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The influence of woodlot size and location in suburban and rural matrices on bird species richness and individual abundance

Neil Allen Chartier

THE INFLUENCE OF WOODLOT SIZE AND LOCATION IN SUBURBAN AND RURAL MATRICES ON BIRD SPECIES RICHNESS AND INDIVIDUAL ABUNDANCE

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Neil Allen Chartier

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Thesis Committee:

Peter Bednekoff, PhD, Chair

Gary Hannan, PhD

Cara Shillington, PhD

Michael Kielb, MS

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ABSTRACT

This study assessed the influence of woodlot area and matrix composition on bird species richness and individual abundance. Bird surveys were conducted in winter 2004 and 2005 and spring 2005. Woodlot area and landscape composition were analyzed using GIS software. In winter, resident species richness and abundance increased as landscape diversity increased, whereas in spring, resident species richness decreased with increased landscape openness and abundance increased as woodlot area increased. Spring migrant species richness increased with increased landscape openness, and abundance decreased as woodlot area increased. In winter, Tufted Titmice were more likely to be present in smaller woodlots, whereas in spring, they were somewhat more common in larger woodlots. Tufted Titmouse may exploit the habitat structure of smaller woodlots in fragmented landscapes to increase access to foraging habitat. Conservation strategies that reduce fragmentation and promote greater habitat diversity may lead to greater bird species diversity and abundance.

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Introduction

In southeast Michigan today, human development has produced a landscape with a variety of disturbed and fragmented habitats that differ in composition and configuration (Yaukey 1996). For example, parks and residential areas may leave portions of the original vegetative cover intact or allow vegetation reestablishment after it has been altered, whereas commercial and industrial areas and their associated roads, buildings, and parking lots leave very little of the original vegetation (Yaukey 1996). The altered spatial structure of the remaining habitat patches (Fahrig and Merriam 1994) affects arthropods (Burke and Nol 1998, Haddad and Baum 1999), microclimate (Blake 1987), and vegetation in neighboring forest areas (Chen et al. 1992).

Fragmentation has raised concerns about the viability of and changes in bird populations (Dunning et al. 1992, Andren 1994, Bender et al. 1998). Previous studies have reported positive associations of fragment size, total forest cover, or other metrics related to habitat areas, with bird species richness (Boulinier et al. 2001), abundance (Lee et al. 2002), or temporal stability in populations and communities (Hames et al. 2001).

Most of this research has focused on the breeding season and on Neotropical migrants. Breeding season studies in agricultural landscapes have shown strong

landscape effects on forest birds (Andren 1994, Hinsley et al. 1995a, Lee et al. 2002), whereas breeding season studies in forest landscapes (Addicott et al. 1987, McIntyre and Hobbs 1999) have reported weak landscape effects (McGarigal and McComb 1995, Jansson and Angelstam 1999, Hagen and Meehan 2002, Lichstein et al. 2002, Crozier and Niemi 2003, Cushman and McGarigal 2003).

Resident species are found locally year round (Kielb et al. 1992), and few studies have specifically assessed the effects of deforestation on their richness or individual abundance (Hinsley et al. 1995a, 1995b, Bellamy et al. 1996a, 1996b), especially during the nonbreeding season (Blake 1987, Hamel et al. 1993, McIntyre 1995) despite its importance in the annual cycle of birds (Turcotte and Desrochers 2005).

Harsh weather during the winter may require many species to be less specific and more wide-ranging in their selection of habitat (Wachob 1996, Dolby and Grubb 1999, Pino et al. 2000, Yahner 2000). Severe weather (Dolby and Grubb 1999, Doherty and Grubb 2002) can increase edge effects in fragmented landscapes and further reduce available habitat (Laurance and Yensen 1991, Saunders et al. 1991, Dolby and Grubb 1999). As birds forage closer to exposed edges in fragmented landscapes (Blake 1987, Dolby and Grubb 1999), metabolic expenditures may increase (Wolf and Walsberg 1996) and winter survival may be reduced (Mayer et al. 1979).

Fragmented landscapes can also increase predation risks for birds and result in fewer foraging opportunities and lower body mass (Rogers 1987). From a bird's perspective, open areas created by forest fragmentation may act as landscape

barriers that isolate forest patches and result in reduced movement (Beier and Noss 1998, Belisle et al. 2001), disrupted habitat selection (Bernstein et al. 1991, Danielson 1992, Beauchampe et al. 1997), and reduced dispersal (With et al. 1997). Forest birds are generally reluctant to move into open areas because of greater predation risks (Lima and Dill 1990, Todd and Cowie 1990), reduced perceptual range for landscape element identification and detection (Lima and Zollner 1996), or the absence of proper habitats to exploit in the matrix.

The objective of this study was to determine how the interaction between spatial characteristics of fragmented patches (e.g., woodlots) and the surrounding heterogeneous landscape matrices in suburban and rural southeast Michigan influenced resident bird species richness and individual abundance in winter. A matrix is the landscape that surrounds the woodlot study site and is composed of different types of landcover (e.g., land that is developed, wooded, open, or covered by water). A suburban matrix can be characterized by moderate- to high-density, single- or double-storied, single-family housing, commonly with lawns and gardens, and interspersed with basic services, light industry, and multifamily housing (Marzluff et al. 2001). In southeast Michigan, a suburban matrix was expected to have more developed and/or open land than wooded land. A rural landscape matrix can be characterized as an agricultural landscape sparsely settled by individual homesteads, recreation developments, small towns, and villages (Marzluff et al. 2001). In southeast Michigan, a rural matrix was expected to have more open and/or wooded land than developed land. It was hypothesized that if landscape context and woodlot size influence resident species richness and individual

abundance in winter, greater resident species richness and individual abundance would be found in large woodlots located in wooded matrices.

Data collection for this study also provided an opportunity to compare the effectiveness of two fundamentally different survey methods for detecting birds in winter: (1) passive, silent point counts that use bird activity (e.g., sound and movement) for data collection and (2) playback point counts that broadcast a recording of Black-capped Chickadees (*Poecile atricapillus*) mobbing an Eastern Screech Owl (*Otus asio*) to stimulate bird activity allowing for data collection. In this experiment, the passive, silent point count was the control, the playback point count was the treatment, and bird detection was the dependent variable.

By November, most migrating forest birds have left the study area and do not return before March (Kielb et al. 1992). Surveying for resident birds in winter presents challenges, as birds generally use larger areas than in the breeding season and are also less vocal (Turcotte and Desrochers 2005). These factors result in decreased detection probabilities, which make passive, silent point counts less reliable during winter (Turcotte and Desrochers 2005).

Mobbing is a widespread behavior in birds (Hurd 1996, Gunn et al. 2000), used mostly when stationary predators are discovered (Belisle and Desrochers 2002). Mobbing calls by Black-capped Chickadees are known to communicate the presence of predators to conspecifics and heterospecifics that quickly aggregate around a mobbing bird (Turcotte and Desrochers 2002). The use of playbacks of Black-capped Chickadee mobbing calls allows for the targeting of the species whose vocalizations were broadcast on playbacks, as well as a large proportion of the other

species present in the community (Gunn et al. 2000). Although not in southeast Michigan, previous studies have found that the playback treatment, when compared to standard silent point counts, was more efficient (Kosinski et al. 2004) and detected more species and individuals (Turcotte and Desrochers 2002). It was predicted that in southeast Michigan, the playback point count method would be more effective at detecting birds in winter.

In order to conserve bird diversity, knowledge of bird-environment relationships during birds' annual cycles, not only of breeding habitats, but also of wintering habitats, is needed (Sherry and Holmes 1996, Rappole et al. 2003). By examining the responses of resident bird species to fragmented landscape matrices in winter, the impact of fragmentation on resident populations during the non-breeding season can be factored into the annual cycle (Lima and Zollner 1996, Debinski and Holt 2000). In this context, rural and suburban landscape matrices in southeast Michigan provide an appropriate field of study, and the information gained may help identify types of woodlots for high conservation priority.

Methods

Study sites

Forty-five woodlot study sites on public and private land within both suburban and rural matrices in Ingham, Washtenaw, and Wayne Counties in Michigan were located by consulting local bird watchers and township, city, and county officials (see Appendix A for locations). Woodlot areas ranged from 0.9 to 325.2 ha (see Appendix B for areas of woodlots). The mean area of the woodlot study sites was 38.5 ha, and the median was 19.8 ha. Thirty-nine of the woodlots were under 52 ha in area, whereas six woodlots were larger. The habitat of the study sites was primarily oak (*Quercus* spp.) and hickory (*Carya* spp.) forest.

Data collection

Surveys were conducted in winter 2004 (1 November through 15 December) and winter 2005-2006 (7 December 2005 through 1 January 2006, hereafter referred to as winter 2005).

Each woodlot was surveyed for 15 min on three separate visits (Kosinski et al. 2004) at least one week apart (see Appendix D for survey dates). Surveys took place at a single point at the center of the woodlot, using both silent point counts and playbacks of Black-capped Chickadees mobbing an Eastern Screech Owl. Black-capped Chickadees mobbing an Eastern Screech Owl were recorded by R. C. Stein and H. McIsaac, and the recording was acquired from the Macauley Library of Natural Sounds, Cornell Lab of Ornithology, Cornell University, Ithaca, NY. In Quebec, Canada, playback treatment results (species richness and individual

abundance) have been shown to be unaffected by time of day (Turcotte and Desrochers 2002). To our knowledge, the playback method has not been used in southeast Michigan, and in order to reduce any potential survey time-of-day bias, each woodlot was surveyed once during each of the following periods: (1) AM: sunrise at approximately 0800 EST-1040 EST, (2) mid-day: 1040 EST-1320 EST, and (3) PM: 1320 EST-1600 EST (see Appendix D for time period of each survey).

Before beginning the survey, observer disturbance was reduced by allocating approximately 2 min of quiet time. Surveys were based on Turcotte and Desrochers' (2002) protocol. A 5-min, passive, silent point count was used as a control, and all new birds heard or seen within 50 m of the survey point were recorded every 30 s. High-flying birds that passed over the woodlot but did not land or forage within its perimeter were not recorded (Porter et al. 2005). Total species and individuals were summed after the 5-min control point count interval (see Appendix D for Control 1 results at each woodlot).

This passive, silent point count was immediately followed by a 5-min mobbing call broadcast during which the count began anew and all new birds heard or seen within 50 m of the survey point were recorded every 30 s. During the 5-min playback interval, mobbing calls were broadcast for 5 min on two 2.5-w speakers attached to a portable compact disc player placed approximately one m above the ground and played at a volume similar to that produced by live birds. Total species and individuals were summed after the 5-min playback interval (see Appendix D for Playback results at each woodlot).

In addition, the protocol of Turcotte and Desrochers (2002) was modified to account for any birds arriving in response to but after the conclusion of the playback. Immediately following the playback interval, another 5-min control point count began during which any new birds heard or seen within 50 m of the survey point were recorded every 30 s. Total species and individuals were summed after the second 5-min control point count interval (see Appendix D for Control Point Count 2 results at each woodlot).

At each study site, the total number of species detected for each survey (e.g., the three survey intervals combined) was calculated by summing all the species detected during the three survey intervals (see Appendix D for survey species totals). At each study site, the total number of individuals for each survey (e.g., the three survey intervals combined) was calculated by using the greatest number of individuals of each species detected during any 30-s count so as not to count any individuals more than once (see Appendix D for survey individual totals)

Data analysis

Landscape matrix heterogeneity was analyzed by downloading 1998 Series US Geological Survey Digital Orthophoto Quadrangles (1:40,000 acquisition scale, nominal pixel size of 1 m x 1 m) from the Michigan Department of Interior's Center for Geographic Information, the most recent available to us, into ArcView 3.3 GIS software (Environmental Systems Research Institute 2002). Orthophotos represent aerial images in which the perspective view of the camera is corrected to fit the geometry of a flat map.

The percentage of land of a certain landcover class can be used to measure landcover composition. The percentage of landcover (e.g., developed, open, wooded, water) is considered an important indicator of ecological conditions because some ecological properties of a patch (i.e., forest vegetation; Chen et al. 1992, arthropod abundance; Burke and Nol 1998, Haddad and Baum 1999, and microclimate; Blake 1987) can be influenced by the surrounding landscape (Alberti et al. 2001). For this study, the landcover was classified as follows: (1) developed land: buildings, roads, parking lots, etc; (2) open land: agricultural fields, recreational fields, large rural residential lawns that extended approximately 100 m beyond the housing; (3) wooded land: forested, not developed land or open land; and (4) water: streams, rivers, ponds, lakes (Porter et al. 2005).

ArcView was used to generate a 1-km buffer around each woodlot (Rodewald and Matthews 2005). Visual interpretation of the digital orthophotos determined the perimeter of each woodlot and classified landcover within the 1-km buffer. During landcover classification, visual interpretation was conducted from approximately 3,000 to 5,000 ft altitude in order to achieve the equivalent magnification within the matrix for each woodlot. Percentages of each landcover class and the area of each woodlot were calculated in ArcView (Porter et al. 2005) (see Appendix B for the area of each woodlot and the percentages of each landcover class at each study site).

The Shannon Dominance metric is an important metric of landscape composition (Alberti et al. 2001). However, in this study, some values for landcover class percentages had values of zero, which meant that the Shannon Dominance metric could not be used. Instead, to gain an understanding of the landscape

heterogeneity at and between the study sites, the percentage of landcover of each class was used to generate a Simpson's Dominance Index, *c*:

$$c = \sum_{i-1}^{S} p^2$$

where *i* equals the area of the landcover class, *p* equals the percentage of the landcover class, and *S* equals the total number of landcover classes (Simpson 1949). The lower the value of the Simpson's Dominance Index is, the higher the diversity of the landscape within the 1-km buffer is. Woodlot area measures were log-transformed prior to analysis to make the distribution approximately normal (Austen et al. 2001).

Winter 2004 and winter 2005 survey results for each woodlot were used to calculate two commonly used measures for ornithological research: (1) species richness, that is, the total number of species, and (2) individual abundance, that is, the total number of individuals (see Appendix D for winter 2004 and 2005 survey results, species richness, and individual abundance for each woodlot).

Multiple regression with a backwards step-wise procedure in JMP 3.2.1 statistical software (SAS Institute Inc. 1997) was used to perform analysis of the relationships between resident species richness and individual abundance and woodlot area and landscape heterogeneity. This study had a number of potential explanatory variables (e.g., survey year, woodlot area, percentages of landcover classes, Simpson's Dominance Index) and interactions between potential explanatory variables for predicting the observed variability of species richness and individual abundance. A backward elimination procedure was used to decide which

variables or combination of variables to retain in the regression model and which variables or combination of variables to leave out of the regression model (Pagano and Gauvreau 2000).

Pagano and Gauvreau (2000) described the backward elimination procedure as follows: (1) all explanatory variables and combinations of variables are included in the model; (2) variables and combinations of variables are dropped one at a time, beginning with the one that reduced R^2 by the least amount and thus explained the smallest proportion of the observed variability in species richness or individual abundance given the other variables and combinations of variables in the model; (3) at each step in the analyses, an *F*-statistic is calculated for each variable or combination of variables in the model; and (4) the equation is evaluated at each step. The procedure is repeated until each of the variables or combinations of variables remaining in the model explained a significant portion of the observed variation in the response ($p < 0.1$). Because of analytical limitations of JMP 3.2.1, only combinations of up to three variables were tested.

Results

Overall, there was greater resident species richness in winter 2005 than in winter 2004 ($F_{1, 269} = 6.4597$, $p = 0.0124$; see Fig. 1). There was also greater individual abundance richness in winter 2005 than in winter 2004 ($F_{1, 269} = 11.1694$, $p = 0.0012$; see Fig. 2)

Results indicate that the playback treatment was more effective than the control treatment in detecting resident species ($F_{1, 269} = 69.2763$, $p < 0.0001$; see Fig. 1) and individuals ($F_{1, 269} = 11.9973$, $p < 0.0012$; see Fig. 2). Though the playback treatment was highly effective in each winter as compared to the control treatment, the playback was more effective than the control in detecting resident species in winter 2005 (interaction $F_{1, 269} = 9.9476$, $p = 0.0029$; see Fig. 1). The playback had roughly the same effect on detecting individuals, as the playback detected more individuals than the control in winter 2005 (interaction $F_{1, 269} = 0.4799$, $p = 0.4722$; see Fig. 2).

Resident species richness increased as landcover diversity within the 1-km buffer surrounding each woodlot, as indicated by the Simpson's Dominance Index, increased ($F_{1, 42} = 11.6431$, $p = 0.0014$; see Fig. 3). No other potential explanatory variables (e.g., woodlot area, percentages of landcover classes) or interactions between potential explanatory variables that were tested had significant relationships with species richness.

Within the 1-km buffer surrounding each woodlot, individual abundance of residents increased as landcover diversity, as indicated by the Simpson's Dominance Index, increased ($F_{1, 41} = 8.2736$, $p = 0.0064$; see Fig. 4). There were no

other significant relationships between potential explanatory variables (e.g., woodlot area, percentages of landcover classes) or interactions between potential explanatory variables that were tested and individual abundance of residents.

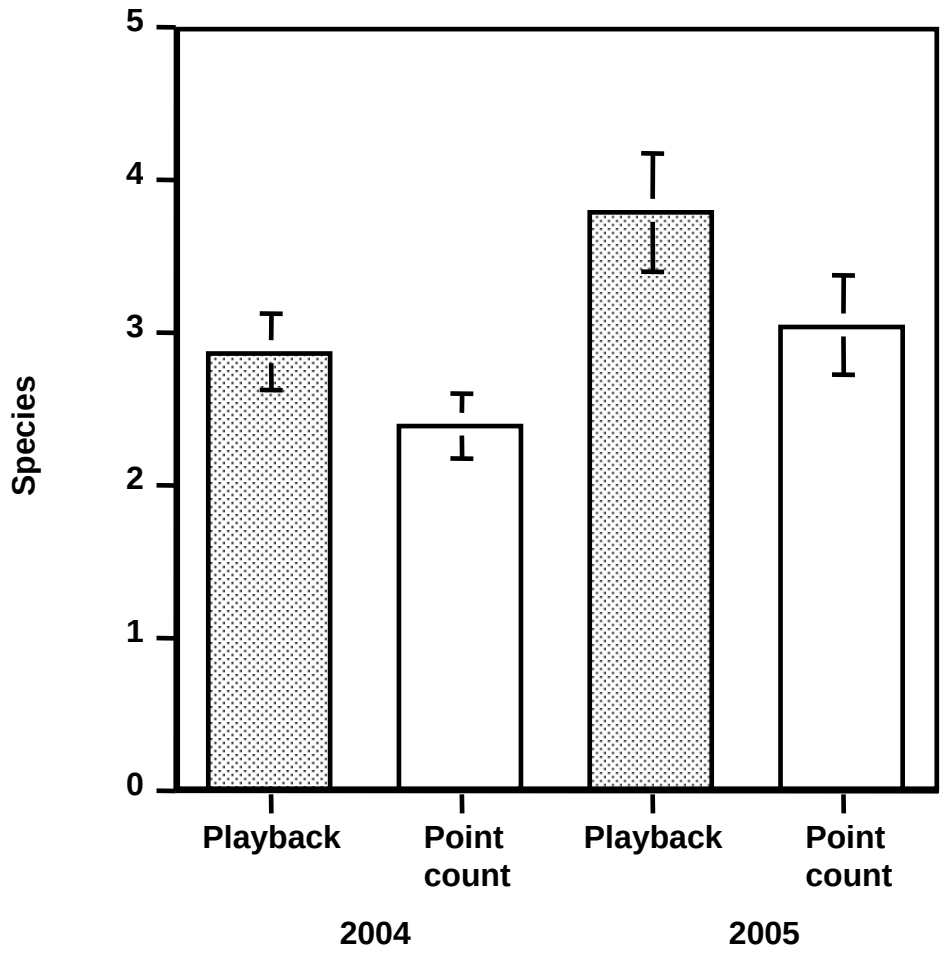

Figure 1 The playback point counts detected greater resident species richness than control point counts in each winter, and there were more species detected in winter 2005 than in winter 2004. Error bars represent the standard error of the mean for the overall analysis

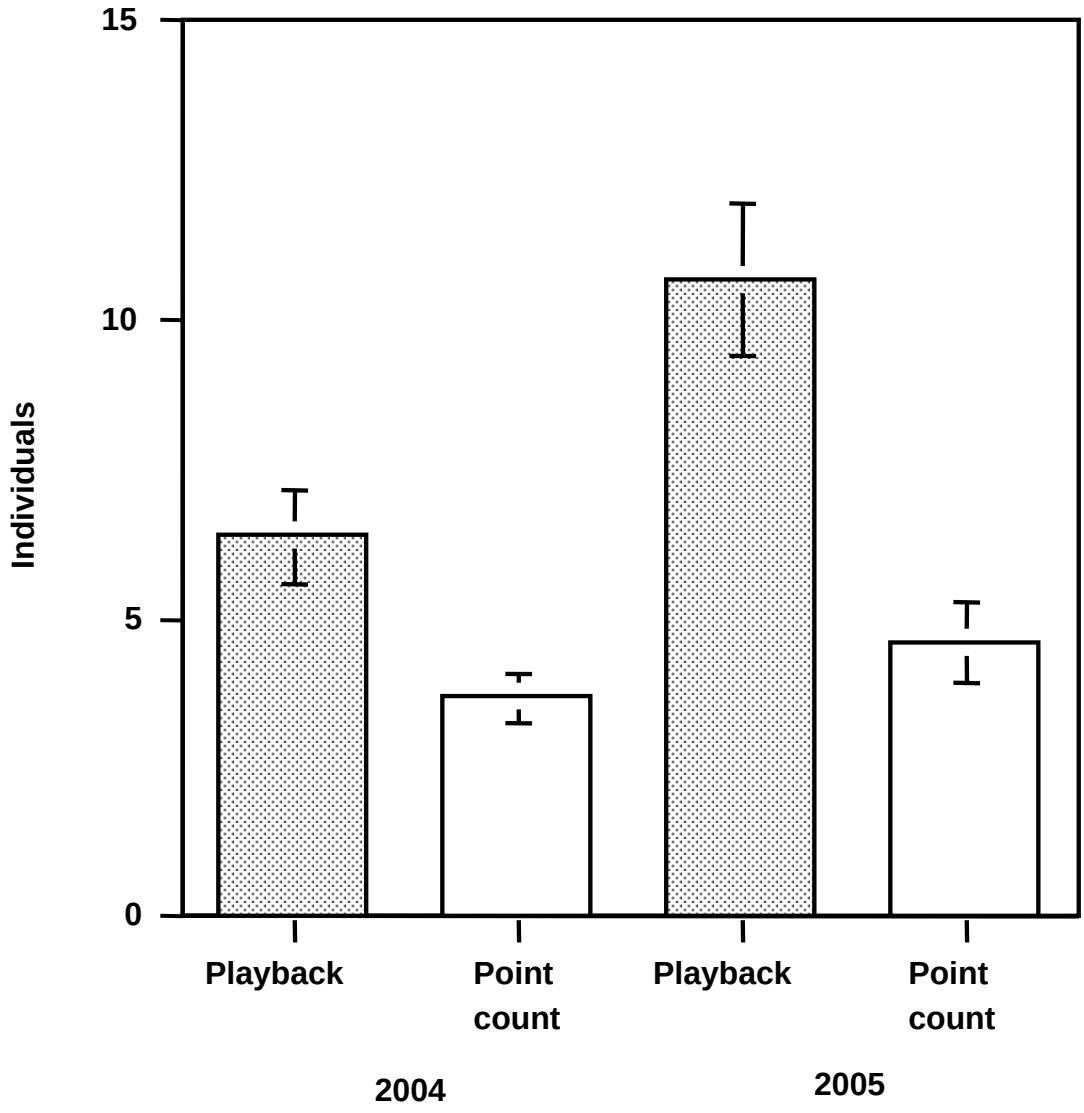

Figure 2 The playback point counts detected greater resident individual abundance than control point counts in each winter, and there were more individuals detected in 2005 than in 2004. Error bars represent the standard error of the mean for the overall analysis.

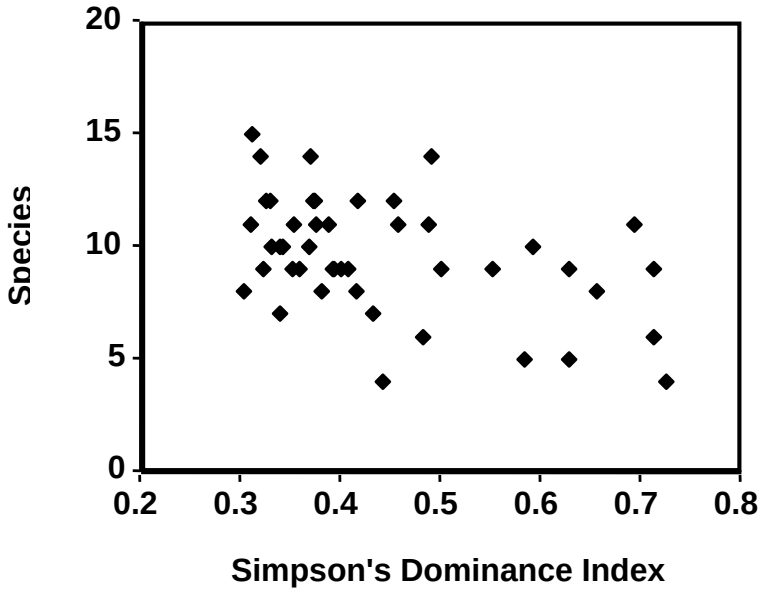

Figure 3 Resident species richness increased as landscape diversity increased

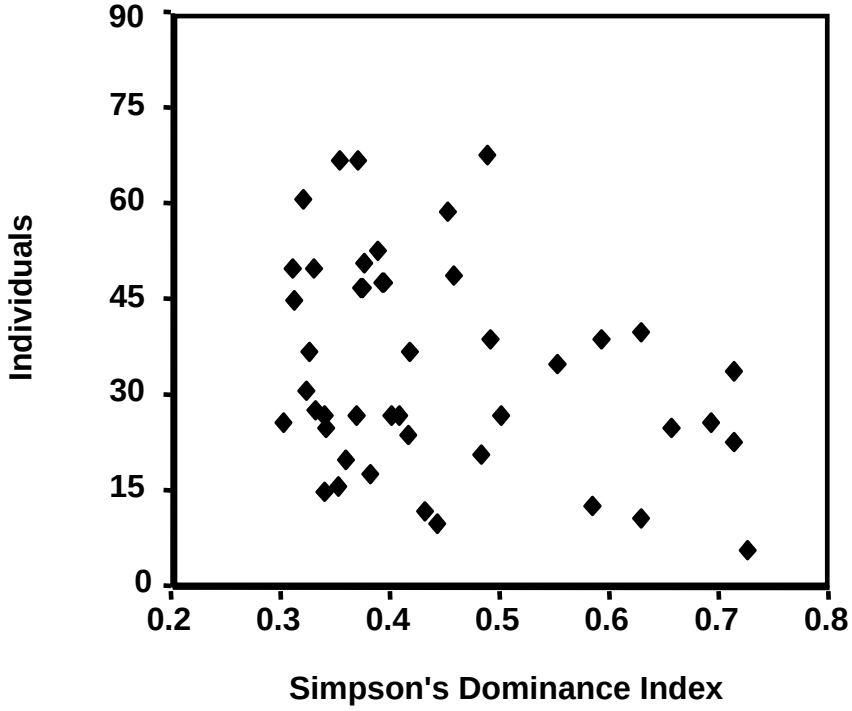

Figure 4 Individual abundance of residents increased as landscape diversity increased

Discussion

This winter study examined two survey techniques and the influence of woodlot size and location in rural and suburban matrices on resident birds.

The data collection allowed for an evaluation of the effectiveness of two fundamentally different survey techniques for censusing resident bird communities in winter. In southeast Michigan woodlots, playback point counts significantly increased the detection of resident species compared to the control point count observations conducted prior to broadcasting mobbing calls. Results indicate that in the winter, control point counts, when combined with mobbing call playback point counts, will produce a more thorough census than when sampled with control point counts alone (Turcotte and Desrochers 2005). The playback point counts may reduce species identification errors through visual observations at close range, as compared to silent point counts (Gunn et al. 2000). In addition, the playback point counts stimulate bird activity, allowing for data collection beyond just the morning hours (Gunn et al. 2000). However, the volume of the playback point counts may reduce the ability of the observer to hear some birds.

Surveys for resident species in winter indicated that there were greater species richness and individual abundance in 2005 than in 2004. This annual variation in avian species richness and individual abundance is important when calculating colonization and extinction rates and resulting metapopulation dynamics (Doherty and Grubb 2000). The census data from this study may benefit from the addition of future census data to determine which woodlots act as *sinks* during the winter with reduced conservation value for resident birds.

It was hypothesized that greater resident species richness and individual abundance would be found in large woodlots located in wooded matrices. The hypothesis was not supported, as results indicated that within the 1-km matrix, both species richness and individual abundance increased as landscape diversity increased. These results suggest that landcover surrounding woodlots does influence resident species richness and individual abundance in winter. No significant relationships between woodlot size and species richness and abundance were found.

The results of this study suggest that a diverse landscape (e.g., wooded, developed, open, and water) is preferable for more resident species overall in winter. This type of landscape may allow individuals to extend their home ranges (Addicott et al. 1987).

Previous nonbreeding season studies have reported positive associations between habitat area, bird abundance (Turcotte and Desrochers 2005), and species richness (Blake 1987, Doherty and Grubb 2000). Positive associations between forested integrity and species richness and abundance may be explained by landscape matrix effects (e.g., impeded movement as a result of gaps in more deforested landscapes) rather than only by habitat area effects (Turcotte and Desrochers 2005). In addition, Dolby and Grubb (1999) found that fragmentation, through an abiotic edge effect, decreased available forest habitat beyond that expected from the direct loss of habitat resulting from pure forest loss.

Wooded habitat (e.g., forested, not open or developed) was expected to play a favorable role in a landscape preferred by residents by offering movement

corridors (e.g., habitat that provides vegetation for cover), foraging habitat, and shelter. Wooded habitat may provide connectivity (e.g., movement among resource patches that is facilitated or impeded by the landscape; see Taylor et al. 1993) through movement corridors that facilitate immigration and emigration to different patches within a fragmented landscape as required by climatic conditions and food resources (Doherty and Grubb 2000, Yamaura et al. 2005).

Harsh climatic conditions in winter may vary from day to day which patches provide sufficient shelter and/or resources. For example, when the wind changes direction, a patch that may provide sufficient shelter on one day may not the next day.

In addition, birds are also faced with diminished food resources during winter (Grubb and Doherty 1999). Birds that forage on patchy but renewable food supplies exploit areas of their territory systematically, allowing for the resource to be replenished (Elchuk and Wiebe 2003). When climatic conditions are harsh and the expected nonrenewable food supply falls below some threshold level, birds may leave for better shelter and additional foraging opportunities (Turcotte and Desrochers 2005).

If birds can use wooded habitat to commute to patches that provide increased food resources and/or more thermal protection from any particular wind direction, they should realize an energetic benefit (Grubb and Doherty 1999). This may allow for increased overwinter survivorship (Belisle and Desrochers 2002).

Although the hypothesis did not predict that development would be a part of a preferred landscape, it also may be important in providing connectivity, additional

foraging habitat, and shelter. Development may offer movement corridors by providing man-made structures and vegetation for use as cover during movement to other woodlots. In addition, development may also offer supplemental food sources. In winter, use of bird feeders by parids may increase densities in developed areas and decrease winter mortality (Yaukey 1996). Wilson (2001) found that chickadee abundance at bird feeders was greater than would be expected on the basis of point counts. In addition, as many nonparid species follow parids in winter, nonparid birds may also increase their use of bird feeders (Yaukey 1996). Other factors that could increase resident species' use of developed areas in winter include anthropogenic heat and shelter from harsh climatic conditions (Yaukey 1996).

Open areas were not expected to be part of a preferred landscape for resident birds in winter. Woodlot isolation in the landscape matrix plays an important role in determining the occupancy and abundance of winter birds (Doherty and Grubb 2000) by restricting movement between patches (Turcotte and Desrochers 2005) and disrupting population structures and dynamics (Belisle and Desrochers 2002). Open areas create high-risk zones for predation of forest birds (Hinsley et al. 1995b) and are only crossed reluctantly (Machtans et al. 1996, Desrochers and Hannon 1997, Belisle et al. 2001, Belisle and Desrochers 2002). Grubb and Doherty (1999) found forest birds' willingness to cross gaps decreased from fall to late winter, which suggests that open areas may be even more detrimental as an isolation factor as winter progresses.

However, it is possible that the woodlot-open landscape interface (e.g., edges) may represent improved foraging conditions with a more favorable

microclimate resulting in reduced metabolic expenditures (Whelan and Maina 2005). Increased shrub density in edges may result in greater food abundance (Saunders et al. 1991). Daytime temperatures in the surrounding open landscape and the woodlot fragment's edge may be higher than in the interior of the woodlot (Saunders et al. 1991). Thus, residents that are able to forage in edges and open areas will do so in warmer temperatures and thus reduce their metabolic requirements.

In addition, in a fragmented landscape, wind subjects trees along the woodlot's edge to physical damage and increased litter fall (Saunders et al. 1991). Increased litter fall may add to shrubs in the edge to produce denser habitat that may reduce bird detectability and may also impose some physical difficulty for a raptor in capturing a bird after it has been detected (Sapir et al. 2004).

A source of error in the delineation of woodlot area and landscape class may have resulted from the visual image processing of the digital orthophoto quarter quadrangles. This method is subjective and generally unrepeatable (Jensen 2005). The analyst may have made errors in landscape classification, for example, categorizing large yards of developed rural landscapes as open landscapes. Future studies would benefit from more advanced image-classification-protocols. Additional larger woodlots in the set of study sites would improve the statistical analysis, but this may not be possible, as there may not be many large woodlots that are accessible in the area of study.

Funding limitations necessitated the use of a 1998 orthophoto series for woodlot and landscape analysis. Future studies would benefit from the use of more recent orthophotos for woodlot and landscape analysis, as they would likely give a

more accurate picture of the woodlots and surrounding landscapes than did the 1998 orthophoto series used in this study. Still, on the basis of anecdotal observations during this study, the 1998 orthophoto series appeared to represent a generally accurate picture of the study sites and the surrounding landscapes.

Although many resident bird species in southeast Michigan may be common and widespread, their distributions may be influenced by woodlot and landscape features. Forest fragmentation can be detrimental to the nutritional condition of resident birds in winter and may affect their survivorship (Doherty and Grubb 2002). Woodlots embedded in a diverse landscape may allow winter bird populations the option of using a variety of habitats for additional foraging sites (Dunning et al. 1992), corridors (Wiens et al. 1985, Taylor et al. 1993), and buffer areas under severe environmental conditions (Yamaura et al. 2005).

Conservation strategies for improving foraging sites, movement corridors, and buffer areas may include a network of diverse woodlots within larger areas of unsuitable habitat consisting of agricultural fields and development, as commonly occur in southeast Michigan, while allowing fragmented habitat to grow back into larger blocks. This may have positive effects on resident bird species by increasing overwinter survival (Whelan and Maina 2005). Understanding the relationship between resident bird species, habitat, and landscape will lead to a more comprehensive understanding of their demography (Doherty and Grubb 2000).

CHAPTER 2: THE INFLUENCE OF WOODLOT SIZE AND LOCATION IN SUBURBAN AND RURAL MATRICES ON SPRING BIRD ABUNDANCE

Introduction

Landscape fragmentation resulting from habitat loss and changes in habitat configuration (Villard et al. 1999) is one of the greatest threats to the conservation of biodiversity in terrestrial environments today (Reunanen and Grubb 2005). In recent decades, development has pushed into rural areas and increased human pressures on natural areas (Friesen et al. 1995). In the Midwest, 80-90% of the original continuous woodland has been lost, and the remaining 10-20% have been left as mostly small remnant fragments in agricultural and developed landscapes (Reunanen and Grubb 2005).

Riparian forests and small woodlots often provide the primary forested habitats in fragmented landscapes (Heglund and Skagen 2005). Riparian forests in the Midwest have high conservation value because they protect water quality and provide wildlife habitat, whereas upland forest woodlands have received less conservation attention but are also potentially important habitat for both resident and migrating forest landbird species in highly fragmented landscapes (Austen et al. 2001, Rodewald 2004).

The loss or conversion of forest to other land uses and the resulting fragmentation dynamics may alter patterns in forest bird assemblages (Dunford and Freemark 2004). Fragmentation dynamics include edge effects (e.g., increased nest parasitism and higher predation rates of eggs and young; see Robinson et al. 1995)

and declines in food abundance in small forests in fragmented landscapes (Burke and Nol 1998, Zanette 2000). Fragmentation dynamics subject remnant forest patches to the adverse effects of development, and although it may not result in the loss of the forest, it may negatively affect forest avifauna (Friesen et al. 1995). Fragmentation dynamics can cumulatively influence all stages of the life cycle of birds, from settlement and pairing (Villard et al. 1993, Rodewald and Yahner 2000) to reproduction and recruitment into the breeding population (Porneluzi et al. 1993, Weinberg and Roth 1998, Porneluzi and Faaborg 1999). As fragmentation increases, bird species abundance and community composition are negatively influenced (Brittingham and Temple 1983, Wilcove 1985, Robinson et al. 1995).

In addition to reduced habitat and fragmentation dynamics, fragment location in the landscape matrix may negatively affect landbird communities. Fragmentation may result in remnant forest patches that are isolated in the landscape matrix. In eastern North America, many species have been shown to occur less frequently or at lower densities, to have lower pairing success, or to have reduced nesting success in isolated woodlots (Freemark et al.1995).

Habitat fragmentation also affects landbirds that migrate between wintering and breeding grounds. Most landbirds are unable to deposit sufficient fat reserves for nonstop flight and require periodic stopovers for feeding and resting before continuing (Blem 1980). In the interior of North America, migratory routes offer forest stopover habitats of varying quality (Rodewald and Matthews 2005) that can influence whether migration is successful, prolonged, or abandoned (Heglund and Skagen 2005). Extensive landscape changes along these migratory pathways have

increased the risks of completing a successful migration (Heglund and Skagen 2005). The loss of suitable stopover habitat may be linked to the population decline of Neotropical migrant species in recent decades (Somershoe and Chandler 2004). An important component of bird conservation is monitoring critical stopover habitats (Wilson et al. 2000), and woodlots are among the most common stopover sites (Mehlman et al. 2005). However, because migration is a transitory period in a bird's annual cycle, it is difficult to quantify the effects of landscape on stopover ecology (Heglund and Skagen 2005). Previous research on migration patterns of Neotropical and Nearactic woodland migrants has concentrated on the role of coastal stopover habitat for migratory landbirds, whereas inland stopover habitat sites have received less attention (Wilson et al. 2000, Swanson et al. 2003). Although positive species-area relationships for migrant birds in forest patches have been found, there is currently a poor understanding of species-habitat relationships during migration because of a lack of information about which inland habitat types are important during migration and how the distribution and abundance of these habitats are changing (Wilson and Twedt 2003, Somershoe and Chandler 2004). Although several studies have shown that Neotropical migrants use woodlots during migration, they have not focused on migratory stopover (Swanson et al. 2003).

An understanding of landscape structure and animal community relationships are necessary for biodiversity maintenance at broad landscape scales (Mitchell et al. 2006). In order for management agencies and private landowners to implement responsive and effective conservation efforts on the appropriate scale and with the best financial value, data on the spatial scale (e.g., local- and landscape-level

factors) at which resident and migrant landbird species assess and use landscapes are needed (Heglund and Skagen 2005).

In land management, it is not feasible to manage for all species individually, as landscape-scale habitat relationships are most likely unique for each bird species (Mitchell et al. 2006). However, there may be less variability among groups of ecologically similar species (Mitchell et al. 2006). Wildlife managers engaged in ecosystem management are interested in how shared life-history characteristics of multiple species (e.g., guilds) are related to habitat quality (Verner 1984, Poiani et al. 2000). Guilds have been used to examine patterns of bird abundance in relation to habitat features (Freemark and Merriam 1986, Miller et al. 1997, Jones et al. 2000) and to evaluate effects of habitat management or cumulative habitat changes (Croonquist and Brooks 1991, Whitaker and Montevecchi 1999). In this study, the following guilds based on migratory status were used: (1) resident species are found locally year-round; (2) migrant-breeder species migrate from their winter range to breed locally; and (3) passage migrant species are normally found locally during their migration from their winter ranges to their breeding ranges (Kielb et al. 1992).

This study examined the spatial relationship between spring landbird distribution and landscape-level effects on the scale of patch (e.g., woodlot) and within one km of the patch in both suburban and rural matrices in southeast Michigan. The objectives of this study were to compare species richness and individual abundance of three different bird guilds in woodlots of varying areas and matrix composition and to identify types of woodlots for high conservation priority. A matrix is the landscape that surrounds the woodlot study site and is composed of

different types of landcover (e.g., land that is developed, wooded, open, or covered by water). A suburban matrix can be characterized by moderate- to high-density, single- or double-storied, single-family housing, commonly with lawns and gardens and interspersed with basic services, light industry, and multifamily housing (Marzluff et al. 2001). In southeast Michigan, a suburban matrix was expected to have more developed and/or open land and less wooded land. A rural landscape matrix can be characterized as an agricultural landscape sparsely settled by individual homesteads, recreation developments, small towns, and villages (Marzluff et al. 2001). In southeast Michigan, a rural matrix was expected to have more open and/or wooded land and less developed land. It was hypothesized that if landscape context and woodlot size influence species richness and individual abundance of bird guilds in spring, each guild would have greater species richness and individual abundance in larger woodlots located in wooded matrices. As lost or degraded woodlot habitat may limit both reproductive and migration success, data from bird-woodlot relationships may make significant contributions to bird conservation.

Methods

Study sites

Thirty woodlot study sites on public and private land within both suburban and rural matrices in Washtenaw County, Michigan, were located by consulting local bird watchers and township, city, and county officials (see Appendix A for woodlot locations). Woodlot areas ranged from 2.5 to124 ha (see Appendix B for areas of woodlots surveyed). The mean area of the woodlot study sites was 57.6 ha, and the median area of the woodlot study sites was 19.5 ha. Twenty-eight of the woodlots were under 50 ha in area, whereas two woodlots were larger. The habitat of the study sites was primarily oak (*Quercus* spp.) and hickory (*Carya* spp.) forest.

Data collection

Spring 2005 surveys were divided into three periods: (1) early migration: 17 April–1 May; (2) mid-migration: 2 May–16 May; and (3) late migration: 17 May–31 May (Kielb et al. 1992). Each woodlot was surveyed three times, once during each period (see Appendix E for survey dates).

Transect surveys were used, as they have been shown to yield greater estimates of avian species richness and total abundance per unit of effort during the breeding season regardless of forest type (Wilson et al. 2000, Rodewald and Brittingham 2004). Transect survey lines were 250 m where woodlot size allowed and shortened as necessary because of the small size of some woodlots (Rodewald and Brittingham 2004). A transect began 25 m from the woodlot edge and ran through the center of each woodlot (Rodewald and Brittingham 2004). Surveys were

conducted between sunrise and 1100 EST on mornings without significant precipitation (Wilson and Twedt 2003).

All birds seen or heard within 50 m of a transect were identified and classified in a guild: (1) resident species; (2) migrant-breeder species; or (3) passage migrant species (see Appendix C for bird species detected and their migratory status and Appendix E for survey results). High-flying birds that passed over the woodlot but did not land or forage within its perimeter were not recorded (Porter et al. 2005).

Data analysis

Quantification of landscape matrix heterogeneity was analyzed by downloading 1998 Series US Geological Survey Digital Orthophoto Quadrangles (1:40,000 acquisition scale, nominal pixel size of 1 m x 1 m) from the Michigan Department of Interior's Center for Geographic Information, the most recent available to us, into ArcView 3.3 GIS software (Environmental Systems Research Institute 2002). Orthophotos represent aerial images in which the perspective view of the camera is corrected to fit the geometry of a flat map.

The percentage of land of a certain landcover class can be used to measure landcover composition. The percentage of landcover (e.g., developed, open, wooded, water) is considered an important indicator of ecological conditions (Alberti et al. 2001). The landscape surrounding a patch can influence ecological properties of the patch (i.e., forest vegetation; see Chen et al. 1992, arthropod abundance; see Burke and Nol 1998, Haddad and Baum 1999, and microclimate; see Blake 1987). For this study, the landcover was classified as follows: (1) developed land: buildings,

roads, parking lots, etc; (2) open land: agricultural fields, recreational fields, large rural residential lawns that extended approximately 100 m beyond the housing; (3) wooded land: forested, not developed land or open land; and (4) water: streams, rivers, ponds, lakes (Porter et al. 2005).

ArcView was used to generate a 1-km buffer around each woodlot, as it was expected that this spatial scale was typical of habitat selection of migrating birds (Rodewald and Matthews 2005). Visual interpretation of the digital orthophotos determined the perimeter of each woodlot and classified landcover within the 1-km buffer. During landcover classification, visual interpretation was conducted from approximately 3,000 to 5,000 ft altitude in order to achieve the equivalent magnification within the matrix for each woodlot. Percentages of each landcover class and the area of each woodlot were calculated in ArcView (Porter et al. 2005) (see Appendix B for the area of each woodlot and the percentages of each landcover class at each study site).

The Shannon Dominance metric is an important metric of landscape composition (Alberti et al. 2001). However, in this study, some values for landcover class parentages had values of zero, which meant that the Shannon Dominance metric could not be used. Instead, to gain an understanding of the landscape heterogeneity at and between the study sites, the percentage of landcover of each class was used to generate a Simpson's Dominance Index, *c*:

$$c = \sum_{i-1}^{S} p^2$$

where *i* equals the area of the landcover class, *p* equals the percentage of the landcover class, and *S* equals the total number of landcover classes (Simpson 1949). The lower the value of the Simpson's Dominance Index was, the higher the diversity of the landscape within the 1-km buffer was. Woodlot area measures were log-transformed prior to analysis to make the distribution approximately normal (Austen et al. 2001).

Spring 2005 survey results for each woodlot were used to calculate two commonly used measures for ornithological research: (1) species richness, that is, the total number of species, and (2) individual abundance, that is, the total number of individuals (see Appendix E for spring 2005 survey results, species richness, and individual abundance for each woodlot).

Multiple regression with a backwards step-wise procedure in JMP 3.2.1 statistical software (SAS Institute Inc. 1997) was performed to analyze the relationships between each guild's species richness and each guild's individual abundance and woodlot area and landscape heterogeneity.

This study had a number of potential explanatory variables (e.g., survey year, woodlot area, percentages of landcover classes, Simpson's Dominance Index) and interactions between potential explanatory variables for predicting the observed variability of species richness and individual abundance. A backward elimination procedure was used to decide which variables or combination of variables to retain in the regression model and which variables or combination of variables to leave out of the regression model (Pagano and Gauvreau 2000).

Pagano and Gauvreau (2000) described the backward elimination procedure as follows: (1) all explanatory variables and combinations of variables are included in the model; (2) variables and combinations of variables are dropped one at a time, beginning with the one that reduced R^2 by the least amount and thus explained the smallest proportion of the observed variability in species richness or individual abundance given the other variables and combinations of variables in the model; (3) at each step in the analyses, an *F*-statistic is calculated for each variable or combinations of variables in the model; and (4) the equation is evaluated at each step. The procedure is repeated until each of the variables or combinations of variables remaining in the model explains a significant portion of the observed variation in the response ($p < 0.1$). Because of analytical limitations of JMP 3.2.1, only combinations of up to three variables were tested.

Results

Results indicated that within the 1-km buffer, species richness for migrant-breeders and passage migrants increased with increased landscape openness, whereas resident species richness declined with increased openness (interaction: $F_{1, 42} = 6.7696$, $p = 0.0109$; see Fig. 5). No other landcover classes or potential explanatory variables (e.g., woodlot area, Simpson's Dominance Index) or interactions between potential explanatory variables that were tested had significant relationships with the species richness of each guild.

Results indicated that within the 1-km buffer, migrant-breeders' and passage migrants' individual abundance decreased as woodlot area increased, whereas resident individual abundance increased as woodlot area increased (interaction: $F_{1, 41} = 7.7493$, $p = 0.0066$; see Fig. 6). No other potential explanatory variables (e.g. Simpson's Dominance Index, landcover class percentages) or interactions between potential explanatory variables that were tested had significant relationships with the individual abundance of each guild.

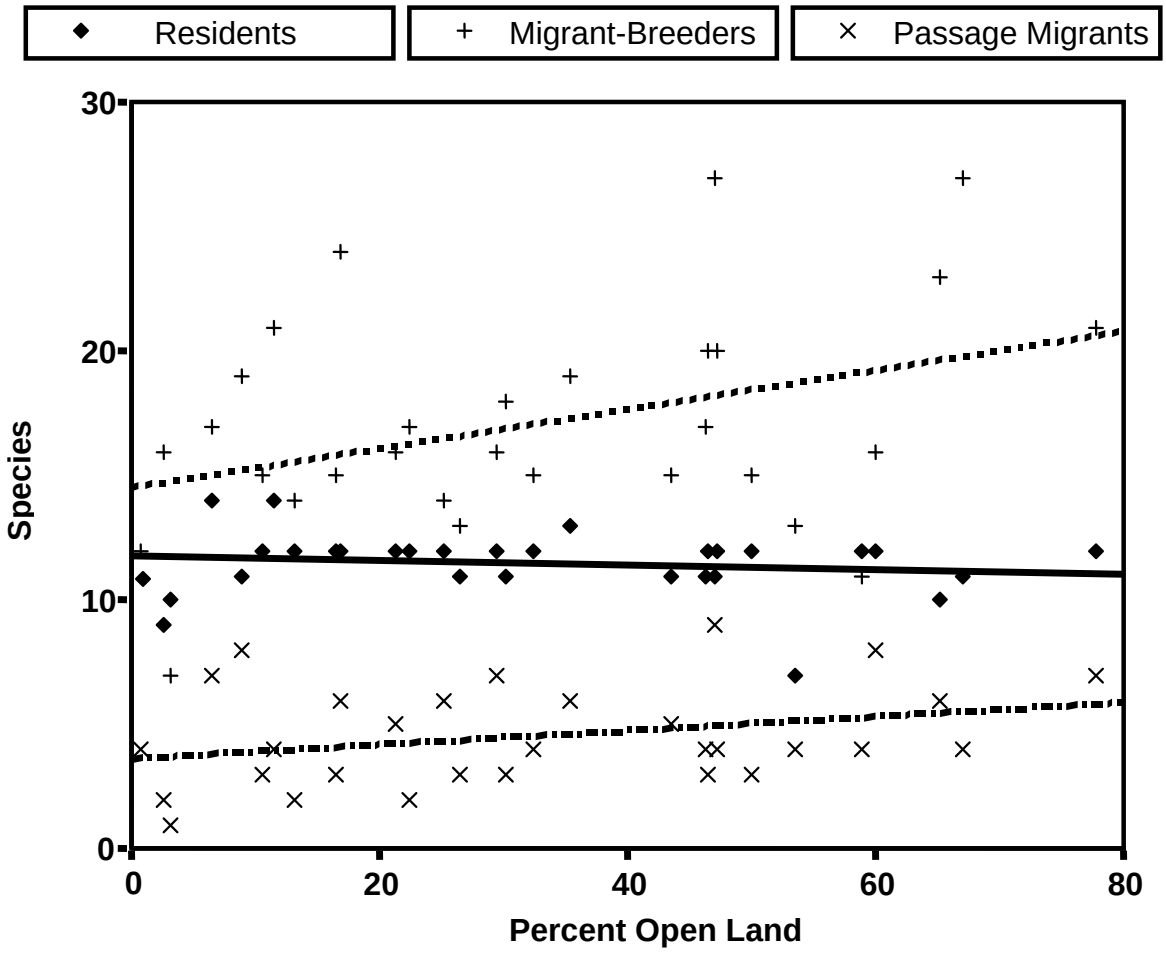

Figure 5 In spring, migrant-breeders' and passage migrants' species richness increased with increased landscape openness, whereas resident species richness decreased with increased landscape openness

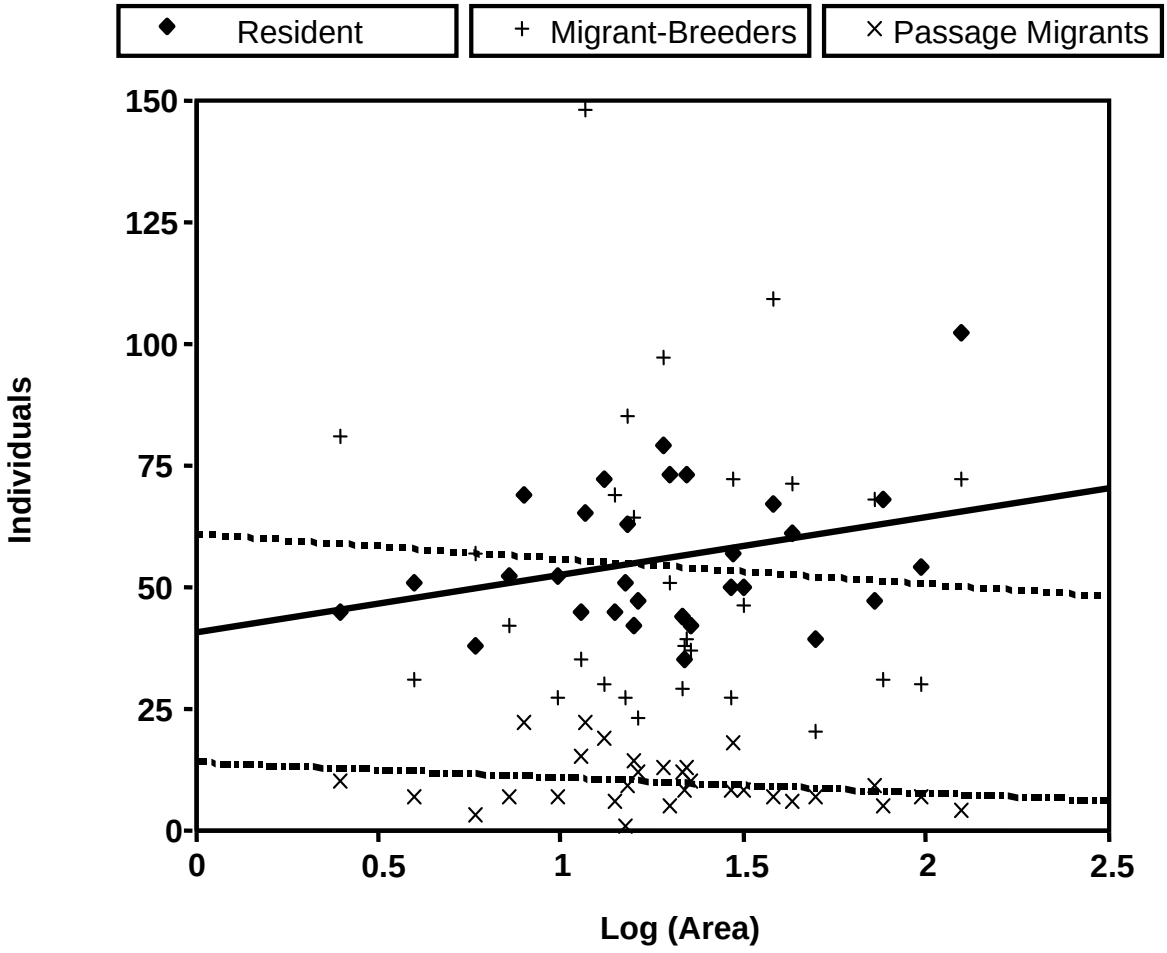

Figure 6 In spring, migrant-breeders' and passage migrants' individual abundance decreased as woodlot area increased, whereas resident individual abundance increased as woodlot area increased

Discussion

It was hypothesized that each of the three guilds would have greater species richness and individual abundance in large woodlots located in wooded matrices.

For resident species, the hypothesis was not supported. Results indicated that there was higher resident species richness in larger woodlots and higher resident individual abundance in woodlots with less open landcover in the matrix. Higher resident species richness with increasing fragment size was not surprising, as this result has been found in previous studies (Freemark and Collins 1992, Burke and Nol 1998, Fauth et al. 2000). Breeding-season studies in agricultural landscapes (e.g., open landscapes) have shown strong landscape effects on forest birds (Andren 1994, Hinsley et al 1995a, Lee et al. 2002). Larger woodlots have higher interior-to-edge ratios, and less edge may result in decreased edge effects (e.g., brood parasitism and predation) with higher nesting success and greater recruitment.

For migrant-breeders, the hypothesis was not supported. Results indicated that there was higher species richness in smaller woodlots and higher individual abundance in woodlots with more open landcover in the matrix. This result was surprising, as previous studies have suggested that as fragmentation increases, bird species abundance and community composition are negatively influenced (Brittingham and Temple 1983, Wilcove 1985, Robinson et al. 1995).

Smaller woodlots may act as reservoirs for migrant-breeders excluded from the larger woodlots (Nol et al. 2005). Resident species, which begin the breeding season at the earliest possible time that climatic conditions allow, may get a head

start in claiming breeding territories in the limited number of larger woodlots before the arrival and to the exclusion of migrant-breeders. Migrant-breeder species that are excluded from larger woodlots because of intra- and interspecific competition for preferred habitat within fragmented landscapes (Fauth et al. 2000, Nol et al. 2005), may find suitable, although not necessarily preferred, nesting habitat in smaller woodlots.

For migrant-breeder species considered *edge specialists* (e.g., more likely to be found near the forest edge than in the forest interior; see Freemark and Collins 1992), the habitat structure of small woodlots (e.g., high edge-to-interior ratio) may offer nesting habitat and reduce detectability and may also impose some physical difficulty for a raptor in capturing a bird after it has been detected (Sapir et al. 2004). It was anecdotally noted that many woodlots in this study had increased shrub density in edges. Additionally, in fragmented landscapes, trees at woodlot edges have increased litter fall as a result of damage from wind exposure (Saunders et al. 1991) that may contribute to edge habitat density. Increased shrub density may result in increased nesting density (Murcia 1995, Bayne and Hobson 1997) with the additional benefit of greater food abundance (Saunders et al. 1991).

In addition, a woodlot that by itself is too small to support certain species may do so if there is additional habitat nearby (Blake and Karr 1987). Although results indicated that open landscapes in the matrix surrounding a woodlot were preferable for migrant-breeders, if additional nonopen habitat (e.g., forest or development) were nearby, birds might enlarge their territories beyond forest boundaries (Blake and

Karr 1987). Howe (1984) showed that birds breeding in small (< 7 ha) woodlots may incorporate several nearby patches within their territory.

For passage migrant species, the hypothesis was not supported, as results indicated that there was higher species richness in smaller woodlots and higher individual abundance in woodlots with more open landcover in the matrix. As with migrant-breeder species, this result for passage migrant species was not expected, as previous studies have suggested that as fragmentation increases, bird species abundance and community composition are negatively influenced (Brittingham and Temple 1983, Wilcove 1985, Robinson et al. 1995). Small woodlots in an open landscape may provide enough food for refueling and cover for resting before passage migrants to continue their migration.

Passage migrants may exploit altered microclimates in woodlot edges surrounded by open land for increased food resources and reduced metabolic expenditures while foraging. As previously stated, increased shrub density (e.g., edges) may result in greater food abundance (Saunders et al. 1991). In addition, daytime temperatures at woodlot edges are higher than in the interior of the woodlot (Saunders et al. 1991). Passage migrants that are able to forage in edges may do so in warmer temperatures and thus reduce their metabolic requirements, especially on spring days with cooler temperatures. Then, at night, passage migrants may retreat for roosting to the woodlot interior, where night temperatures are warmer than in the surrounding landscape (Saunders et al. 1991).

Results indicated that migrant-breeder and passage migrant individual abundance increased in woodlots with more open landscapes in the surrounding

matrix, whereas resident individual abundance decreased in woodlots with more open landscapes in the surrounding matrix.

Both migrant-breeders and passage migrants may use open landscapes in the matrix as a buffer to reduce competition with or avoid species adapted to development (Engles and Sexton 1994, Kluza et al. 2000). Neotropical migrants and forest-interior species' diversity and abundance have been shown to be negatively affected by development (Freisen et al 1995, Kluza et al. 2000, Dunford and Freemark 2004). Rural development changes vegetation structure and may subsidize high densities of nest predators (Kluza et al. 2000), such as Blue Jays (*Cyanocitta cristata*), squirrels (*Sciurus* spp.), raccoons (*Procyon lotor*) (Hoffman and Gottschang 1977), Common Grackles (*Quiscalus quiscula*), house cats (*Felis catus*), and dogs (*Canis familiaris*) (Mancke and Gavin 2000). Increased noise levels from development may also be a negative effect of development (Dunford and Freemark 2004). Open landscapes may create a buffer to development and decrease potential movement corridors from development to woodlots for some of these predators.

Resident species may be better adapted to development and not require a buffer created by open landscapes. In eastern Pennsylvania, Mancke and Gavin (2000) found that American Robins (*Turdus migratorius*), House Finches (*Carpodacus mexicanus*), and House Sparrows (*Passer domesticus*) (species considered common residents in this study) may require buildings or suburban or urban edge habitat. In addition, Mancke and Gavin (2000) found that American Crows (*Corvus brachyrhynchos*), Blue Jays, Common Grackles, Northern Cardinals

(*Cardinalis cardinalis*), and Tufted Titmouse (*Baeolophus bicolor*) (species considered common residents in this study) may prefer many buildings or yards. Graber and Graber (1963) found that Blue Jays and Common Grackles prefer residential areas to fields or woods. In Ontario, Canada, near Ottawa, Dunford and Freemark (2004) found that resident bird species were positively affected by developed land and adversely affected by pasture, hay fields, and old fields (e.g., open land).

A source of unidentified variance was that species richness and individual abundance estimates were based on transect counts. Bird surveys have inconsistent detection probabilities (Sauer et al. 1994, Farnsworth et al. 2002) because of mated males' decreasing their singing rate and becoming less likely to be detected (Parker et al. 2005). For example, unpaired male Ovenbirds (*Seiurus aurocapilla*) and Kentucky Warblers (*Oporonis formosus*), both migrant species, may be more likely to sing and therefore more likely to be detected on point counts than paired birds (Gibbs and Wenny 1993). If lower pairing success occurs in small fragments and results in higher calling rates, it would suggest that the negative relationship between woodlot size and migrants results from an overestimation of the value of small woodlots for migrants. It would also suggest that resident species have higher pairing success in small fragments, resulting in lower calling rates and an underestimation of the value of small woodlots for residents. This will require additional study, such as further examination of the interaction between the date of the survey and woodlot size.

With additional time for study, a different guild-classification system may allow for more powerful tests in determining why the migrant guilds preferred smaller woodlots surrounded by more open landscapes. Guilds may be separated by habitat: (1) *forest-interior specialists*, which nest mainly within the interior of forest patches; (2) *interior-edge specialists*, which are more likely to have territories anywhere within the forest; and (3) *edge specialists*, which are more likely to be found near the forest edge than in the forest interior (Freemark and Collins 1992). If there were many migratory species that could be classified as edge specialists in this study, the results would be more in line with results from previous studies that found that edge specialists increased with decreased woodlot size (Austen et al. 2001).

The understanding of how forest species respond to human-dominated land uses in the matrix is still developing, and it is still difficult to cleanly assess the effects of matrix composition on bird assemblages (Dunford and Freemark 2004). Forest bird species richness and individual abundance can be strongly influenced by forest patch size (Freemark and Collins 1992, Burke and Nol 1998, Fauth et al. 2000), within-patch habitat composition and structure (DeGraaf et al. 1998), and the amount of habitat available in the landscape (Dunford and Freemark 2004). These variables make it difficult to analyze matrix effects without confounding effects from these variables (Dunford and Freemark 2004). Correlations among explanatory variables may be avoided through careful study design, but this is often logistically difficult in landscape-scale studies (Lichstein et al. 2002) such as this one.

Results indicated that smaller woodlots surrounded by a matrix with open landscapes should be considered a priority for conservation, as they are important habitats for passage migrant and migrant-breeder species. However, in order to provide a more complete estimate of the quality of woodlot habitat for both breeding and stopover, other factors need to be considered.

For example, this study only quantified species richness and individual abundance at sites and did not assess the energetic condition of passage migrants or migrant-breeders. This type of data may help to determine whether the woodlot allowed passage migrants to leave in better condition than they arrived. In addition, different strategies of weight gain/load and both intrinsic and extrinsic factors unrelated to food acquisition that may contribute to a location's suitability as a stopover or breeding site, including low predation rates or its geographic position relative to a migratory route that is restricted for physiographic or climatic reasons, must be considered (Hutto 2000). The collection of fecundity data from migrant-breeders may offer a better estimation of whether small woodlots surrounded by open landscapes are *sources* or *sinks* for these populations. Adding these variables to the census and matrix information of this study would give a better indication of the usefulness of a woodlot for both migrant guilds.

Additional larger woodlots in the set of study sites would improve the statistical analysis, but this may not be possible, as there may not be many large woodlots that are accessible in the area of study.

In the analysis, the statistical issue of correlation between the landscape variables of open land and those of developed land caused concern, as it was not

clear which had the greater impact. Correlations among explanatory variables often make it difficult to distinguish between landscape composition effects, and failure to account for their covariances may lead to incorrect interpretations of ecological data (Lichstein et al. 2002). Correlation may be removed by partial-regression analysis, although this requires the investigator to make subjective decisions about which variables are most important (Lichstein et al. 2002). This study used multiple regression with a backward step-wise procedure to determine bird response to landscape patterns. This regression approach removed correlations between sets of variables (Lichstein et al. 2002).

It is possible that the statistical method selected open land when it should have selected developed land or that the effect of open land is really an effect of developed land. Models that included both open land and developed land were tested. The model that included open land was found to be more informative because the model that included open land described more variation than did the model with developed land included. However, it is still not known whether the biological effect is due to development, but the biological effect was described more efficiently when the percent open variable was used. This will require further study for clarification.

A source of error in the delineation of woodlot area and landscape class may have resulted from the visual image processing of the digital orthophoto quarter quadrangles. This method is subjective and generally unrepeatable (Jensen 2005). The analyst may have made errors in landscape classification, for example,

categorizing large yards of developed rural landscapes as open landscapes. Future studies would benefit from more advanced image-classification protocols.

Funding limitations necessitated the use of 1998 orthophoto series for woodlot and landscape analysis. Future studies would benefit from the use of more recent orthophotos for woodlot and landscape analysis, as they would likely give a more accurate picture of the woodlots and surrounding landscapes than the 1998 orthophoto series used in this study. Still, on the basis of anecdotal observations during this study, the 1998 orthophoto series appeared to represent a generally accurate picture of the study sites and the surrounding landscapes.

This study examined how woodlot area and matrix location may be used to identify woodlots used by migrant and resident bird species for priority conservation. Birds, especially migratory species, use a variety of places that are not normally considered potential conservation areas, including small woodlots and parks (Diehl et al. 2003) like those used in this study. The results of this study indicated that small woodlots embedded in open matrices may be of high-priority conservation value for birds.

In many parts of the agriculturally altered Midwest, woodlots may be real island patches of habitat. The choice among forest, agricultural fields, and development may be more important than differences within and among woodlots as the criterion for patch selection (Blake and Karr 1987). Habitat patches such as parks, woodlots, and small forest blocks in a generally inhospitable landscape matrix can be thought of as both breeding habitat and *stepping stone* stopover sites (e.g., habitat where birds can briefly rest and easily replenish fat or muscle or both; see

Mehlman et al. 2005). A small woodlot with a large edge-to-interior ratio in an open landscape might rank low in comparison to a large woodlot surrounded by woodland, but it may be the best option for migrants in an otherwise inhospitable landscape consisting of agricultural fields and development, as commonly occurs in southeast Michigan. This study suggests that research should identify a network of diverse woodlots within larger areas of unsuitable habitat that may function as breeding habitat useful for a diverse community of bird species, as well as stopover sites that could fill gaps between large protected sites.

CHAPTER 3: THE INFLUENCE OF WOODLOT SIZE AND LOCATION IN SUBURBAN AND RURAL MATRICES ON TUFTED TITMOUSE RANGE EXPANSION

Introduction

Tufted Titmice (*Baeolophus bicolor*) are cavity-nesting passerines in Temperature Zone deciduous forests that contain tall vegetation, large numbers of tree species, and dense canopy (Grubb and Pravosudov 1994). Their feeding niche is concentrated on the bark of small, live branches high in the canopy, where they feed on insects and seeds (Grubb and Pravosudov 1994, Doherty and Grubb 2003). These habitat requirements are important determinants of fragmented woodlot suitability for Tufted Titmice (Grubb and Pravosudov 1994, Dolby and Grubb 1999).

The range of Tufted Titmice has changed dramatically over the last 100 years (Granlund et al. 1994). In the late 1800s, Tufted Titmice were considered accidental visitors in southern Michigan, and since then, the species has experienced a major range expansion and growth in population (Brewer et al. 1991). National Audubon Society Christmas Bird Count (2002) data indicate that there was a dramatic rise in the population beginning in the 1930s (Figs. 7-10). By 1948, Tufted Titmice occurred in moderate numbers throughout the southern part of the state (Van Tyne 1948), and today the species is a permanent resident (Brewer et al. 1991).

The following hypotheses have been proposed to explain Tufted Titmice range expansion and population growth: (1) Landscape change during the first half of the 1900s created more suitable habitat (Brewer et al. 1991); (2) climate change

in the first half of the 1900s enabled increased overwinter survivorship (Kielb et al. 1992); and (3) an increase in supplemental food sources as a result of human development enabled increased overwinter survivorship (Granlund et al. 1994).

The objective of this study was to determine the influence of woodlot area and matrix composition in suburban and rural southeast Michigan on Tufted Titmice occupancy in winter and spring. A matrix is the landscape that surrounds the woodlot study site and is composed of different types of landcover (e.g., land that is developed, wooded, open, or covered by water). A suburban matrix can be characterized by moderate- to high-density, single- or double-storied, single-family housing, commonly with lawns and gardens, and interspersed with basic services, light industry, and multifamily housing (Marzluff et al. 2001). In southeast Michigan, a suburban matrix was expected to have more developed and/or open land and less wooded land. A rural landscape matrix can be characterized as an agricultural landscape sparsely settled by individual homesteads, recreation developments, small towns, and villages (Marzluff et al. 2001). In southeast Michigan, a rural matrix was expected to have more open and/or wooded land and less developed land. It was expected that in both winter and spring, Tufted Titmice would prefer woodlots with greater area. It was also expected that in both winter and spring, Tufted Titmice would prefer woodlots located in wooded matrices.

The data collected on Tufted Titmice habitat preferences today can be used for comparison with regional historic land-use records to determine which set of landscape conditions were present at the time of range expansion. Future research can review climate change and development in southern Michigan in the first half of

the 1900s and add these data to the landscape data collected in this study for a more thorough analysis of the conditions that contributed to Tufted Titmice range expansion and population growth. Then, it may be possible to determine which of the three proposed hypotheses best explains Tufted Titmice range expansion.

Methods

Study sites – Winter

In winter, forty-five woodlot study sites on public and private land were surveyed within both suburban and rural matrices in Ingham, Washtenaw, and Wayne Counties, in Michigan (see Appendix A for locations). Woodlot area ranged from 0.9 to 325.2 ha (see Appendix B for area of woodlots). The mean area of the woodlot study sites was 38.5 ha, and the median was 19.8 ha. Thirty-nine of the woodlots were under 52 ha in area, whereas six woodlots were larger. The habitat of the study sites was primarily oak (*Quercus* spp.) and hickory (*Carya* spp.) forest.

Study sites – Spring

In spring, a subset of the winter study sites consisting of 30 woodlots on public and private land within both suburban and rural matrices in Washtenaw County, Michigan, were surveyed (see Appendix A for woodlot locations). Woodlot area ranged from 2.5 to 124 ha (see Appendix B for area of woodlots). The mean area of the woodlot study sites was 57.6 ha, and the median was 19.5 ha. Twenty-eight of the woodlots were under 50 ha in area, whereas two woodlots were larger.

Data collection – Winter

This study used data collected for the winter portion of this thesis (see Chapter 1) because the surveys noted Tufted Titmice presence. Surveys were conducted in winter 2004 (1 November through 15 December) and winter 2005-2006 (7 December 2005 through 1 January 2006, hereafter referred to as winter 2005).

Each woodlot was surveyed for 15 min on three separate visits (Kosinski et al. 2004) at least one week apart, once during each of the following periods: (1) AM: sunrise at approximately 0800 EST-1040 EST; (2) mid-day: 1040 EST-1320 EST; and (3) PM: 1320 EST-1600 EST (see Appendix D for date and time period of each survey).

Surveys took place at a single point at the center of each woodlot, using both silent point counts and playbacks of Black-capped Chickadees mobbing an Eastern Screech Owl. Black-capped Chickadees mobbing an Eastern Screech Owl were recorded by R. C. Stein and H. McIsaac and acquired from the Macauley Library of Natural Sounds, Cornell Lab of Ornithology, Cornell University, Ithaca, New York.

Mobbing is a widespread behavior in birds (Hurd 1996, Gunn et al. 2000), used mostly when stationary predators are discovered (Belisle and Desrochers 2002). Mobbing calls by Black-capped Chickadees are known to communicate the presence of predators to heterospecifics, including Tufted Titmice, which quickly aggregate around a mobbing bird (Turcotte and Desrochers 2002).

Prior to the start of a survey, approximately 2 min of quiet time was allocated in order to reduce observer disturbance. Following the protocol of Turcotte and Desrochers (2002), a 5-min silent point count was conducted during which Tufted Titmice heard or seen within 50 m of the survey point indicated their presence in the woodlot (see Appendix D for Control 1 point count results).

The first silent point count was immediately followed by a 5-min mobbing call broadcast. During the 5-min playback interval, mobbing calls were broadcast for 5 min on two 2.5-w speakers attached to a portable compact disc player placed

approximately 1 m above the ground and played at a volume similar to that produced by live birds. Tufted Titmice heard or seen within 50 m of the survey point indicated their presence in the woodlot (see Appendix D for Playback results).

Turcotte and Desrochers (2002) protocol was modified to account for any Tufted Titmice arriving in response to but after the conclusion of the playback. Immediately following the playback interval, another 5-min silent point count began during which any Tufted Titmice heard or seen within 50 m of the survey point indicated their presence in the woodlot (see Appendix D for Control 2 point count results).

Tufted Titmice were scored as present if a Tufted Titmouse was seen or heard during any portion of a survey. Because some the same individuals might be counted in each portion of a survey, the number of individual Tufted Titmice present in a woodlot could not be determined.

Data collection – **Spring**

Data collected for the spring portion of this thesis were also used for this study (see Chapter 2), as the surveys noted Tufted Titmice presence. Each woodlot was surveyed once during each of the following periods: (1) 17 April–1 May, (2) 2 May–16 May, and (3) 17 May–31 May (see Appendix E for survey dates). Surveys were conducted between sunrise and 1100 EST on mornings without significant precipitation (Wilson and Twedt 2003).

Transect surveys were used because they have been shown to yield greater estimates of total individual abundance per unit of effort during the breeding season

regardless of forest type (Wilson et al. 2000, Rodewald and Brittingham 2004). Transect survey lines were 250 m where woodlot size allowed and were shortened as necessary because of the small size of some woodlots (Rodewald and Brittingham 2004). Transects began 25 m from a woodlot's edge and ran through the center of each woodlot (Rodewald and Brittingham 2004). Surveys were conducted between sunrise and 1100 EST on mornings without significant precipitation (Wilson and Twedt 2003). Tufted Titmice seen or heard within 50 m of the transect indicated their presence in the woodlot (see Appendix E for spring survey results).

Tufted Titmice frequency of occupancy of woodlots in spring was used as an indicator of habitat suitability. Frequency was defined as follows: (1) if no Tufted Titmouse were detected in a woodlot during spring surveys or if Tufted Titmice were only detected once in a woodlot during spring surveys, Tufted Titmice were considered *rare* in that woodlot; and (2) if Tufted Titmice were detected in a woodlot during two or three spring surveys, Tufted Titmice were considered *common* in that woodlot.

Data analysis

Quantification of landscape matrix heterogeneity was analyzed by downloading 1998 Series US Geological Survey Digital Orthophoto Quadrangles (1:40,000 acquisition scale, nominal pixel size of 1 m x 1 m) from the Michigan Department of Interior's Center for Geographic Information, the most recent available to us, into ArcView 3.3 GIS software (Environmental Systems Research

Institute 2002). Orthophotos represent aerial images in which the perspective view of the camera is corrected to fit the geometry of a flat map.

The percentage of land of a certain landcover class can be used to measure landcover composition. The percentage of landcover (e.g., developed, open, wooded, water) is considered an important indicator of ecological conditions (Alberti et al. 2001). The landscape surrounding a patch can influence some ecological properties of the patch (i.e., forest vegetation; see Chen et al. 1992, arthropod abundance; see Burke and Nol 1998, Haddad and Baum 1999, and microclimate; see Blake 1987). For this study, the landcover was classified as follows: (1) developed land: buildings, roads, parking lots, etc; (2) open land: agricultural fields, recreational fields, large rural residential lawns that extended approximately 100 m beyond the housing; (3) wooded land: forested, not developed land or open land; and (4) water: streams, rivers, ponds, lakes (Porter et al. 2005).

ArcView was used to generate a 1-km buffer around each woodlot (Rodewald and Matthews 2005). Visual interpretation of the digital orthophotos determined the perimeter of each woodlot and classified landcover within the 1-km buffer. During landcover classification, visual interpretation was conducted from approximately 3,000 to 5,000 ft altitude in order to achieve the equivalent magnification within the matrix for each woodlot. Percentages of each landcover class and the area of each woodlot were calculated in ArcView (Porter et al. 2005) (see Appendix B for the area of each woodlot and the percentages of each landcover class at each study site).

Logistic regression was used to analyze the relationship between a binary dependent variable (e.g., Tufted Titmice presence/absence in spring or

common/rare in winter) and a set of continuous and discrete independent variables (e.g., woodlot size, percent forest, and percent development in the matrix) (Forthhofer and Lee 1995). The relationships between Tufted Titmouse presence or frequency and woodlot area and landscape heterogeneity were analyzed with JMP 3.2.1 statistical software (SAS Institute Inc. 1997).

Results

In winter, Tufted Titmice were more likely to be present in smaller woodlots (x^2 = 4.2360, p = 0.0396; see Fig. 11a) surrounded by greater percentages of wooded landscapes (x^2 = 4.1873, p = 0.0407; see Fig. 11a). Results for year (x^2 = 3.1273, p = 0.0770) and percentage developed (x^2 = 2.2304, p = 0.1353) were not statistically significant.

In spring 2005, Tufted Titmice were present in a wider variety of woodlots. They were detected in all woodlots that they had been detected in during winter 2004, as well as in other woodlots. Tufted Titmice were more common in woodlots surrounded by greater percentages of wooded landscapes (x^2 = 4.4830, p = 0.0342; see Fig. 11b). In spring, Tufted Titmice were more common in larger woodlots although this result was not statistically significant (x^2 = 1.2644, p = 0.2608; see Fig. 11b). Results for percentage developed (x^2 = 2.6843, p = 0.1013) were not statistically significant.

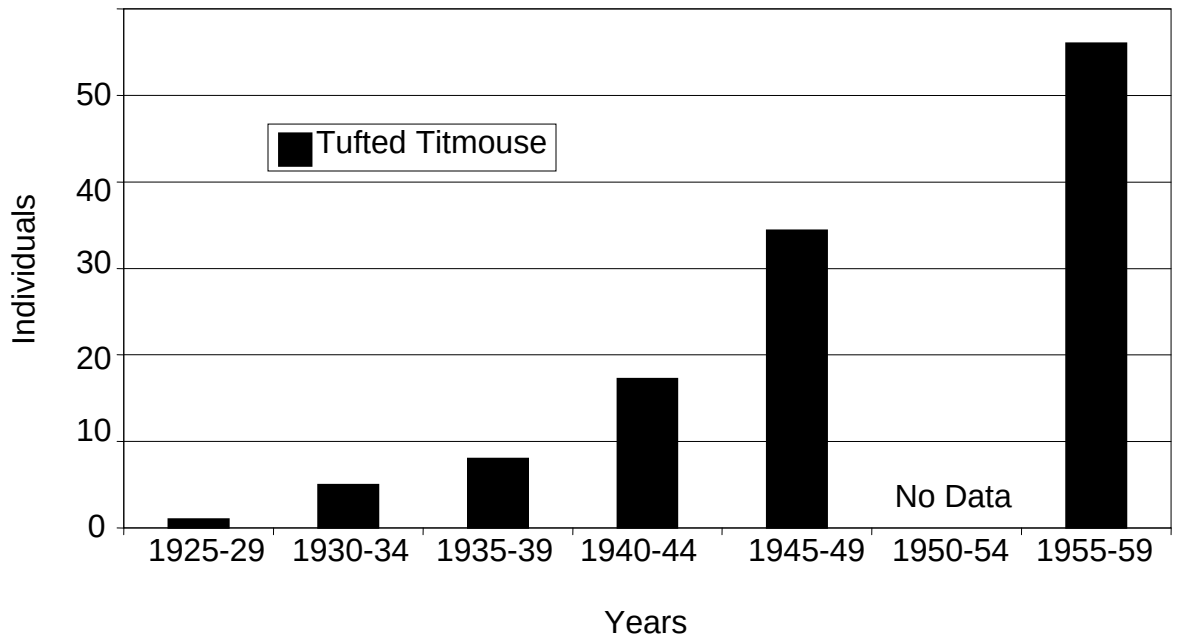

Figure 7 Christmas Bird Count five-year averages of individuals detected show an increase for Tufted Titmice in Ann Arbor, MI, from 1925 to1959

Figure 8 Christmas Bird Count five-year averages of individuals detected show an increase for Tufted Titmice in East Lansing, MI, from 1935 to1944

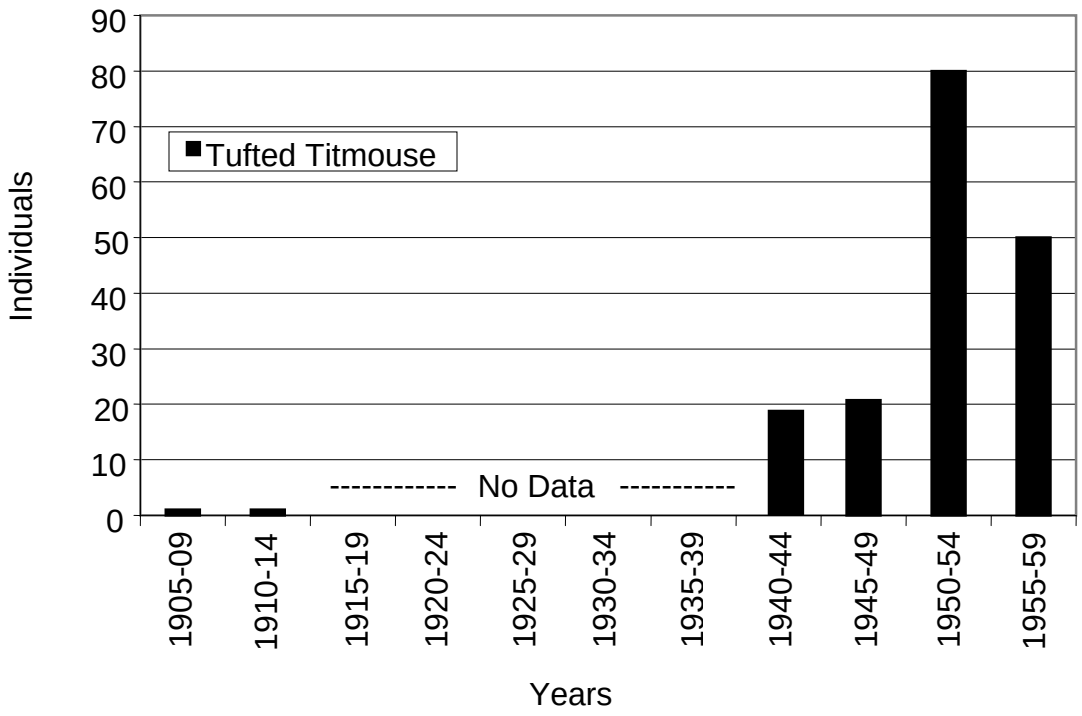

Figure 9 Christmas Bird Count five-year averages of individuals detected show an increase for Tufted Titmice in Detroit, MI, from 1905 to1959

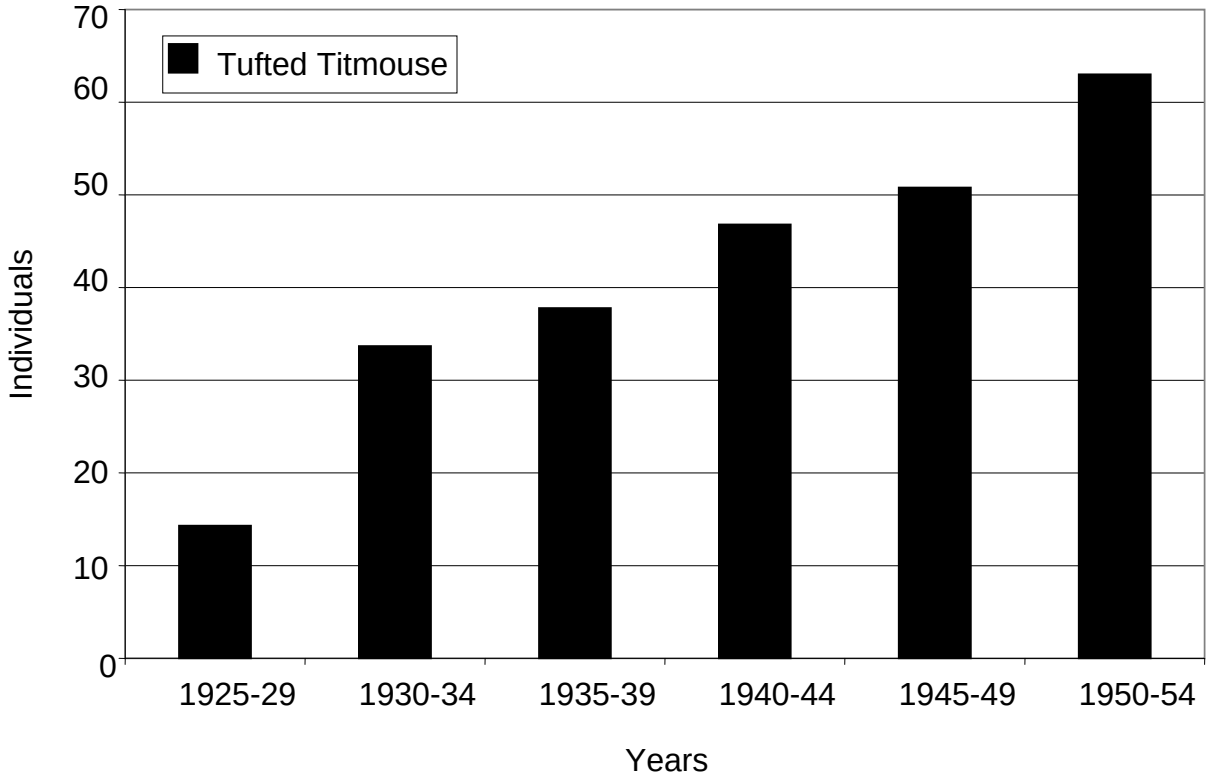

Figure 10 Christmas Bird Count five-year averages of individuals detected show an increase for Tufted Titmice in Toledo, OH, from 1925 to1954

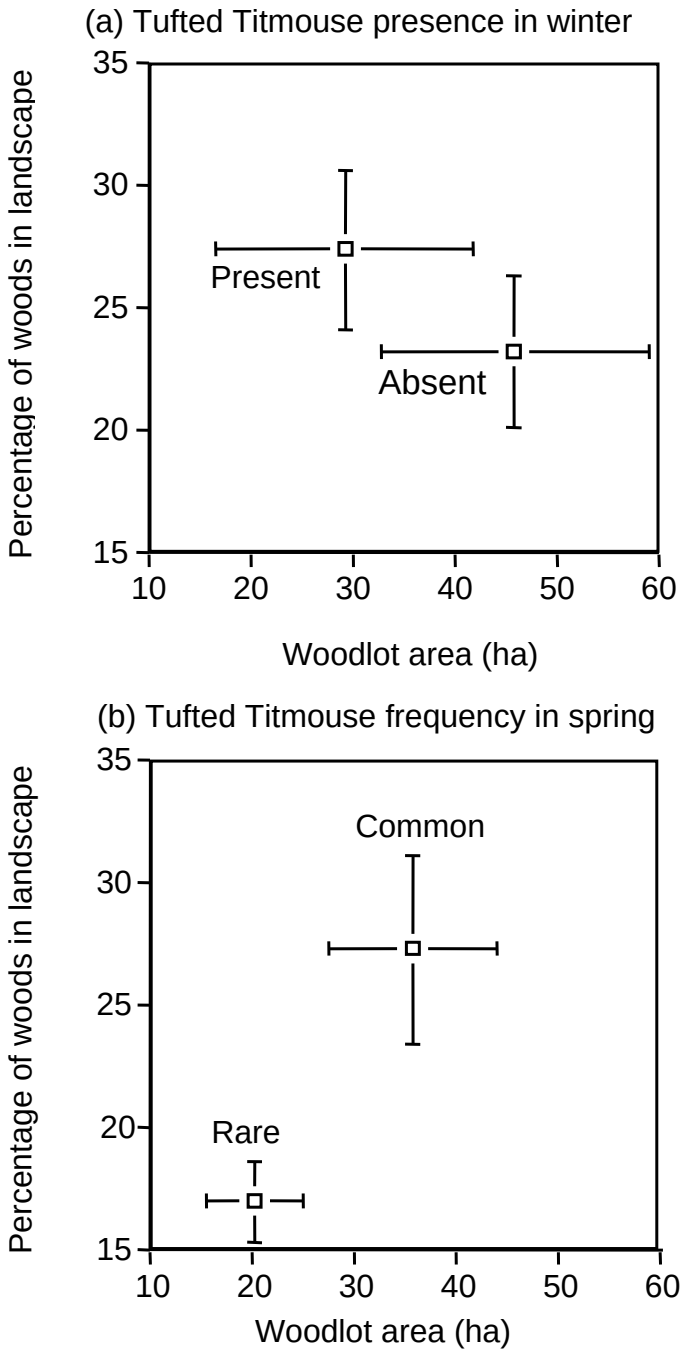

Figure 11 Tufted Titmice habitat preferences changed from winter to spring. In winter (a), Tufted Titmice were more likely to be present in smaller woodlots surrounded by greater percentages of woods. In spring (b), Tufted Titmice were more likely to be common in larger woodlots surrounded by greater percentages of woods. Error bars represent the standard error of the mean for the overall analysis.

Discussion

This study investigated the influence of woodlot size and matrix composition in rural and suburban southeast Michigan on Tufted Titmice occupancy. Results indicated that woodlot size and landscape variables were significantly associated with Tufted Titmouse presence in winter and frequency in spring.

It was expected that in both winter and spring Tufted Titmice would prefer woodlots with greater area. In winter, the hypothesis was not supported, as Tufted Titmice were more likely to be present in smaller woodlots. In spring, the hypothesis was not strongly supported although Tufted Titmouse were somewhat more common in larger woodlots. These results suggest that the habitat needs of Tufted Titmice change from winter to spring.

In winter, the habitat structure of smaller woodlots may play a role in the preference of Tufted Titmice. Tufted Titmice have a heavy reliance on ground feeding, concentrating on fallen mast when it is present, and reduced snow cover in smaller woodlots may make more leaf litter available for foraging (Doherty and Grubb 2002). Smaller woodlots have higher edge-to-interior ratios than larger woodlots. With greater edge area, solar radiation may penetrate more area of a small woodlot than of a large woodlot. Temperature and humidity in the edges is generally higher, especially in the daytime (Saunders et al. 1991, Murcia 1995), and these conditions may result in reduced snow cover as compared to the interior habitat of the forest fragment. Thus, Tufted Titmice that are able to forage around the edges in smaller woodlots may do so in warmer temperatures with reduced snow cover and greater access to leaf litter.

Additionally, edge habitat has denser understory vegetation than interior forest habitat (Saunders et al. 1991), as was anecdotally noted in this study. The use of edge habitat may provide protection both from wind-induced convective heat loss and from hawk predation, also contributing to greater winter survival (Doherty and Grubb 2000).

Results indicated that in spring Tufted Titmice were present in a wider variety of woodlots (e.g., they were detected in all woodlots that they had been detected in during the previous winter, as well as in other woodlots). Spring is the start of the breeding season. This species breeds in natural tree cavities (Grubb and Pravosudov 1994), and there is likely a limited number of natural tree cavities available in smaller woodlots, as was anecdotally noted in this study, where Tufted Titmice were more likely to be present in winter. Reduced snow cover in spring resulting in greater access to leaf litter may allow for the use of a wider variety of woodlots as Tufted Titmice seek nesting habitat. However, there is a lack of information on Tufted Titmouse reproductive success and demography (Grubb and Pravosudov 1994), and this will require further study.

It was expected that in both winter and spring Tufted Titmice would prefer woodlots located in wooded matrices, as percentage of forest cover has been significantly and positively correlated to Tufted Titmouse abundance (Grubb and Pravosudov 1994). The hypothesis was supported because in winter Tufted Titmice were more likely to be present in woodlots surrounded by greater percentages of wooded landscapes and in spring they were more common in woodlots surrounded by greater percentages of wooded landscapes. Isolation and connectedness of a

woodlot to the surrounding landscape play important roles in determining the occupancy of birds (Doherty and Grubb 2000) although Brown and Sullivan (2005) found Tufted Titmice increased in relative abundance with increasing fragmentation and isolation or were not affected by these factors.

Landscapes that provide movement corridors (e.g., cover for movement) between patches may facilitate immigration/emigration as climatic conditions and food resources require (Doherty and Grubb 2000), allowing for higher survivorship (Belisle and Desrochers 2002). Harsh weather, diminished food resources, or both (Grubb and Doherty 1999) often force birds to leave their territory for additional foraging opportunities (Turcotte and Desrochers 2005) and buffer areas under severe environmental conditions (Yamaura et al. 2005). If Tufted Titmice can commute to patches that provide more thermal protection and/or increased food resources, they should realize an energy benefit (Grubb and Doherty 1999).

This study presents data relating to Tufted Titmouse habitat preferences as they occur today. Given this information, it is possible to conclude that a mechanism that likely contributed to the conditions necessary for Tufted Titmouse range expansion and population growth was landscape changes, beginning in the late 1800s, that resulted in more suitable habitat (i.e., the regrowth of forests in and around agricultural and developed lands).

The loss of existing ecological communities and their conversion to other uses (e.g. agriculture or development) are two of the major factors that have most affected bird distribution and population numbers in Michigan (Wolinski 1988). Since European settlement, the forests of Michigan have been almost completely

destroyed by development (Bourda 1956) and conversion to commercial activity (Whitney 1987). By the 1800s, agriculture was the dominant land use in the region (Walsh et al. 2003), and by the end of the 1890s, nearly all remaining arable land in the Midwest was occupied (Prince 1997). In addition, population increase has been closely associated with rapid land conversion (Walsh et al. 2003). By the 1920s, most of the old-growth pine and hardwood forests of Michigan were destroyed or reduced to small fragments (Whitney 1987).

Over time, marginal farmland was taken out of production (Whitney 1994) or abandoned, and vegetative succession may have resumed. However, the disturbance regimes that defined presettlement forest composition and successional pathways were severely altered by human activities and resulted in the development of extensive oak-dominated (*Quercus* spp.) forests, a preferred habitat for Tufted Titmice (Doherty and Grubb 2000), where few had existed in the presettlement landscapes (Palik and Pregitzer 1992).

In some cases, agricultural conversion resulted in scattered plantings of windbreaks/shelter belts (narrow, protective strips of trees) and remnant or planted woodlots (larger, not necessarily linear, woodland areas) around farmsteads and agricultural fields (Swanson et al. 2003). Windbreaks/shelter belts and woodlots function as wooded habitat islands surrounded by agricultural fields or development (Swanson et al. 2003) that may have also provided suitable habitat for Tufted Titmice to exploit.

Advancing human settlement resulted in a deforested, fragmented landscape matrix of residential, agricultural, and natural land use/covers. This type of matrix

may offer few habitat options for species attempting to breed or overwinter, but less-than-optimum habitat conditions may not preclude the presence of a species if it can adapt to the available environment (Brown and Sullivan 2005). Tufted Titmice are forest generalists unaffected by edges (Kroodsma 1984), and they may even prefer many buildings or yards or roads though woodlots (Mancke and Gavin 2000).

Increased oak-hickory forest habitat, which Tufted Titmouse use for nesting cavities and shelter, may have contributed to range expansion. Tufted Titmice breed in natural tree cavities (Grubb and Pravosudov 1994), and if competition, including nest predation, parasitism, or displacement, is greater in fragments, using cavities for nesting or roosting may offer protective benefits (Brown and Sullivan 2005).

Future research investigating the range expansion and population growth of Tufted Titmouse (Loery and Nichols 1985) may examine the influence of increased temperatures (Doherty and Grubb 2002). Evidence suggests that mean global surface temperatures have increased by 0.6 °C during the 20th century with a greater increase in winter than in summer (Bourque et al. 2005). During the first half of the 20th century, temperatures increased and warmer winters with decreased snow cover in smaller woodlots may have increased foraging habitat and resulted in increased overwinter survivorship (Kielb et al. 1992).

Future study might also further examine the influence of supplemental food on range expansion and population growth. Previous studies suggest that supplementary food reduces the winter mortality of resident woodland birds, but supplemental food has been shown to have no positive effect on the nutritional

condition (Doherty and Grubb 2002) or survivorship (Doherty and Grubb 2003) of Tufted Titmice.

The northward expansion of Tufted Titmouse may have coincided with increased temperatures and the regrowth of forests.

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APPENDICES

Appendix A. Study site locations (** winter surveys only)

Study site	Global Positioning System decimal degrees	
Bach's property **	N 42.28257	W 83.64389
Beckwith Conservancy **	N 42.45397	W 84.17283
Bendor's property**	N 42.29811	W 83.61166
Black Pond Woods **	N 42.30343	W 83.72906
Booth's property **	N 42.40092	W 83.99745
Brown Park	N 42.24134	W 83.70829
Bryant's property	N 42.19036	W 83.66528
Cherry Hill Nature Preserve	N 42.30602	W 83.64024
County Farm Park	N 42.25737	W 83.70863
Creekshead Nature Preserve **	N 42°38184	W 83.61091
Curtis Park	N 42°16032	W 83.78924
Dolph Nature Area **	N 42°28017	W 83.79632
Ford Heritage Park	N 42°20966	W 83.59772
Ford Lake Park East	N 42°20896	W 83.57392
Ford Lake Park West	N 42°21186	W 83.58098
Hewens Creek Park	N 42°17589	W 83.62609
Horner Woods	N 42°32222	W 83.66701
Kurta's property **	N 42°40944	W 84.10253
Lakewood Nature Area **	N 42.27602	W 83.79308
LeFurge Nature Preserve	N 42.28314	W 83.59701
Leslie Woods Nature Area **	N 42.30328	W 83.71819
Lille Park	N 42.22398	W 83.68882
Marshall Park	N 42.31355	W 83.66372
Mary McCann Park	N 42.16419	W 83.71592
Matthaei Botanical Gardens	N 42.30518	W 83.65979
Miller Woods **	N 42.36639	W 83.52498
Montibeller Park	N 42.23552	W 83.67385
North Bay Park	N 42.22886	W 83.61162
Oakwoods Nature Area **	N 42.31836	W83.69862
Osbourne Mill Preserve **	N 42.32901	W 83.81097
Park Lyndon South **	N 42.37683	W 84.05953
Parker Mill Park	N 42.27312	W 83.66411
Pittsfield Preserve North 1	N 42.20375	W 83.71766
Pittsfield Preserve North 2	N 42.21272	W 83.71613
Pittsfield Preserve Phase 1 Development	N 42.19823	W 83.71877
Pittsfield Preserve Southeast Property	N 42.19913	W 83.70725
Rodman Preserve	N 42.17353	W 83.81793
Rolling Hills Park	N 42.17449	W 83.65428
Saginaw Forest **	N 42.27327	W 83.80614
Sandra Richardson Park	N 42.15168	W 83.69072
Scarlett-Mitchell Nature Area	N 42.23279	W 83.69392

Appendix A continued. Study site locations (** winter surveys only)

Study site	**Global Positioning System decimal degrees**	
Schroeter Park	N 42.33157	W 83.58725
Searles Nature Preserve	N 42.16161	W 83.65692
Springhill Nature Preserve	N 42.31363	W 83.59447
Wilderness Park	N 42.15785	W 83.77367

Appendix B. Woodlot study site areas and landscape percentages (** winter surveys only)

Woodlot Study Site	Hectares	Percent Developed	Percent Wooded	Percent Open	Percent Water
Kurta's property **	0.89	7.49	45.55	38.70	8.27
Springhill Nature Preserve	2.47	7.44	44.32	46.12	2.12
Bryant's property	3.97	60.46	27.52	10.39	1.63
Schroeter Park	5.87	20.40	44.43	30.15	1.87
Ford Lake Park West	7.20	42.27	12.32	0.71	44.71
Pittsfield Preserve North 1	7.89	10.82	23.64	65.02	0.52
Lakewood Nature Area **	9.35	79.68	13.48	3.78	3.06
Wilderness Park	9.75	30.99	17.59	49.85	1.57
Bach's property **	10.32	18.84	34.23	40.75	6.19
Miller Woods **	10.56	83.61	10.22	5.67	0.50
Curtis Park	11.37	50.91	16.48	29.40	3.21
North Bay Park	11.66	57.38	3.88	16.81	21.94
Montibeller Park	13.19	82.29	10.61	6.44	0.66
Ford Lake Park East	14.12	42.06	14.11	2.51	41.32
County Farm Park	15.01	84.17	12.67	3.01	0.15
Hewens Creek Park	15.18	14.43	17.75	66.91	0.91
Osbourne Mill Preserve **	15.58	39.94	31.79	23.83	4.44
Lille Park	15.74	43.67	19.02	35.33	1.98
Dolph Nature Area **	15.78	74.96	15.90	6.00	3.13
Leslie Woods Nature Area **	15.82	77.80	12.08	9.33	0.79
Rodman Preserve	16.31	14.94	24.52	59.93	0.61
Rolling Hills Park	19.14	35.64	16.07	46.86	1.42
Parker Mill Park	19.75	40.40	36.00	16.42	7.19
Mary McCann Park	21.61	43.19	9.14	47.09	0.58
Pittsfield Preserve Southeast Property	21.93	27.23	28.06	43.39	1.32
Ford Heritage Park	22.02	43.16	12.23	25.12	19.49
Beckwith Conservancy **	22.22	36.51	24.76	33.58	5.15
Pittsfield Preserve Phase One Development	22.66	21.81	23.50	53.41	1.29

Appendix B continued. Woodlot study site areas and landscape percentages (** winter surveys only)

Woodlot Study Site	Hectares	Percent Developed	Percent Wooded	Percent Open	Percent Water
Bendor's property **	23.47	7.05	29.59	62.44	0.92
Black Pond Woods **	25.25	65.15	23.57	8.46	2.82
Searles Nature Preserve	29.42	34.64	29.31	32.31	3.74
Brown Park	29.54	83.81	5.12	8.79	2.27
Sandra Richardson Park	31.69	38.05	14.37	46.45	1.14
Oakwoods Nature Area **	33.35	46.88	26.48	25.02	1.61
Creekshead Nature Preserve **	37.72	29.09	32.86	37.03	1.02
Cherry Hill Nature Preserve	38.28	13.75	62.70	21.26	2.29
Scarlett-Mitchell Nature Area	43.02	74.58	11.45	11.47	2.51
Pittsfield Preserve North 2	49.58	15.53	24.71	58.85	0.91
Saginaw Forest **	51.72	45.05	15.44	36.14	3.37
LeFurge Nature Preserve	72.64	5.80	14.72	77.61	1.87
Marshall Park	76.00	51.13	34.83	12.98	1.06
Horner Woods	96.64	36.61	36.73	26.40	0.26
Matthaei Botanical Gardens	124.20	38.23	37.77	22.31	1.70
Park Lyndon South **	266.77	6.56	72.27	6.60	14.57
Booth's property **	325.17	19.72	56.04	5.18	19.07

Appendix C. Species detected during winter and spring surveys. Migratory Status: Permanent resident = 1; Migrant-breeder = 2; Passage migrant = 3.

Species	**Scientific Name**	**Migratory Status**
Acadian Flycatcher	*Empidonax virescens*	2
Alder Flycatcher	*Empidonax alnorum*	3
American Crow	*Corvus brachyrhynchos*	1
American Goldfinch	*Carduelis tristis*	1
American Redstart	*Setophaga ruticilla*	2
American Robin	*Turdus migratorius*	1
Baltimore Oriole	*Icterus galbula*	2
Barn Swallow	*Hirundo rustica*	2
Bay-breasted Warbler	*Dendroica castanea*	3
Black-and-white Warbler	*Mniotilta varia*	3
Black-billed Cuckoo	*Coccyzus erythropthalmus*	2
Blackburnian Warbler	*Dendroica fusca*	3
Black-capped Chickadee	*Poecile atricapillus*	1
Blackpoll Warbler	*Dendroica striata*	3
Black-throated Blue Warbler	*Dendroica caerulescens*	3
Blue Jay	*Cyanocitta cristata*	1
Blue-gray Gnatcatcher	*Polioptila caerulea*	2
Blue-headed Vireo	*Vireo solitarius*	3
Blue-winged Warbler	*Vermivora pinus*	2
Brown Thrasher	*Toxostoma rufum*	2
Brown-headed Cowbird	*Molothrus ater*	2
Canada Warbler	*Wilsonia canadensis*	3
Cedar Waxwing	*Bombycilla cedrorum*	1
Chestnut-sided Warbler	*Dendroica pensylvanica*	2
Chipping Sparrow	*Spizella passerina*	2
Common Grackle	*Quiscalus quiscula*	2
Common Yellowthroat	*Geothlypis trichas*	2
Cooper's Hawk	*Accipiter cooperii*	1
Dark-eyed Junco	*Junco hyemalis*	3
Downy Woodpecker	*Picoides pubescens*	1
Eastern Bluebird	*Sialia sialis*	1
Eastern Kingbird	*Tyrannus tyrannus*	2
Eastern Meadowlark	*Sturnella magna*	2
Eastern Phoebe	*Sayornis phoebe*	2
Eastern Towhee	*Pipilo erythrophthalmus*	2
Eastern Wood-Pewee	*Contopus virens*	2
Empidonax spp.		3

Appendix C continued. Species detected during winter and spring surveys. Migratory Status: Permanent resident = 1; Migrant-breeder = 2; Passage migrant = 3.

Species	**Scientific Name**	**Migratory Status**
European Starling	*Sturnus vulgaris*	1
Field Sparrow	*Spizella pusilla*	2
Golden-crowned Kinglet	*Regulus satrapa*	3
Gray Catbird	*Dumetella carolinensis*	2
Great Blue Heron	*Ardea herodias*	2
Great Crested Flycatcher	*Myiarchus crinitus*	2
Great Horned Owl	*Bubu virginianus*	1
Green Heron	*Butorides virescens*	3
Hairy Woodpecker	*Picoides villosus*	1
Hermit Thrush	*Catharus guttatus*	3
Hooded Warbler	*Wilsonia citrina*	2
Hooded Warbler	*Wilsonia citrina*	2
House Finch	*Carpodacus mexicanus*	1
House Sparrow	*Passer domesticus*	1
House Wren	*Troglodytes aedon*	2
Indigo Bunting	*Passerina cyanea*	2
Killdeer	*Charadrius vociferus*	2
Least Flycatcher	*Empidonax minimus*	2
Magnolia Warbler	*Dendroica magnolia*	3
Mourning Dove	*Zenaida macroura*	1
Mourning Warbler	*Oporornis philadelphia*	3
Nashville Warbler	*Vermivora ruficapilla*	3
Northern Cardinal	*Cardinalis cardinalis*	1
Northern Flicker	*Colaptes auratus*	1
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	2
Olive-sided Flycatcher	*Contopus cooperi*	3
Ovenbird	*Seiurus aurocapilla*	2
Palm Warbler	*Dendroica palmarum*	3
Pine Warbler	*Dendroica pinus*	2
Red-bellied Woodpecker	*Melanerpes carolinas*	1
Red-breasted Nuthatch	*Sitta canadensis*	2
Red-eyed Vireo	*Vireo olivaceus*	2
Red-tailed Hawk	*Buteo jamaicensis*	1
Red-winged Blackbird	*Agelaius phoeniceus*	2
Ring-necked Pheasant	*Phasianus colchicus*	1
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	2
Ruby-crowned Kinglet	*Regulus calendula*	3

Appendix C continued. Species detected during winter and spring surveys. Migratory Status: Permanent resident = 1; Migrant-breeder = 2; Passage migrant = 3.

Species	**Scientific Name**	**Migratory Status**
Ruby-throated Hummingbird	*Archilochus colubris*	2
Sandhill Crane	*Grus canadensis*	2
Scarlet Tanager	*Piranga olivacea*	2
Song Sparrow	*Melospiza melodia*	1
Swainson's Thrush	*Catharus ustulatus*	3
Tennessee Warbler	*Vermivora peregrina*	3
Tree Swallow	*Tachycineta bicolor*	2
Tufted Titmouse	*Baeolophus bicolor*	1
Warbler spp.		3
Warbling Vireo	*Vireo gilvus*	2
White-breasted Nuthatch	*Sitta carolinensis*	1
White-crowned Sparrow	*Zonotrichia leucophrys*	3
White-throated Sparrow	*Zonotrichia albicollis*	3
Willow Flycatcher	*Empidonax traillii*	2
Winter Wren	*Troglodytes troglodytes*	3
Wood Thrush	*Hylocichla mustelina*	2
Yellow Warbler	*Dendroica petechia*	2
Yellow-rumped Warbler	*Dendroica coronata*	3
Yellow-throated Vireo	*Vireo flavifrons*	2

Appendix D. Winter bird survey results

Bach's property				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/07/05	American Robin	1	0	0
	Black-capped Chickadee	0	1	0
	Blue Jay	2	3	0
	Downy Woodpecker	2	2	0
	Golden-crowned Kinglet	0	1	0
	Northern Flicker	0	0	1
	Red-bellied Woodpecker	1	2	0
	Red-tailed Hawk	1	0	0
	White-breasted Nuthatch	2	2	0
	Abundance/treatment	9	11	1
	Species/treatment	6	6	1
	Total survey abundance	14		
	Total survey species	9		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
1/1/06	Black-capped Chickadee	0	6	0
	Blue Jay	1	1	0
	Downy Woodpecker	0	0	1
	Red-bellied Woodpecker	1	2	0
	White-breasted Nuthatch	0	1	2
	Abundance/treatment	2	10	3
	Species/treatment	2	4	2
	Total survey abundance	12		
	Total survey species	5		

Appendix D continued. Winter bird survey results

Bach's property				
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/22/05	Black-capped Chickadee	0	0	1
	Downy Woodpecker	0	1	0
	Red-bellied Woodpecker	1	2	0
	White-breasted Nuthatch	0	0	1
	Abundance/treatment	1	3	2
	Species/treatment	1	2	2
	Total survey abundance	5		
	Total survey species	4		
Total abundance = 31 **Total species = 9**				

Appendix D continued. Winter bird survey results

Beckwith Conservancy				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/23/05	American Goldfinch	1	0	1
	Black-capped Chickadee	2	7	0
	Dark-eyed Junco	1	0	1
	Downy Woodpecker	1	0	0
	Northern Cardinal	2	1	0
	White-breasted Nuthatch	1	0	0
	Abundance/treatment	8	8	2
	Species/treatment	6	2	2
	Total survey abundance	13		
	Total survey species	6		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/16/05	American Goldfinch	0	1	0
	Black-capped Chickadee	0	8	0
	Blue Jay	3	2	0
	Dark-eyed Junco	0	2	0
	Downy Woodpecker	1	1	0
	Northern Cardinal	1	1	0
	Tufted Titmouse	0	2	0
	White-breasted Nuthatch	0	2	0
	White-throated Sparrow	0	0	1
	Abundance/treatment	5	19	1
	Species/treatment	3	8	1
	Total survey abundance	21		
	Total survey species	9		

Appendix D continued. Winter bird survey results

Beckwith Conservancy continued				
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/31/05	American Goldfinch	3	1	2
	Black-capped Chickadee	3	6	0
	Blue Jay	0	0	1
	Downy Woodpecker	1	0	0
	Golden-crowned Kinglet	0	2	0
	Northern Cardinal	1	2	0
	Red-bellied Woodpecker	0	0	1
	Tufted Titmouse	0	0	1
	Abundance/treatment	8	11	5
	Species/treatment	4	4	4
	Total survey abundance	17		
	Total survey species	8		
Total abundance = 51 **Total species = 11**				

Appendix D continued. Winter bird survey results

Bendor's property				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/07/05	Black-capped Chickadee	0	1	0
	Downy Woodpecker	1	1	0
	Northern Flicker	0	1	0
	Red-bellied Woodpecker	1	1	0
	White-breasted Nuthatch	0	1	0
	Abundance/treatment	2	5	0
	Species/treatment	2	5	0
	Total survey abundance	5		
	Total survey species	5		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
1/1/06	Black-capped Chickadee	0	6	0
	Blue Jay	1	1	0
	Downy Woodpecker	0	2	0
	Red-bellied Woodpecker	0	2	3
	White-breasted Nuthatch	1	2	0
	Abundance/treatment	2	13	3
	Species/treatment	2	5	1
	Total survey abundance	14		
	Total survey species	5		
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/22/05	Red-bellied Woodpecker	2	2	0
	Abundance/treatment	2	2	0
	Species/treatment	1	1	0
	Total survey abundance	2		
	Total survey species	1		
Total abundance = 21 **Total species = 6**				

Appendix D continued. Winter bird survey results

Black Pond Woods				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
01/01/06	American Crow	0	30	0
	Black-capped Chickadee	0	5	0
	Blue Jay	1	0	0
	Northern Cardinal	1	1	0
	Tufted Titmouse	0	4	0
	White-breasted Nuthatch	1	2	0
	Abundance/treatment	3	42	0
	Species/treatment	3	5	0
	Total survey abundance	43		
	Total survey species	6		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/7/05	American Robin	2	1	2
	Black-capped Chickadee	0	7	0
	Blue Jay	1	0	0
	Downy Woodpecker	2	0	0
	Golden-crowned Kinglet	0	0	1
	Northern Cardinal	2	3	0
	White-breasted Nuthatch	0	1	0
	Abundance/treatment	7	12	3
	Species/treatment	4	4	2
	Total survey abundance	17		
	Total survey species	7		

Appendix D continued. Winter bird survey results

Black Pond Woods continued				
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/22/05	American Goldfinch	2	0	1
	Blue Jay	1	0	0
	Downy Woodpecker	1	0	0
	Hermit Thrush	0	1	0
	Northern Cardinal	0	3	0
	Abundance/treatment	4	4	1
	Species/treatment	3	2	1
	Total survey abundance	8		
	Total survey species	5		
Total abundance = 68 **Total species = 11**				

Appendix D continued. Winter bird survey results

Booth's property				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/16/05	American Goldfinch	0	15	0
	Black-capped Chickadee	0	5	6
	Eastern Bluebird	0	4	0
	Northern Flicker	0	1	0
	Red-bellied Woodpecker	0	0	2
	White-breasted Nuthatch	0	0	1
	Abundance/treatment	0	25	9
	Species/treatment	0	4	3
	Total survey abundance	29		
	Total survey species	6		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/23/05	American Goldfinch	1	0	0
	Black-capped Chickadee	1	5	0
	Blue Jay	1	0	0
	Downy Woodpecker	1	0	2
	Golden-crowned Kinglet	0	0	1
	Northern Flicker	1	0	0
	Red-bellied Woodpecker	1	1	0
	White-breasted Nuthatch	2	2	0
	Abundance/treatment	8	8	3
	Species/treatment	7	3	2
	Total survey abundance	14		
	Total survey species	8		

Appendix D continued. Winter bird survey results

Booth's property continued				
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/31/05	Blue Jay	1	0	0
	Downy Woodpecker	0	1	0
	Northern Flicker	1	0	0
	White-breasted Nuthatch	0	2	0
	Abundance/treatment	2	3	0
	Species/treatment	2	2	0
	Total survey abundance	5		
	Total survey species	4		
Total abundance = 48 **Total species = 9**				

Appendix D continued. Winter bird survey results

Brown Park				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
11/20/04	American Goldfinch	0	0	1
	American Robin	1	0	0
	Black-capped Chickadee	0	0	2
	Blue Jay	2	0	1
	Downy Woodpecker	1	2	3
	Northern Cardinal	1	0	0
	White-breasted Nuthatch	0	2	0
	Abundance/treatment	5	4	7
	Species/treatment	4	2	4
	Total survey abundance	12		
	Total survey species	7		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/9/04	American Crow	0	0	18
	Abundance/treatment	0	0	18
	Species/treatment	0	0	1
	Total survey abundance	18		
	Total survey species	1		
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/2/04	American Robin	0	0	1
	Downy Woodpecker	1	1	0
	Red-bellied Woodpecker	0	1	0
	White-breasted Nuthatch	0	0	1
	Abundance/treatment	1	2	2
	Species/treatment	1	2	2
	Total survey abundance	4		
	Total survey species	4		
Total abundance = 34 **Total species = 9**				

Appendix D continued. Winter bird survey results

Bryant's property				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/14/2004	American Goldfinch	1	1	0
	American Robin	12	0	15
	Black-capped Chickadee	1	4	0
	Cedar Waxwing	4	6	0
	Dark-eyed Junco	0	2	0
	Downy Woodpecker	1	1	2
	Northern Cardinal	1	1	2
	Tufted Titmouse	1	2	1
	Abundance/treatment	21	17	20
	Species/treatment	7	7	4
	Total survey abundance	34		
	Total survey species	8		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/2/2004	American Goldfinch	1	1	0
	Black-capped Chickadee	3	4	0
	Blue Jay	0	0	2
	Downy Woodpecker	0	1	0
	Hermit Thrush	0	2	3
	Northern Cardinal	0	0	2
	Red-bellied Woodpecker	1	2	0
	Tufted Titmouse	1	0	0
	White-breasted Nuthatch	0	1	0
	Abundance/treatment	6	11	7
	Species/treatment	4	6	3
	Total survey abundance	17		
	Total survey species	9		

Appendix D continued. Winter bird survey results

Bryant's property continued				
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
11/23/2004	American Goldfinch	1	0	0
	American Robin	0	2	1
	Black-capped Chickadee	1	1	2
	Downy Woodpecker	1	0	0
	Northern Cardinal	1	1	0
	Red-bellied Woodpecker	0	1	0
	Abundance/treatment	4	5	3
	Species/treatment	4	4	2
	Total survey abundance	8		
	Total survey species	6		
Total abundance = 59 **Total species = 12**				

Appendix D continued. Winter bird survey results

Cherry Hill Nature Preserve				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/12/04	Brown Creeper	0	1	1
	Downy Woodpecker	1	1	1
	Abundance/treatment	1	2	2
	Species/treatment	1	2	2
	Total survey abundance	2		
	Total survey species	2		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/5/04	American Goldfinch	6	20	0
	Black-capped Chickadee	1	8	0
	Blue Jay	0	1	0
	Dark-eyed Junco	0	0	2
	Downy Woodpecker	1	0	0
	Eastern Bluebird	0	5	0
	Hermit Thrush	1	0	0
	House Finch	0	4	0
	Northern Cardinal	0	0	1
	White-breasted Nuthatch	1	1	2
	Abundance/treatment	10	39	5
	Species/treatment	5	6	3
	Total survey abundance	45		
	Total survey species	10		
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
11/23/04	Downy Woodpecker	1	1	1
	Brown Creeper	0	1	0
	Abundance/treatment	1	2	1
	Species/treatment	1	2	1
	Total survey abundance	2		
	Total survey species	2		
Total abundance = 49 **Total species = 11**				

Appendix D continued. Winter bird survey results

County Farm Park				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
11/23/04	Downy Woodpecker	0	1	1
	Abundance/treatment	0	1	1
	Species/treatment	0	1	1
	Total survey abundance	1		
	Total survey species	1		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/11/2004	American Robin	0	0	1
	Black-capped Chickadee	0	1	2
	Abundance/treatment	0	1	3
	Species/treatment	0	1	2
	Total survey abundance	3		
	Total survey species	2		
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/4/04	Downy Woodpecker	1	1	0
	Northern Flicker	1	0	0
	Abundance/treatment	2	1	0
	Species/treatment	2	1	0
	Total survey abundance	2		
	Total survey species	2		
Total abundance = 6 **Total species = 4**				

Appendix D continued. Winter bird survey results

Creekshead Nature Preserve				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
01/01/06	Black-capped Chickadee	0	4	0
	Blue Jay	1	0	0
	Downy Woodpecker	1	2	0
	Red-bellied Woodpecker	1	0	0
	White-breasted Nuthatch	0	3	0
	Abundance/treatment	3	9	0
	Species/treatment	3	3	0
	Total survey abundance	11		
	Total survey species	5		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/22/05	American Goldfinch	1	0	0
	Black-capped Chickadee	0	2	0
	Blue Jay	0	1	0
	Downy Woodpecker	0	2	0
	Golden-crowned Kinglet	3	3	0
	Red-bellied Woodpecker	2	1	0
	Tufted Titmouse	0	1	0
	White-breasted Nuthatch	2	3	0
	Abundance/treatment	8	13	0
	Species/treatment	4	7	0
	Total survey abundance	15		
	Total survey species	8		

Appendix D continued. Winter bird survey results

Creekshead Nature Preserve continued				
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/14/05	American Goldfinch	0	8	0
	American Robin	1	0	0
	Black-capped Chickadee	2	0	0
	Brown Creeper	0	0	1
	Downy Woodpecker	1	1	2
	Eastern Bluebird	0	2	0
	Great Horned Owl	1	0	0
	Red-bellied Woodpecker	1	0	0
	Tufted Titmouse	0	2	0
	White-breasted Nuthatch	0	4	0
	Abundance/treatment	6	17	3
	Species/treatment	5	5	2
	Total survey abundance	24		
	Total survey species	10		
Total abundance = 50 **Total species = 12**				

Appendix D continued. Winter bird survey results

Curtis Park				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/11/2004	American Robin	2	0	2
	Black-capped Chickadee	0	5	0
	Brown Creeper	0	1	0
	Downy Woodpecker	0	1	2
	Golden-crowned Kinglet	0	3	0
	Northern Cardinal	2	0	0
	Northern Flicker	0	0	1
	White-breasted Nuthatch	1	4	0
	Abundance/treatment	5	14	5
	Species/treatment	3	5	3
	Total survey abundance	20		
	Total survey species	8		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/4/2004	American Robin	2	0	0
	Black-capped Chickadee	1	4	0
	Cedar Waxwing	1	0	2
	Dark-eyed Junco	2	0	0
	Downy Woodpecker	0	2	0
	Golden-crowned Kinglet	0	3	0
	Tufted Titmouse	0	2	0
	White-breasted Nuthatch	0	1	0
	Abundance/treatment	6	12	2
	Species/treatment	4	5	1
	Total survey abundance	18		
	Total survey species	8		

Appendix D continued. Winter bird survey results

Curtis Park continued				
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
11/21/2004	Black-capped Chickadee	2	1	0
	Brown Creeper	0	1	0
	Downy Woodpecker	1	2	0
	Tufted Titmouse	2	2	1
	White-breasted Nuthatch	0	2	0
	Abundance/treatment	5	8	1
	Species/treatment	3	5	1
	Total survey abundance	9		
	Total survey species	5		
Total abundance = 47 **Total species = 12**				

Appendix D continued. Winter bird survey results

Dolph Nature Area				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/24/05	American Goldfinch	2	0	0
	Black-capped Chickadee	0	7	0
	Blue Jay	1	4	0
	Downy Woodpecker	1	1	0
	Northern Cardinal	2	3	0
	Red-bellied Woodpecker	0	0	1
	Tufted Titmouse	0	0	2
	White-breasted Nuthatch	0	0	2
	Abundance/treatment	6	15	5
	Species/treatment	4	4	3
	Total survey abundance	22		
	Total survey species	8		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/14/05	American Goldfinch	1	0	0
	American Robin	1	1	0
	Black-capped Chickadee	1	3	0
	Blue Jay	0	1	0
	Abundance/treatment	3	5	0
	Species/treatment	3	3	0
	Total survey abundance	6		
	Total survey species	4		

Appendix D continued. Winter bird survey results

Dolph Nature Area continued				
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/31/05	American Goldfinch	1	0	0
	Black-capped Chickadee	2	4	0
	Blue Jay	0	3	0
	Dark-eyed Junco	1	0	0
	Northern Cardinal	1	0	0
	Tufted Titmouse	0	1	0
	Abundance/treatment	5	8	0
	Species/treatment	4	3	0
	Total survey abundance	11		
	Total survey species	6		
Total abundance = 39 **Total species = 10**				

Appendix D continued. Winter bird survey results

Ford Heritage Park				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
11/21/2004	Black-capped Chickadee	0	2	5
	Downy Woodpecker	1	2	0
	Red-bellied Woodpecker	1	0	0
	White-breasted Nuthatch	0	0	2
	Abundance/treatment	2	4	7
	Species/treatment	2	2	2
	Total survey abundance	10		
	Total survey species	4		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/11/2004	American Goldfinch	0	8	9
	Dark-eyed Junco	0	1	0
	Downy Woodpecker	1	0	0
	Red-bellied Woodpecker	0	1	0
	Abundance/treatment	1	10	9
	Species/treatment	1	3	1
	Total survey abundance	12		
	Total survey species	4		
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/4/2004	Downy Woodpecker	0	1	2
	Golden-crowned Kinglet	0	1	0
	White-breasted Nuthatch	0	1	0
	Abundance/treatment	0	3	2
	Species/treatment	0	3	1
	Total survey abundance	4		
	Total survey species	3		
Total abundance = 26 **Total species = 8**				

Appendix D continued. Winter bird survey results

Ford Lake Park East				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
11/21/2004	American Goldfinch	0	3	0
	American Robin	0	0	1
	Black-capped Chickadee	0	5	0
	Downy Woodpecker	2	2	0
	Golden-crowned Kinglet	0	0	2
	Northern Flicker	0	1	0
	Red-bellied Woodpecker	0	1	0
	Abundance/treatment	2	12	3
	Species/treatment	1	5	2
	Total survey abundance	15		
	Total survey species	7		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/11/2004	Black-capped Chickadee	0	7	0
	Dark-eyed Junco	0	1	0
	Downy Woodpecker	0	0	1
	Northern Cardinal	1	1	0
	Red-bellied Woodpecker	0	0	1
	Abundance/treatment	1	9	2
	Species/treatment	1	3	2
	Total survey abundance	11		
	Total survey species	5		
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/4/2004	American Goldfinch	0	1	0
	Abundance/treatment	0	1	0
	Species/treatment	0	1	0
	Total survey abundance	1		
	Total survey species	1		
Total abundance = 27 **Total species = 9**				

Appendix D continued. Winter bird survey results

Ford Lake Park West				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
11/21/2004	American Goldfinch	1	0	0
	American Robin	0	1	10
	American Tree Sparrow	2	0	0
	Blue Jay	1	0	0
	Cedar Waxwing	4	0	0
	Downy Woodpecker	1	1	0
	Abundance/treatment	9	2	10
	Species/treatment	5	2	1
	Total survey abundance	19		
	Total survey species	6		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/8/2004	American Robin	1	14	0
	Blue Jay	0	1	0
	Downy Woodpecker	0	2	0
	Northern Cardinal	0	1	0
	Abundance/treatment	1	18	0
	Species/treatment	1	4	0
	Total survey abundance	18		
	Total survey species	4		
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/13/2004	American Robin	0	1	2
	Black-capped Chickadee	0	4	5
	Downy Woodpecker	0	1	0
	Northern Cardinal	1	0	2
	White-breasted Nuthatch	0	1	0
	Abundance/treatment	1	7	9
	Species/treatment	1	4	3
	Total survey abundance	11		
	Total survey species	5		
Total abundance = 48 **Total species = 9**				

Appendix D continued. Winter bird survey results

Hewens Creek Park				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/4/2004	American Goldfinch	1	0	0
	Black-capped Chickadee	0	0	2
	Northern Cardinal	1	0	0
	Abundance/treatment	2	0	2
	Species/treatment	2	0	1
	Total survey abundance	4		
	Total survey species	3		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
11/21/2004	American Robin	1	0	0
	Black-capped Chickadee	2	6	0
	Blue Jay	1	0	0
	Dark-eyed Junco	0	0	1
	Golden-crowned Kinglet	0	2	0
	Hermit Thrush	0	0	1
	White-breasted Nuthatch	1	0	0
	Abundance/treatment	5	8	2
	Species/treatment	4	2	2
	Total survey abundance	13		
	Total survey species	7		
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/11/2004	Golden-crowned Kinglet	0	2	0
	Black-capped Chickadee	1	3	0
	Blue Jay	0	1	0
	Hermit Thrush	0	0	1
	Northern Cardinal	1	3	0
	Abundance/treatment	2	9	1
	Species/treatment	2	4	1
	Total survey abundance	10		
	Total survey species	5		
Total abundance = 27 **Total species = 9**				

Appendix D continued. Winter bird survey results

Horner Woods				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/5/2004	American Robin	0	2	0
	Downy Woodpecker	1	1	0
	Northern Cardinal	0	1	0
	Red-bellied Woodpecker	1	0	0
	White-breasted Nuthatch	0	1	0
	Abundance/treatment	2	5	0
	Species/treatment	2	4	0
	Total survey abundance	6		
	Total survey species	5		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
11/23/2004	American Goldfinch	0	0	1
	Downy Woodpecker	2	0	1
	White-breasted Nuthatch	0	1	1
	Abundance/treatment	2	1	3
	Species/treatment	1	1	3
	Total survey abundance	4		
	Total survey species	3		
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/13/2004	American Crow	1	0	0
	Red-bellied Woodpecker	2	1	1
	White-breasted Nuthatch	0	2	2
	Abundance/treatment	3	3	3
	Species/treatment	2	2	2
	Total survey abundance	5		
	Total survey species	3		
Total abundance = 15 **Total species = 7**				

Appendix D continued. Winter bird survey results

Kurta's property				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/23/05	American Robin	0	0	1
	Black-capped Chickadee	0	8	0
	Blue Jay	3	3	0
	Dark-eyed Junco	0	1	0
	Downy Woodpecker	1	1	0
	Eastern Bluebird	1	0	0
	Northern Cardinal	1	0	0
	Northern Flicker	1	0	0
	Red-bellied Woodpecker	0	0	1
	Tufted Titmouse	0	2	0
	Abundance/treatment	7	15	2
	Species/treatment	5	5	2
	Total survey abundance	20		
	Total survey species	10		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/31/05	Black-capped Chickadee	2	4	0
	Blue Jay	1	2	3
	Dark-eyed Junco	0	3	0
	Northern Cardinal	2	1	2
	Abundance/treatment	5	10	5
	Species/treatment	3	4	2
	Total survey abundance	12		
	Total survey species	4		

Appendix D continued. Winter bird survey results

Kurta's property continued				
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/16/05	American Goldfinch	1	0	0
	Black-capped Chickadee	0	10	0
	Blue Jay	2	3	0
	Dark-eyed Junco	0	2	4
	Downy Woodpecker	0	2	0
	Eastern Bluebird	9	1	0
	Northern Cardinal	0	1	0
	Red-bellied Woodpecker	1	1	0
	Red-tailed Hawk	0	0	1
	White-breasted Nuthatch	1	2	0
	Abundance/treatment	14	22	5
	Species/treatment	5	8	2
	Total survey abundance	34		
	Total survey species	10		
Total abundance = 66 **Total species = 13**				

Appendix D continued. Winter bird survey results

Lakewood Nature Area				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/14/05	Black-capped Chickadee	1	1	2
	Blue Jay	0	1	0
	Abundance/treatment	1	2	2
	Species/treatment	1	2	1
	Total survey abundance	3		
	Total survey species	2		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/24/05	American Goldfinch	3	0	1
	Black-capped Chickadee	0	5	0
	Blue Jay	1	0	0
	Downy Woodpecker	2	0	0
	Northern Cardinal	1	0	0
	Red-bellied Woodpecker	0	0	1
	Tufted Titmouse	0	1	0
	White-breasted Nuthatch	0	3	0
	Abundance/treatment	7	9	2
	Species/treatment	4	3	2
	Total survey abundance	17		
	Total survey species	8		
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/31/05	Black-capped Chickadee	1	0	0
	Downy Woodpecker	0	0	1
	White-breasted Nuthatch	0	3	0
	Abundance/treatment	1	3	1
	Species/treatment	1	1	1
	Total survey abundance	5		
	Total survey species	3		
Total abundance = 25 **Total species = 8**				

Appendix D continued. Winter bird survey results

LeFurge Nature Preserve				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
11/23/2004	American Goldfinch	1	0	0
	Downy Woodpecker	0	1	2
	Red-bellied Woodpecker	1	1	1
	Abundance/treatment	2	2	3
	Species/treatment	2	2	2
	Total survey abundance	4		
	Total survey species	3		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/12/2004	American Robin	1	0	0
	Downy Woodpecker	0	0	1
	Abundance/treatment	1	0	1
	Species/treatment	1	0	1
	Total survey abundance	2		
	Total survey species	2		
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/5/2004	American Crow	3	0	0
	Downy Woodpecker	0	1	0
	Red-bellied Woodpecker	0	1	0
	Abundance/treatment	3	2	0
	Species/treatment	1	2	0
	Total survey abundance	5		
	Total survey species	3		
Total abundance = 11 **Total species = 5**				

Appendix D continued. Winter bird survey results

Leslie Woods Nature Area				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
01/01/06	Black-capped Chickadee	1	6	0
	Blue Jay	1	0	1
	Downy Woodpecker	1	1	0
	Red-bellied Woodpecker	2	1	2
	Tufted Titmouse	3	3	0
	White-breasted Nuthatch	2	3	0
	Abundance/treatment	10	14	3
	Species/treatment	6	5	2
	Total survey abundance	16		
	Total survey species	6		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/7/05	American Robin	2	0	0
	Downy Woodpecker	1	1	2
	Northern Flicker	1	0	1
	Red-bellied Woodpecker	0	1	2
	Tufted Titmouse	0	2	0
	White-breasted Nuthatch	1	3	4
	Abundance/treatment	5	7	9
	Species/treatment	4	4	4
	Total survey abundance	13		
	Total survey species	6		

Appendix D continued. Winter bird survey results

Leslie Woods Nature Area continued				
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/22/05	American Goldfinch	0	0	2
	American Robin	0	0	1
	Downy Woodpecker	1	0	1
	Red-bellied Woodpecker	1	3	0
	Tufted Titmouse	0	0	3
	White-breasted Nuthatch	0	0	1
	Abundance/treatment	2	3	8
	Species/treatment	2	1	5
	Total survey abundance	11		
	Total survey species	6		
Total abundance = 40 **Total species = 9**				

Appendix D continued. Winter bird survey results

Lille Park				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/11/2004	American Robin	1	0	0
	Downy Woodpecker	2	2	1
	Abundance/treatment	3	2	1
	Species/treatment	2	1	1
	Total survey abundance	3		
	Total survey species	2		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
11/20/2004	Downy Woodpecker	0	1	1
	Hermit Thrush	2	0	2
	Northern Flicker	1	0	0
	White-breasted Nuthatch	0	2	2
	Abundance/treatment	3	3	5
	Species/treatment	2	2	3
	Total survey abundance	6		
	Total survey species	4		
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/2/2004	American Crow	2	0	0
	Brown Creeper	0	0	1
	Downy Woodpecker	1	0	0
	Golden-crowned Kinglet	0	1	0
	Red-bellied Woodpecker	1	0	0
	White-breasted Nuthatch	0	2	0
	Abundance/treatment	4	3	1
	Species/treatment	3	2	1
	Total survey abundance	8		
	Total survey species	6		
Total abundance = 17 **Total species = 9**				

Appendix D continued. Winter bird survey results

Marshall Park				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
11/23/2004	Black-capped Chickadee	3	4	5
	Downy Woodpecker	1	2	0
	Red-bellied Woodpecker	1	1	0
	White-breasted Nuthatch	3	2	0
	Abundance/treatment	8	9	5
	Species/treatment	4	4	1
	Total survey abundance	11		
	Total survey species	4		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/5/2004	Black-capped Chickadee	3	4	0
	Downy Woodpecker	1	0	0
	Golden-crowned Kinglet	1	0	0
	Red-bellied Woodpecker	1	0	0
	White-throated Sparrow	0	0	3
	Abundance/treatment	6	4	3
	Species/treatment	4	1	1
	Total survey abundance	10		
	Total survey species	5		
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/13/2004	American Robin	1	0	0
	American Crow	1	0	0
	American Goldfinch	0	0	1
	Black-capped Chickadee	0	0	1
	Red-bellied Woodpecker	1	0	1
	White-breasted Nuthatch	0	1	0
	Abundance/treatment	3	1	3
	Species/treatment	3	1	3
	Total survey abundance	6		
	Total survey species	6		
Total abundance = 27 **Total species = 9**				

Appendix D continued. Winter bird survey results

Mary McCann Park				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/14/2004	American Goldfinch	1	0	4
	Black-capped Chickadee	1	1	0
	Downy Woodpecker	1	2	3
	Golden-crowned Kinglet	3	4	0
	Hawk spp.	1	0	0
	Northern Cardinal	0	1	2
	Red-bellied Woodpecker	0	1	0
	White-breasted Nuthatch	0	4	0
	Abundance/treatment	7	13	9
	Species/treatment	5	6	3
	Total survey abundance	20		
	Total survey species	8		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/6/2004	American Crow	3	0	0
	Blue Jay	1	0	0
	Downy Woodpecker	0	2	0
	White-breasted Nuthatch	0	0	2
	Abundance/treatment	4	2	2
	Species/treatment	2	1	1
	Total survey abundance	8		
	Total survey species	4		
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
11/23/2004	American Goldfinch	1	0	0
	Brown Creeper	0	1	0
	Downy Woodpecker	0	1	0
	Northern Flicker	0	0	1
	Red-bellied Woodpecker	1	0	0
	White-breasted Nuthatch	0	2	4
	Abundance/treatment	2	4	5
	Species/treatment	2	3	2
	Total survey abundance	9		
	Total survey species	6		
Total abundance = 37 **Total species = 12**				

Appendix D continued. Winter bird survey results

Matthaei Botanical Gardens				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/12/2004	American Goldfinch	0	0	1
	Northern Cardinal	0	1	2
	Abundance/treatment	0	1	3
	Species/treatment	0	1	2
	Total survey abundance	3		
	Total survey species	2		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/5/2004	American Goldfinch	0	1	4
	Black-capped Chickadee	2	4	0
	Blue Jay	2	2	0
	Cedar Waxwing	1	0	0
	Downy Woodpecker	0	0	1
	Northern Cardinal	0	3	0
	White-breasted Nuthatch	1	0	1
	Abundance/treatment	6	10	6
	Species/treatment	4	4	3
	Total survey abundance	16		
	Total survey species	7		
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
11/23/2004	American Robin	1	0	0
	American Tree Sparrow	0	0	2
	Black-capped Chickadee	0	0	2
	Downy Woodpecker	1	0	1
	Eastern Screech Owl	0	1	0
	White-breasted Nuthatch	1	0	0
	Abundance/treatment	3	1	5
	Species/treatment	3	1	3
	Total survey abundance	8		
	Total survey species	6		
Total abundance = 27 **Total species = 10**				

Appendix D continued. Winter bird survey results

Miller Woods				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
01/01/06	American Goldfinch	0	0	1
	Black-capped Chickadee	1	0	3
	Blue Jay	0	0	1
	Downy Woodpecker	1	0	0
	Northern Cardinal	0	4	0
	Red-bellied Woodpecker	0	1	0
	Abundance/treatment	2	5	5
	Species/treatment	2	2	3
	Total survey abundance	11		
	Total survey species	6		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/22/05	Blue Jay	0	2	0
	Northern Cardinal	1	0	0
	Red-bellied Woodpecker	1	0	1
	Abundance/treatment	2	2	1
	Species/treatment	2	1	1
	Total survey abundance	4		
	Total survey species	3		
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/14/05	Black-capped Chickadee	0	5	7
	Red-bellied Woodpecker	1	0	0
	Abundance/treatment	1	5	7
	Species/treatment	1	1	1
	Total survey abundance	8		
	Total survey species	2		
Total abundance = 23 **Total species = 6**				

Appendix D continued. Winter bird survey results

Montibeller Park				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
11/20/2004	American Robin	1	0	0
	Black-capped Chickadee	1	5	4
	Blue Jay	0	1	1
	Downy Woodpecker	2	0	0
	Northern Cardinal	2	1	1
	Tufted Titmouse	2	0	1
	White-breasted Nuthatch	0	0	1
	Abundance/treatment	8	7	8
	Species/treatment	5	3	5
	Total survey abundance	14		
	Total survey species	7		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/11/2004	Dark-eyed Junco	1	0	0
	Downy Woodpecker	1	0	0
	Hermit Thrush	0	2	0
	Red-bellied Woodpecker	1	0	1
	Tufted Titmouse	0	0	1
	Abundance/treatment	3	2	2
	Species/treatment	3	1	2
	Total survey abundance	6		
	Total survey species	5		

Appendix D continued. Winter bird survey results

Montibeller Park continued				
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/2/2004	American Goldfinch	0	0	1
	American Robin	0	0	1
	Black-capped Chickadee	0	0	1
	Northern Cardinal	1	1	1
	Red-bellied Woodpecker	1	1	0
	Tufted Titmouse	0	1	1
	Abundance/treatment	2	3	5
	Species/treatment	2	3	4
	Total survey abundance	6		
	Total survey species	6		
Total abundance = 26 **Total species = 11**				

Appendix D continued. Winter bird survey results

North Bay Park				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/8/2004	American Goldfinch	0	1	0
	Blue Jay	1	0	0
	Downy Woodpecker	1	0	0
	Northern Cardinal	2	1	0
	Abundance/treatment	4	2	0
	Species/treatment	3	2	0
	Total survey abundance	5		
	Total survey species	4		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/14/2004	American Goldfinch	1	1	1
	American Robin	0	1	1
	Black-capped Chickadee	0	0	3
	Golden-crowned Kinglet	1	0	0
	Northern Cardinal	2	1	2
	Abundance/treatment	4	3	7
	Species/treatment	3	3	4
	Total survey abundance	8		
	Total survey species	5		
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
11/20/2004	Black-capped Chickadee	6	8	0
	Downy Woodpecker	0	1	0
	Northern Cardinal	0	1	2
	Red-bellied Woodpecker	0	1	0
	White-breasted Nuthatch	0	2	0
	Abundance/treatment	6	13	2
	Species/treatment	1	5	1
	Total survey abundance	14		
	Total survey species	5		
Total abundance = 27 **Total species = 9**				

Appendix D continued. Winter bird survey results

Oakwoods Nature Area				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
01/01/06	American Goldfinch	0	0	1
	Black-capped Chickadee	0	6	0
	Dark-eyed Junco	0	4	0
	Downy Woodpecker	0	1	0
	Golden-crowned Kinglet	0	1	0
	Tufted Titmouse	0	3	0
	White-breasted Nuthatch	1	5	0
	Abundance/treatment	1	20	1
	Species/treatment	1	6	1
	Total survey abundance	21		
	Total survey species	7		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/22/05	American Goldfinch	5	2	0
	Black-capped Chickadee	3	5	0
	Dark-eyed Junco	0	1	6
	Downy Woodpecker	2	2	3
	Hairy Woodpecker	0	1	0
	Mourning Dove	0	1	0
	Red-tailed Hawk	1	0	0
	Tufted Titmouse	2	2	0
	White-breasted Nuthatch	1	3	0
	Abundance/treatment	14	17	9
	Species/treatment	6	8	2
	Total survey abundance	27		
	Total survey species	9		

Appendix D continued. Winter bird survey results

Oakwoods Nature Area continued				
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/14/05	American Goldfinch	0	1	3
	Black-capped Chickadee	2	6	0
	Dark-eyed Junco	1	0	0
	Downy Woodpecker	0	2	0
	Red-bellied Woodpecker	0	1	0
	Tufted Titmouse	0	4	0
	White-breasted Nuthatch	0	2	0
	Abundance/treatment	3	16	3
	Species/treatment	2	6	1
	Total survey abundance	19		
	Total survey species	7		
Total abundance = 67 **Total species = 11**				

Appendix D continued. Winter bird survey results

Osbourne Mill Preserve				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/16/05	Black-capped Chickadee	5	6	0
	Blue Jay	1	3	0
	Brown Creeper	0	1	0
	Dark-eyed Junco	0	0	1
	Downy Woodpecker	0	2	0
	Hermit Thrush	0	1	0
	Northern Cardinal	0	2	0
	Red-bellied Woodpecker	1	0	1
	Tufted Titmouse	2	0	1
	White-throated Sparrow	0	1	0
	Abundance/treatment	9	16	3
	Species/treatment	4	7	3
	Total survey abundance	20		
	Total survey species	10		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/31/05	Black-capped Chickadee	1	0	0
	Blue Jay	1	0	3
	Downy Woodpecker	1	0	0
	Northern Cardinal	0	1	0
	Red-bellied Woodpecker	0	0	1
	Abundance/treatment	3	1	4
	Species/treatment	3	1	2
	Total survey abundance	7		
	Total survey species	5		

Appendix D continued. Winter bird survey results

Osbourne Mill Preserve				
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/23/05	American Goldfinch	1	0	0
	American Robin	4	5	6
	Black-capped Chickadee	2	7	0
	Blue Jay	3	3	0
	Dark-eyed Junco	1	4	0
	Downy Woodpecker	0	0	1
	Hermit Thrush	1	1	0
	Northern Cardinal	2	4	0
	Northern Flicker	0	1	0
	Red-bellied Woodpecker	0	1	0
	Tufted Titmouse	2	3	0
	White-breasted Nuthatch	1	3	0
	Abundance/treatment	17	32	7
	Species/treatment	9	10	2
	Total survey abundance	35		
	Total survey species	12		
Total abundance = 62 **Total species = 14**				

Appendix D continued. Winter bird survey results

Park Lyndon South				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/31/05	Black-capped Chickadee	0	8	0
	Blue Jay	2	2	0
	Golden-crowned Kinglet	0	0	1
	Northern Flicker	0	1	0
	Red-bellied Woodpecker	0	1	0
	Tufted Titmouse	0	2	0
	White-breasted Nuthatch	0	0	2
	Abundance/treatment	2	14	3
	Species/treatment	1	5	2
	Total survey abundance	17		
	Total survey species	7		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/23/05	American Robin	0	0	3
	Black-capped Chickadee	1	5	0
	Blue Jay	1	0	1
	Downy Woodpecker	0	0	1
	Golden-crowned Kinglet	0	0	1
	Tufted Titmouse	0	0	1
	White-breasted Nuthatch	0	1	2
	Abundance/treatment	2	6	9
	Species/treatment	2	2	6
	Total survey abundance	14		
	Total survey species	7		
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/16/05	Downy Woodpecker	0	1	0
	White-breasted Nuthatch	0	2	0
	Blue Jay	0	1	0
	Abundance/treatment	0	4	0
	Species/treatment	0	3	0
	Total survey abundance	4		
	Total survey species	3		
Total abundance = 35 **Total species = 9**				

Appendix D continued. Winter bird survey results

Parker Mill Park				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/5/2004	American Goldfinch	1	0	0
	American Robin	0	3	4
	Black-capped Chickadee	6	8	0
	Blue Jay	0	1	0
	Downy Woodpecker	1	2	0
	Hermit Thrush	0	2	0
	Northern Cardinal	1	2	0
	Northern Flicker	1	0	0
	Red-bellied Woodpecker	0	1	0
	Tufted Titmouse	2	2	2
	Abundance/treatment	12	21	6
	Species/treatment	6	8	2
	Total survey abundance	24		
	Total survey species	10		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/14/2004	Black-capped Chickadee	1	0	0
	Downy Woodpecker	1	0	2
	Abundance/treatment	2	0	2
	Species/treatment	2	0	1
	Total survey abundance	3		
	Total survey species	2		

Appendix D continued. Winter bird survey results

Parker Mill Park continued				
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/9/2004	American Goldfinch	0	0	1
	Black-capped Chickadee	2	0	0
	Blue Jay	0	1	0
	Dark-eyed Junco	1	0	0
	Downy Woodpecker	0	1	0
	Golden-crowned Kinglet	1	0	0
	Hermit Thrush	0	0	1
	Northern Cardinal	1	2	2
	Abundance/treatment	5	4	4
	Species/treatment	4	3	3
	Total survey abundance	10		
	Total survey species	8		
Total abundance = 37 **Total species = 12**				

Appendix D continued. Winter bird survey results

Pittsfield Preserve North 1				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
11/30/2004	American Crow	1	0	0
	American Goldfinch	0	0	1
	Black-capped Chickadee	0	5	0
	Blue Jay	1	0	0
	Northern Cardinal	1	0	0
	Northern Flicker	0	0	2
	Red-bellied Woodpecker	0	1	0
	Abundance/treatment	3	6	3
	Species/treatment	3	2	2
	Total survey abundance	12		
	Total survey species	7		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/9/2004	American Goldfinch	1	0	0
	American Robin	0	0	3
	American Tree Sparrow	0	0	1
	Blue Jay	1	0	0
	Dark-eyed Junco	1	0	0
	Hermit Thrush	1	1	0
	Red-bellied Woodpecker	1	0	0
	White-breasted Nuthatch	0	1	0
	Abundance/treatment	5	2	4
	Species/treatment	5	2	2
	Total survey abundance	10		
	Total survey species	8		

Appendix D continued. Winter bird survey results

Pittsfield Preserve North 1 continued				
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
11/20/2004	American Crow	3	0	0
	American Goldfinch	2	0	0
	Black-capped Chickadee	0	4	0
	Blue Jay	0	0	1
	Downy Woodpecker	1	1	2
	Red-bellied Woodpecker	1	0	0
	Tufted Titmouse	0	3	2
	White-breasted Nuthatch	0	1	0
	Abundance/treatment	7	9	5
	Species/treatment	4	4	3
	Total survey abundance	17		
	Total survey species	8		
Total abundance = 39 **Total species = 14**				

Appendix D continued. Winter bird survey results

Pittsfield Preserve North 2				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/9/2004	American Crow	1	0	0
	Red-bellied Woodpecker	1	1	0
	White-breasted Nuthatch	0	1	0
	Abundance/treatment	2	2	0
	Species/treatment	2	2	0
	Total survey abundance	3		
	Total survey species	3		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
11/20/2004	American Crow	1	0	0
	American Robin	0	0	1
	Downy Woodpecker	1	0	0
	Northern Flicker	0	1	0
	Red-bellied Woodpecker	0	0	1
	Red-tailed Hawk	1	0	1
	White-breasted Nuthatch	0	0	1
	Abundance/treatment	3	1	4
	Species/treatment	3	1	4
	Total survey abundance	7		
	Total survey species	7		
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/2/2004	Downy Woodpecker	0	1	2
	Red-bellied Woodpecker	0	0	1
	Abundance/treatment	0	1	3
	Species/treatment	0	1	2
	Total survey abundance	3		
	Total survey species	2		
Total abundance = 13 **Total species = 7**				

Appendix D continued. Winter bird survey results

Pittsfield Preserve Phase One Development				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
11/30/2004	Black-capped Chickadee	2	2	3
	Downy Woodpecker	1	1	1
	Hermit Thrush	0	0	1
	Northern Cardinal	0	1	0
	Northern Flicker	1	0	0
	Abundance/treatment	4	4	5
	Species/treatment	3	3	3
	Total survey abundance	7		
	Total survey species	5		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
11/20/2004	American Tree Sparrow	6	0	0
	American Goldfinch	0	1	0
	Black-capped Chickadee	2	6	3
	Dark-eyed Junco	0	0	1
	Downy Woodpecker	1	2	1
	Northern Cardinal	2	3	3
	Red-bellied Woodpecker	1	1	0
	White-breasted Nuthatch	0	1	1
	Abundance/treatment	12	14	9
	Species/treatment	5	6	5
	Total survey abundance	21		
	Total survey species	8		

Appendix D continued. Winter bird survey results

Pittsfield Preserve Phase One Development continued				
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/9/2004	American Robin	6	15	0
	Black-capped Chickadee	2	4	0
	Downy Woodpecker	0	0	1
	Hermit Thrush	0	0	1
	Northern Cardinal	2	3	1
	Northern Flicker	0	1	0
	Abundance/treatment	10	23	3
	Species/treatment	3	4	3
	Total survey abundance	25		
	Total survey species	6		
Total abundance = 53 **Total species = 11**				

Appendix D continued. Winter bird survey results

Pittsfield Preserve Southeast Property				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
11/30/2004	American Goldfinch	1	0	0
	Downy Woodpecker	0	0	1
	Eastern Bluebird	1	0	0
	Tufted Titmouse	0	1	0
	Abundance/treatment	2	1	1
	Species/treatment	2	1	1
	Total survey abundance	4		
	Total survey species	4		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/9/2004	American Goldfinch	0	0	1
	Black-capped Chickadee	2	0	0
	Dark-eyed Junco	0	0	1
	Downy Woodpecker	0	0	1
	Northern Cardinal	0	0	1
	Northern Flicker	1	0	0
	White-breasted Nuthatch	0	0	1
	Abundance/treatment	3	0	5
	Species/treatment	2	0	5
	Total survey abundance	8		
	Total survey species	7		
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
11/20/2004	American Goldfinch	1	0	0
	Downy Woodpecker	0	2	0
	Eastern Bluebird	1	4	0
	Red-bellied Woodpecker	0	2	0
	White-breasted Nuthatch	1	4	0
	Abundance/treatment	3	12	0
	Species/treatment	3	4	0
	Total survey abundance	13		
	Total survey species	5		
Total abundance = 25 **Total species = 10**				

Appendix D continued. Winter bird survey results

Rodman Preserve				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/11/2004	Downy Woodpecker	0	0	1
	Red-bellied Woodpecker	0	1	0
	Abundance/treatment	0	1	1
	Species/treatment	0	1	1
	Total survey abundance	2		
	Total survey species	2		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/4/2004	Downy Woodpecker	1	1	0
	Red-bellied Woodpecker	1	1	0
	White-breasted Nuthatch	0	1	2
	Abundance/treatment	2	3	2
	Species/treatment	2	3	1
	Total survey abundance	4		
	Total survey species	3		
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
11/21/2004	American Crow	0	0	1
	Downy Woodpecker	0	0	1
	White-breasted Nuthatch	1	1	2
	Abundance/treatment	1	1	4
	Species/treatment	1	1	3
	Total survey abundance	4		
	Total survey species	3		
Total abundance = 10 **Total species = 4**				

Appendix D continued. Winter bird survey results

Rolling Hills Park				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/14/2004	American Goldfinch	1	0	0
	Blue Jay	1	0	0
	Downy Woodpecker	0	1	1
	Golden-crowned Kinglet	0	1	1
	Northern Cardinal	0	1	1
	Red-bellied Woodpecker	0	1	1
	Tufted Titmouse	0	0	1
	Abundance/treatment	2	4	5
	Species/treatment	2	4	5
	Total survey abundance	7		
	Total survey species	7		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/4/2004	American Goldfinch	0	1	2
	Black-capped Chickadee	0	2	0
	Dark-eyed Junco	2	3	4
	White-breasted Nuthatch	1	0	1
	Abundance/treatment	3	6	7
	Species/treatment	2	3	3
	Total survey abundance	9		
	Total survey species	4		

Appendix D continued. Winter bird survey results

Rolling Hills Park continued				
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
11/21/2004	American Crow	0	1	0
	Black-capped Chickadee	3	10	0
	Blue Jay	1	0	0
	Dark-eyed Junco	1	4	0
	Downy Woodpecker	0	0	1
	Eastern Bluebird	0	3	5
	Red-bellied Woodpecker	0	2	0
	Tufted Titmouse	0	1	0
	White-breasted Nuthatch	0	4	5
	Abundance/treatment	5	25	11
	Species/treatment	3	7	3
	Total survey abundance	30		
	Total survey species	9		
Total abundance = 47 **Total species = 12**				

Appendix D. Winter survey results continued.

Saginaw Forest				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/24/05	American Goldfinch	2	0	0
	Black-capped Chickadee	1	7	0
	Downy Woodpecker	1	0	0
	Golden-crowned Kinglet	1	0	0
	Red-bellied Woodpecker	0	0	1
	White-breasted Nuthatch	1	2	0
	Abundance/treatment	6	9	1
	Species/treatment	5	2	1
	Total survey abundance	14		
	Total survey species	6		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/14/05	Black-capped Chickadee	0	2	0
	Brown Creeper	0	0	1
	Great Horned Owl	0	1	0
	Hermit Thrush	0	1	0
	Abundance/treatment	0	4	1
	Species/treatment	0	3	1
	Total survey abundance	5		
	Total survey species	4		
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/31/05	Hermit Thrush	0	1	0
	Abundance/treatment	0	1	0
	Species/treatment	0	1	0
	Total survey abundance	1		
	Total survey species	1		
Total abundance = 20 **Total species = 9**				

Appendix D continued. Winter bird survey results

Sandra Richardson Park				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/14/2004	Black-capped Chickadee	0	1	0
	Downy Woodpecker	0	0	1
	Golden-crowned Kinglet	4	4	0
	Abundance/treatment	4	5	1
	Species/treatment	1	2	1
	Total survey abundance	6		
	Total survey species	3		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
11/21/2004	American Robin	1	0	0
	Black-capped Chickadee	0	0	1
	Blue Jay	1	0	0
	Downy Woodpecker	0	3	0
	Northern Flicker	0	0	1
	Red-bellied Woodpecker	0	2	0
	Abundance/treatment	2	5	2
	Species/treatment	2	2	2
	Total survey abundance	9		
	Total survey species	6		
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/6/2004	American Goldfinch	0	1	0
	Black-capped Chickadee	0	1	0
	Downy Woodpecker	1	0	1
	Abundance/treatment	1	2	1
	Species/treatment	1	2	1
	Total survey abundance	3		
	Total survey species	3		
Total abundance = 18 **Total species = 8**				

Appendix D continued. Winter bird survey results

Scarlett-Mitchell Nature Area				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
11/20/2004	American Robin	0	0	1
	Black-capped Chickadee	0	1	2
	Downy Woodpecker	2	1	0
	Northern Cardinal	0	0	1
	White-breasted Nuthatch	0	4	0
	Abundance/treatment	2	6	4
	Species/treatment	1	3	3
	Total survey abundance	10		
	Total survey species	5		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/9/2004	White-breasted Nuthatch	0	2	0
	Abundance/treatment	0	2	0
	Species/treatment	0	1	0
	Total survey abundance	2		
	Total survey species	1		
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/2/2004	Northern Cardinal	1	1	1
	Abundance/treatment	1	1	1
	Species/treatment	1	1	1
	Total survey abundance	1		
	Total survey species	1		
Total abundance = 13 **Total species = 5**				

Appendix D continued. Winter bird survey results

Schroeter Park				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/5/2004	American Goldfinch	0	0	1
	Downy Woodpecker	0	1	0
	Northern Cardinal	1	1	0
	Tufted Titmouse	2	0	0
	White-breasted Nuthatch	2	0	3
	Abundance/treatment	5	2	4
	Species/treatment	3	2	2
	Total survey abundance	8		
	Total survey species	5		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
11/23/2004	Black-capped Chickadee	4	1	0
	Blue Jay	0	0	2
	Dark-eyed Junco	0	4	0
	Downy Woodpecker	1	2	1
	Northern Cardinal	0	1	0
	Northern Flicker	0	1	2
	Tufted Titmouse	1	1	0
	White-breasted Nuthatch	1	0	1
	Yellow-rumped Warbler	0	2	0
	Abundance/treatment	7	12	6
	Species/treatment	4	7	4
	Total survey abundance	19		
	Total survey species	9		
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/13/2004	Black-capped Chickadee	0	1	0
	Abundance/treatment	0	1	0
	Species/treatment	0	1	0
	Total survey abundance	1		
	Total survey species	1		
Total abundance = 28 **Total species = 10**				

Appendix D continued. Winter bird survey results

Searles Nature Preserve				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/14/2004	Black-capped Chickadee	3	2	0
	Brown Creeper	0	1	1
	Dark-eyed Junco	2	0	0
	Downy Woodpecker	0	1	0
	Eastern Bluebird	0	6	8
	Golden-crowned Kinglet	1	2	1
	Hermit Thrush	0	2	2
	Northern Cardinal	2	2	2
	Red-bellied Woodpecker	1	0	0
	Tufted Titmouse	2	4	0
	White-breasted Nuthatch	0	1	0
	Abundance/treatment	11	21	14
	Species/treatment	6	9	5
	Total survey abundance	27		
	Total survey species	11		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
11/21/2004	American Crow	0	2	0
	Black-capped Chickadee	2	0	0
	Blue Jay	1	1	0
	Dark-eyed Junco	0	2	0
	Golden-crowned Kinglet	0	1	0
	Hermit Thrush	0	0	1
	Northern Cardinal	1	0	0
	Northern Flicker	0	2	0
	Red-bellied Woodpecker	0	1	0
	White-breasted Nuthatch	1	2	0
	Abundance/treatment	5	11	1
	Species/treatment	4	7	1
	Total survey abundance	15		
	Total survey species	10		

Appendix D continued. Winter bird survey results

Searles Nature Preserve continued				
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/6/2004	American Goldfinch	0	0	1
	Black-capped Chickadee	0	1	0
	Hermit Thrush	0	1	0
	Abundance/treatment	0	2	1
	Species/treatment	0	2	1
	Total survey abundance	3		
	Total survey species	3		
Total abundance = 45 **Total species = 15**				

Appendix D continued. Winter bird survey results

Springhill Nature Preserve				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/15/2004	American Crow	2	0	0
	Black-capped Chickadee	0	1	1
	Downy Woodpecker	0	1	0
	Northern Flicker	1	0	0
	Red-bellied Woodpecker	0	0	1
	Abundance/treatment	3	2	2
	Species/treatment	2	2	2
	Total survey abundance	6		
	Total survey species	5		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
11/23/2005	American Goldfinch	1	0	2
	Black-capped Chickadee	3	0	0
	Downy Woodpecker	1	0	1
	White-breasted Nuthatch	0	0	1
	Abundance/treatment	5	0	4
	Species/treatment	3	0	3
	Total survey abundance	7		
	Total survey species	4		
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/5/2004	Black-capped Chickadee	0	4	0
	Blue Jay	0	1	0
	Downy Woodpecker	2	1	2
	Northern Flicker	0	1	0
	Red-bellied Woodpecker	0	2	0
	White-breasted Nuthatch	1	0	0
	Abundance/treatment	3	9	2
	Species/treatment	2	5	1
	Total survey abundance	11		
	Total survey species	6		
Total abundance = 24 **Total species = 8**				

Appendix D continued. Winter bird survey results

Wilderness Park				
AM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/11/2004	American Crow	1	1	0
	American Goldfinch	2	0	0
	Black-capped Chickadee	2	2	3
	Downy Woodpecker	0	2	0
	Northern Cardinal	0	2	0
	White-breasted Nuthatch	0	1	0
	Abundance/treatment	5	8	3
	Species/treatment	3	5	1
	Total survey abundance	11		
	Total survey species	6		
Mid-day Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
12/4/2004	American Crow	1	0	0
	American Goldfinch	1	0	0
	Black-capped Chickadee	0	5	0
	Dark-eyed Junco	1	8	0
	Downy Woodpecker	1	2	0
	Northern Cardinal	0	1	3
	Red-breasted Nuthatch	0	1	0
	Red-tailed Hawk	0	0	1
	Abundance/treatment	4	17	4
	Species/treatment	4	5	2
	Total survey abundance	22		
	Total survey species	8		

Appendix D continued. Winter bird survey results

Wilderness Park continued				
PM Survey	**Common name**	**Control 1**	**Playback**	**Control 2**
11/21/2004	Black-capped Chickadee	1	6	0
	Cedar Waxwing	2	5	0
	Dark-eyed Junco	0	1	0
	Downy Woodpecker	1	2	0
	Northern Cardinal	0	2	0
	Red-breasted Nuthatch	0	1	0
	Tufted Titmouse	0	1	0
	Abundance/treatment	4	18	0
	Species/treatment	3	7	0
	Total survey abundance	18		
	Total survey species	7		
Total abundance = 51 **Total species = 11**				

Appendix E. Spring bird survey results

	Brown Park		
	Survey 1	**Survey 2**	**Survey 3**
Common Name	**4/29/2005**	**5/13/2005**	**5/23/2005**
American Goldfinch	3	5	6
American Redstart	0	1	2
American Robin	2	2	1
Black-capped Chickadee	0	1	4
Blue Jay	1	0	1
Brown-headed Cowbird	2	2	2
Canada Warbler	0	0	2
Common Grackle	0	5	2
Downy Woodpecker	2	1	1
Gray Catbird	0	5	6
Northern Cardinal	6	5	5
Northern Flicker	1	0	1
Red-eyed Vireo	0	0	2
Red-bellied Woodpecker	1	1	0
Red-winged Blackbird	5	5	5
Rose-breasted Grosbeak	0	3	1
Scarlet Tanager	0	2	1
Song Sparrow	1	1	1
Warbling Vireo	0	1	2
White-breasted Nuthatch	1	1	1
White-throated Sparrow	5	2	0
Wilson's Warbler	0	0	3
Yellow Warbler	0	6	3
Yellow-rumped Warbler	0	2	0
Individuals/survey	32	54	61
Species/survey	14	22	30
Total individuals = 147			
Total species = 38			

**Species detected once:
Survey 1: Blue-gray Gnatcatcher, Blue-headed Vireo;
Survey 2: Ruby-crowned Kinglet, Ruby-throated Hummingbird;
Survey 3: Alder Flycatcher, Chestnut-sided Warbler, Eastern Phoebe, Eastern Wood-Pewee, *Empidonax* spp., House Wren, Mourning Dove, Tennessee Warbler.

Appendix E continued. Spring bird survey results

	Bryant's property		
	Survey 1	**Survey 2**	**Survey 3**
Common Name	**4/30/2005**	**4/15/2005**	**5/25/2005**
American Goldfinch	1	4	2
American Redstart	0	2	0
American Robin	1	2	0
Black-capped Chickadee	3	1	2
Blue Jay	5	3	2
Brown-headed Cowbird	1	0	2
Chipping Sparrow	0	2	0
Common Yellowthroat	0	1	3
Eastern Bluebird	0	0	2
Gray Catbird	0	2	2
House Wren	0	1	2
Mourning Dove	1	0	1
Northern Cardinal	2	1	2
Northern Flicker	1	1	0
Red-eyed Vireo	0	1	1
Red-bellied Woodpecker	1	0	1
Red-winged Blackbird	2	0	1
Song Sparrow	3	2	3
Tufted Titmouse	1	2	0
White-throated Sparrow	5	0	0
Yellow Warbler	0	0	2
Individuals/survey	29	30	30
Species/survey	15	19	17
Total individuals = 89			
Total species = 30			

**Species detected once:
Survey 1: Field Sparrow, Golden-crowned Kinglet;
Survey 2: Downy Woodpecker, Great Crested Flycatcher, Hermit Thrush, Rose-breasted Grosbeak, Wood Thrush;
Survey 3: Baltimore Oriole, Eastern Wood-Pewee.

Appendix E continued. Spring bird survey results

	Cherry Hill		
	Survey 1	**Survey 2**	**Survey 3**
Common Name	**4/27/2005**	**5/6/2005**	**5/21/2005**
American Goldfinch	2	4	1
American Robin	1	3	6
Black-and-white Warbler	0	0	3
Black-capped Chickadee	6	6	2
Blue Jay	1	2	0
Brown-headed Cowbird	6	1	9
Common Grackle	0	0	6
Common Yellowthroat	0	0	6
Downy Woodpecker	2	3	1
Eastern Towhee	4	4	4
Field Sparrow	3	1	2
Great Crested Flycatcher	0	0	3
House Wren	0	0	2
Indigo Bunting	0	0	3
Mourning Dove	2	0	1
Northern Cardinal	4	2	1
Northern Flicker	2	1	0
Red-eyed Vireo	0	0	2
Red-bellied Woodpecker	1	1	1
Red-winged Blackbird	11	10	15
Rose-breasted Grosbeak	0	0	3
Sandhill Crane	0	0	2
Song Sparrow	0	2	2
Tufted Titmouse	3	1	0
White-breasted Nuthatch	2	1	0
Yellow Warbler	0	1	8
Individuals/survey	52	45	86
Species/survey	17	18	25
Total individuals = 183			
Total species = 33			

**Species detected once:
Survey 1: Baltimore Oriole, White-throated Sparrow;
Survey 2: Hermit Thrush, Palm Warbler;
Survey 3: Black-throated Green Warbler, Blue-gray Gnatcatcher, Eastern Wood-Pewee.

Appendix E continued. Spring bird survey results

	County Farm Park		
	Survey 1	**Survey 2**	**Survey 3**
Common Name	**4/29/2005**	**5/13/2005**	**5/23/2005**
American Goldfinch	3	4	5
American Robin	2	5	1
Black-capped Chickadee	2	2	0
Brown-headed Cowbird	1	1	2
Cooper's Hawk	2	0	0
Eastern Towhee	1	2	1
Gray Catbird	0	3	3
Indigo Bunting	0	0	2
Northern Cardinal	3	8	5
Song Sparrow	0	2	2
Tufted Titmouse	0	2	0
Yellow Warbler	0	2	7
Individuals/survey	17	32	30
Species/survey	10	11	11
Total individuals = 79			
Total species = 18			

**Species detected once:
Survey 1: Downy Woodpecker, Red-bellied Woodpecker, White-throated Sparrow;
Survey 2: Mourning Dove;
Survey 3: Red-eyed Vireo, Ruby-throated Hummingbird.

Appendix E continued. Spring bird survey results

	Curtiss Park		
	Survey 1	**Survey 2**	**Survey 3**
Common Name	**4/17/2005**	**5/3/2005**	**5/17/2005**
American Goldfinch	0	3	2
American Redstart	0	0	3
American Robin	3	2	3
Black-capped Chickadee	0	3	0
Blue Jay	0	3	1
Brown-headed Cowbird	2	3	3
Chestnut-sided Warbler	0	0	4
Common Yellowthroat	0	0	1
Downy Woodpecker	1	2	1
Gray Catbird	0	0	4
Northern Cardinal	3	6	1
Red-bellied Woodpecker	2	0	1
Scarlet Tanager	0	0	2
Song Sparrow	1	0	1
Tufted Titmouse	0	0	2
Warbling Vireo	0	0	3
White-breasted Nuthatch	0	1	1
White-throated Sparrow	1	5	3
Wood Thrush	0	0	2
Individuals/survey	16	30	49
Species/survey	10	11	29
Total individuals = 95			
Total species = 35			

**Species detected once:
Survey 1: Dark-eyed Junco, Downy Woodpecker, Golden-crowned Kinglet, Red-bellied Woodpecker, Red-winged Blackbird, White-throated Sparrow;
Survey 2: Eastern Phoebe, Mourning Dove;
Survey 3: Baltimore Oriole, Black-and-white Warbler, Blue-gray Gnatcatcher, Great Crested Flycatcher, Nashville Warbler, Northern Flicker, Rose-breasted Grosbeak, Ruby-crowned Kinglet, Swainson's Thrush, Yellow Warbler, Yellow-throated Vireo.

Appendix E continued. Spring bird survey results

	Ford Heritage Park		
	Survey 1	**Survey 2**	**Survey 3**
Common Name	**4/25/2005**	**5/4/2005**	**5/16/2005**
American Goldfinch	0	3	6
American Redstart	0	0	3
American Robin	5	3	6
Black-capped Chickadee	3	2	4
Black-throated Blue Warbler	0	0	3
Blue Jay	0	2	1
Brown-headed Cowbird	2	3	2
Chipping Sparrow	3	1	1
Common Yellowthroat	0	0	2
Downy Woodpecker	1	1	1
Eastern Towhee	0	2	3
Field Sparrow	3	0	3
Gray Catbird	0	0	2
Hermit Thrush	1	2	0
Indigo Bunting	0	0	2
Northern Cardinal	3	5	5
Northern Flicker	0	5	2
Red-bellied Woodpecker	1	0	1
Rose-breasted Grosbeak	0	0	2
Song Sparrow	3	2	1
Tufted Titmouse	0	2	2
White-breasted Nuthatch	0	1	1
White-throated Sparrow	0	1	3
Individuals/survey	25	37	63
Species/survey	10	17	29
Total individuals = 125			
Total species = 32			

**Species detected once:
Survey 2: Blue-headed Vireo, Red-tailed Hawk;
Survey 3: Baltimore Oriole, Blackburnian Warbler, Blue-winged Warbler, Nashville Warbler, Red-eyed Vireo, Red-winged Blackbird, Scarlet Tanager.

Appendix E continued. Spring bird survey results

	Ford Lake Park East		
	Survey 1	**Survey 2**	**Survey 3**
Common Name	**4/25/2005**	**5/4/2005**	**5/16/2005**
American Goldfinch	1	0	1
American Redstart	0	0	7
American Robin	7	4	5
Baltimore Oriole	0	0	2
Black-capped Chickadee	1	4	1
Blue Jay	0	0	2
Brown-headed Cowbird	2	4	0
Common Grackle	0	1	1
Common Yellowthroat	0	0	2
Downy Woodpecker	3	0	1
Gray Catbird	0	0	4
House Wren	0	0	2
Least Flycatcher	0	0	2
Mourning Dove	0	2	0
Northern Cardinal	3	5	0
Northern Flicker	3	1	0
Red-winged Blackbird	7	9	4
Rose-breasted Grosbeak	0	1	2
Warbling Vireo	0	0	4
White-throated Sparrow	2	0	2
Yellow Warbler	0	3	9
Individuals/survey	29	36	55
Species/survey	9	12	21
Total individuals = 120			
Total species = 27			

**Species detected once:
Survey 2: Chipping Sparrow, Song Sparrow;
Survey 3: Chestnut-sided Warbler, Eastern Towhee, *Empidonax* spp., Palm Warbler.

Appendix E continued. Spring bird survey results

	Ford Lake Park West		
	Survey 1	**Survey 2**	**Survey 3**
Common Name	**4/25/2005**	**5/4/2005**	**5/16/2005**
American Goldfinch	0	2	1
American Redstart	0	0	2
American Robin	4	7	6
Baltimore Oriole	0	0	2
Black-capped Chickadee	2	1	2
Blue Jay	2	1	2
Brown-headed Cowbird	3	1	1
Chipping Sparrow	0	1	1
Gray Catbird	0	0	4
House Wren	0	1	1
Mourning Dove	1	1	2
Northern Cardinal	2	2	2
Northern Flicker	3	1	1
Red-bellied Woodpecker	0	1	1
Red-winged Blackbird	7	6	1
Rose-breasted Grosbeak	0	0	2
Song Sparrow	1	1	1
Warbling Vireo	0	0	4
White-breasted Nuthatch	0	1	0
White-throated Sparrow	0	3	0
Yellow Warbler	0	1	2
Yellow-rumped Warbler	0	1	1
Individuals/survey	25	34	42
Species/survey	9	19	23
Total individuals = 101			
Total species = 27			

**Species detected once:
Survey 2: European Starling, Ruby-crowned Kinglet;
Survey 3: Blue-gray Gnatcatcher, Chestnut-sided Warbler, White-crowned Sparrow.

Appendix E continued. Spring bird survey results

	Hewens Creek Park		
	Survey 1	**Survey 2**	**Survey 3**
Common Name	**4/25/2005**	**5/15/2005**	**5/26/2005**
American Goldfinch	3	7	3
American Robin	3	3	1
Baltimore Oriole	0	1	2
Black-capped Chickadee	3	4	0
Blue Jay	0	1	1
Blue-gray Gnatcatcher	0	2	0
Brown-headed Cowbird	3	4	2
Chestnut-sided Warbler	0	1	0
Chipping Sparrow	1	1	0
Common Grackle	0	2	2
Common Yellowthroat	0	2	2
Cooper's Hawk	2	0	1
Downy Woodpecker	1	2	2
Eastern Kingbird	0	1	2
Eastern Wood-Pewee	0	0	2
Field Sparrow	0	3	1
Gray Catbird	0	4	3
Indigo Bunting	0	0	2
Northern Cardinal	5	3	4
Northern Flicker	1	1	0
Red-eyed Vireo	0	1	1
Red-winged Blackbird	1	2	1
Rose-breasted Grosbeak	0	1	1
Ruby-crowned Kinglet	2	0	0
Song Sparrow	4	3	3
Warbling Vireo	0	4	4
White-throated Sparrow	1	3	0
Willow Flycatcher	0	1	2
Wood Thrush	0	2	0

Appendix E continued. Spring bird survey results

	Hewens Creek Park continued		
	Survey 1	**Survey 2**	**Survey 3**
Common Name	**4/25/2005**	**5/15/2005**	**5/26/2005**
Yellow Warbler	0	7	6
Yellow-rumped Warbler	2	0	0
Individuals/survey	32	69	56
Species/survey	14	28	30
Total individuals = 157			
Total species = 42			

**Species detected once:
Survey 2: Eastern Towhee, House Wren, Ovenbird, White-breasted Nuthatch;
Survey 3: American Redstart, Black-billed Cuckoo, Killdeer, Mourning Dove, Ruby-throated Hummingbird, Great Crested Flycatcher, Swainson's thrush.

Appendix E continued. Spring bird survey results

	Horner Woods		
	Survey 1	**Survey 2**	**Survey 3**
Common Name	**4/27/2005**	**5/5/2005**	**5/22/2005**
American Goldfinch	0	5	1
American Robin	2	1	2
Baltimore Oriole	0	0	2
Black-capped Chickadee	2	2	1
Blue Jay	2	1	3
Brown-headed Cowbird	1	0	1
Downy Woodpecker	2	2	2
Eastern Wood-Pewee	0	0	2
Northern Cardinal	2	2	1
Northern Flicker	1	1	1
Red-eyed Vireo	0	0	2
Red-bellied Woodpecker	1	1	1
Red-winged Blackbird	2	3	6
Scarlet Tanager	0	0	2
Song Sparrow	0	1	1
Tufted Titmouse	0	3	3
White-breasted Nuthatch	3	3	1
Wood Thrush	0	0	3
Yellow-rumped Warbler	3	2	0
Individuals/survey	24	28	39
Species/survey	14	14	22
Total individuals = 91			
Total species = 27			

**Species detected once:
Survey 1: American Redstart, Eastern Phoebe, Field Sparrow, Ruby-crowned Kinglet;
Survey 2: Chipping Sparrow;
Survey 3: Black-and-white Warbler, Common Yellowthroat, Ruby-throated Hummingbird.

Appendix E continued. Spring bird survey results

	Lefurge Nature Preserve		
	Survey 1	**Survey 2**	**Survey 3**
Common Name	**4/28/2005**	**5/14/2005**	**5/25/2005**
American Goldfinch	1	0	6
American Redstart	0	4	1
American Robin	2	3	5
Black-and-white Warbler	0	1	0
Black-capped Chickadee	2	0	1
Black-throated Blue Warbler	0	2	0
Blue Jay	1	1	0
Brown-headed Cowbird	0	2	3
Common Grackle	0	3	0
Common Yellowthroat	0	0	3
Eastern Bluebird	0	0	2
Field Sparrow	0	6	5
Gray Catbird	0	1	3
House Wren	0	1	3
Northern Cardinal	1	3	1
Ovenbird	0	1	1
Red-eyed Vireo	0	1	1
Red-bellied Woodpecker	2	2	0
Red-winged Blackbird	0	5	6
Ruby-crowned Kinglet	0	2	0
Song Sparrow	0	4	6
Tree Swallow	0	1	3
Willow Flycatcher	0	0	2
Yellow Warbler	0	1	3
Individuals/survey	11	49	64
Species/survey	8	24	27
Total individuals = 124			
Total species = 40			

**Species detected once:
Survey 1: Downy Woodpecker, Baltimore Oriole, Tufted Titmouse;
Survey 2: Black-throated Green Warbler, Chestnut-sided Warbler, Hermit Thrush, Indigo Bunting, Scarlet Tanager;
Survey 3: Eastern Towhee, Eastern Wood-Pewee, European Starling, Killdeer, Magnolia Warbler, Northern Flicker, Swainson's Thrush, Wood Thrush.

Appendix E continued. Spring bird survey results

	Lille Park		
	Survey 1	**Survey 2**	**Survey 3**
Common Name	**4/21/2005**	**5/2/2005**	**5/19/2005**
American Goldfinch	2	2	2
American Redstart	0	0	2
American Robin	5	1	3
Blue Jay	0	1	1
Brown-headed Cowbird	3	2	1
Downy Woodpecker	1	2	1
Field Sparrow	0	1	1
Hermit Thrush	0	2	0
Mourning Dove	0	4	0
Northern Cardinal	4	1	3
Northern Flicker	1	1	0
Red-winged Blackbird	8	10	8
Ruby-throated Hummingbird	0	0	2
Song Sparrow	0	1	2
Tree Swallow	7	2	2
White-throated Sparrow	0	6	0
Yellow Warbler	0	1	3
Yellow-rumped Warbler	0	2	0
Individuals/survey	35	41	44
Species/survey	12	18	26
Total individuals = 120			
Total species = 38			

**Species detected once:
Survey 1: Brown Creeper, Eastern Phoebe, Red-bellied Woodpecker, Ruby-crowned Kinglet;
Survey 2: Black-capped Chickadee, White-breasted Nuthatch;
Survey 3: Brown Thrasher, Chestnut-sided Warbler, Eastern Bluebird, Eastern Wood-Pewee, Gray Catbird, Great Crested Flycatcher, House Wren, Magnolia Warbler, Red-eyed Vireo, Rose-breasted Grosbeak, Warbler spp., Willow Flycatcher, Wood Thrush.
.

Appendix E continued. Spring bird survey results

	Marshall Park		
	Survey 1	**Survey 2**	**Survey 3**
Common Name	**4/27/2005**	**5/5/2005**	**5/21/2005**
American Goldfinch	3	5	5
American Robin	2	0	4
Black-capped Chickadee	5	3	5
Blue Jay	1	3	2
Blue-gray Gnatcatcher	0	2	0
Blue-headed Vireo	1	1	0
Blue-winged Warbler	0	0	2
Brown-headed Cowbird	3	2	2
Downy Woodpecker	2	1	1
Eastern Towhee	0	0	2
Hermit Thrush	1	1	0
House Sparrow	0	0	4
Indigo Bunting	0	0	6
Northern Cardinal	3	3	4
Red-eyed Vireo	0	0	2
Red-bellied Woodpecker	1	1	1
Red-winged Blackbird	1	0	2
Tufted Titmouse	0	2	3
White-breasted Nuthatch	1	1	1
Wood Thrush	0	0	2
Individuals/survey	25	25	54
Species/survey	13	12	23
Total individuals = 104			
Total species = 28			

**Species detected once:
Survey 1: Chipping Sparrow;
Survey 3: Eastern Wood-Pewee, Hooded Warbler, House Wren, Northern Flicker, Ruby-throated Hummingbird, Warbler spp.

Appendix E continued. Spring bird survey results

	Mary McCann Park		
	Survey 1	**Survey 2**	**Survey 3**
Common Name	**4/17/2005**	**5/3/2005**	**5/20/2005**
American Goldfinch	0	1	2
American Robin	4	3	2
Black-throated Green Warbler	0	0	2
Blue Jay	1	1	1
Brown-headed Cowbird	2	1	1
Common Yellowthroat	0	0	3
Dark-eyed Junco	2	0	0
Downy Woodpecker	2	1	0
Field Sparrow	0	1	1
Great Crested Flycatcher	0	0	2
Hermit Thrush	0	2	0
Northern Cardinal	1	2	2
Northern Flicker	4	0	1
Ovenbird	0	0	2
Red-bellied Woodpecker	0	2	1
Red-winged Blackbird	2	0	4
Sparrow sp.	2	0	0
Tufted Titmouse	0	2	2
White-breasted Nuthatch	1	1	2
White-throated Sparrow	0	1	1
Wood Thrush	0	0	2
Individuals/survey	22	20	43
Species/survey	11	14	29
Total individuals = 85			
Total species = 36			

**Species detected once:
Survey 1: Acadian Flycatcher, Ring-necked Pheasant;
Survey 2: Song Sparrow, Yellow Warbler;
Survey 3: American Redstart, Black-capped Chickadee, Blue-gray Gnatcatcher, Eastern Wood-Pewee, *Empidonax* spp., Gray Catbird, Red-eyed Vireo, Ruby-throated Hummingbird, Scarlet Tanager, Warbler spp., Yellow-throated Vireo.

Appendix E continued. Spring bird survey results

	Mathaei Botanical Gardens		
	Survey 1	**Survey 2**	**Survey 3**
Common Name	**4/27/2005**	**5/5/2005**	**5/21/2005**
American Goldfinch	2	3	3
American Robin	4	5	5
Baltimore Oriole	0	1	3
Black-capped Chickadee	5	11	2
Blue Jay	0	2	3
Brown-headed Cowbird	5	3	4
Chipping Sparrow	0	0	3
Common Yellowthroat	0	0	5
Downy Woodpecker	3	2	1
Eastern Kingbird	0	0	2
Gray Catbird	0	0	2
Mourning Dove	0	1	1
Northern Cardinal	4	3	4
Northern Flicker	1	2	0
Red-bellied Woodpecker	1	2	1
Red-winged Blackbird	7	6	15
Rose-breasted Grosbeak	0	0	2
Song Sparrow	4	8	7
Tufted Titmouse	0	4	1
Warbling Vireo	0	0	2
White-breasted Nuthatch	2	4	1
White-throated Sparrow	0	3	0
Yellow Warbler	0	2	3
Individuals/survey	40	64	74
Species/survey	13	19	26
Total individuals = 178			
Total species = 31			

**Species detected once:
Survey 1: Great Blue Heron, Pine Warbler;
Survey 2: Brown Creeper, Field Sparrow;
Survey 3: Blue-gray Gnatcatcher, Common Grackle, Eastern Wood-Pewee, Wood Thrush.

Appendix E continued. Spring bird survey results

	Montibeller Park		
	Survey 1	**Survey 2**	**Survey 3**
Common Name	**4/21/2005**	**5/2/2005**	**5/19/2005**
American Goldfinch	0	6	5
American Robin	3	5	3
Black-capped Chickadee	2	1	4
Brown-headed Cowbird	1	1	3
Chipping Sparrow	0	1	2
Common Grackle	0	0	2
Cooper's Hawk	0	2	1
Downy Woodpecker	3	1	1
Eastern Bluebird	0	0	2
Gray Catbird	0	0	4
House Sparrow	0	0	4
Northern Cardinal	3	3	5
Northern Flicker	1	1	0
Red-eyed Vireo	0	0	4
Red-bellied Woodpecker	1	1	1
Red-winged Blackbird	0	2	0
Rose-breasted Grosbeak	0	0	2
Ruby-crowned Kinglet	0	5	0
Song Sparrow	3	0	4
Tufted Titmouse	0	1	1
White-breasted Nuthatch	1	1	1
White-throated Sparrow	0	3	2
Yellow-rumped Warbler	1	1	1
Individuals/survey	20	35	66
Species/survey	10	16	34
Total individuals = 121			
Total species = 38			

**Species detected once:
Survey 1: Golden-crowned Kinglet;
Survey 2: Killdeer, Magnolia Warbler;
Survey 3: Blackpoll Warbler, Blue Jay, Blue-gray Gnatcatcher, Common Yellowthroat, Eastern Towhee, Eastern Wood-Pewee, *Empidonax* spp., Northern Parula, Ruby-throated Hummingbird, Warbler spp., Yellow Warbler, Yellow-throated Vireo.
.

Appendix E continued. Spring bird survey results

	North Bay Park		
	Survey 1	**Survey 2**	**Survey 3**
Common Name	**4/30/2005**	**5/14/2005**	**5/25/2005**
American Goldfinch	1	1	2
American Redstart	0	12	6
American Robin	8	8	15
Baltimore Oriole	0	2	2
Barn Swallow	10	10	15
Blue Jay	4	2	3
Brown-headed Cowbird	1	1	2
Chipping Sparrow	1	2	0
Common Yellowthroat	0	1	2
Eastern Kingbird	0	2	2
Gray Catbird	0	4	7
Indigo Bunting	0	0	3
Mourning Dove	0	2	1
Northern Cardinal	5	2	2
Northern Flicker	1	0	1
Palm Warbler	0	3	0
Red-eyed Vireo	0	1	3
Red-winged Blackbird	6	0	5
Rose-breasted Grosbeak	0	3	1
Tufted Titmouse	1	0	1
Warbling Vireo	0	4	9
White-crowned Sparrow	0	2	0
White-throated Sparrow	6	1	0
Wood Thrush	0	2	1
Yellow Warbler	5	5	10
Yellow-rumped Warbler	5	2	0
Individuals/survey	59	78	98
Species/survey	18	28	26
Total individuals = 235			
Total species = 42			

**Species detected once:
Survey 1: Black-capped Chickadee, Blue-gray Gnatcatcher, Field Sparrow, Hermit Thrush, House Wren, Song Sparrow;
Survey 2: Black-throated Green Warbler, Chestnut-sided Warbler, Common Grackle, Red-bellied Woodpecker, Scarlet Tanager, Willow Flycatcher;
Survey 3: Cedar Waxwing, Downy Woodpecker, Eastern Towhee, *Empidonax* spp.

Appendix E continued. Spring bird survey results

	Parker Mill Park		
	Survey 1	**Survey 2**	**Survey 3**
Common Name	**4/28/2005**	**5/8/2005**	**5/22/2005**
American Goldfinch	2	5	3
American Redstart	0	0	2
American Robin	2	3	4
Black-capped Chickadee	1	2	1
Blue Jay	3	5	2
Blue-gray Gnatcatcher	0	1	0
Brown-headed Cowbird	2	3	1
Common Yellowthroat	0	0	3
Downy Woodpecker	2	3	1
Eastern Phoebe	0	2	2
Gray Catbird	0	1	2
House Finch	2	0	0
House Wren	0	1	1
Indigo Bunting	0	0	6
Nashville Warbler	0	2	0
Northern Cardinal	1	6	8
Northern Flicker	1	0	1
Red-eyed Vireo	0	0	2
Red-bellied Woodpecker	1	1	0
Red-winged Blackbird	2	5	3
Rose-breasted Grosbeak	0	1	2
Song Sparrow	0	4	3
Tufted Titmouse	1	1	1
White-breasted Nuthatch	0	1	2
White-throated Sparrow	2	0	0
Yellow Warbler	0	3	3
Individuals/survey	22	52	55
Species/survey	13	21	23
Total individuals = 129			
Total species = 30			

**Species detected once:
Survey 2: Winter Wren, Yellow-throated Vireo;
Survey 3: Eastern Wood-Pewee, Ruby-throated Hummingbird.

Appendix E continued. Spring bird survey results

	Pittsfield Preserve Phase 1 Development		
	Survey 1	**Survey 2**	**Survey 3**
Common Name	**4/21/2005**	**5/2/2005**	**5/24/2005**
American Goldfinch	0	5	3
American Robin	2	2	1
Black-capped Chickadee	1	5	2
Brown-headed Cowbird	1	0	2
Common Yellowthroat	0	0	2
Downy Woodpecker	1	1	0
Gray Catbird	0	0	2
Mourning Dove	1	3	0
Northern Cardinal	3	5	2
Red-eyed Vireo	0	0	5
Red-winged Blackbird	4	9	5
Ruby-crowned Kinglet	1	2	0
Song Sparrow	2	1	2
White-throated Sparrow	0	4	0
Individuals/survey	16	37	36
Species/survey	9	10	20
Total individuals = 89			
Total species = 24			

**Species detected once:
Survey 3: Alder Flycatcher, American Redstart, Black-throated Green Warbler, Eastern Wood-Pewee, Great Crested Flycatcher, Indigo Bunting, Warbler spp., Warbling Vireo, Wood Thrush, Yellow Warbler.

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Appendix E continued. Spring bird survey results

	Pittsfield Preserve North 1		
	Survey 1	**Survey 2**	**Survey 3**
Common Name	**4/29/2005**	**5/15/2005**	**5/24/2005**
American Goldfinch	4	5	6
American Redstart	0	3	0
American Robin	3	3	1
Barn Swallow	0	3	3
Black-capped Chickadee	5	0	3
Brown-headed Cowbird	0	1	2
Chipping Sparrow	0	2	0
Common Yellowthroat	0	2	1
Downy Woodpecker	0	2	0
Gray Catbird	0	2	5
Great Blue Heron	0	2	0
House Wren	0	1	1
Indigo Bunting	0	2	0
Killdeer	0	1	1
Northern Cardinal	2	4	3
Red-bellied Woodpecker	2	1	1
Red-winged Blackbird	2	8	13
Song Sparrow	6	6	7
Tufted Titmouse	0	0	2
Warbling Vireo	0	1	1
White-throated Sparrow	6	7	2
Yellow Warbler	0	2	1
Yellow-rumped Warbler	0	2	
Individuals/survey	32	65	62
Species/survey	10	26	26
Total individuals = 159			
Total species = 39			

**Species detected once:
Survey 1: Northern Flicker, Tree Swallow;
Survey 2: Common Grackle, Nashville Warbler, Sandhill Crane, Sparrow spp., Yellow-throated Vireo;
Survey 3: Blue Jay, Field Sparrow, Great Crested Flycatcher, Magnolia Warbler, Mourning Warbler, Red-eyed Vireo, Warbler spp., Wilson's Warbler, Wood Thrush.

Appendix E continued. Spring bird survey results

	Pittsfield Preserve North 2		
	Survey 1	**Survey 2**	**Survey 3**
Common Name	**4/21/2005**	**5/2/2005**	**5/19/2005**
American Goldfinch	2	5	0
American Robin	3	2	0
Blue Jay	0	1	1
Blue-headed Vireo	1	0	1
Brown-headed Cowbird	2	4	1
Downy Woodpecker	1	3	0
Gray Catbird	0	0	2
Northern Cardinal	2	1	1
Northern Flicker	2	0	0
Red-eyed Vireo	0	0	2
Red-bellied Woodpecker	2	1	0
Red-winged Blackbird	3	0	0
Song Sparrow	0	2	2
Tufted Titmouse	0	3	1
White-breasted Nuthatch	1	1	0
Yellow-rumped Warbler	0	2	0
Individuals/survey	19	29	18
Species/survey	10	15	15
Total individuals = 66			
Total species = 27			

**Species detected once:
Survey 1: American Redstart;
Survey 2: Black-and-white Warbler, Black-capped Chickadee, Eastern Bluebird, Ruby-crowned Kinglet;
Survey 3: Eastern Towhee, Eastern Wood-Pewee, Great Crested Flycatcher, Warbler spp., Wood Thrush, Yellow-throated Vireo.

Appendix E continued. Spring bird survey results

	Pittsfield Preserve Southeast Property		
	Survey 1	**Survey 2**	**Survey 3**
Common Name	**4/29/2005**	**5/15/2005**	**5/24/2005**
American Goldfinch	0	1	2
American Redstart	0	2	1
American Robin	2	3	2
Black-capped Chickadee	1	0	1
Blue Jay	0	1	1
Blue-gray Gnatcatcher	0	1	1
Brown-headed Cowbird	1	0	1
Common Yellowthroat	0	0	2
Downy Woodpecker	2	1	1
Gray Catbird	0	0	2
Great Crested Flycatcher	0	0	2
Indigo Bunting	0	2	0
Northern Cardinal	2	3	1
Northern Flicker	1	1	1
Red-eyed Vireo	0	0	2
Red-bellied Woodpecker	3	0	0
Red-winged Blackbird	9	3	3
Song Sparrow	0	2	1
Swainson's Thrush	0	0	2
White-throated Sparrow	0	2	0
Wood Thrush	0	1	1
Individuals/survey	21	28	32
Species/survey	8	18	23
Total individuals = 81			
Total species = 31			

**Species detected once:
Survey 2: Black-throated Green Warbler, Hermit Thrush, Tufted Titmouse, Warbler spp., Yellow-throated Vireo;
Survey 3: Baltimore Oriole, Eastern Wood-Pewee, Red-tailed Hawk, Rose-breasted Grosbeak, Winter Wren.

Appendix E continued. Spring bird survey results

	Rodman Preserve		
	Survey 1	**Survey 2**	**Survey 3**
Common Name	**4/17/2005**	**5/3/2005**	**5/17/2005**
American Goldfinch	2	1	1
American Robin	3	3	0
Black-capped Chickadee	5	4	0
Black-throated Green Warbler	0	0	2
Brown-headed Cowbird	0	1	2
Chipping Sparrow	0	2	1
Downy Woodpecker	1	0	1
Eastern Phoebe	1	1	0
Great Blue Heron	1	0	1
Mourning Dove	2	0	0
Northern Cardinal	4	1	3
Red-eyed Vireo	0	0	3
Red-bellied Woodpecker	2	0	1
Song Sparrow	0	1	1
Tufted Titmouse	0	2	2
White-breasted Nuthatch	2	1	1
White-throated Sparrow	0	0	2
Yellow Warbler	0	0	2
Yellow-rumped Warbler	0	1	1
Individuals/survey	25	20	37
Species/survey	12	13	28
Total individuals = 82			
Total species = 36			

**Species detected once:
Survey 1: Dark-eyed Junco, Red-tailed Hawk;
Survey 2: Cooper's Hawk, Golden-crowned Kinglet;
Survey 3: American Redstart, Baltimore Oriole, Bay-breasted Warbler, Black-and-white Warbler, Blue-gray Gnatcatcher, Blue-winged Warbler, Common Yellowthroat, Eastern Wood-Pewee, Indigo Bunting, Rose-breasted Grosbeak, Ruby-crowned Kinglet, Warbler spp., Yellow-throated Vireo.

Appendix E continued. Spring bird survey results

	Rolling Hills Park		
	Survey 1	**Survey 2**	**Survey 3**
Common Name	**4/30/2005**	**5/16/2005**	**5/25/2005**
American Goldfinch	4	7	4
American Redstart	0	3	1
American Robin	5	7	4
Baltimore Oriole	0	2	3
Barn Swallow	0	3	2
Black-capped Chickadee	5	5	1
Blue Jay	2	4	2
Blue-gray Gnatcatcher	0	3	0
Brown-headed Cowbird	5	3	4
Chestnut-sided Warbler	0	1	0
Chipping Sparrow	2	3	1
Common Yellowthroat	0	2	2
Downy Woodpecker	2	0	0
Eastern Towhee	0	2	2
Field Sparrow	2	2	1
Gray Catbird	0	6	2
House Wren	0	1	1
Indigo Bunting	0	1	2
Killdeer	2	0	0
Northern Cardinal	5	3	2
Northern Rough-winged Swallow	0	4	0
Red-eyed Vireo	0	1	3
Red-bellied Woodpecker	1	2	0
Red-winged Blackbird	5	3	1
Rose-breasted Grosbeak	0	2	0
Song Sparrow	2	3	4
Tufted Titmouse	0	2	0
Warbling Vireo	0	4	1

Appendix E continued. Spring bird survey results

	Rolling Hills Park continued		
	Survey 1	**Survey 2**	**Survey 3**
Common Name	**4/30/2005**	**5/16/2005**	**5/25/2005**
White-breasted Nuthatch	1	1	0
White-crowned Sparrow	0	2	0
Yellow Warbler	0	2	1
Yellow-rumped Warbler	0	3	0
Individuals/survey	46	93	50
Species/survey	17	36	27
Total individuals = 189			
Total species = 47			

**Species detected once:
Survey 1: Dark-eyed Junco, Ruby-crowned Kinglet, White-throated Sparrow;
Survey 2: Black-throated Green Warbler, Blue-winged Warbler, Brown Thrasher, Blue-headed Vireo, Hermit Thrush, Northern Flicker, Ovenbird, Palm Warbler;
Survey 3: Eastern Wood-Pewee, *Empidonax* spp., Tree Swallow, Willow Flycatcher.

Appendix E continued. Spring bird survey results

	Sandra Richardson Park		
	Survey 1	**Survey 2**	**Survey 3**
Common Name	**4/17/2005**	**5/3/2005**	**5/20/2005**
American Goldfinch	0	1	2
American Redstart	0	0	3
American Robin	3	2	1
Black-capped Chickadee	1	1	1
Blue Jay	1	2	2
Brown Thrasher	0	2	0
Brown-headed Cowbird	2	3	2
Downy Woodpecker	1	2	0
Eastern Bluebird	2	1	0
Eastern Towhee	0	0	3
Field Sparrow	2	3	2
Gray Catbird	0	0	2
House Wren	0	0	2
Northern Cardinal	2	3	5
Northern Flicker	2	2	1
Ovenbird	0	0	2
Red-eyed Vireo	0	0	2
Red-bellied Woodpecker	1	2	0
Red-winged Blackbird	2	0	2
Song Sparrow	1	1	0
Tufted Titmouse	0	3	1
White-breasted Nuthatch	1	2	0
White-throated Sparrow	0	5	1
Wood Thrush	0	0	2
Yellow Warbler	0	0	2
Individuals/survey	22	35	47
Species/survey	14	16	28
Total individuals = 104			
Total species = 35			

**Species detected once:
Survey 1: Eastern Meadowlark;
Survey 3: Blue-winged Warbler, Common Grackle, Eastern Wood-Pewee, Indigo Bunting, Olive-sided Flycatcher, Rose-breasted Grosbeak, Swainson's Thrush, Willow Flycatcher, Yellow-throated Vireo.

Appendix E continued. Spring bird survey results

	Scarlett-Mitchell Park		
	Survey 1	**Survey 2**	**Survey 3**
Common Name	**4/29/2005**	**5/13/2005**	**5/23/2005**
American Goldfinch	3	2	5
American Redstart	0	0	4
American Robin	1	1	3
Black-capped Chickadee	1	1	2
Black-throated Green Warbler	0	1	0
Blue Jay	1	2	1
Brown-headed Cowbird	1	0	2
Chestnut-sided Warbler	0	0	3
Chipping Sparrow	1	0	1
Common Yellowthroat	0	2	3
Cooper's Hawk	2	0	0
Downy Woodpecker	1	1	2
Eastern Wood-Pewee	0	1	1
Gray Catbird	0	2	3
House Wren	0	1	2
Mourning Dove	0	0	2
Northern Cardinal	2	3	5
Red-eyed Vireo	0	2	4
Red-bellied Woodpecker	2	1	0
Red-winged Blackbird	0	0	5
Ring-necked Pheasant	2	0	0
Rose-breasted Grosbeak	0	1	1
Song Sparrow	2	0	0
Tree Swallow	0	0	2
Tufted Titmouse	2	3	2
Warbling Vireo	0	1	3

Appendix E continued. Spring bird survey results

	Scarlett-Mitchell Park continued		
	Survey 1	**Survey 2**	**Survey 3**
Common Name	**4/29/2005**	**5/13/2005**	**5/23/2005**
White-breasted Nuthatch	2	2	1
White-throated Sparrow	2	1	0
Yellow Warbler	1	7	10
Individuals/survey	26	37	75
Species/survey	16	21	31
Total individuals = 138			
Total species = 39			

**Species detected once:
Survey 2: Great Crested Flycatcher, Ovenbird;
Survey 3: Alder Flycatcher, Eastern Phoebe, Green Heron, Indigo Bunting, Northern Flicker, Ruby-throated Hummingbird, Tennessee Warbler, Wood Thrush.

Appendix E continued. Spring bird survey results

	Schroeter Park		
	Survey 1	**Survey 2**	**Survey 3**
Common Name	**4/28/2005**	**5/8/2005**	**5/22/2005**
American Goldfinch	3	2	3
American Robin	1	6	1
Black-capped Chickadee	1	1	1
Blue Jay	0	1	1
Blue-winged Warbler	0	1	2
Brown Thrasher	1	1	0
Brown-headed Cowbird	2	4	1
Chipping Sparrow	0	4	1
Downy Woodpecker	1	0	1
Eastern Towhee	2	2	2
Field Sparrow	2	1	1
Gray Catbird	0	3	6
Nashville Warbler	0	2	0
Northern Cardinal	1	1	3
Northern Flicker	1	3	0
Red-winged Blackbird	2	2	0
Tufted Titmouse	0	1	1
Yellow Warbler	0	4	4
Individuals/survey	18	46	34
Species/survey	12	24	20
Total individuals = 98			
Total species = 32			

**Species detected once:
Survey 1: White-breasted Nuthatch;
Survey 2: Baltimore Oriole, Black-and-white Warbler, Eastern Phoebe, Eastern Wood-Pewee, Killdeer, Red-bellied Woodpecker, White-throated Sparrow, Yellow-throated Vireo;
Survey 3: Common Grackle, Common Yellowthroat, Magnolia Warbler, Rose-breasted Grosbeak, Wood Thrush.

Appendix E continued. Spring bird survey results

	Searles Nature Preserve		
	Survey 1	**Survey 2**	**Survey 3**
Common Name	**4/25/2005**	**5/4/2005**	**5/20/2005**
American Goldfinch	3	2	2
American Redstart	0	0	3
American Robin	3	0	1
Black-capped Chickadee	6	2	1
Blue Jay	0	3	1
Blue-gray Gnatcatcher	0	3	0
Brown-headed Cowbird	0	4	0
Downy Woodpecker	0	2	1
Eastern Towhee	0	2	1
Hermit Thrush	2	1	0
Northern Cardinal	4	5	4
Red-eyed Vireo	0	0	3
Rose-breasted Grosbeak	0	0	2
Scarlet Tanager	0	0	2
Song Sparrow	0	2	1
Tufted Titmouse	0	2	1
Yellow-rumped Warbler	0	2	0
Individuals/survey	18	35	32
Species/survey	5	17	22
Total individuals = 85			
Total species = 31			

**Species detected once:
Survey 2: Chipping Sparrow, Mourning Dove, Northern Flicker, Ruby-crowned Kinglet, White-breasted Nuthatch;
Survey 3: Acadian Flycatcher, Blue-winged Warbler, Eastern Wood-Pewee, Gray Catbird, Hooded Warbler, Red-bellied Woodpecker, Swainson's Thrush, Warbler spp., Yellow Warbler.

Appendix E continued. Spring bird survey results

	Springhill Preserve		
	Survey 1	**Survey 2**	**Survey 3**
Common Name	**4/28/2005**	**5/8/2005**	**5/22/2005**
American Robin	7	5	5
Black-capped Chickadee	2	2	1
Blue Jay	1	1	1
Brown-headed Cowbird	0	1	1
Common Yellowthroat	0	1	5
Downy Woodpecker	1	2	0
Gray Catbird	0	0	6
Indigo Bunting	0	0	2
Northern Cardinal	2	0	2
Northern Flicker	2	1	1
Red-eyed Vireo	0	0	2
Red-bellied Woodpecker	0	2	0
Red-winged Blackbird	12	11	15
Rose-breasted Grosbeak	0	1	2
Song Sparrow	0	0	2
Tufted Titmouse	1	2	1
White-breasted Nuthatch	1	1	0
White-throated Sparrow	1	4	0
Wood Thrush	0	1	1
Yellow Warbler	0	6	4
Yellow-rumped Warbler	0	0	3
Individuals/survey	34	41	61
Species/survey	14	15	24
Total individuals = 136			
Total species = 32			

**Species detected once:
Survey 1: Blue-gray Gnatcatcher, Brown Thrasher, Eastern Towhee, Killdeer;
Survey 3: Alder Flycatcher, American Goldfinch, Blue-winged Warbler, Eastern Wood-Pewee, Field Sparrow, Great Crested Flycatcher, Swainson's Thrush.

Appendix E continued. Spring bird survey results

	Wilderness Park		
	Survey 1	**Survey 2**	**Survey 3**
Common Name	**4/17/2005**	**5/3/2005**	**5/17/2005**
American Goldfinch	0	3	5
American Redstart	0	0	2
American Robin	5	2	2
Black-capped Chickadee	2	3	4
Blue Jay	2	3	1
Brown-headed Cowbird	4	1	1
Downy Woodpecker	2	1	1
Gray Catbird	0	0	4
Northern Cardinal	3	3	3
Northern Flicker	1	1	0
Red-winged Blackbird	2	1	2
White-throated Sparrow	1	2	1
Individuals/survey	25	22	39
Species/survey	12	12	24
Total individuals = 86			
Total species = 31			

**Species detected once:
Survey 1: Dark-eyed Junco, House Sparrow, Mourning Dove;
Survey 2: Chipping Sparrow, Song Sparrow;
Survey 3: Baltimore Oriole, Common Yellowthroat, Cooper's Hawk, House Wren, Ovenbird, Red-eyed Vireo, Chestnut-sided Warbler, Ruby-throated Hummingbird, Swainson's Thrush, Tufted Titmouse, Warbler spp., Yellow Warbler, Yellow-throated Vireo.