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A COMPARISON OF CONSTANT-EFFORT MIST NETTING RESULTS AT A COASTAL AND INLAND NEW ENGLAND SITE DURING MIGRATION

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Abstract. We compared population trends from spring and fall migration capture data from two constant-effort banding stations in New England: one coastal (Manomet Center for Conservation Sciences, hereafter "Manomet") and one inland (Vermont Institute of Natural Science, "VINS"). Data were examined for two time periods, 1981–1992 and 1986–1992. Twelve-year population trends were compared to regional Breeding Bird Survey (BBS) data for the same period. The two migration data sets showed little congruence. Of 22 species examined, Manomet data showed significant declines in 11 during one or both seasons, whereas seven species increased significantly at VINS. The number of significant trends at both sites increased between a 7-year and a 12-year sample. Among six species that were strictly transient at the two sites, five showed the same 12-year trend in fall. In general, Manomet tracked BBS data from the Northern Spruce-Hardwood region reasonably well, while VINS more closely tracked BBS trends from Northern New England. Neither site correlated well with BBS trends from Quebec. VINS captured significantly higher proportions of adult birds than did Manomet in 81% of species examined. However, the two sites tracked trends in age ratios largely independently. Several factors appeared to account for the weak congruence between sites, and we discuss the limitations in comparing these two data sets.

Key Words: age ratios, banding station, capture data, migration, New England, population trends.

Despite an extensive network of migration banding operations in North America and Europe, there have been relatively few studies to establish the validity of migration capture data to monitor bird population changes. Hagan et al. (1992) showed that a 19-year migration data set from the Manomet Center for Conservation Sciences (Manomet) in coastal Massachusetts correlated well with documented population changes in several passerine species that breed in northeastern North America. These included resident species (Tufted Titmouse and Northern Cardinal [scientific names listed in Table 1]), short-distance migrants (Golden-crowned Kinglet and Ruby-crowned Kinglet), and neotropical migrants (Tennessee Warbler, Cape May Warbler, and Bay-breasted Warbler). The Manomet data also corresponded with regional Breeding Bird Survey (BBS) data, as 24 of 38 species examined (63%) showed significant positive correlation of annual indices with those from BBS from at least one northeastern physiographic BBS stratum. Positive correlations between the Manomet and BBS data were more common for physiographic strata close to Manomet, suggesting geographic limitations to the usefulness of migration capture data.

However, Manomet trend data correlated poorly with those from another long-term migration banding station in eastern North America, the Powdermill Nature Reserve, located 800 km west–southwest of Manomet (Hagan et al. 1992). Of 40 species analyzed in both data sets, only one showed a significant positive correlation between the two sites. This suggested that different source populations undergoing independent changes were likely sampled at each site, and that local habitat changes might have biased samples of migrants through time, particularly at the Powdermill site.

In a study comparing 1979–1991 banding totals among 13 transient species at two Michigan sites 0.75 km apart, Dunn et al. (1997) found significant positive correlations between trends from capture data and those from Michigan and Ontario BBS data. Moreover, the trends between banding and BBS data were of similar magnitude. Although the two sites showed little overall correlation in trends, this was due to discrepancies in one species, and trend differences were small in most cases. These results suggested that standardized mist netting can serve as a useful and accurate population monitoring tool.

Other comparisons of banding capture data with regionally appropriate BBS data have also shown good concordance between the two (Hussell et al. 1992, Dunn and Hussell 1995, Francis and Hussell 1998), but relatively few comparisons between or among migration banding stations have been made. Under the assumption that migration capture data can accurately track population changes, such comparisons might provide valuable information on population trends within a given region. In this study we compare data from two northeastern U.S. migration

TABLE 1. BREEDING STATUS, SAMPLE SIZE, AND POPULATION TRENDS FOR SELECTED SPECIES FROM MIGRATION CAPTURE DATA AT MANOMET AND VINS, AND BBS DATA FROM NORTHERN NEW ENGLAND (NNE) AND NORTHERN SPRUCE-HARDWOOD (NS-H) STRATA, 1981–1992

		Status[a]		N captured				Trend (percent/yr)				BBS trend (percent/yr)	
				Manomet		VINS		Manomet		VINS			
Species	Code	Manomet	VINS	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	NNE	NS-H
Eastern Phoebe (*Sayornis phoebe*)	EAPH	B	B	63	123	61	373	nd	1.9*	nd	4.9	7.4*	3.9*
Red-eyed Vireo (*Vireo olivaceus*)	REVI	B	B	106	973	33	378	-1.1	-6.8*	nd	7.8	-1.2*	1.7*
Black-capped Chickadee (*Poecile atricapilla*)	BCCH	B	B	760	9,680	158	603	-11.1*	-8.6	8.1*	-3.9	2.8*	1.2
Ruby-crowned Kinglet (*Regulus calendula*)	RCKI	T	T	399	524	134	334	0.8	1.2	6.7	0.7	nd	2.0*
Veery (*Catharus fuscescens*)	VEER	T	B	213	209	25	151	-3.7*	-3.7	nd	7.9*	-0.8	-3.1*
Swainson's Thrush (*C. ustulatus*)	SWTH	T	T	510	358	3	265	-3.4	-2.8	nd	-1.6	nd	-2.9*
Hermit Thrush (*C. guttatus*)	HETH	B	B	537	403	17	573	4.7	2.0	nd	10.6*	10.3*	3.2*
American Robin (*Turdus migratorius*)	AMRO	B	B	370	1,977	70	1,378	-1.8	-6.0	nd	23.4*	0.9	0.7
Gray Catbird (*Dumetella carolinensis*)	GRCA	B	B	471	5,922	177	722	-2.5	-5.9*	3.4	1.4	-1.0	-3.9*
Nashville Warbler (*Vermivora ruficapilla*)	NAWA	T	T	23	116	17	236	nd	-1.8*	nd	-11.0*	-4.9*	-1.6*
Yellow Warbler (*Dendroica petechia*)	YWAR	B	B	268	114	141	30	-0.1	-2.4	-5.0	nd	-0.1	-0.1
Magnolia Warbler (*D. magnolia*)	MAWA	T	T	772	232	27	231	2.1	-2.2*	nd	-3.3	-6.4*	0.7
Yellow-rumped Warbler (*D. coronata*)	MYWA	T	B	183	4,446	377	935	1.4	-9.8*	10.8	-2.7	5.9*	-0.03
American Redstart (*Setophaga ruticilla*)	AMRE	B	B	921	1,047	70	112	-2.6	-5.5*	nd	-5.3	-0.9	-2.0*
Ovenbird (*Seiurus aurocapillus*)	OVEN	B	B	340	228	10	198	0.3	-1.7	nd	4.7	1.4*	-1.0*
Common Yellowthroat (*Geothlypis trichas*)	COYE	B	B	1,266	497	286	1,159	-1.3	-2.8*	-20.0*	-24.0*	-1.8*	-1.3*
Canada Warbler (*Wilsonia canadensis*)	CAWA	T	T	524	150	48	112	-3.5	-2.3	nd	-5.3	-1.2	-2.9*
Song Sparrow (*Melospiza melodia*)	SOSP	B	B	291	869	122	881	-1.9	-0.1	6.7*	-0.9	0.7	0.1
Swamp Sparrow (*M. georgiana*)	SWSP	T	B	314	257	31	206	0.7	3.0*	nd	5.9*	4.3	0.5
White-throated Sparrow (*Zonotrichia albicollis*)	WTSP	T	B	1,853	1,697	209	1,792	-3.6	-5.4	11.8*	19.4*	-2.2*	-1.7*
Dark-eyed Junco (*Junco hyemalis*)	DEJU	T	B	106	415	90	288	-3.3	-4.0*	nd	6.9*	-0.2	-3.0*
Purple Finch (*Carpodacus purpureus*)	PUFI	T	T	10	195	27	283	nd	-3.4	nd	6.3	-3.6	-5.3*

Note. "nd" denotes insufficient data for analysis.

[a] Status: T = strictly transient, B = regularly breeds within 25 km of banding site.

* denotes P = 0.05

banding stations, Manomet and the Vermont Institute of Natural Science (VINS). We use population indices based on migration captures to examine correlations between the two data sets, and we compare trends from banding data at each site with regional BBS trends to further assess congruence. We briefly examine age ratios and their correlation through time of fall migrants at both sites. Finally, we discuss the validity of comparing these two data sets in light of between-site differences.

METHODS

Study Areas

Manomet, located on the western shore of Cape Cod Bay, Plymouth Co., Massachusetts (41°50'N, 70°30'W), lies about 250 km southeast of VINS, located in Woodstock, Windsor County, Vermont (43°36'N, 72°32'W). Both sites are characterized by heterogeneous second-growth deciduous shrub-woodland, consisting of brushy thickets interspersed with groves of largely mature trees. Hagan et al. (1992) described dominant vegetation on the 7-ha Manomet study plot. On the 3-ha study plot used for the VINS banding operation, dominant trees include sugar maple (*Acer saccharum*), bigtooth aspen (*Populus grandidentata*), black cherry (*Prunus serotina*), and white ash (*Fraxinus americana*); dominant shrubs include willow (*Salix* spp.), autumn olive (*Elaeagnus umbellata*), steeplebush (*Spiraea tomentosa*), hawthorne (*Crataegus* spp.), dwarf juniper (*Juniperus communis*), and common buckthorn (*Rhamnus cathartica*).

The rate of successional habitat change differed between Manomet and VINS, although vegetation data were not systematically collected at either site. Because of its coastal exposure, Manomet underwent little successional change during the 1981–1992 study period. Because of VINS's more sheltered, inland location, and the gradual maturation of its habitats from open farmland prior to 1970, relatively more rapid plant succession occurred at that site. Limited vegetation management at VINS during the study slowed the rate of habitat change, but vegetation height around some VINS nets likely increased by 50% or more over the 12-year period. Any effects of successional change on netting totals were probably more pronounced at VINS than at Manomet.

The two study sites occupy contrasting landscapes. Manomet is a 7-ha "oasis" in a coastal belt that is highly fragmented by suburban development, with an increasingly dense human population. VINS lies on a largely forested 32-ha preserve in a predominantly forested and unfragmented rural landscape, with little human population growth.

Data Collection

From 1969–1992, inclusive, Manomet annually operated 45–50 nylon mist nets (12 × 2.6 m, 4-panel, 36-mm extended mesh) at fixed locations. During the spring (15 April through 15 June) and fall (15 August through 15 November) migrations, nets remained open at least five days a week from 0.5 h before sunrise to 0.5 h after sunset. From 1981–1992, inclusive, VINS operated 15–20 mist nets (12 × 2.6 m, 4-panel, 36-mm extended mesh) each year, generally from 15 April to 15 June in spring, and 1 August to 15 November in fall. Standardization of the VINS operation was less uniform than at Manomet, and differed between 1981–1985 and 1986–1992. During the earlier period, nets were opened on an average of two to three days a week for three to five morning hours. Between 1986–1992, nets were opened five days a week for 6 h, beginning 0.5 h before sunrise. Although some net site locations at VINS shifted during the study period, nets were maintained at fixed locations after 1987. At both Manomet and VINS, nets were closed under adverse weather conditions, and records were kept of opening and closing times of nets.

Data Analysis

We analyzed data only for the period 1981–1992, when both banding stations were in operation. We compared both spring and fall data. We compared only those species for which ≥ 100 captures were obtained at each site, combined over both seasons and all years. To restrict our analyses to migrant birds, we eliminated all known or presumed breeding individuals, that is, those with enlarged cloacal protuberances or well-developed brood patches. For each species we calculated a site-specific temporal migration window, defined as those dates after the 1st percentile and before the 99th percentile of captures within each migration season, all years combined.

For each species we calculated a daily population index for each date within its migration window. This was derived by dividing the number of captured individuals of a species by the number of net hours for that date, multiplying that number by 1,000 and adding a constant of 1, then taking the natural log. We calculated an annual population index for each species at each site by computing the mean of the logged daily indices. This procedure smoothed out variation due to days with unusually large numbers of captures (Dunn and Hussell 1995). Population trends were then calculated as the slope of the annual indices regressed on year, producing an estimated annual percent rate of change. Because three species each had annual indices of zero in one year, we did not back-transform indices and remove the constant of one prior to calculating population trends, as log transformation of zero would have resulted in a negative index.

We examined population trends at Manomet and VINS by dividing the data into two time periods: the entire 12-year period from 1981–1992, and a 7-year subset from 1986–1992, during which time the VINS operation was relatively standardized. We suspected that the lack of uniform standards at VINS during 1981–1985 might have obscured or biased actual population trends at that site over the longer 1981–1992 study period. We thus compared trends over both 7 and 12 years.

We obtained BBS population trends for 1981–1992 from the U.S. Geological Survey's Patuxent Wildlife Research Center webpage (http://www.mbr-pwrc.usgs.gov/bbs/bbs.html). We compared trends from spring and fall migration capture data at both sites with trends from BBS data for three regions: Northern New England (physiographic strata 27), Northern Spruce-Hardwood (physiographic strata 28), and the province of Quebec. We believe that these three areas represent the most likely geographic source of migrants sampled at Manomet and VINS. We calculated Spearman rank correlations (one-tailed significance tests) between trends from VINS and Manomet banding totals and those from the BBS (SYSTAT 1998).

We compared age ratios in the migration window in those species with adequate sample sizes at both sites (see criteria above). We used only those species for which the proportion of unknown-age birds was less than 5% and less than the proportion of adults at each site. We used Manomet capture data from 1969 to 1992 and VINS data from 1981 to 1992. We excluded spring migrants from our analysis of age ratios due to generally small samples of known-age (second-year and after second-year) individuals at each site. We examined differences of age ratio differences using a t-test, and we compared annual changes in age ratios at both sites using a Pearson product-moment correlation (SAS Institute 1985).

RESULTS

Correlation Between Manomet and VINS Population Trends

The combined Manomet and VINS migration capture data set consisted of 22 species with sufficient sample sizes for between-site comparison (Table 1). Migration trends from 1981–1992 for all species combined for which there were data from both sites were uncorrelated both for fall ($r = -0.031$, $N = 21$ species, $P > 0.10$) and spring ($r = -0.238$, $N = 8$, $P > 0.10$; Fig. 1). For three species (American Robin, Common Yellowthroat, and White-throated Sparrow), VINS trends were biologically unrealistic (>15%/year increase or decrease), but excluding them did not improve the correlation among the remaining species in fall. Comparison of fall trends over the 7-year subset of data (1986–1992) revealed similarly poor correlation between the two sites ($r = 0.008$, $P > 0.10$).

Direction of Manomet and VINS Population Trends

Over the 12-year period, 13 species showed significant ($P \leq 0.05$) population trends in one or both seasons at Manomet, whereas populations of 10 species changed significantly at VINS (Table 1). During the fall season, there was moderate agreement in the direction of trends between the two sites, with 13 (62%) species agreeing and eight (38%) disagreeing (Table 2). At Manomet, two species significantly increased in fall, whereas eight species experienced significant declines. VINS data showed significant increases in six species and significant declines in two. Swamp Sparrow was the only species to increase significantly at both sites in fall, whereas Nashville Warbler and Common Yellowthroat declined significantly at both. Only Dark-eyed Junco showed an opposite significant trend at the two sites, declining at Manomet and increasing at VINS (Table 1).

During the spring, there was little correspondence in trend direction between the two sites, with four species agreeing and four disagreeing (Table 2). At Manomet, three species showed significant population trends, all declines. Despite small sample sizes at VINS, which reduced the number of species included in spring analyses to eight, three species showed significant increases and one a significant decline (Table 1). No species showed the same significant trend at both sites, but Black-capped Chickadee declined significantly at Manomet while increasing significantly at VINS.

A comparison of population trends over both 12 and 7 years indicated that although most trends became non-significant over the shorter time period, three species showed significant population changes only during this period. Three species (Swamp Sparrow at Manomet, Common Yellowthroat and White-throated Sparrow at VINS) showed the same significant trend in the same season over both 12 and 7 years. Two species (American Redstart and Canada Warbler) at Manomet showed significant declines during both periods, but in different seasons. No species showed opposite significant trends at Manomet and VINS during 1986–1992.

Comparison of Banding Data with BBS Data

For neither site did trends correlate well with BBS trends from Quebec. Trends for all species from Manomet were significantly correlated with those from the Northern Spruce-Hardwood region when Black-capped Chickadee (an irruptive species) was excluded ($r = 0.424$, $N = 20$, $P < 0.05$) but not otherwise ($r = 0.312$, $N = 21$, $P > 0.05$; Fig. 2). The relationship between Manomet trends and BBS trends from Northern New England was weaker ($r = 0.112$, $P > 0.10$ for all species; and $r = 0.205$, $P > 0.10$ excluding Black-capped Chickadee).

TABLE 2. MEAN AGE RATIOS OF 21 SPECIES WITH ADEQUATE SAMPLE SIZES FROM FALL CAPTURES AT MANOMET (1969–1992) AND VINS (1981–1992)

	Mean age ratio (percent)			
	Manomet		VINS	
Species	After hatch year	Hatch year	After hatch year	Hatch year
Eastern Phoebe	10.99	89.01	7.43	92.57
Black-capped Chickadee	6.41	93.59	5.65	94.35
Ruby-crowned Kinglet	19.00	81.00	7.64	92.36
Veery	16.10	83.90	23.53	76.47
Swainson's Thrush *	5.57	94.43	36.47	63.53
Hermit Thrush	9.18	90.82	6.76	93.24
American Robin	4.86	95.14	9.51	90.49
Gray Catbird *	2.49	97.51	8.23	91.77
Red-eyed Vireo *	1.85	98.15	16.55	83.45
Nashville Warbler *	3.07	96.93	21.34	78.66
Magnolia Warbler *	5.08	94.92	33.57	66.43
Yellow-rumped Warbler	9.43	90.57	11.58	88.42
American Redstart *	2.86	97.14	18.32	81.68
Ovenbird *	2.69	97.31	17.49	82.51
Common Yellowthroat *	6.00	93.00	17.97	82.03
Canada Warbler *	3.18	96.82	21.45	78.55
Song Sparrow *	4.28	95.72	13.38	86.62
Swamp Sparrow *	1.87	98.13	28.50	71.50
White-throated Sparrow *	3.21	96.79	29.66	70.34
Dark-eyed Junco *	6.60	93.40	40.15	59.85
Purple Finch *	10.08	89.92	30.80	69.20

* denotes species with significantly different age ratios between sites (t-test, $P < 0.05$).

Similarly, trends from VINS were significantly correlated with those from Northern New England when White-throated Sparrow was excluded ($r = 0.425$, $P < 0.05$, $n = 18$), but not overall ($r = 0.291$, $N = 19$, $P > 0.10$; Fig. 3). Correlation with BBS from the Northern Spruce-Hardwood region was less strong ($r = 0.083$, $P > 0.10$).

Four specific examples, using fall data only from 1981–1992, illustrate the range of comparisons in population trends between the two sites and their congruence to regional BBS data:

Common Yellowthroat.—This species showed a highly significant decline in capture rate at both Manomet ($r^2 = 0.410$, $P = 0.025$) and VINS ($r^2 = 0.851$, $P < 0.001$; Fig. 4A). Both sites tracked a steady decline that was reflected in BBS data from both physiographic strata 27 and 28 (Table 1). However, the trend at VINS was so steep (24%/year) as to be biologically unrealistic.

Nashville Warbler.—Although population indices showed more variance over time for this species than for Common Yellowthroat, significant declines occurred at both Manomet ($r^2 = 0.341$, $P = 0.046$) and VINS ($r^2 = 0.515$, $P = 0.009$; Fig. 4B). These were also reflected in regional BBS data, as both strata 27 and 28 showed significant declines (Table 1).

Veery.—This species significantly increased at VINS ($r^2 = 0.450$, $P = 0.017$) and significantly decreased at Manomet ($r^2 = 0.323$, $P = 0.054$) during the study period (Fig. 4C). The population increase at VINS was due primarily to a pulse of migrants between 1989–1992. Regional BBS data indicated significant and nonsignificant declines in both strata. Veerys breed in the vicinity of the VINS banding station, and the increase at VINS may have reflected an increase in local breeding populations that masked a more widespread decline.

Red-eyed Vireo.—This species showed a significant decline at Manomet ($r^2 = 0.482$, $P = 0.012$), and a nonsignificant positive trend at VINS ($r^2 = 0.287$, $P = 0.073$; Fig. 4D). BBS data from the Northern Spruce-Hardwood region showed a significant increase in Red-eyed Vireos, whereas Northern New England BBS data showed a significant decline.

COMPARISON OF AGE RATIOS

Of the 21 fall migrant species for which we examined age ratios at the two sites, VINS captured a higher ratio of AHY (after hatching year) to HY (hatching year) birds for 17 (81%), whereas Manomet's ratio of AHY birds was higher for only

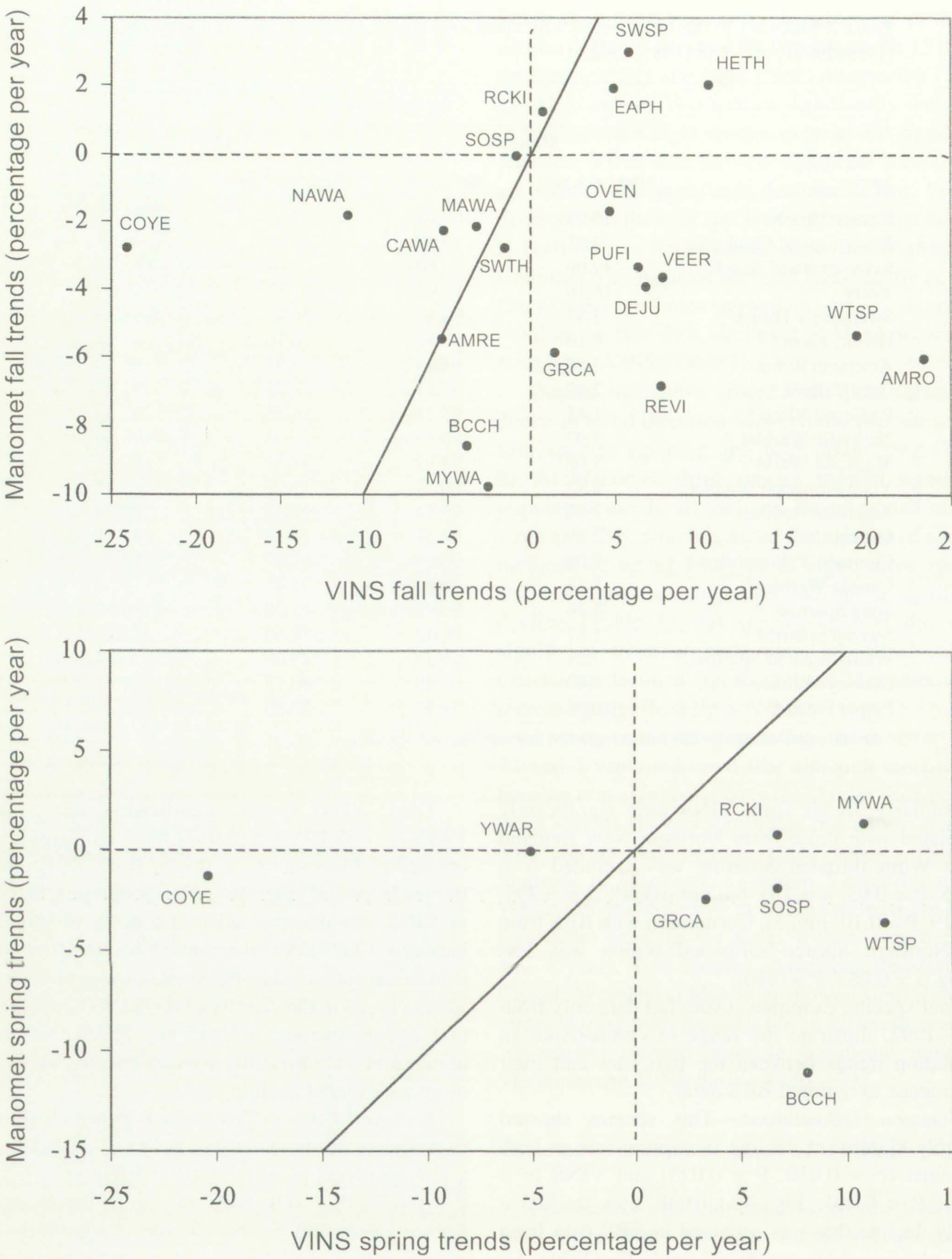

FIGURE 1. Rates of change (%/year) in fall (top) and spring (bottom) migration count indices at Manomet and VINS, 1981–1992. Solid line indicates one-to-one correspondence. See Table 1 for species codes.

four species (19%; Table 3). Fourteen of the 21 age ratio differences were significant ($P < 0.05$, t-test).

To assess the degree to which Manomet and VINS tracked changes in age ratios, we examined correlations among species over the 12-year period. We found no significant correlations; thus there appeared to be little year-to-year synchrony in age ratios at the two sites.

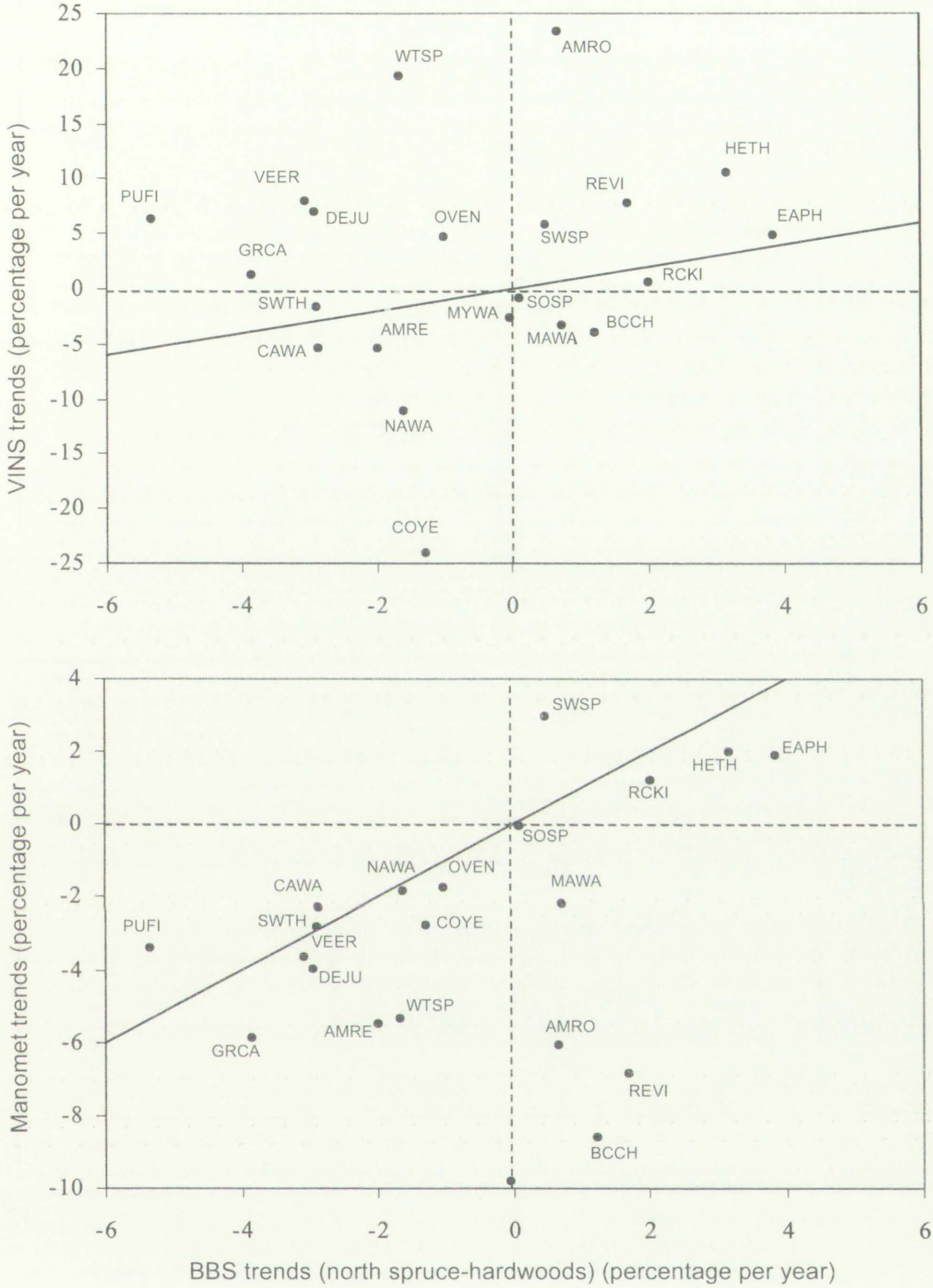

FIGURE 2. Rates of change (%/year) in fall migration capture indices at VINS (top) and Manomet (bottom) and BBS trends for Northern Spruce-Hardwoods physiographic stratum, 1981–1992. Solid line indicates one-to-one correspondence. See Table 1 for species codes.

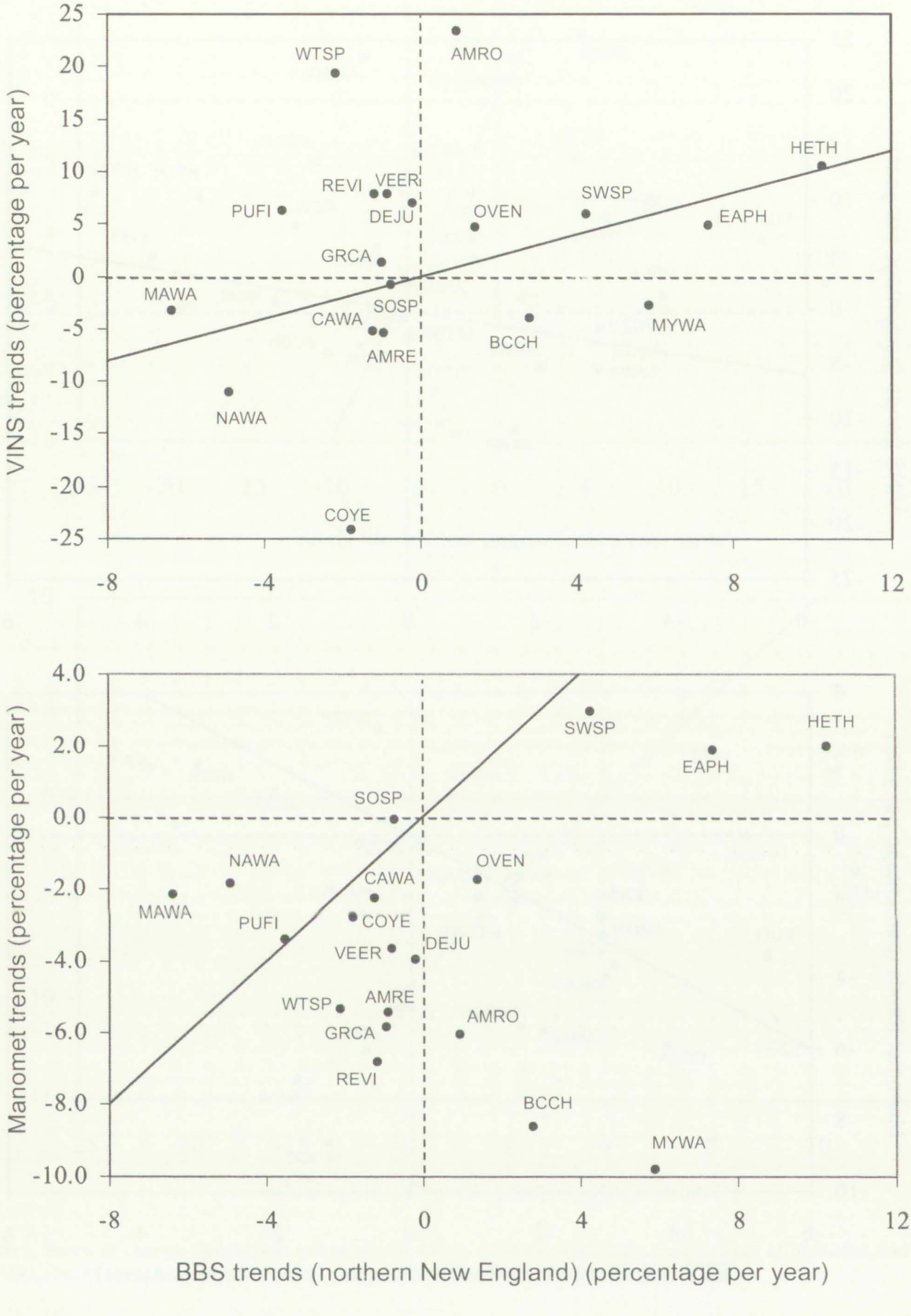

FIGURE 3. Rates of change (%/year) in fall migration capture indices at VINS (top) and Manomet (bottom) and BBS trends for Northern New England physiographic stratum, 1981–1992. Solid line indicates one-to-one correspondence. See Table 1 for species codes.

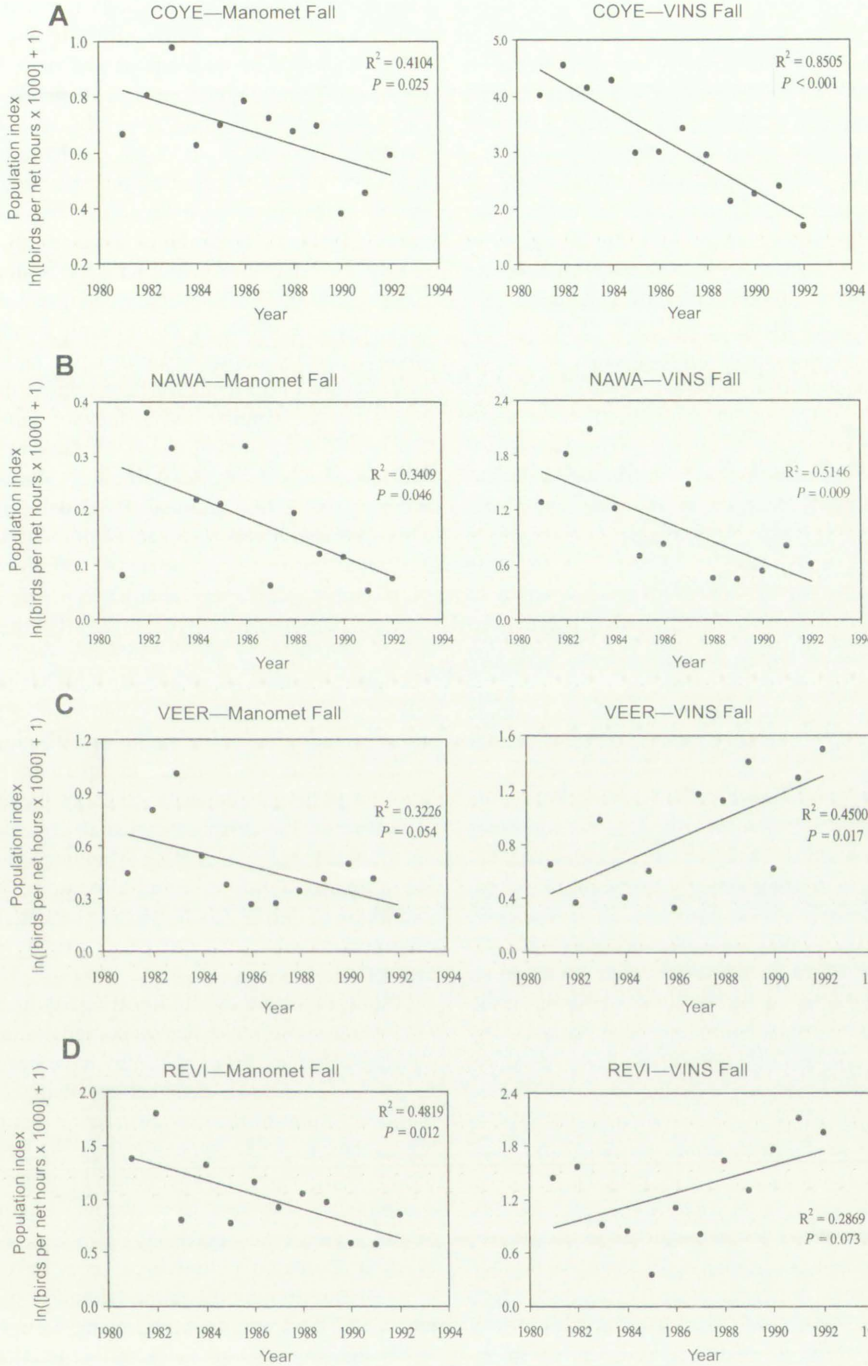

FIGURE 4. Linear regression of annual population indices from fall migration capture data for: (A) Common Yellowthroat; (B) Nashville Warbler; (C) Veery; and (D) Red-eyed Vireo during 1981–1992 at VINS and Manomet.

DISCUSSION

For three species, fall trends at VINS were biologically unrealistic (23.4% annual increase in American Robin, 24% annual decrease in Common Yellowthroat, and 19.4% annual increase in White-throated Sparrow). Even excluding these outliers, however, there was generally poor correlation between population trends calculated from Manomet and VINS migration capture data. Possible reasons include the following: (1) 7 or 12 years may be too short a period for detection of trends; (2) sample sizes at VINS, particularly during the 1981–1985 period, may have been inadequate for many species; (3) inconsistent standardization of methods at VINS during the study period may have obscured actual trends and reduced comparability of the two data sets; (4) changes in local breeding populations may have unduly biased VINS' data; (5) local or landscape-level habitat change may have biased population indices at either or both study sites, by differentially affecting the composition or abundance of species captured through time; and (6) different source populations may have been sampled by each station, such that population differences were real.

We suspect that the combination of small sample sizes (Table 1) and relative inconsistency of operating standards at VINS may have affected validity of many of the trend comparisons between VINS and Manomet. The minimum sample sizes we arbitrarily selected for analysis may have been too small, despite resulting in a number of significant trends for species captured in low numbers. For example, among species for which we obtained only 100–250 fall captures during 1981–1992, three of eight at Manomet and three of seven at VINS showed statistically significant population changes (Table 1). We can not be confident that trends based on such small samples are biologically meaningful. Inconsistent standardization of the VINS station, especially in 1981–1985 when fewer numbers of nets were used for shorter and more variable periods on fewer days each week than in 1986–1992, undoubtedly increased variance of the capture data in those early years. This unequal variance may in part explain the poor congruence of Manomet and VINS data. More rigorously standardized data collection at VINS would likely have resulted in more directly comparable data sets.

We suspect that the proportion of locally breeding and dispersing birds in the overall VINS sample was substantially higher than at Manomet. Among the VINS sample of 22 species, only six can be classified as true transients (regularly breeding >25 km from banding site), whereas 11 species captured at Manomet were wholly transient, or very nearly so (Table 1). Fluctuations in local breeding populations of migrants at and near VINS, as well as differing annual rates of dispersal onto and away from the site, may have obscured trends of transient populations at VINS, particularly in fall. However, of the six species that we judged to be strictly transient at both Manomet and VINS, five showed the same direction of trend in fall, whereas one species (Ruby-crowned Kinglet) with adequate capture data showed the same trend direction at both sites in spring (Table 1). Only Purple Finch showed opposite trends among fall transients, and this species is more of an irruptive than regular migrant at both sites (C. Rimmer and S. Faccio, unpubl. data; T. Lloyd-Evans, unpubl. data). Of the five transient species with similar fall trends at Manomet and VINS, 1982–1991 regional BBS data showed a corresponding trend for each (Table 1). This suggests that the two sites corresponded more closely in tracking population changes of fall transient species than of species with local breeding populations. Although we believe that the great majority of captures among all species at both Manomet and VINS were of migrant individuals rather than dispersing local breeders or fledglings, because of our migration window criteria, comparisons between sites could be strengthened if locally breeding species were excluded from trend analyses. Among the six transient species at both Manomet and VINS, the correspondence in trend directions (with the exception of Purple Finch) was not reflected in trend magnitudes, which correlated poorly ($r = -0.371$, $P > 0.10$).

Whereas the VINS site experienced greater vegetation succession than the Manomet site during the 12 years of study, Manomet may have been subject to greater landscape level habitat change, through increased suburbanization of coastal southeastern Massachusetts. Either type of change may have influenced the diversity and abundance of migrants using the two sites. The very large declines of some early to mid-successional species at VINS (e.g., Nashville Warbler, Common Yellowthroat) may have resulted in part from decreased habitat suitability of the maturing old field communities in the vicinity of the VINS banding station. Increased vegetation height around nets may also have reduced capture rates. At Manomet, increasing isolation of the 7-ha site as a habitat "fragment" in a predominantly suburban coastal landscape may have variably altered its use by stopover migrants over time. Local changes in vegetation at Manomet, while less pronounced than those at VINS, may also have contributed to changes in migrant bird populations using the site. Because no quantitative habitat assessment was conducted at either site, we were unable to evaluate the extent of such changes. We believe that regular, standardized measurements of habitat features on both local and landscape levels are needed to evaluate the context of changes in migrant bird populations within and between sites.

Trends from each of the two stations were most congruent with regional BBS data from different strata. Although the presumed southeasterly direction of many fall migrants in the northeastern United States (e.g., Ralph 1978) might well have carried some Vermont birds to coastal Massachusetts, this can not be assumed. BBS data suggest that Manomet migrants may have originated largely in northeastern areas of New England and maritime Canada, whereas VINS's migrant sample may have been composed largely of birds from northwestern New England, southern Quebec and southeastern Ontario. These results suggest that each station may have tracked largely independent population changes, as suggested by Hagan et al. (1992) in their comparison of data from Manomet and a station at Powdermill, Pennsylvania. Without knowledge of the source populations being sampled, and of possible annual variation in the geographic composition of migrant captures, population trends at different sites must be compared cautiously. We believe that careful, species-specific analyses of BBS data from appropriate physiographic strata or specific geographic regions may be a good means of inferring the extent to which different banding stations sample similar source populations.

Population Trends

The preponderance of declining species at Manomet and of increasing species at VINS is difficult to explain, even in light of potential within- and between-site biases. The possibility that one or both sites failed to track population changes accurately can not be discounted. However, Hagan et al. (1992) demonstrated that Manomet migration capture data collected over a 19-year period accurately measured known population changes in several species in northeastern North America. The VINS data are less clear in this regard. Although several species (e.g., Nashville Warbler, Common Yellowthroat) showed corresponding trend directions at both sites and in regional BBS data, others (e.g., Veery, White-throated Sparrow, Dark-eyed Junco) showed poor congruence between Manomet and VINS. That Manomet trend data more closely matched those of the BBS stratum directly to its north than did VINS, which correlated with BBS data within its own stratum, leads us to believe that Manomet more accurately measured actual population changes among migrants. Although a more detailed, species-by-species analysis of the two migration capture data sets and data from appropriate BBS strata might have enabled us to more fully evaluate this, such an analysis was beyond the scope of this paper.

Productivity Indices

The significantly higher proportion of HY birds at Manomet and of AHY birds at VINS conforms to the coastal–inland ratio typical of most autumn passerine migrants (e.g., Drury and Keith 1962; Ralph 1971, 1978, 1981). The "coastal effect" results from most adults following overland routes in fall while immatures travel both inland and on the coast, or from differential behavior of the age classes upon reaching coastlines (Dunn and Nol 1980). Manomet migration capture data, which consisted largely of HY birds, may have been more strongly influenced, and thus potentially biased, by weather-related phenomena affecting their abundance and behavior at the coast (see Dunn et al. *this volume b* and Hussell *this volume* for evidence that weather affects age ratios). Further, age ratios at Manomet and VINS may have differed in part due to sampling different source populations, as discussed above. Finally, different trends in age ratios at the two sites may have masked agreement in the annual directions of change (Dunn et al. *this volume b*).

CONCLUSION

We recognize that our comparison of these two data sets is an imperfect one. We believe, however, that it reflects the realities of comparing migration capture data from geographically distant sites subject to different sources of variability. We further believe that migration capture data collected under standardized conditions (Ralph et al. *this volume a*) can provide a valid means of assessing avian population trends, and we encourage more comparisons of data among migration banding stations. Careful analyses of migration capture data from a network of long-term banding stations might yield valuable information on regional population trends and demographics of migrant birds. Comparisons among multiple sites could provide needed independent tests of results obtained from breeding season studies.

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