NEW RESEARCH

CHANGES IN THE SUGARCREEK METROPARK BIRD COMMUNITY BETWEEN 1978 AND 2010

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ABSTRACT

Baseline bird surveys provide an anchor for contemporary observations. The rate and magnitude of changes observed are more accurately judged as our temporal perspective broadens. Here we conduct an avifauna survey of Sugarcreek Metropark in 2010, matching an identical survey conducted in 1978. We examined changes in avifauna species richness and composition and compared local changes to statewide trends. Species richness declined 19%. This decline was most pronounced for migratory species, which declined 28%. Only three species ranked among the ten most abundant species in both time periods. These results demonstrate a major turnover in the avian community. Local trends for individual species mostly mirrored statewide trends. Historic surveys provide a useful baseline for contemporary observations, and re-surveys allow us to develop a more complete understanding of how our avifauna is changing.

INTRODUCTION

Since 1966, the North American Breeding Bird Survey (BBS) has generated a wealth of data highlighting both continental and regional bird population trends, which in turn stimulated research into the consequences and mechanisms of habitat fragmentation (Robbins et al. 1989; Askins 1993). However, the utility of BBS data is limited for natural areas managers, because the spatial resolution of the BBS is too coarse (Hutto and Young 2002). Park-specific bird surveys are of more use to managers, but budget constraints often prevent continuous monitoring efforts. In addition, the absence of historical baseline surveys pose a challenge, because the more restricted our temporal perspective, the more likely we are to misjudge the rate and magnitude of change (Magnuson 1990). Historic baselines provide an anchor for contemporary observations.

Several researchers have repeated historical surveys to evaluate local avifauna changes through time (Ambuel and Temple 1982; Hall 1984; Horn 1985; Wilcove 1988). Because repeating historical surveys cover only two (or sometimes more) points in time, researchers cannot always disentangle short-term variability from meaningful change. However, repeating historical surveys remains a valid way to assess change at a particular locale between two points in time, and it can be a useful supplemental source of data for regional or national monitoring efforts conducted at coarser spatial scales.

In this study, we repeat an historical survey to examine changes in the bird community at Sugarcreek Metropark between 1978 and 2010. Part of the Five Rivers Metropark system, Sugarcreek Metropark (39.62º N, -84.10ºW) is located in Greene County in southwestern Ohio, 24 km SE of Dayton. The Five Rivers GIS system indicates that vegetation in the 237 hectare (585 acre) park consists mostly of broadleaf deciduous forest (89%) and grassland (6%) with lesser amounts of controlled succession, conifer forest, and developed areas (Hays 2011). One major change in vegetation occurred between the sampling periods. In the late 1970s, Amur honeysuckle (Lonicera maackii) established and spread throughout the park, forming a dense shrub layer. Field surveys conducted by park staff reveal that over half of the forest contains > 40% coverage by Amur honeysuckle (Hays 2011).

This study had three objectives: 1) Identify changes in the richness and abundance of resident and migrant species at Sugarcreek, 2) Identify changes in the abundance of the ten most common species during each time period, and 3) Compare changes at Sugarcreek Metropark to statewide trends during the same time period. Our goal was to provide a picture of how the bird community at Sugarcreek changed between 1978 and 2010.

METHODS

In 1978, Noss (1981) surveyed the birds of

Sugarcreek to determine species richness, composition, and relative abundance during the breeding and postbreeding season. From 31 May to 9 August, Noss conducted 33 breeding bird surveys, beginning a half hour before sunrise and continuing for three hours. Surveys were conducted during mornings of fair weather conditions. Using both an auditory and visual fixed-strip technique with a 40-m width (Emlen 1971), Noss walked the existing trails, with frequent stops to look and listen for birds. The number and identity of all birds seen, heard, or flying over the strip was recorded. Different trail routes were walked on different days to provide a stratified sample each week. The identity and number of each species recorded is provided in Noss (1981).

We repeated this study in 2010, conducting 33 surveys from 31 May to 8 August. We consulted with Noss, making sure that we correctly replicated his methods and effort in our protocol. We tallied the identity and number of each species encountered in each survey.

We used rarefaction analysis to compare species richness between 1978 and 2010. Rarefaction is a desirable statistical approach when there is an unequal number of individuals present in different samples, because it provides an expected species richness for a sample consisting of fewer individuals (Gotelli and Colwell 2001). For 1978 and 2010, we generated a rarefaction curve using Analytic Rarefaction 2.0 (Hunt Mountain Software 2009). This software also allowed us to obtain 95% confidence intervals for each species richness estimate, following Heck et al. (1975). Therefore we could determine, for a given number of birds, whether species richness significantly differed between the 1978 and 2010 samples. We also partitioned data into resident and migratory species. Resident species are those that are present throughout the year. This category is broad, in that it includes species like Blue Jay that have both resident and migratory populations (Tarvin and Woolfenden 1999). These populations in summer and winter could be made up of different individuals, but we classify the species as resident. It also includes Carolina Wren, a species undergoing a range expansion (Haggerty and Morton 1995). It was absent in 1978, but a permanent resident by 2010. Migratory species are those that are not present throughout the year, and includes both short- and long-distance migrants. We computed separate rarefaction curves for resident and migratory species in both1978 and 2010. Species maintained the same designation during both sample periods.

To determine if there were any changes in the abundance of the most common birds between sampling periods, we determined the ten most abundant species in 1978, and the ten most common in 2010. Because three species were common to both periods, we analyzed data for 17 species. For each species, we tested the null hypothesis that the proportion of individuals present did not change between sampling periods. We tested this hypothesis using a 2 x 2 contingency table, and evaluated statistical significance using a chi-square test. To obtain expected frequencies, we computed the average relative abundance of a given species using the combined 1978 and 2010 survey data. We multiplied this value by the total number of individuals present in 1978 to obtain an expected abundance in 1978, and by the total number of individuals present in 2010 to obtain an expected abundance in 2010. Because we conducted 17 chi-square tests, we applied a Bonferroni correction for multiple comparisons to our P-values. As a result, we required a threshold of $P < 0.0029$ (0.05/17) for a result to be considered statistically significant.

To compare population trends of individual species at Sugarcreek to statewide trends in Ohio, we calculated annualized growth or decline ratesfor each species as:

$$S(x) = (\ln (Ix2010) / (Ix1978)) / 32)$$

where S(x) is the annualized change in species x, and Ix is the number of individuals for that species. These annualized percent changes were compared to the statewide data for Ohio (BBS 2011), using data from 1978 and 2010 to compute the same annualized change. We confined this anlysis to species with ten or more individuals observed for each year at Sugarcreek (n = 31). To determine if there was a significant relationship between local and statewide trends in growth or decline rates, we used a Spearman rank correlation.

RESULTS

The 1978 survey contained 7,609 individuals representing 77 bird species. In the 2010 survey we counted 6,443 individuals representing 63 species (Table 1). If species richness had not changed between 1978 and 2010, we should have observed 76.5 species even with the reduced number of individuals in our sample (Fig. 1). Instead, we recorded a 19% decline in species richness between 1978 and 2010.

Resident species comprised 64% of all individuals recorded in 1978, and 80% in 2010. Despite the total increase in resident individuals, rarefaction revealed an 8% decline in resident species richness between 1978 and 2010 (Fig. 1). Between 1978 and 2010, there was a decline in the relative proportion (36% to 20%) of individuals belonging to migratory species. The abundance of individuals belonging to migratory species recorded in 2010 was less than half (48%) of the number recorded in 1978. We recorded a 28% decline in migratory species richness between 1978 and 2010 (Fig. 1). Migrants detected in 1978 but absent in 2010 are listed in Table 1.

Of the ten most abundant species in either 1978 or 2010, six have increased at least two-fold since 1978: Northern Cardinal, American Crow, American Robin, Blue Jay, Tufted Titmouse, and Red-Bellied Woodpecker (Fig. 2a). In contrast, seven species declined by more than 50% since 1978: Common Grackle, Red-winged Blackbird, American Goldfinch, Blue-gray Gnatcatcher, European Starling, Field Sparrow, and Brown-headed Cowbird (Fig 2b). Indigo Bunting declined 33%. Three species showed no statistically significant changes in abundance: Carolina Chickadee, Acadian Flycatcher, and Eastern Towhee.

Temporal change in species abundance at Sugarcreek generally reflected changes in Ohio during the same period ($n = 31$; Spearman $r = 0.40$; $P = 0.03$). Although the magnitude of changes of particular species at Sugarcreek are greater than for the state as a whole, the local and state-wide data exhibit a positive rank correlation for species with ten or more individuals recorded in each time period.

DISCUSSION

When compared to 1978, the avifauna at Sugarcreek in 2010 consisted of fewer species and fewer individuals. These declines were largely concentrated in migratory species. The relative abundance of resident species increased during this time, although absolute abundances declined. There was considerable turnover in the most common species; only 3 of the ten most common species in 1978 were still among the ten most common in 2010. Changes in the abundance of particular species at Sugarcreek generally mirrored statewide trends, with a few exceptions. It may seem exceptional that a protected area would experience such drastic declines in species richness in just a few decades. However, such declines were predicted by Noss (1981). We encourage readers to carefully consider the caveats and qualifications when interpreting our results.

First, we recorded 15% fewer individuals than Noss (1981). Were there really fewer individuals present in 2010? It is possible that there was a real decline in the number of individual birds over the past 32 years. Other researchers have reported declines in total abundance of birds through time (Holmes and Sherry 1986, 2001; Askins and Philbrick 1987; Rittenhouse et al. 2010). Two possible mechanisms for bird declines include year-to-year weather variation and migration hazards. The winter of 1978 was among the coldest on record in southwestern Ohio, whereas 2010 had a warm and wet spring. It is possible that in 1978, there were still late spring migrants passing through Sugarcreek in late May and early June, which may have inflated the 1978 number of birds observed. However, only migratory birds that breed locally were observed in both surveys, suggesting that late migrants cannot account for this difference. The Deepwater Horizon oil spill in the Gulf of Mexico that occurred in spring 2010 may have reduced the numbers of successful trans-Gulf migrants (Table 1). Research to date has focused on oil spill impacts on shorebirds (Henkel et al. 2012), but passerines might also be affected. Trans-Gulf migrants were only a third as abundant in 2010 as they were in 1978 at Sugarcreek. However, this study is not designed to assess what fraction of these declines (if any) might be attributable to the Deepwater Horizon oil spill.

Alternatively, there may not have been a real decline in bird numbers. Environmental stochasticity (i.e., year-to-year variation in survival and reproduction) alone could account for an above average number of birds breeding in 1978, and/or a below average number of birds breeding in 2010. Likewise, differences between the birding skills of observers could also create an apparent decline in individuals when in fact no such decline exists (Preston 1979). While we were careful to replicate the protocols, timing, and intensity of the original survey, differences in skill level could account for differences in the number of birds recorded. In "snapshot" type studies from a single site like ours, even simple questions like "Have the number of individual birds declined?" is difficult to answer, as there are multiple factors that can influence standardized counts 32 years apart.

Despite differences in in the numbers of individuals present during both sampling periods, rarefaction analysis allows us to infer with confidence that there has been a real decline in species richness, particularly for migratory species. There have been many studies in recent decades that found sustained declines of migratory species in wooded habitats bordered by agricultural and residential land uses (Ambuel and Temple 1982; Brooks and Bonter 2010). Despite our failure to detect many migratory species in 2010 (Table 1), we make no claims that these species are extirpated from Sugarcreek. Our field surveys were not designed to exhaustively survey all species present at Sugarcreek, so some of these species (like Chimney Swift and Baltimore Oriole) may have in fact been present in the park but undetected. It seems probable that in some years these species will return in larger numbers some years to breed, so we are not confident that any of the species missing in 2010 reflect permanent extirpations.

There was considerable turnover in the identity of the most abundant species between 1978 and 2010. It is tempting to offer explanations for why some species increased and others declined over the interval. For example, the increase in Northern Cardinals and American Robins could be due to the local increase of Amur Honeysuckle over the past 32 years (McClusker et al. 2010; Gleditschand and Carlo 2011; Rodewald 2012), and the decline in Red-winged Blackbirds probably reflects in the disappearance of a damp depression that persisted for several years following the installation of a sewer line in 1972 (Noss 1981; Hays 2011). However, our study was designed only to identify shifts in species composition and abundance, not the underlying causes. However, future researchers will likely be able to evaluate how honeysuckle has shaped this bird community. Five Rivers Metroparks currently lists honeysuckle control as a high management priority at Sugarcreek, and this is likely to occur within the next few years. If honeysuckle is driving population changes for American Robin, Northern Cardinal, and other frugivores, we predict these species will decline following management intervention.

Shifts in the avifauna at Sugarcreek between 1978 and 2010 were positively correlated with shifts in Ohio. Of the thirty-one species analyzed, twenty-two exhibited the same trend abundance (either an increase or decrease) both at Sugarcreek and throughout Ohio between 1978 and 2010. Nine species did not follow this trend. Six species declined locally but increased statewide: Yellow-throated Warbler, Red-eyed Vireo, Mourning Dove, Indigo Bunting, House Wren, and Common Grackle. Acadian Flycatcher (thought to be adversely affected by Amur honeysuckle – Rodewald 2012), Eastern Wood-Pewee, and Tufted Titmouse increased at Sugarcreek, but declined statewide. Holmes and Sherry (2001) found similar patterns in population trends when they compared twenty-four forest bird species at Hubbard Brook Experimental Forest to Breeding Bird Survey data in New Hampshire. Most but not all species at Hubbard Brook mirrored statewide trends.

Are these 32-year changes in the Sugarcreek avifuana real, or a short-term deviation? While we do not have a compelling answer to this question, this question could not even be asked without the careful and well-documented research by Noss (1981). While Noss (1981) sought to describe the richness and composition of the Sugarcreek avifauna and interpret the results in the context of reserve design, we have re-purposed his data to describe the dynamic nature of richness and composition. Because historic baseline surveys provide a conceptual anchor for contemporary observations, we encourage ornithologists to locate existing baselines and conduct re-surveys whenever possible. Together, we can construct a more nearly complete picture of how bird life is changing in the state.

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Table 1. Mean number of individuals per species recorded per 3 hr survey (n = 33 surveys) during the breeding seasons of 1978 and 2010. Status indicates whether the species is a permanent resident (R) or migratory (M). Trans-Gulf migrants are denoted as M*.

SPECIES	1978	2010	STATUS
Canada Goose	0.0	0.5	R
Wood Duck	0.1	0.2	M
Mallard	0.6	0.6	R
Northern Bobwhite	0.3	0.0	R
Ring-necked Pheasant	0.6	0.0	R
Great Blue Heron	<0.1	0.1	R
Green Heron	0.5	0.0	M
Turkey Vulture	<0.1	1.7	M
Cooper's Hawk	0.0	0.1	R
Red-shouldered Hawk	0.0	0.1	R
Red-tailed Hawk	0.1	0.2	R
American Kestrel	0.3	0.0	R
Killdeer	0.3	0.0	R
Spotted Sandpiper	0.1	0.0	M
American Woodcock	0.1	0.0	M
Rock Pigeon	2.7	0.0	R
Mourning Dove	1.1	0.4	R
Yellow-billed Cuckoo	2.8	0.0	M*
Black-billed Cuckoo	0.8	0.0	M*
Great-horned Owl	<0.1	<0.1	R
Barred Owl	0.1	<0.1	R
Chimney Swift	3.9	0.0	M*
Ruby-throated Hummingbird	0.2	0.1	M*
Belted Kingfisher	0.9	0.2	R
Red-headed Woodpecker	0.2	0.0	R
Red-bellied Woodpecker	1.7	6.3	R
Downy Woodpecker	3.9	4.9	R
Hairy Woodpecker	0.1	0.2	R
Northern Flicker	3.0	1.9	R
Pileated Woodpecker	0.5	2.7	R
Easterb Wood-Pewee	3.1	5.2	M*
Acadian Flycatcher	7.6	8.9	M
Willow Flycatcher	1.9	0.0	M
Great Crested Flycatcher	0.8	0.3	M*
Eastern Kingbird	0.2	1.1	M*
White-eyed Vireo	1.7	0.0	M*
Yellow-throated Vireo	0.9	0.4	M*
Warbling Vireo	0.4	0.0	M*
Red-eyed Vireo	7.6	3.6	M*
Blue Jay	2.0	7.0	R
American Crow	5.2	15.1	R

SPECIES	1978	2010	STATUS
Purple Martin	0.5	0.0	M*
Tree Swallow	0.1	1.2	M
Northern Rough-winged Swallow	1.2	0.0	M
Barn Swallow	0.7	<0.1	M*
Carolina Chickadee	13.6	14.2	R
Tufted Titmouse	5.6	11.8	R
White-breasted Nuthatch	0.9	5.0	R
Carolina Wren	0.0	2.4	R
House Wren	3.4	0.3	M*
Blue-gray Gnatcatcher	11.7	4.0	M
Eastern Bluebird	0.0	0.2	R
Wood Thrush	1.1	2.2	M*
American Robin	8.0	17.6	R
Gray Catbird	1.2	0.3	M*
Northern Mockingbird	0.1	0.1	R
Brown Thrasher	2.1	<0.1	M
European Starling	10.6	0.5	R
Cedar Waxwing	0.5	0.0	R
Ovenbird	0.2	0.2	M*
Blue-winged Warbler	0.2	0.0	M*
Black-and-white Warbler	0.3	0.0	M*
Kentucky Warbler	1.1	0.1	M*
Common Yellowthroat	6.1	2.1	M*
Prairie Warbler	0.0	<0.1	M*
American Redstart	0.6	0.0	M*
Cerulean Warbler	3.7	0.1	M*
Northern Parula	0.0	0.7	M*
Yellow Warbler	1.2	0.1	M*
Yellow-throated Warbler	1.0	0.3	M*
Yellow-breasted Chat	3.4	0.0	M*
Eastern Towhee	7.0	6.6	R
Chipping Sparrow	0.0	<0.1	M
Field Sparrow	9.6	3.8	R
Song Sparrow	4.6	0.3	R
Scarlet Tanager	0.1	<0.1	M*
Northern Cardinal	13.6	48.9	R
Indigo Bunting	10.0	6.7	M
Red-winged Blackbird	13.1	0.3	R
Eastern Meadowlark	0.2	0.0	R
Common Grackle	16.1	1.2	R
Brown-headed Cowbird	8.6	0.8	R
Baltimore Oriole	0.2	0.0	M*
American Goldfinch	12.0	1.2	R
House Sparrow	0.6	0.2	R

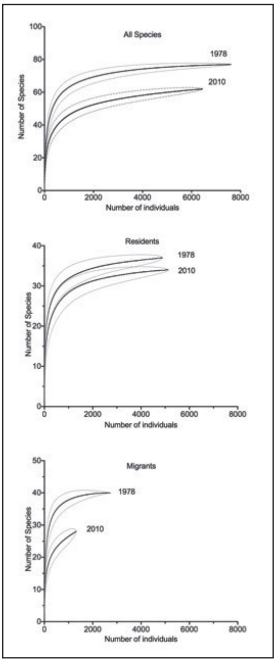

Fig. 1

Rarefaction curves and 95% confidence intervals in 1978 and 2019 for all species, residents only, and migrants only.

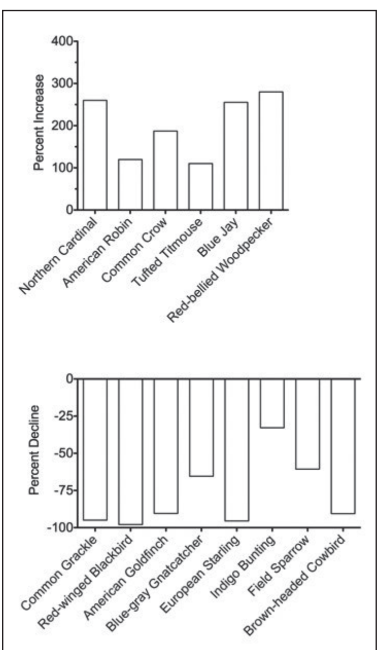

Fig. 2

Identity and percent change of ten most abundant species in 1978 and/or 2010. All species increasing at Sugarcreek also increased statewide, except American Crow (no change) and Tufted Titmouse (declined). All species decreasing at Sugarcreek also decreased statewide, except Common Grackle and Indigo Bunting (both increased).