopovers is suggested. Explanations for other site differences may not be so obvious. For example, what site characteristic could make the cemetery in Weston so much more attractive to the Overbird than Mount Auburn? It would be very useful to determine whether the relative-abundance differences between sites are consistent year after year. If they are, then the significance of site characteristics would be established. This would certainly make the problem of interpreting migration data more complicated, and some interesting questions of broader ornithological significance would be opened.

A time/history analysis technique was developed and used to demonstrate a three-to-four-day cycle in migrant abundance. The source of this variation (weather patterns?) is yet to be determined.

Regardless of the ultimate explanations of the results, the study has certainly made clear the difficulties an observer at a single site would have in forming conclusions about the regional abundances of migrant species. It also suggests that there may be pitfalls in relying upon one or two sites for monitoring changes in abundance. What is needed is a quantitative methodology for monitoring migration on the basis of inputs from many field observers. It is hoped this study is an initial step in that direction.

Acknowledgements

A commendation is due the group of competent field workers whose data collection efforts made this study possible.

REFERENCES

Reference 1: Robinson, L.J., "Some Thoughts About Counting Birds", BOEM, Vol. 5, No. 4, July-August 1977.

Reference 2: Andrews, J.W., "Relative Abundance Analysis: A Technique for Assessing Bird Count Data", BOEM, Vol. 6, No. 4, July 1978.

Reference 3: Robinson, L.J., quoted in "Summary for May 1977", BOEM, Vol. 5, No. 4, July-August 1977.

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NORTH CAROLINA GULF STREAM PELAGIC TRIP

On May 24, 1981, there will be a pelagic birding trip into the Gulf Stream off North Carolina's Outer Banks. The trip, which will leave from Hatteras, is famous lately because of Black-capped Petrel sightings as well as the expected specialties such as Audubon's Shearwater and Bridled Tern. For complete information on the trip, please contact the leaders: Robert L. Ake (615 Carolina Ave., Norfolk, VA 23508; phone 804-625-6082, evenings to 11 p.m.) or Paul G. DuMont (4114 Fessenden St., NW, Washington, D.C. 20016; phone 202-363-8994, evenings to 11 p.m.) The trip costs $36.00 per person.