THE CONSTANCY AND DISTINCTNESS OF URBAN BIRD COMMUNITIES

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ABSTRACT

Temporal constancy and local distinctness are documented in 13 bird communities around Chicago. The bird community that was counted monthly followed a repeatable annual cycle. Annual variation among areas in the same year was greater than variation within areas between years. Disturbed urban areas were more constant between years and varied less among sites than forested areas.

INTRODUCTION

Community ecologists often assume that a community is at equilibrium in order to develop theories about competition, coexistence, and diversity. Tests of the equilibrium hypothesis require the discovery of regular patterns in the composition of communities. Annual repeatable cycles (temporal constancy) and repeatable differences between study areas (local distinctness) are two regular patterns that may support the equilibrium hypothesis.

The presence of regular patterns is not sufficient to demonstrate equilibria in urban bird communities. Communities in variable environments may never reach the equilibrium state (Connell, 1978). Temporal and local variation in the environment may lead to a steady state at levels below the equilibrial sizes determined by resources (Wiens, 1977). For example, the coexistence of plankton (Hutchinson, 1961) in a lake environment demonstrates nonequilibrial coexistence. In a like manner urban bird communites are open systems without clearly defined limits between communites. Birds may fly across habitat boundaries, or migrate to other areas. The seasonality of breeding and nonbreeding periods further complicates the study of temperate-zone birds (Fretwell, 1972).

Temporal constancy and local distinctness may distinguish urban bird communities in spite of the variable environment. This study tests (1) the constancy of community composition between years in a study area, and (2) differences in community composition between local sites, such that the assemblages of birds at two different sites may be regarded as distinct communities.

STUDY AREAS AND METHODS

Thirteen study areas were selected to cover a range of habitats from intense urban to forested suburb and forest, and from grassy cemetery with few trees to developed suburbs with few trees. Study areas are listed in Table 1, and detailed locations are listed in Guth (1980). Densities of large trees taller than 7 m were computed to give an indication of habitat type (Table 1). Each sampled area included more than 16 ha.

Birds were sampled by the segment method (Geis, 1974). Bird counts usually began within 30 minutes of sunrise. A sample coverage of all segments included four-minute counts of all birds seen or heard using each segment. I sampled 10 to 24 segments (91.4 m x 91.4 m) within each study

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area. The Evanston study area was sampled almost monthly over a 24-month period. Other areas were sampled during June of at least two consecutive years between 1974 and 1977. Bird densities per segment were computed for each month and study area, and 95% confidence intervals were computed using the standard error between segments.

Communities were compared using an index of bird species difference adapted from MacArthur (1972, p. 189):

$$\text{Bird species difference} = \frac{2}{1 + \dfrac{2 \Sigma p_i q_i}{\Sigma p_i^2 + \Sigma q_i^2}} - 1$$

where p_i and q_i are the relative abundances of the ith bird species in the study areas considered. This index is 0.0 for identical communities, and 1.0 for communities with no species in common. The most abundant species are given the greatest weight in this index. Bird species difference was compared between months in Evanston, and between years and areas in June for all study areas. A cluster analysis was used to ordinate bird species difference between areas. In the cluster analysis each study area was grouped with the area or cluster containing the area that had the least bird species difference from the study area. The N_2 index (Hill, 1973), where $D = 1/\Sigma p_i^2$, was used to describe species diversity. Linear correlation was used to analyze bird density and diversity, and nonparametric statistics were used to analyze bird species difference.

RESULTS

The Evanston bird community followed a regular annual cycle. The number of Evanston species was 4 to 7 each winter, and 6 to 9 in June. A surge of migrants appeared each April and May (up to 25 species seen), and each September and October (up to 15 species seen). Bird densities per segment for the monthly Evanston counts are listed in Guth (1980). Bird species diversity D in Evanston was correlated with bird species diversity twelve months earlier ($r = .63$, $p < .01$), but was not significantly correlated with bird species diversity found one month earlier ($r = .19$, $p > .40$). The median value of bird species difference for Evanston bird counts within the same month was .0048. The median difference for counts twelve months apart was .0043 (8 of 16 larger than within months, sign test, $p > .40$), but for counts one month apart, the median was .0093 (16 of 21 larger than within months, $p < .02$). Total density was less strongly correlated with densities one month earlier ($r = .43$, $p < .05$) and one year earlier ($r = .06$).

Annual variation within areas was lower than variation among areas for all study sites (Table 1, Figure 1). Between-areas June bird species difference exceeded the within-areas difference in 153 of 156 cases (sign test, $p < .01$). There was significant repeatability to the June bird count results in most areas (Guth, 1980). The largest bird species differences within areas (Busse Forest edge and Busse Forest mixed) may reflect the small number of birds observed in these two areas.

Residential areas were less variable in June than forest areas (Figure 1). Bird species difference within residential areas was less than .06 and was significantly smaller than difference within forest areas (Wilcoxon's two-sample test, $T = 10$, d.f. $= 7, 4$; $p < .01$). Four inner-city residential areas (North Central Chicago, Evanston, Skokie, and Wilmette) formed a very similar group of bird communities with little difference. Bird species difference between the four inner-city areas was less than .11 and was significantly smaller than difference between forest areas ($T = 21$, $p < .01$) or between inner-city and forest areas ($T = 21$, $p < .01$).

TABLE 1. Tree density and bird species difference within 13 study areas between years for June censuses.

Study areas	Number of years	Tree density per segment	Bird species difference within areas
Residential areas:			
Chicago Loop	2	0	.003
North Central Chicago	4	18.3	.008
South Evanston	4	28.8	.010
Skokie	4	24.8	.024
Wilmette	4	42.3	.043
Addison	3	12.2	.059
Lake Forest	4	53.4	.026
Cemeteries:			
Calvary Cemetery	3	7.0	.021
Rosehill Cemetery	2	29.7	.060
Forests:			
Busse Forest edge	3	164	.218
Harms Woods	2	87.8	.074
Busse Forest	3	235	.062
Busse Forest mixed	3	81.8	.346

DISCUSSION

Although urban communities represent an advanced state of human disturbance, simplification, and utilization (Curtis, 1956), there is remarkable constancy of community composition between years in these urban sites. Human disturbance of forests and grasslands has created unprecedented constancy in vegetation (Detwyler, 1971, p. 507). The bird species difference within sites between years suggests a similar several-fold increase in community constancy of urban sites compared to forest.

Regular sustained disturbance may contribute to very constant local communities. Human disturbances of the urban ecosystem are frequent and extensive (Falk, 1976). Studies of extensive forests now suggest that high diversity may be maintained by repeated disturbance (intermediate disturbance hypothesis of Connell, 1978). Turnover between years in small forest woodlots is well documented (Whitcomb *et at.,* 1976). If "stable" forest systems have internal fluctuation, urban systems may represent more constant local communities than forest systems. Although urban bird densities may greatly fluctuate, relative abundances of birds are constant between years and vary between neighborhoods (Guth, 1979).

Variation among forest sites is higher than among disturbed sites. Bird species difference among the four forest study areas is higher than among the four inner-city urban areas above, or between the two cemeteries (Figure 1). In tropical and temperate forests, beta diversity is high, and local forests vary greatly in community composition. Although total variation between disturbed sites is reduced, different sites are significantly different, because local constancy of disturbed sites is greater than that of forests. Reduced variation among disturbed sites may contribute to local constancy in these sites.

The dynamic stability of these urban systems is unresolved in spite of the observation of constancy. Extensive invasions of exotic birds in some metropolitan areas (Bull, 1973; Hardy, 1973; Owre, 1973) point to the invasibility of urban faunas. Whether competitive equilibria account for the predictable responses to environments requires additional investigation.

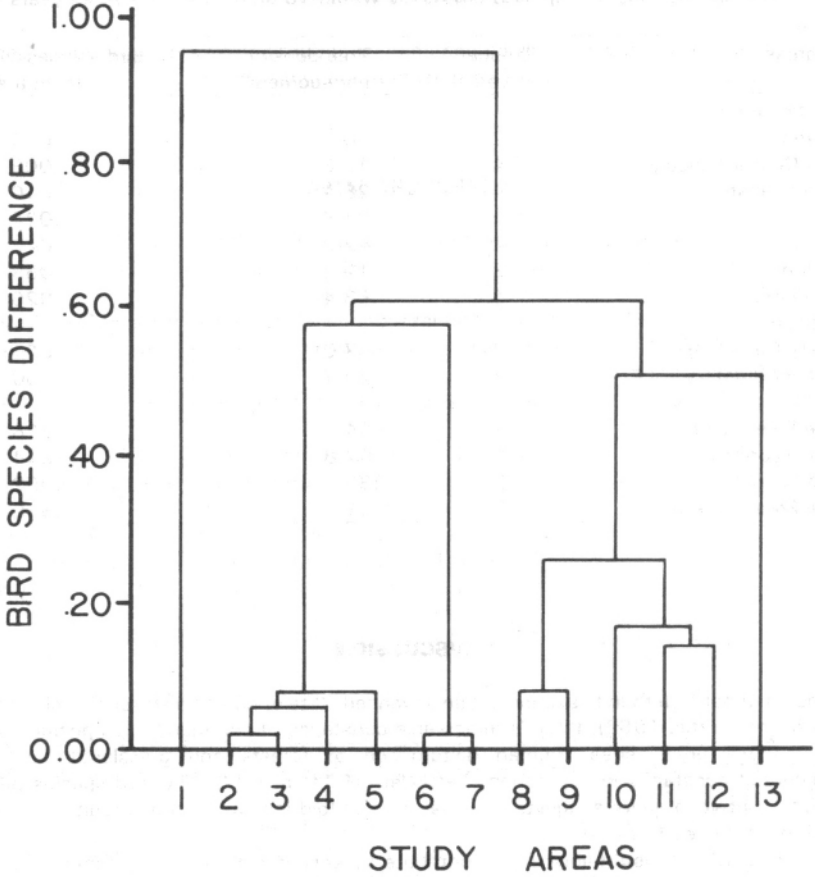

FIGURE 1. Cluster analysis of bird species differences between study areas. The closest areas or groups of areas are joined such that community distinctness is illustrated. The study areas are (1) Chicago Loop, (2) North Central Chicago, (3) South Evanston, (4) Skokie, (5) Wilmette, (6) Calvary Cemetery, (7) Rosehill Cemetery, (8) Addison, (9) Lake Forest, (10) Harms Woods, (11) Busse Forest edge. (12) Busse Forest mature, and (13) Busse Forest mixed. Note the closeness of urban areas 2 to 5 compared to forest areas 10 to 13.

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