# FOREST HABITATS IN FRAGMENTED LANDSCAPES NEAR LAKE ERIE: DEFINING QUALITY STOPOVER SITES FOR MIGRATING LANDBIRDS

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## ABSTRACT

In the Western Basin of Lake Erie in northwestern Ohio, stopover migrants are concentrated into remnant patches of woody habitat in landscapes dominated by agriculture. These habitat areas likely are important for migrants but little research has quantified the relative use and quality of available habitats. From mid-April through May 2003-2005, I studied landbird stopover using point count surveys, mist-netting, assessment of daily mass gain, and habitat measurements. Sites were located in mature inland forest (0.4-5.3 km from lakeshore; 14 sites), dogwood shrubland (1.3-5.3 km from lakeshore; 7 sites), and mature beach ridge forest along the lakeshore (7 sites). Point-counts were conducted at 28 sites (5-6 times per year) and mist netting occurred at 12 sites (4 sites per habitat) on 8 days per site and year and included 15,384 mist-net-hours.

The four most abundant stopover migrants recorded during point count surveys were (in decreasing abundance): White-throated Sparrow, Yellow-rumped Warbler, American Redstart, and Ruby-crowned Kinglet. Point count surveys indicated that 14 of 21 species (67%) of stopover migrants tested had greater abundance within beach ridges relative to other habitats, with mature inland forest typically having more individuals than in dogwood shrub habitat. The magnitude of the difference was large with 9 of the 14 species recorded at least two times more frequently in beach ridge relative to the habitat of second highest abundance. Only Rusty Blackbird was more abundant in mature inland forest and dogwood shrubland.

The most abundant stopover migrants captured in mist net surveys were (in decreasing abundance): Yellow-rumped Warbler, White-throated Sparrow, Magnolia Warbler, and Palm Warbler. Twelve of 16 species (75%) of stopover migrants tested exhibited significant differences among habitats, and 10 of these 12 species had higher capture rates in beach ridge forest. Similar to point count data, the magnitude of the difference between beach ridge and other habitats was large for many species. For 7 of the 16 species tested, relatively higher capture rates were recorded in dogwood shrubland relative to mature inland forest, a pattern that likely resulted from higher capture probability within shrubland habitats.

A condition index (size-adjusted mass) was regressed against time of capture to assess daily mass gain. Despite intensive netting effort, very few species were captured in sufficient numbers in the three different habitats, thereby limiting comparisons of energetic condition among habitats. Results indicated that no species had a significant negative trend in mass gain in any habitat. Relatively small numbers of the 19 species tested exhibited significant positive trends in diurnal mass gain within the habitats. Only 1 of 15 species in dogwood shrubland (White-throated Sparrow) and only 3 of 19 species (Ruby-crowned Kinglet, Hermit Thrush, and Palm Warbler) in beach ridge forest exhibited significant positive trends in body mass. In contrast, 5 of 9 migrant species (55.5%) had positive diurnal trends in mature inland forest. Yellow-rumped Warbler, Ovenbird, Northern Waterthrush, and White-throated Sparrow each showed positive trends in mass gain in mature inland forest, but no significant increases

in beach ridge sites; Hermit Thrush was the only species that gained mass in beach ridge forest, but not in mature inland forest. This suggests that migrants may have had more success in gaining mass in mature inland forest than in beach ridge forest or dogwood shrubland. Such a pattern might be expected given that high densities of migrants in shoreline areas could depress arthropod availability and reduce mass gain due to increased competition for food. However, more data are needed for a wider variety of species to fully interpret patterns of mass gain among habitat types, and these results should be viewed as preliminary.

Across all habitats, the model that best explained variation in spring abundance of migrants included lake distance, trees 23-38 cm dbh, and stem density 2-3 m in height; lake distance appeared in all top-ranked models suggesting a higher importance of this variable in contributing to observed abundances. Sites that were closer to the lake had more migrants, as did sites with both mature trees and more developed understory vegetation. However, from a management perspective, it was necessary to examine these questions at the site/habitat level.

In dogwood shrubland the factor that was most strongly associated with migrant abundance was small trees (8-23 cm in dbh). Sites that had a mix of emergent small trees, which increased both horizontal and vertical heterogeneity in habitat, clearly had higher abundance of stopover migrants. Within beach ridge forest, the model containing trees 23-38 cm in dbh was by far the best at explaining variation in abundance of stopover migrants. Beach ridge sites that had more mature trees of this size class had more landbirds migrants. Within mature inland forest sites, the model that best explained variation in migrant abundance included lake distance and stems 2-3 m in height. This suggested that mature forests with higher density of understory vegetation were more strongly used. However, for the 14 mature inland forest sites, lake distance was clearly the most important variable as it appeared in all top-ranked models. Put simply, each 1 km increase in distance from the lake shore resulted on average in an 18.7% decline in stopover migrants for mature inland forest.

Although the specific mechanisms that concentrate migrant landbirds in shoreline areas and their relative importance are imperfectly understood, geography and the reluctance of small landbird migrants to initiate daytime flights across the western end of Lake Erie likely contribute strongly to the phenomenon. As a result, landbird migrants are expected to concentrate in shoreline areas for reasons that may not always be closely linked to the amount of available habitat and prey resources. For this reason, management and restoration of beach ridge habitats and mature inland forest patches closer to Lake Erie is warranted and should be pursued to the extent possible. In many cases, it may be necessary to restore or 'create' a forest in what was an agricultural field or other low-quality habitat. Although beyond the scope of the results presented here, the creation and/or restoration of beach ridge forests should be coupled with connectivity via trees rows and hedgerows to inland forest habitats and connectivity along the lake shore. Where possible, landbird migrants should be provided the ability to move more freely within the landscape. This should benefit birds that may become 'trapped' in small, isolated habitat patches that may have low food availability or offer

less protection from poor weather conditions. A variety of habitat management recommendations for the three habitats are provided in the discussion of this report and are being developed for an outreach-type pamphlet for public land managers and private landownders.

## INTRODUCTION

During the last 20 years, ornithologists and bird watchers have been very concerned about the conservation of migratory birds, as populations of some species have strongly declined in North America (Terborgh 1989; Askins et al. 1990). These declines were originally attributed to events occurring on breeding grounds (e.g. nest predation, forest fragmentation) or events occurring in wintering areas (e.g. tropical deforestation). However, recent evidence now suggests that populations of migratory landbirds may be limited by events occurring during migration. One recent indirect estimate suggests that up to 85% of annual adult mortality in the Black-throated Blue Warbler (*Dendroica caerulescens*) may occur during migratory periods (Sillett and Holmes 2002). Loss or degradation of stopover habitats is a likely factor contributing to population declines (Moore 2000). Nevertheless, current conservation plans for migratory bird species do not adequately address stopover habitat issues and typically consider only breeding and wintering periods (e.g. see Rosenberg 2000). Clearly, a much better understanding of landbird ecology during migratory stopover is needed to develop conservation strategies for migratory birds that include all aspects of their annual cycle.

During spring migration in the northern hemisphere, hundreds of species of landbirds leave their tropical or temperate wintering grounds and fly north to breeding areas. These birds are typically unable to accomplish this feat in a single non-stop flight and must repeatedly stop *en route* to feed and rest in stopover habitats before continuing their migration. Migrant landbirds encounter numerous difficulties during their migration, including high energetic costs of travel, adjusting to unfamiliar habitats or poor weather conditions, competing with migrant and resident birds, and avoiding predation (Moore et al. 1995). Selection of high quality stopover habitat should be important to migrants in lowering risks associated with migration and allowing them to meet their high energetic demands more efficiently. Habitat quality is largely indicated by a migrant's ability to replenish the energy stores (i.e. subcutaneous body fat) it needs to continue migration. An increase in energetic condition achieved through use of high quality habitat should increase a migrant's chances of successfully reaching breeding areas and may affect arrival condition on the breeding grounds, which, in turn, could ultimately affect reproductive output (Moore 2000).

In North America, habitat use and selection by migratory landbirds during stopover periods has been somewhat overlooked in ecological literature. Both local habitat features (e.g., habitat structure or plant species composition) (Petit 2000) and landscape-level factors (e.g., amount of forest cover in the surrounding landscape) (Moore et al. 1995) may affect the relative use of stopover habitats, but the relative influence of such factors is not well understood. Several studies confirm that migrating landbirds actively select certain habitats (reviewed in Petit 2000), but these studies have been largely conducted on Gulf and Atlantic coasts or in western ecosystems. There are relatively few published accounts of stopover habitat use in inland regions of eastern and Midwestern North America, and fewer still that have examined migrant energetic condition with respect to patterns of habitat use (but see Yong et al. 1998 and Dunn 2000). An examination of habitat quality is especially important given that high

use of a particular habitat by migrants does not necessarily indicate high habitat quality (e.g. Van Horne 1983). That is, birds could potentially have difficulty replenishing fat stores, even in habitats where they are common.

In the Western Basin of Lake Erie in Ohio, stopover migrants must choose among small, often isolated patches of natural habitat (e.g. mature forest, shrubland, or wetland areas) in landscapes dominated by agriculture. These habitats likely represent important stopover habitat to landbird migrants simply because a relatively small proportion of the landscape remains as potential habitat. However, because migrant landbirds traveling north in spring are reluctant to cross open waters of Lake Erie, unusually high densities of migrants often accumulate. Indeed, concentrations of migrant landbirds near the shoreline in the Western Basin of Lake Erie may be unparalleled in Midwestern states (Black Swamp Bird Observatory, 2007). As a result, remaining areas of natural habitat should be even more critical to migrating birds using this area. Identifying the important local habitat and landscape features that affect the use and quality of forest habitats could have significant implications for the conservation and management of forest habitats in both the Western Basin and in other fragmented Midwestern landscapes.

Recently, some researchers have stressed the need for additional information of the ecology and behavior of migrating birds to develop comprehensive plans to conservation migrant populations. Ewert et al. (2006) specifically mentioned a need to determine the spatial and temporal use of sites and habitats by migrants as well as the attributes that define a high quality stopover site. Similarly, Knutson et al. (2001) emphasized the need for research in the Upper Great Lakes Plain that identifies high quality migration habitat as a basis for conservation action.

The objectives of this study were to: 1) assess the relative abundance of migrating landbirds in three forest habitat types (mature inland forest, dogwood shrubland, and beach ridge forest) using point counts and mist netting, 2) assess the quality of stopover sites by quantifying energetic condition (i.e., size-adjusted body mass) of common migrants to estimate diurnal mass gain in the three forest habitats, 3) examine the relationship between distance from lake and variation in migrant abundance, 4) evaluate relationships between local habitat characteristics and the abundance of migrating birds in the three habitats, and 5) develop guidelines to assist land managers and private landowners in managing or restoring habitats on their property in ways that benefit migratory birds.

## METHODOLOGY AND STUDY DESIGN

***Study area, habitats, and site selection*** – Migration research was conducted from mid April to early June in 2003-2005. In early spring 2003, I selected 28 forest study sites in Ottawa and Lucas counties of northwestern Ohio (Table 1). Nearly 70% of all sites used in the study were located within Ottawa National Wildlife Refuge

(Ottawa and Darby Units) and Cedar Point National Wildlife Refuge (Table 1). Other locations of study sites were primarily within state wildlife areas managed by the Ohio Dept. of Natural Resources - Division of Wildlife, including Magee Marsh Wildlife Area, Toussaint Wildlife Area, Little Portage Wildlife Area. A small number of additional study sites were located within Crane Creek State Park, Maumee Bay State Park, and Pearson Metropark (Figures 1-5). Sites were located in three different habitat types: mature inland forest [0.43-5.27 km from Lake Erie; n = 14 sites], dogwood shrub (1.76-5.34 km; n = 7 sites), and mature beach ridge forest (0.03-0.84 km; n = 7 sites) (Table 1). All sites were located at least 500 m apart.

Mature inland forest and beach ridge forest sites had canopies from 18–24 m tall and were dominated by trees in the 23-38 cm diameter class, with some trees >38 cm in diameter. Forest canopies were largely continuous, with occasional tree-fall gaps in mature inland forest; beach ridge forest had more tree-fall gaps and a less continuous canopy. Understory shrubs and saplings were typically sparse and patchily distributed in mature inland forest, whereas beach ridge sites had well-developed understory trees and shrubs. Common overstory tree species within mature inland forests included, American elm (*Ulmus americana*), ashes (*Fraxinus* sp.), hackberry (*Celtis occidentalis*), red maple (*Acer rubrum*), silver maple (*A. saccharinum*), basswood (*Tilia americana*), honey locust (*Gleditsia tricanthos*), a variety of oaks [e.g. pin oak (*Quercus palustris*), red oak (*Q. rubra*), swamp white oak (*Q. bicolor*), and hickories such as shagbark (*Carya ovata*)]. Forest canopy trees in beach ridge sites tended to be more dominated by cottonwood (*Populus deltoides*), hackberry, ashes, and elms. Common woody understory plants in both mature forests included a variety of shrubs species and saplings of canopy trees (e.g. ashes, red maple, hackberry), and small trees like boxelder (*Acer negundo*), and hawthorn (*Crataegus* sp.). Dogwood shrubland was dominated by dense shrubs 2-4 m tall, including several species of *Cornus* shrubs and occasional willows (*Salix* sp.). Small trees (5-10 m tall) were scattered within shrubland sites and were mostly cottonwood, ashes, and boxelder.

***Point count surveys of migrants*** – Point count surveys were conducted at each of the 28 sites from mid April to the end of May over a three year period (2003-2005). Birds were surveyed between 0700-1100 on all days except those with strong wind or rain. Each of the 28 sites was surveyed approximately weekly on five occasions during the spring of 2003 and on six occasions in both spring 2004 and 2005 (i.e. one point count survey per site during each week of the study). During each survey day, 2 mature inland forest sites, 1 beach ridge forest site, and 1 dogwood shrub site were surveyed. A single observer recorded all birds seen or heard and estimated the distance to each individual during a 10-minute period.

***Mist netting of migrants and energetic condition*** – Energetic condition of migrant landbirds was assessed by mist netting migrants on a subset of 12 of the 28 sites (i.e. four sites each for mature inland forest, beach ridge forest, and dogwood shrubland; Table 1). At the same time, mist netting provided information on occurrence of migrants within habitats. However, interpretation of mist net capture data should be done with caution given the possible biases associated with different capture

probabilities among habitats (e.g. Remsen and Good 1996). Mist netting occurred daily during the study and each site was netted on 8 days per year. On each day that nets were operated, 7-12 nets were simultaneously operated in two different habitats for 6-7 hours starting at 30 minutes before sunrise. Net opening and closing times were recorded for each individual net and a total number of mist net hours were recorded by site for each day spent netting birds.

Migrants were captured using 2.6 x 12 meter mist nets (30 mm mesh). Birds were removed from nets every 20-30 minutes and held in individual cloth holding bags prior to processing. Each migrant captured was identified and banded with a U.S. Geological Survey aluminum leg band. Data collected included: time of capture, age, sex, wing chord, tarsus length, and molt status. Body mass was measured using an Ohaus CS 2000 digital scale. Subcutaneous body fat was recorded using the 6-point ordinal scale of Helms and Drury (1960).

***Measurement of habitat characteristics*** – During early June 2003, habitat characteristics were measured at each of the study sites using 11.3-m-radius circular plots (James and Shugart 1970). Within a 5-m radius of the plot center, shrubs and saplings taller than 0.5 m were recorded by species in 0-2.5 cm and 2.5-8 cm diameter classes (measured 10 cm above ground). Percentages of vegetative cover <0.5 m tall within the 5-m circle were recorded as shrub, herbaceous plant, downed log, or leaf litter. Within an 11.3-m radius, trees were recorded by species in diameter at breast height (dbh) classes 8-23 cm, 23-38 cm, and >38 cm. Standing dead trees were counted in 12-23 cm, 23-38 cm, and >38 cm dbh classes. Using a sighting tube, canopy cover >2 m high was estimated at 2-m intervals along two perpendicular transects running through the plot center. Canopy height and percent slope were measured using a clinometer and plot aspect was measured with a compass.

***Data analysis*** – Landbird species recorded during point count and mist netting surveys were classified as either non-breeding transient species (hereafter "stopover migrants" or "transients"; $n$ = 65 species; Appendix 1) or locally breeding species.

*Survey data: point counts* – Using data from point count surveys, total abundance was calculated separately by site and year for individual transient species and transients as a group by summing abundances over all visits to each site within each year. Only species recorded at least 20 times during the study ($n$ = 21 species) were included in individual species analyses. A generalized linear model that accounted for Poisson-distributed count data, (PROC GENMOD; SAS Institute, 1990) was used to test for differences in abundance among habitats using data from point counts.

*Survey data: mist netting* – Using count data from mist net surveys, total abundance was separately calculated by site and year for transients and individual species as the number of individuals per 100 mist-net-hours. Only 16 transient species met the minimum of 60 records needed to run analyses for individual species. Because the variance was greater than the mean for the count data from mist net surveys, generalized linear models for a negative binomial distribution and a log-likelihood ratio

test was used to test for differences in abundance among the three habitats (White and Bennetts 1996).

*Energetic condition* – For each bird captured, body mass was divided by wing chord to standardize for body size. Analyses of migrant condition were run separately by species for those species with at least 20 captures. To examine migrant condition at sites, I regressed size-adjusted body mass against time of capture following methods described by Dunn (2000). These methods allow for an examination of diurnal mass gain in migrants within a habitat(s) and without the need to recapture and weigh individuals. When conducting multiple tests, false discovery rate was controlled following Benjamini and Hochberg (1995).

*Site attributes and point count data* – The influence of local habitat structure and distance from lakeshore on the stopover habitat use of 65 species of transient migrants was examined using a stepwise information-theoretic approach (Burnham and Anderson 2002, Carrie et al. 2002, Venables and Ripley 2002). Predictor variables were evaluated for inter-correlation, and where Pearson Correlation Coefficients were greater than 0.7, one variable was selected. Abundance data were transformed using square root+0.5 to address assumptions of normality. A null model was first generated and then using forward selection each of the habitat variables was added in sequence. The predictor variables that reduced the AIC value the greatest were retained. Because sample sizes were small, a correction term ($AIC_c$) was applied to AIC values. The $AIC_c$ scores were ranked and the model weights were generated across candidate models.

Four separate analyses were completed; the first analysis combined all three habitats and examined the site attributes that influenced transient abundance across all habitats (i.e. independent of habitat type). When all sites were considered transient abundance data were transformed using square root (abundance+0.5) to meet normality assumptions. To examine the influence of site attributes specific to each of the three habitats, separate analyses were run for beach ridge forest, mature inland forest, and dogwood shrubland. These analyses should provide some insight into the potential habitat characteristics associated with transient abundance across the three habitats. Model weights provided additional evidence as to the variables that best explained transient abundance within the three habitats.

## RESULTS

***Point count surveys*** – The four most abundant stopover migrants recorded during point count surveys at the 28 sites were (in order of decreasing abundance): White-throated Sparrow, Yellow-rumped Warbler, American Redstart, and Ruby-crowned Kinglet (Figures 6A-6C; Appendix 1). Fourteen of 21 species (67%) of stopover migrants tested had greater abundance within beach ridge forest relative to other habitats (Table 2). The magnitude of the difference was large with 9 of the 14 species recorded at least two times more frequently in beach ridge relative to the habitat

of second highest abundance. For the large majority of species, mature inland forest typically had more individuals than dogwood shrub, but in only two cases were differences significant. For three species (Red-eyed Vireo, Black-throated Green Warbler, Bay-breasted Warbler) abundance was not significantly different between beach ridge and mature inland forests. Six species showed no difference in abundance among habitats and only Rusty Blackbird was more abundant in mature inland forest and dogwood shrubland.

***Mist net surveys*** – During the 15,384 mist-net-hours accumulated in mist netting operations, a total of 9,715 individuals of 102 species were captured (Appendix 2, Appendix 3). The four most abundant stopover migrants captured at the 12 sites were (in order of decreasing abundance): Yellow-rumped Warbler, White-throated Sparrow, Magnolia Warbler, and Palm Warbler (Figures 7A, 7B). Twelve of 16 species (75%) of stopover migrants tested exhibited significant differences among habitats (Table 3); of these 12 species, 10 had higher capture rates in beach ridge forest. Similar to abundance data from point count surveys, the magnitude of the difference between beach ridge and other habitats was large for many species (Figures 7A, 7B). In contrast to point count data, capture rates for 7 species tested indicated higher abundance in dogwood shrubland relative to mature inland forest. For Yellow-rumped Warbler, Ovenbird, and Hermit Thrush capture rates in dogwood shrubland were very low relative to beach ridge forest and mature inland forest.

***Migrant energetic condition*** – Nineteen species had sample sizes large enough to permit analyses and relatively few of these exhibited significant positive trends in diurnal mass gain within the habitats. Only 1 of 15 species in dogwood shrubland (White-throated Sparrow) and only 3 of 19 species (Ruby-crowned Kinglet, Hermit Thrush, and Palm Warbler) in beach ridge forest exhibited significant positive trends in body mass (Table 4). In contrast, 5 of 9 migrant species (55.5%) had positive diurnal trends in mature inland forest, including Yellow-rumped Warbler, Palm Warbler, Ovenbird, Northern Waterthrush, and White-throated Sparrow. No species had a significant negative trend in mass gain in any habitat.

Few species were captured in sufficient numbers in all three habitat types, thereby limiting comparisons of energetic condition among habitats. Palm Warblers exhibited positive diurnal trends in mass gain in both beach ridge and mature inland forests, but no significant trend in dogwood shrubland. Yellow-rumped Warbler, Ovenbird, Northern Waterthrush, and White-throated Sparrow each showed positive trends in mass gain in mature inland forest, but no significant increases in beach ridge sites; Hermit Thrush was the only species that gained mass in beach ridge forest, but not in mature inland forest.

***Site attributes and bird abundance*** – The model that best explained variation in the abundance of 65 species of stopover migrants (independent of habitat type) included a combination three explanatory variables, lake distance, trees 23-38 cm dbh, and stem density 2-3 m in height ($\Delta AIC_c = 0$, $\omega_i = 0.265$; Table 5A). However, models containing tree richness and trees 8-23 cm dbh were also plausible (i.e. $\Delta_i$ less than ~2).

Lake distance was negatively associated with bird abundance and appeared in all top-ranked models suggesting a higher importance of this variable in contributing to observed abundances (Figure 8).

In beach ridge forest, the model containing trees 23-38 cm in dbh was best in explaining variation in abundance of stopover migrants ($\Delta AIC_c = 0$, $\omega_i = 0.811$; Table 5B; Figure 9). Trees 23-38 cm were positively associated with bird abundance in beach ridge habitats (95% CI = 17.2 – 80.9). Based on Akaike weights, this model clearly contained the most support of all candidate models. Furthermore, the null model ($\Delta AIC_c = 3.9$, $\omega_i = 0.114$) was the next-best model indicating that all other habitat variables had less support than random.

Within mature inland forest, the model that best explained variation in the abundance of stopover migrants included a combination two explanatory variables: lake distance and stems 2-3 m in height ($\Delta AIC_c = 0$, $\omega_i = 0.265$; Table 5C). However, models containing: 1) lake distance, 2) lake distance + trees 23-38 cm dbh, and 3) lake distance + stems 2-3 m in height + trees 23-38 cm were also plausible (i.e. $\Delta_i$ less than ~2). However, lake distance appeared in all top ranked models indicating a higher importance of this variable ($\Delta AIC_c = 0.7$, $\omega_i = 0.177$; Table 5C). The importance of lake distance was also seen in the model summary statistics which indicated that on average each 1 km increase in distance from the lake resulted in a loss of 16.1 stopover migrants at mature inland forest sites (95% CI = -25.0 – -3.0).

In dogwood shrubland, the model that contained trees 8-23 cm dbh was the top model explaining variation in abundance of stopover migrants ($\Delta AIC_c = 0$, $\omega_i = 0.815$; Table 5D; Figure 10). Based on Akaike weights, this model ranked 5.7x better than the next-best model which was a combination of trees 8-23 cm dbh and trees >38 cm dbh ($\Delta AIC_c = 3.5$, $\omega_i = 0.144$).

# DISCUSSION

***Patterns of migrant habitat use*** – During spring migration in the Western Basin of Lake Erie, a wide variety of individual species of stopover migrants occurred in significantly higher numbers in beach ridge forests than in either mature inland forests or dogwood shrubland based on point count surveys. There are likely a variety of reasons why migrants concentrate in great numbers along the Lake Erie shoreline in spring migration (e.g. increased habitat structural diversity, reluctance to cross Lake Erie, concentration of migrants into remnant patches of terrestrial habitats, potentially increased prey availability), but at this point there is little specific information on the mechanisms that may drive the observed patterns.

For most individual species, mature forests (mature inland and beach ridge) had more migrants than younger dogwood shrubland, suggesting a preference for mature forests during spring migration. Indeed, very low frequencies on point counts for some

common species, such as Yellow-rumped Warbler, Hermit Thrush, and Ovenbird, suggested an avoidance of shrubland in spring. Although the underlying mechanisms remain unclear, higher use of mature forest has been demonstrated in other spring migration studies in eastern North America (e.g. Petit 2000, Rodewald and Brittingham *in press*). Shrubland and early-successional forests tend to receive higher use by migratory mature-forest-breeding birds during fall migration (Rodewald and Brittingham 2004) and post-breeding periods (Vitz and Rodewald 2005) when these habitats contain more fruit resources.

Capture rates obtained from mist netting are potentially biased given differences in the way that mist nets (2.5 m high) may sample shrubland and taller forest habitats (see Remsen and Good 1996). Nonetheless, the majority of data presented here are for species that tend to occur on the ground or within lower forest strata. Such species are expected to typically be sampled more equally among habitats of varying structure. As with point count data, capture rates of stopover migrants for the majority of species, including many common migrants (e.g. Yellow-rumped Warbler, White-throated Sparrow, Magnolia Warbler, Palm Warbler, Ruby-crowned Kinglet, and Hermit Thrush) were significantly higher in beach ridge forest relative to dogwood shrubland. Consistent with the point count data, several species (Yellow-rumped Warbler, White-throated Sparrow, and Veery) also were captured more frequently in mature inland forest than in shrubland, suggesting a possible preference for mature forest habitats in spring. In contrast, a number of mature-forest species (e.g. American Redstart, Canada Warbler, Magnolia Warbler, and Ruby-crowned Kinglet) had relatively high capture rates in dogwood shrubland relative to mature inland forest, a pattern that likely resulted from higher capture probability within shrubland habitats, as discussed above.

***Energetic condition*** – Results from regression analyses indicated that relatively small numbers of the 19 species tested exhibited significant diurnal trends in mass gain within the habitats. This differs from other spring migration studies (e.g. Bonter et al. 2007, Dunn 2002) reporting that the majority of species showed significant increases in condition throughout the day. In my study area, only 1 of 15 species in dogwood shrubland and only 3 of 19 species in beach ridge forest exhibited significant positive trends in body mass. One exception to this pattern was that 5 of 9 migrant species (55.5%) had positive diurnal trends in mature inland forest. This suggests that migrants may have had more success in gaining mass in mature inland forest than in shrubland or beach ridge forest. The best support for this comes from four species, Yellow-rumped Warbler, Ovenbird, Northern Waterthrush, and White-throated Sparrow, that each showed positive trends in mass gain in mature inland forest, but no significant increases in beach ridge sites; Hermit Thrush was the only species that gained mass in beach ridge forest, but not in mature inland forest.

This pattern might be expected given that high densities of migrants in shoreline areas could depress arthropod availability and reduce mass gain due to increased competition for food, as reported in gulf coastal systems (Moore and Yong 1991). However, availability emergent aquatic midges (Diptera: Chironomidae), a prey item heavily consumed by migrant landbirds in the northern Great Lakes (e.g. Smith et al.

2007), seemed high during much of spring migration near beach ridge forests (P. Rodewald, pers. obs.), making it less likely that competitive effects could be involved. Until additional information on energetic condition is available for a wider variety of species across habitats, these results should be viewed as preliminary.

***Site attributes, bird abundance, and management implications -*** Across all habitats, the model that best explained variation in spring abundance of migrants included lake distance, trees 23-38 cm dbh, and stem density 2-3 m in height. Sites that were closer to the lake and had both mature trees and more developed understory vegetation had more landbird stopover migrants, although lake distance was most prominent in this analysis. However, from a management perspective, it was necessary to examine these questions at the site/habitat level. It is worth noting this none of the models examined included patch area. Future analyses will need to incorporate this variable to obtain a more complete picture of the factors that drive habitat selection.

*Dogwood Shrubland* – In shrubland habitat the factor that was strongly associated with migrant abundance was small trees (8-23 cm in dbh). Sites that had a mix of emergent small trees, which increased both horizontal and vertical heterogeneity in habitat, clearly had higher abundance of stopover migrants. This find is consistent with a variety of other studies reporting that habitat diversity is positively related to migrant abundance during stopover (e.g. Petit 2000, Rodewald and Brittingham 2002, Rodewald and Brittingham *in* press). Thus, where appropriate, managing for successional stages that are slightly more advanced relative to lower growing shrubs is something that land managers can do to increase use by spring migrants. That said, it is important to note that dogwood shrubland and other early successional areas are heavily used by a variety of fruit-eating and other migrants during post-breeding periods (Vitz and Rodewald 2005) and in fall migration (Suthers et al. 2000) when these areas often have high fruit availability. Modest increases in numbers of trees 8-23 cm in diameter (e.g. 10-15/hectare) should not have negative effects on many of the frugivorous transients (e.g. *Catharus* thrushes) during fall. Thus, land managers in the Western Basin of Lake Erie will need to consider the habitat needs of migratory birds over time scales that include spring and fall migratory periods, breeding periods.

*Beach Ridge Forests* - A variety of factors, including availability and connectivity of habitats, prey availability, and geographic impediments to migration, may contribute to the high concentrations of migratory birds that occur in lakeshore habitats in the Western Basin of Lake Erie. Although the specific mechanisms that concentrate migrant landbirds in shoreline areas and their relative importance are imperfectly understood, it seems likely that geography and the reluctance of small landbird migrants to initiate daytime flights across the western end of Lake Erie contribute strongly to the phenomenon. As a result, landbird migrants are expected to concentrate in shoreline areas for reasons that may not be closely linked to the amount of available habitat and prey resources. For this reason, management and restoration of beach ridge habitats is warranted and should be pursued to the extent possible.

Within beach ridge forest, the model containing trees 23-38 cm in dbh was by far the best at explaining variation in abundance of stopover migrants. Beach ridge sites that had more mature trees of this size class had more landbirds migrants. Although additional information on patch area will be useful to fully interpret this result, the strong relationship ($r^2$ = 0.87) suggests that management for mature trees within beach ridge sites would be attractive to migrants. Although beyond the scope of the results presented here, the creation and/or restoration of beach ridge forests should be coupled with connectivity via trees rows and hedgerows to inland forest patches, and connectivity along the lake shore. Where possible, landbird migrants should be provided the ability to move more freely within the landscape. This should benefit birds that may become 'trapped' in small, isolated habitat patches that may have low food availability or offer less protection from poor weather conditions or predators.

*Mature Inland Forests* – Within mature inland forest, the model that best explained variation in the abundance of stopover migrants included lake distance and stems 2-3 m in height. This suggested that mature forests with a higher density of understory vegetation and closer to the lakeshore were more strongly used. However, it should be noted that lake distance was clearly the most important variable as it appeared in all top-ranked models. Put simply, each 1 km increase in distance from the lake shore resulted on average in a loss of 16.1 stopover migrants at each mature inland forest site. Using slope and intercept values obtained from the regression analysis, this translated to an 18.7% decline in migrants per kilometer. Although patch size was not included as a variable in this analysis, it is worth noting that both small and larger forest patches were represented at different distances from the lake.

These findings argue for the conservation and restoration of both beach ridge forests and mature inland forest patches, especially those closer to Lake Erie. Where mature forest patches remain in the near-vicinity of Lake Erie or along the shoreline, they should be strongly considered for conservation status. In many cases, it may be necessary to restore or 'create' a forest in what was an agricultural field or other low-quality habitat. Ideally, forest patches will be uneven-aged with respect to tree size-classes, and diverse in vertical habitat structure, with well-developed understory and midstory vegetation layers. In addition, patchiness in canopy structure can increase horizontal heterogeneity within the canopy layer and increase use by migrant landbirds (e.g. Petit 2000, Rodewald and Brittingham *in press*). Canopy gaps can be created in mature forest stands with dense canopy cover by removing a few individual trees in a canopy thinning. Often dense, mature forest stands have little understory development, and creating some canopy gaps in the forest can encourage the development of a more diverse forest understory.

## RESEARCH NEEDS

Ewert et al. 2005 provided a comprehensive list of research topics that require additional information so that migrating landbirds may be managed more effectively in the Western Basin of Lake Erie. Based on results reported in this report, I emphasize that among the most important research questions from a conservation perspective focus on issues related to energetic condition and movement behavior. More specifically, additional data are needed on the energetic condition/refueling rates of migrants that use beach ridge forest and other habitats. Are these habitats of high migrant concentration places where some species lose mass? If so, which species are involved and are there certain site attributes that are associated with changes in energetic condition?

Other key information that is largely lacking relates to the movement behavior of migrants within the landscape. Of special interest is the need for information on the potential mechanisms of habitat selection: which habitat and landscape factors are associated with areas of high use? How long do migrants remain in patches and how does this relate to patch area, connectivity, and local habitat features? Some of these questions are being addressed in an ongoing study involving radio telemetry of Red-eyed Vireos and Yellow-rumped Warblers (A. Buchanan and P. Rodewald). However, with heightened concerns about the development of wind energy in the Western Basin, detailed studies of the flight altitudes, flight behavior of migrants at takeoff and landing, and migrant movements on the ground are badly needed. Such information should be important to fully assess the risks that migrants would face if wind turbines are located within areas where concentrations of migrating birds are often high.

## DISSEMINATION OF RESEARCH RESULTS

These results are presently being communicated as research reports to state, federal, and private conservation organizations that manage lands within the Western Basin in northwest Ohio. These groups include two offices of the U.S. Fish and Wildlife Service in Ohio (Ottawa National Wildlife Refuge and Ecological Services in Reynoldsburg), Ohio Department of Natural Resources-Division of Wildlife, The Nature Conservancy (Ohio and Michigan), Black Swamp Bird Observatory, Black Swamp Conservancy, Audubon Ohio, Ohio Lake Erie Commission, Ohio Wind Working Group, Maumee Bay State Park, Metropolitan Park District of the Toledo Area, and other groups that express interest. Results will be presented as an extension publication (pamphlet); this is being developed in collaboration with Dr. David Ewert (The Nature Conservancy-Michigan Chapter, Great Lakes Program) and currently is in draft form. Where possible, I will meet with key groups to discuss management possibilities. During 2007, I will submit manuscripts to peer-reviewed science journals (e.g. *Conservation Biology*, *The Auk*, *Condor*) and resulting publications will be forwarded to all funding organizations and other interested groups as they become available.

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Table 1. Habitats types, study site locations, and survey information where mist netting and point count surveys were conducted in Lucas and Ottawa counties of northwestern Ohio, mid April to late May, 2003-2005.

| Habitat types and sites | Site # | Location | Latitude-N | Longitude-W | Distance to lake (km) | # mist nets used | Total mist net hours | # 10-min point counts conducted (2003-05) |
|---|---|---|---|---|---|---|---|---|
| *Beach Ridge Forest* | | | | | | | | |
| Darby West | 1 | Ottawa NWR-Darby unit | 41.5374 | -82.9997 | 0.10 | 10 | 1274 | 17 |
| Darby East | 2 | Ottawa NWR-Darby unit | 41.5270 | -82.9786 | 0.09 | 12 | 1553 | 17 |
| Crane Creek Pool 1 | 3 | Ottawa NWR-Ottawa unit | 41.6317 | -83.1971 | 0.04 | 7 | 875 | 17 |
| Lamb's Woods | 4 | Cedar Point NWR | 41.6978 | -83.3253 | 0.07 | 10 | 1319 | 17 |
| CP West | 8 | Cedar Point NWR | 41.7012 | -83.3374 | 0.03 | - | - | 17 |
| Crane Creek Boardwalk | 14 | Magee Marsh Wildlife Area | 41.6279 | -83.1926 | 0.15 | - | - | 17 |
| Pool 3 East [a] | 15 | Ottawa NWR-Ottawa unit | 41.6358 | -83.2284 | 0.84 | - | - | 5 |
| *Mature Inland Forest* | | | | | | | | |
| Darby Pool 2 | 5 | Ottawa NWR-Darby unit | 41.5255 | -83.0007 | 1.26 | 10 | 1331 | 17 |
| Kurdy House | 6 | Ottawa NWR | 41.5891 | -83.1106 | 2.65 | 10 | 1281 | 17 |
| Turtle Creek | 7 | Magee Marsh Wildlife Area | 41.6059 | -83.1568 | 1.44 | 10 | 1282 | 17 |
| Maumee Bay | 9 | Maumee Bay State Park | 41.6801 | -83.3534 | 0.76 | 10 | 1222 | 17 |
| Pearson [b] | 16 | Pearson Metropark | 41.6428 | -83.4355 | 5.27 | - | - | 11 |
| Shopwoods | 17 | Ottawa NWR-Ottawa unit | 41.6114 | -83.1994 | 2.06 | - | - | 17 |
| Butternut | 18 | Ottawa NWR-Ottawa unit | 41.6153 | -83.2269 | 2.67 | - | - | 17 |
| HQ Woods | 19 | Ottawa NWR-Ottawa unit | 41.6110 | -83.2057 | 2.33 | - | - | 17 |
| Public Fishing | 20 | Cedar Point NWR | 41.6754 | -83.3235 | 1.25 | - | - | 17 |
| MS8A Woods | 21 | Ottawa NWR-Ottawa unit | 41.6124 | -83.2149 | 2.54 | - | - | 17 |
| Pool 2B | 22 | Ottawa NWR-Ottawa unit | 41.6199 | -83.2024 | 1.34 | - | - | 17 |
| FU 10 | 23 | Ottawa NWR-Ottawa unit | 41.6079 | -83.2278 | 3.42 | - | - | 17 |
| Pool 9 West | 24 | Ottawa NWR-Ottawa unit | 41.6349 | -83.2515 | 1.98 | - | - | 17 |
| Water Plant | 25 | Cedar Point NWR | 41.6751 | -83.3115 | 0.43 | - | - | 17 |
| *Dogwood Shrubland* | | | | | | | | |
| Little Portage | 10 | Little Portage Wildlife Area | 41.4944 | -83.0277 | 5.35 | 10 | 1334 | 17 |
| Woodies Roost | 11 | Ottawa NWR-Ottawa unit | 41.6050 | -83.1772 | 2.10 | 10 | 1311 | 17 |
| Mini Marsh | 12 | Ottawa NWR-Ottawa unit | 41.6116 | -83.2230 | 2.89 | 10 | 1136 | 17 |
| FU 11 | 13 | Ottawa NWR-Ottawa unit | 41.6099 | -83.2111 | 1.36 | 10 | 1466 | 17 |
| Toussaint | 26 | Toussaint Wildlife Area | 41.5746 | -83.1565 | 4.79 | - | - | 17 |
| Unmanaged Marsh | 27 | Ottawa NWR-Ottawa unit | 41.6154 | -83.2412 | 3.31 | - | - | 17 |
| Pool 9 East | 28 | Ottawa NWR-Ottawa unit | 41.6355 | -83.2483 | 1.76 | - | - | 17 |

[a] A nesting pair of Bald Eagles at Pool 3 East prevented point count surveys in spring 2004 and 2005. This site is located farther from the lake shore than other beach ridge sites, but was structurally similar to beach ridge sites and was the closest forest patch to the lake shore in the immediate area.

[b] Emerald Ash Borer control efforts at Pearson Metropark prevented point count surveys in spring 2005.

Table 2. Mean (± SE) abundance of 21 species of stopover migrants detected within 25-m-radius point counts in Lucas and Ottawa counties of northwestern Ohio, mid April to late May, 2003-2005.

| Species abundance [a] | Beach Ridge Forest [b, c] | Mature Inland Forest | Dogwood Shrubland | Habitat *P* value |
|---|---|---|---|---|
| Least Flycatcher | 0.57 (0.2) | 0.31 (0.10) | 0.48 (0.27) | 0.223 |
| Red-eyed Vireo | 1.0 (0.29)A | 0.74 (0.14)AB | 0.14 (0.10)C | <0.001 |
| Ruby-crowned Kinglet | 2.05 (0.46)A | 1.21 (0.25)B | 1.0 (0.31)B | 0.003 |
| Blue-gray Gnatcatcher | 2.38 (0.83)A | 0.81 (0.20)B | 0.48 (0.16)B | <0.001 |
| Swainson's Thrush | 0.33 (0.14) | 0.29 (0.10) | 0.14 (0.10) | 0.332 |
| Tennessee Warbler | 0.33 (0.16) | 0.21 (0.07) | 0.19 (0.11) | 0.494 |
| Nashville Warbler | 0.67 (0.22) | 0.5 (0.13) | 0.48 (0.21) | 0.493 |
| Chestnut-sided Warbler | 1.43 (0.31)A | 0.36 (0.10)B | 0.24 (0.12)B | <0.001 |
| Magnolia Warbler | 1.81 (0.42)A | 0.57 (0.14)B | 0.38 (0.13)B | <0.001 |
| Black-throated Blue Warbler | 0.62 (0.19)A | 0.21 (0.09)B | 0.14 (0.08)B | 0.007 |
| Yellow-rumped Warbler | 6.52 (1.43)A | 4.9 (1.03)B | 0.76 (0.30)B | <0.001 |
| Black-throated Green Warbler | 0.71 (0.27)A | 0.4 (0.11)AB | 0.19 (.015)B | 0.017 |
| Blackburnian Warbler | 0.33 (0.16) | 0.31 (0.12) | 0.10 (0.07) | 0.128 |
| Palm Warbler | 1.48 (0.39)A | 0.57 (0.17)B | 0.57 (0.23)B | <0.001 |
| Bay-breasted Warbler | 0.52 (0.27)A | 0.57 (0.19)A | 0.14 (0.10)B | 0.017 |
| Blackpoll Warbler | 1.0 (0.27)A | 0.45 (0.11)B | 0.10 (0.07)C | <0.001 |
| Black-and-white Warbler | 0.43 (0.15) | 0.24 (0.09) | 0.14 (0.10) | 0.135 |
| American Redstart | 2.62 (0.59)A | 1.07 (0.22)B | 0.62 (0.18)B | <0.001 |
| Wilson's Warbler | 1.05 (0.3)A | 0.19 (0.07)B | 0.86 (0.30)A | <0.001 |
| White-throated Sparrow | 7.1 (1.83)A | 2.81 (1.11)B | 2.71 (0.71)B | <0.001 |
| Rusty Blackbird | 0.19 (0.13)B | 0.76 (0.46)A | 0.52 (0.28)AB | 0.014 |

[a] Mean abundance calculated by summing abundances over all visits to each site within each year and then calculating means by habitat over sites and years.

[b] Twenty eight sites (14 mature inland forest, 7 beach ridge forest, 7 dogwood shrubland) were surveyed 5 times each in spring 2003, 6 times in spring 2004, and 6 times in spring 2005.

[c] Column means within a row that did not share a letter were different ($P<0.05$).

Table 3. Log likelihood, *G* statistic for log likelihood ratio test, degrees of freedom, probability of G>(*P*), null deviance, residual deviance, and percent of deviance explained for 16 species of migrants captured in mist nets among habitat types, Lucas and Ottawa counties, northwestern Ohio, mid April to late May, 2003-2005.

| Species [a] | Log-likelihood | *G* | df | *P* value | Null deviance | Residual deviance | Percent of deviance explained |
|---|---|---|---|---|---|---|---|
| Red-eyed Vireo | -56.85 | 11.19 | 2 | 0.004 | 38.22 | 27.02 | 29.3 |
| Ruby-crowned Kinglet | -88.09 | 19.38 | 2 | <0.001 | 51.91 | 32.52 | 37.3 |
| Veery | -74.08 | 3.93 | 2 | 0.140 | 39.39 | 35.47 | 10.0 |
| Gray-cheeked Thrush | -52.51 | 3.32 | 2 | 0.190 | 29.22 | 25.89 | 11.4 |
| Hermit Thrush | -111.62 | 15.42 | 2 | <0.001 | 49.56 | 34.14 | 31.1 |
| Nashville Warbler | -82.32 | 9.29 | 2 | 0.009 | 41.68 | 32.39 | 22.3 |
| Chestnut-sided Warbler | -62.17 | 15.11 | 2 | <0.001 | 43.59 | 28.49 | 34.7 |
| Magnolia Warbler | -121.17 | 31.79 | 2 | <0.001 | 64.98 | 33.18 | 48.9 |
| Yellow-rumped Warbler | -176.83 | 29.58 | 2 | <0.001 | 65.77 | 36.19 | 45.0 |
| Palm Warbler | -137.97 | 8.052 | 2 | 0.018 | 45.13 | 37.08 | 17.8 |
| American Redstart | -94.33 | 17.58 | 2 | <0.001 | 51.61 | 34.02 | 34.1 |
| Ovenbird | -111.06 | 10.19 | 2 | 0.006 | 46.19 | 35.99 | 22.1 |
| Northern Waterthrush | -104.21 | 2.97 | 2 | 0.226 | 39.78 | 36.81 | 7.5 |
| Mourning Warbler | -60.79 | 14.62 | 2 | <0.001 | 43.41 | 28.78 | 33.7 |
| Canada Warbler | -64.38 | 12.69 | 2 | 0.001 | 38.39 | 25.69 | 33.1 |
| White-throated Sparrow | -196.71 | 5.16 | 2 | 0.075 | 45.34 | 40.18 | 11.4 |

[a] Each of 12 sites (4 beach ridge forest, 4 mature inland forest, 4 dogwood shrubland) was surveyed with 7-12 mistnets operated 7 hours daily on 8 mornings per year.

Table 4. Sample size and mean (± SE) hourly change in mass (g) for 19 species of stopover migrants within three forest habitats in Lucas and Ottawa counties of northwestern Ohio, mid April to late May, 2003-2005.

| Species | *n* | Beach Ridge Forest [a] | *P* value | *n* | Mature Inland Forest | *P* value | *n* | Dogwood Shrubland | *P* value | Mean wing |
|---|---|---|---|---|---|---|---|---|---|---|
| Least Flycatcher | 35 | 0.17 (0.07) | 0.092 | 5 | 0.08 (0.24) | NA | 24 | -0.02 (0.10) | 0.902 | 61.1 |
| Ruby-crowned Kinglet | 121 | 0.08 (0.02) | 0.005 | 15 | 0.07 (0.08) | NA | 47 | 0.07 (0.06) | 0.318 | 56.8 |
| Veery | 29 | 0.09 (0.31) | 0.864 | 58 | -0.34 (0.23) | 0.271 | 23 | 0.47 (0.28) | 0.268 | 96.6 |
| Gray-cheeked Thrush | 31 | -0.08 (0.49) | 0.913 | 16 | 0.28 (0.57) | NA | 17 | 0.81 (0.45) | NA | 101.6 |
| Swainson's Thrush | 113 | -0.29 (0.24) | 0.318 | 77 | -0.29 (0.24) | 0.318 | 40 | 0.39 (0.39) | 0.399 | 96.7 |
| Hermit Thrush | 112 | 0.28 (0.10) | 0.031 | 108 | 0.03 (0.10) | 0.883 | 14 | 0.37 (0.25) | NA | 90.1 |
| Nashville Warbler | 71 | 0.07 (0.04) | 0.185 | 17 | 0.12 (0.1) | NA | 34 | 0.07 (0.06) | 0.318 | 56.9 |
| Chestnut-sided Warbler | 65 | -0.11 (0.07) | 0.269 | 7 | 0.13 (0.19) | NA | 14 | 0.04 (0.11) | NA | 60.8 |
| Magnolia Warbler | 278 | 0.13 (0.13) | 0.389 | 18 | 0.18 (0.11) | NA | 71 | -0.01 (0.05) | 0.915 | 57.5 |
| Yellow-rumped Warbler | 673 | 0.01 (0.02) | 0.915 | 267 | 0.15 (0.04) | 0.002 | 24 | 0.13 (0.12) | 0.377 | 70.6 |
| Palm Warbler | 190 | 0.09 (0.02) | 0.008 | 105 | 0.15 (0.04) | 0.008 | 44 | 0.05 (0.04) | 0.318 | 63.3 |
| Black-and-white Warbler | 46 | -0.43 (0.92) | 0.748 | 6 | -0.17 (0.14) | NA | 7 | 0.01 (0.21) | NA | 66.6 |
| American Redstart | 119 | 0.06 (0.03) | 0.119 | 11 | -0.12 (0.16) | NA | 50 | 0.13 (0.06) | 0.147 | 59.5 |
| Ovenbird | 81 | 0.14 (0.09) | 0.267 | 123 | 0.35 (0.14) | 0.049 | 24 | 0.27 (0.23) | 0.338 | 73.4 |
| Northern Waterthrush | 45 | 0.27 (0.14) | 0.176 | 49 | 0.35 (0.09) | 0.003 | 95 | -0.13 (0.09) | 0.309 | 73.3 |
| Mourning Warbler | 59 | 0.17 (0.10) | 0.257 | 13 | 0.0 (0.56) | NA | 20 | 0.23 (0.17) | 0.309 | 59.6 |
| Canada Warbler | 74 | 0.07 (0.05) | 0.268 | 5 | 0.13 (0.06) | NA | 26 | 0.12 (0.07) | 0.267 | 63.1 |
| Lincoln's Sparrow | 26 | 0.24 (0.15) | 0.267 | 22 | 0.27 (0.16) | 0.267 | 35 | 0.18 (0.14) | 0.318 | 60.3 |
| White-throated Sparrow | 432 | 0.07 (0.04) | 0.269 | 244 | 0.34 (0.07) | <0.001 | 156 | 0.26 (0.09) | 0.031 | 70.3 |

[a] Both estimates and SE were converted to represent mean change in mass per hour by (y = mean wing * condition gain/100).

Tables 5A-5D. Competing regression models ranked by $AIC_c$ for examining the influence of local habitat structure and distance from lakeshore on the abundance of 65 species of transient migrant landbirds within three forest habitats in Lucas and Ottawa counties of northwestern Ohio, mid April to late May, 2003-2005. Separate analyses were run for all three habitats combined (A), beach ridge forest (B), mature inland forest (C), and dogwood shrubland (D). $K$ is the number of parameters in the model and includes the intercept term and the error sums of squares; $\Delta AIC_c$ is the difference in $AIC_c$ between the top-ranked model and the model in question; $\omega_i$ is the $AIC_c$ weight that indicates the relative liklihood of the model (Burnham and Anderson 2002).

A. All Habitats

| Model | $K$ | $AIC_c$ | $\Delta AIC_c (\Delta_i)$ | $\omega_i$ |
|---|---|---|---|---|
| Lake distance + Trees 23-38cm + Stems 2-3m | 5 | 47.3 | 0 | 0.265 |
| Lake distance + Trees 23-38cm + Stems 2-3m + Tree richness | 6 | 49.1 | 1.8 | 0.107 |
| Lake distance + Trees 23-38cm + Tree richness | 5 | 49.2 | 1.9 | 0.105 |
| Lake distance + Trees 23-38cm + Stems 2-3m + Trees 8-23cm | 6 | 49.4 | 2.1 | 0.091 |
| Lake distance + Trees 23-38cm | 4 | 49.5 | 2.2 | 0.089 |
| Lake distance + Trees 23-38cm + Stems 2-3m + Stems 0.5-1m | 6 | 49.7 | 2.4 | 0.078 |
| Lake distance + Trees 23-38cm + Stems 0.5-1m | 5 | 50.3 | 2.9 | 0.061 |
| Lake distance + Trees 23-38cm + Stems 2-3m + Trees >38cm | 6 | 50.4 | 3.1 | 0.056 |
| Lake distance + Trees 23-38cm + Trees 8-23cm | 5 | 50.8 | 3.4 | 0.046 |
| Lake distance + Trees 23-38cm + Trees >38cm | 5 | 51.5 | 4.1 | 0.033 |
| Lake distance | 3 | 51.9 | 4.6 | 0.026 |

B. Beach Ridge Forest

| Model | $K$ | $AIC_c$ | $\Delta AIC_c (\Delta_i)$ | $\omega_i$ |
|---|---|---|---|---|
| Trees 23-38cm | 3 | 58.0 | 0 | 0.811 |
| Null | 2 | 61.9 | 3.9 | 0.114 |
| Lake distance | 3 | 65.4 | 7.4 | 0.020 |
| Trees >38cm | 3 | 65.9 | 7.9 | 0.016 |

C. Mature Inland Forest

| Model | $K$ | $AIC_c$ | $\Delta AIC_c (\Delta_i)$ | $\omega_i$ |
|---|---|---|---|---|
| Lake distance + Stems 2-3m | 4 | 94.3 | 0 | 0.255 |
| Lake distance | 3 | 95.0 | 0.7 | 0.177 |
| Lake distance + Trees 23-38cm | 4 | 96.4 | 2.1 | 0.089 |
| Lake distance + Stems 2-3m + Trees 23-38cm | 5 | 96.6 | 2.3 | 0.081 |
| Lake distance + Trees 8-23cm | 4 | 97.5 | 3.2 | 0.052 |
| Stems 2-3m | 3 | 97.7 | 3.4 | 0.046 |

D. Dogwood Shrubland

| Model | $K$ | $AIC_c$ | $\Delta AIC_c (\Delta_i)$ | $\omega_i$ |
|---|---|---|---|---|
| Trees 8-23cm | 3 | 34.1 | 0 | 0.815 |
| Trees 8-23cm + Trees >38cm | 4 | 37.6 | 3.5 | 0.144 |
| Trees 8-23cm + Lake distance | 4 | 41.5 | 7.3 | 0.021 |
| Trees 8-23cm + Stem 2-3m | 4 | 41.6 | 7.4 | 0.02 |

Figure 1. LANDSAT™ image depicting locations of all 28 point count and mist-netting surveys in Lucas and Ottawa counties of northwestern Ohio, mid April to late May, 2003-2005.

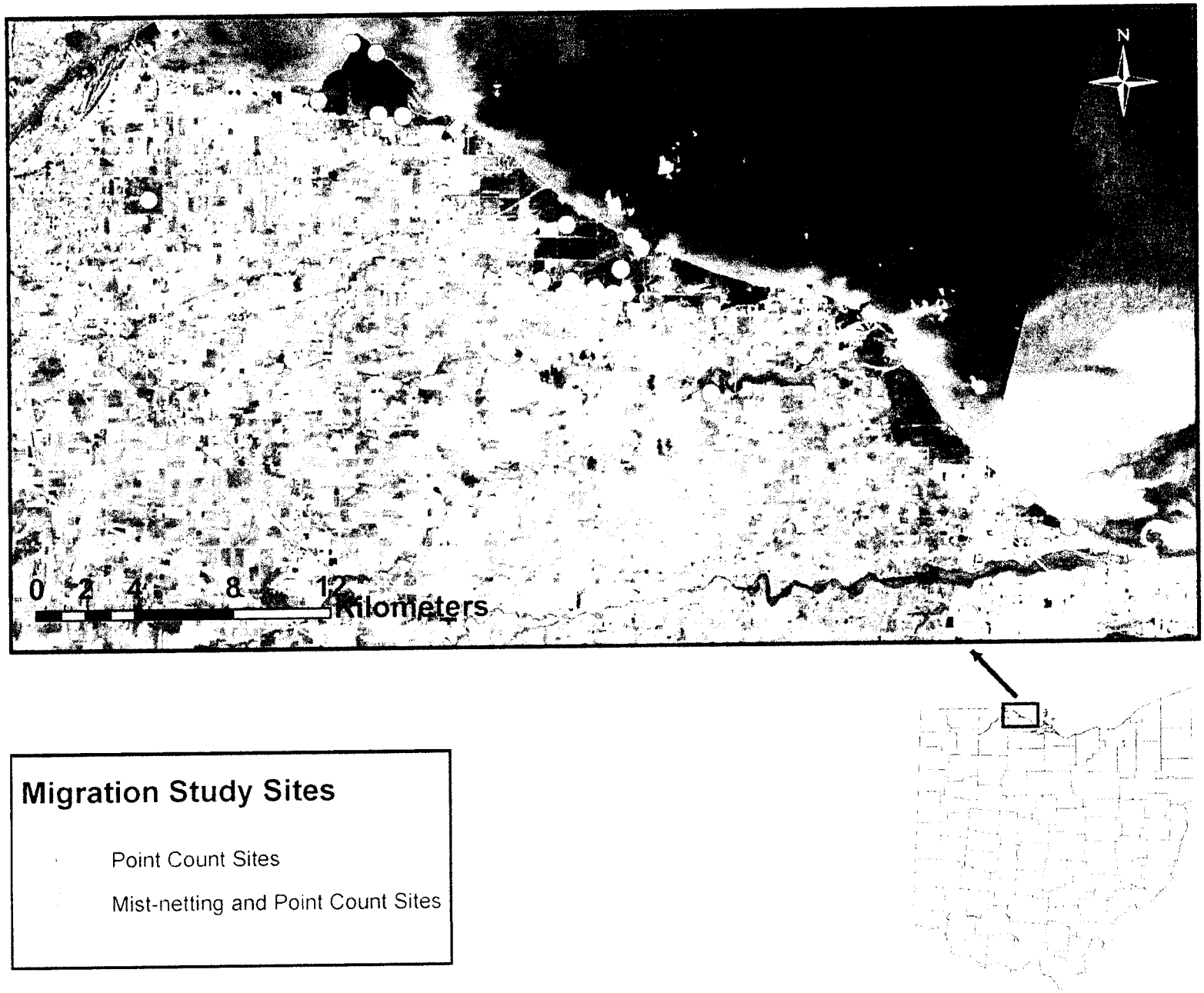


Figure 2. DOQQ image depicting locations of point count and mist-netting surveys at Pearson Metropark (10), Maumee Bay State Park (16), and Cedar Point National Wildlife Refuge (4, 8, 20, 25), mid April to late May, 2003-2005.

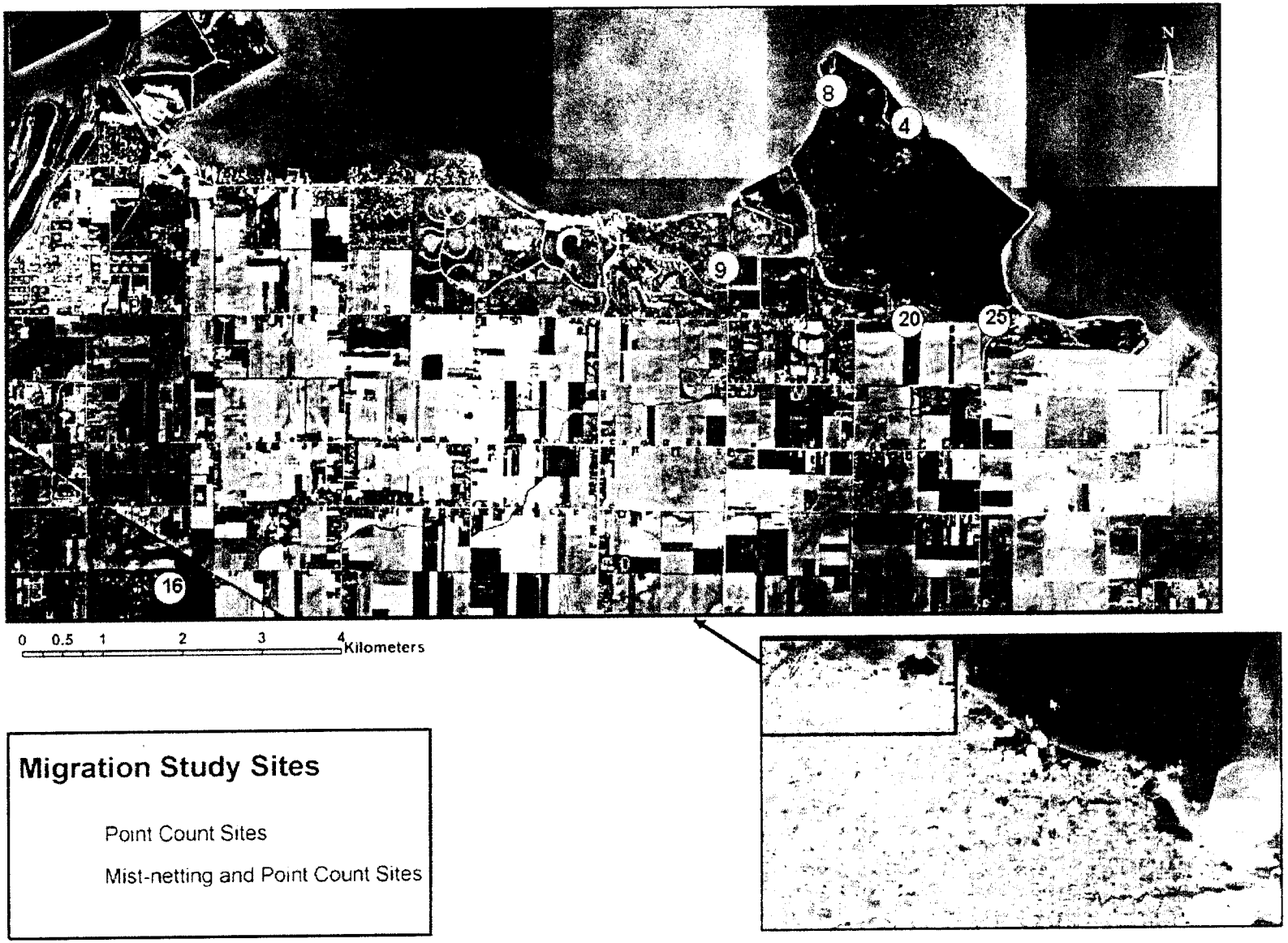


Figure 3. DOQQ image depicting locations of point count and mist-netting surveys within the Ottawa unit of Ottawa National Wildlife Refuge and Magee Marsh Wildlife Area (14) mid April to late May, 2003-2005.

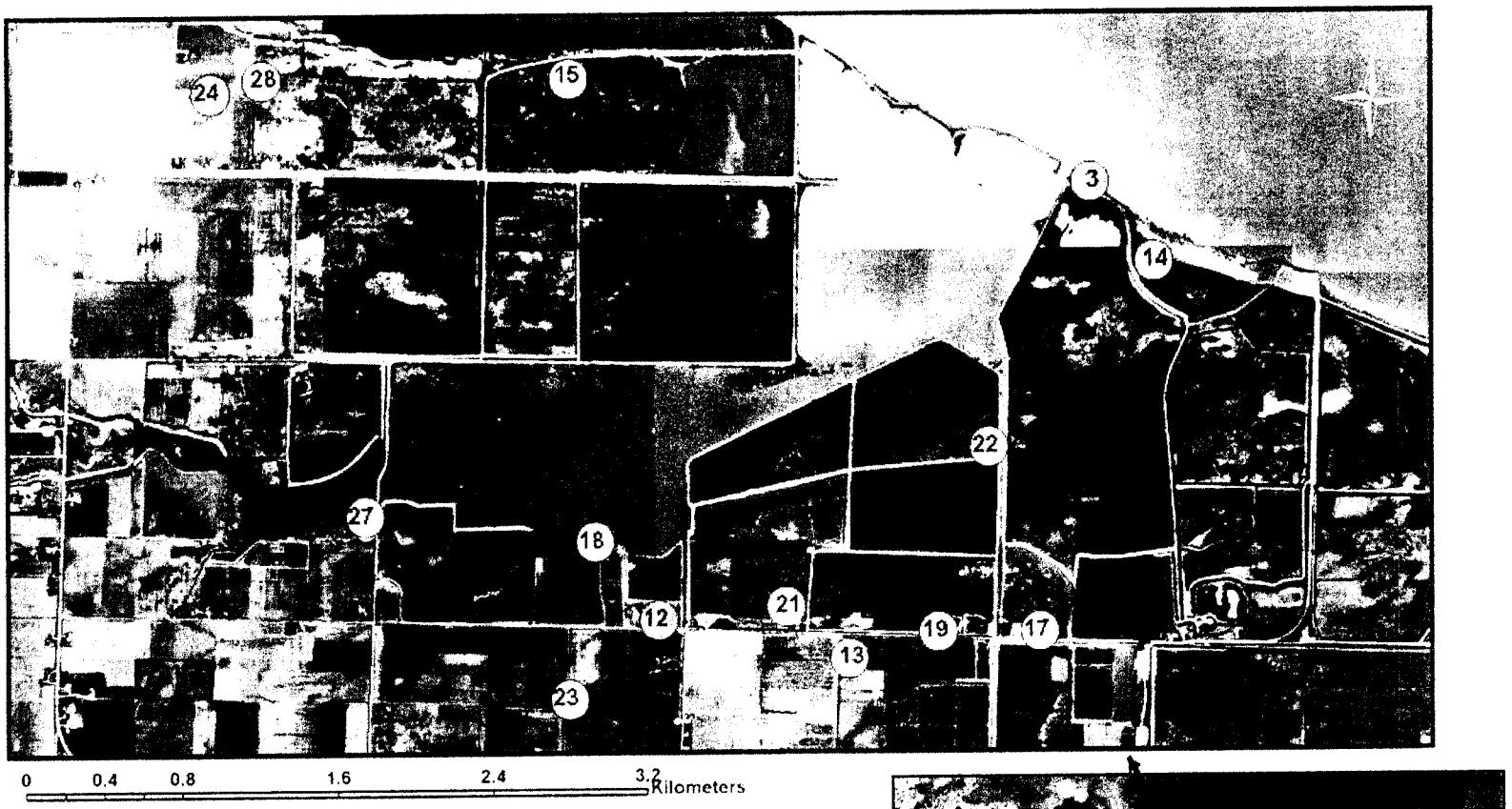


Figure 4. DOQQ image depicting locations of point count/mist-netting surveys in Ottawa Natl. Wildlife Refuge (11), Kurdy property (6; Ottawa NWR), Magee Marsh Wildlife Area (7), Touissaint Wildlife Area (26), mid April to late May, 2003-2005.

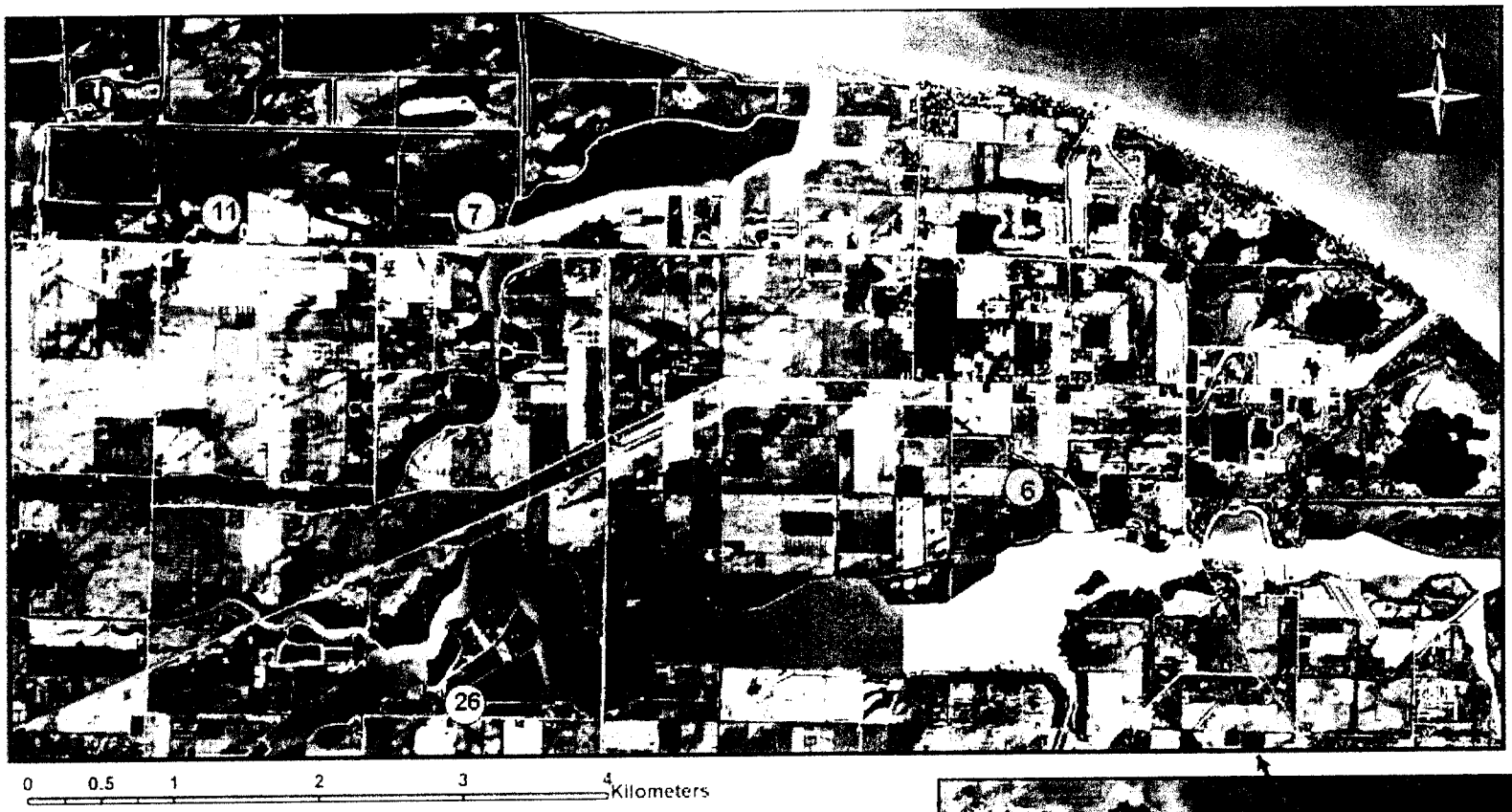


Figure 5. DOQQ image depicting locations of point count and mist-netting surveys within the Darby unit of Ottawa National Wildlife Refuge (1, 2, 5) and Little Portage Wildlife Area (10), mid April to late May 2003-2005.

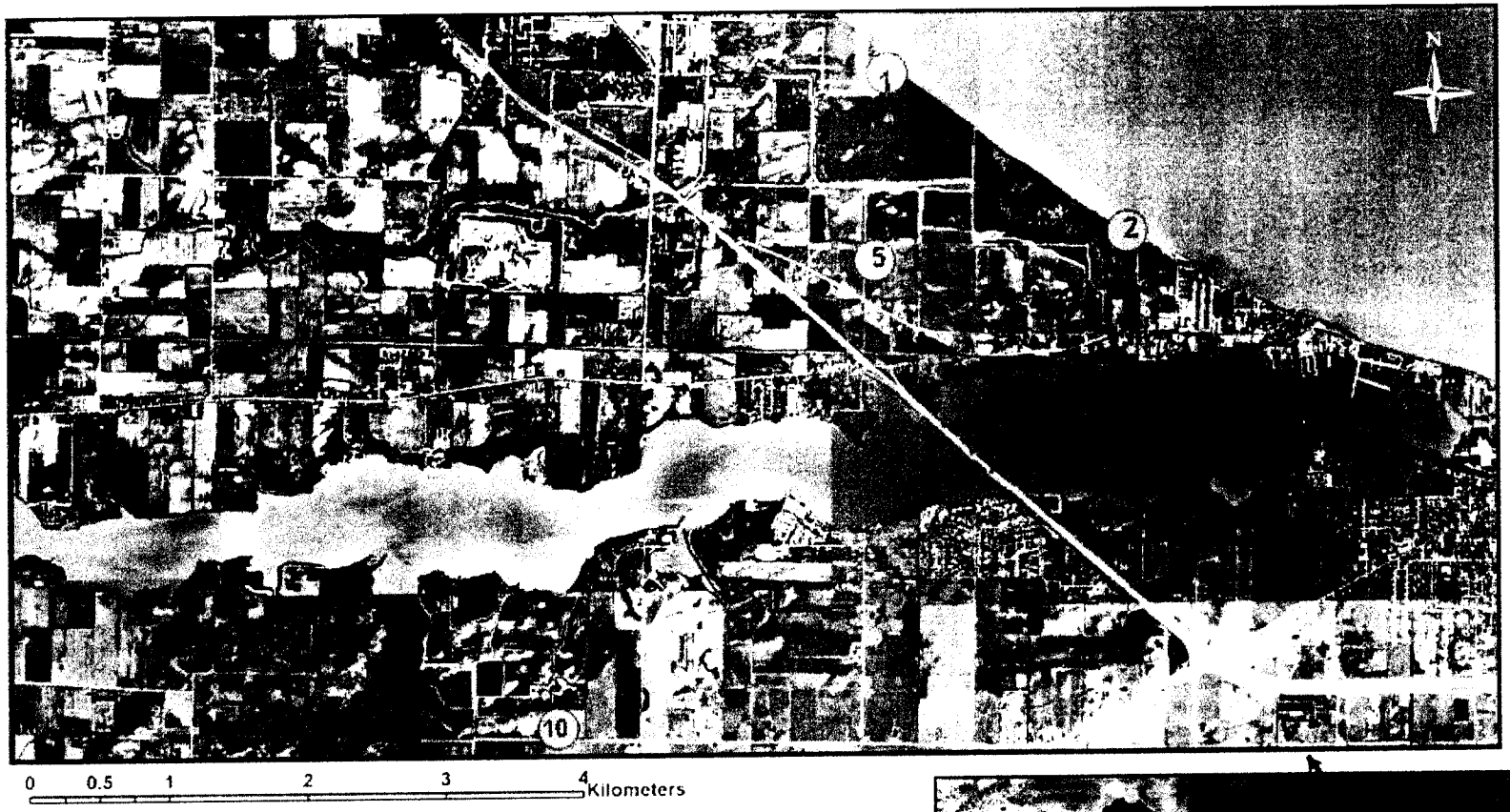


Figure 6A. Mean (± SE) annual abundance for 7 species of stopover migrant landbirds recorded in 3 habitat types in Lucas and Ottawa counties of northwestern Ohio, mid April to late May, 2003-2005. Means calculated by summing abundances over all visits to each site within each year and then calculating means by habitat over sites and years.

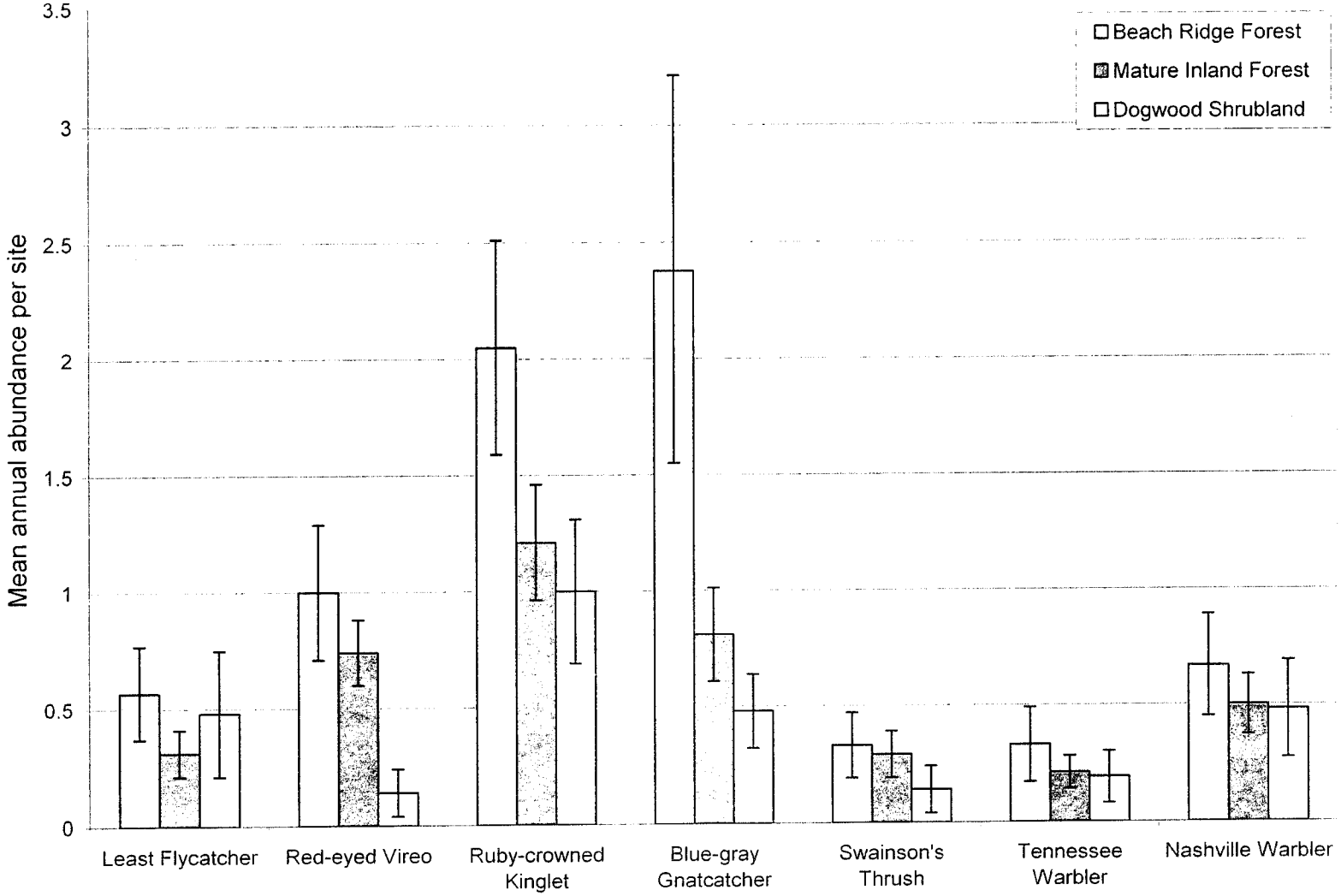


Figure 6B. Mean (± SE) annual abundance for 7 species of stopover migrant landbirds recorded in 3 habitat types in Lucas and Ottawa counties of northwestern Ohio, mid April to late May, 2003-2005. Means calculated by summing abundances over all visits to each site within each year and then calculating means by habitat over sites and years.

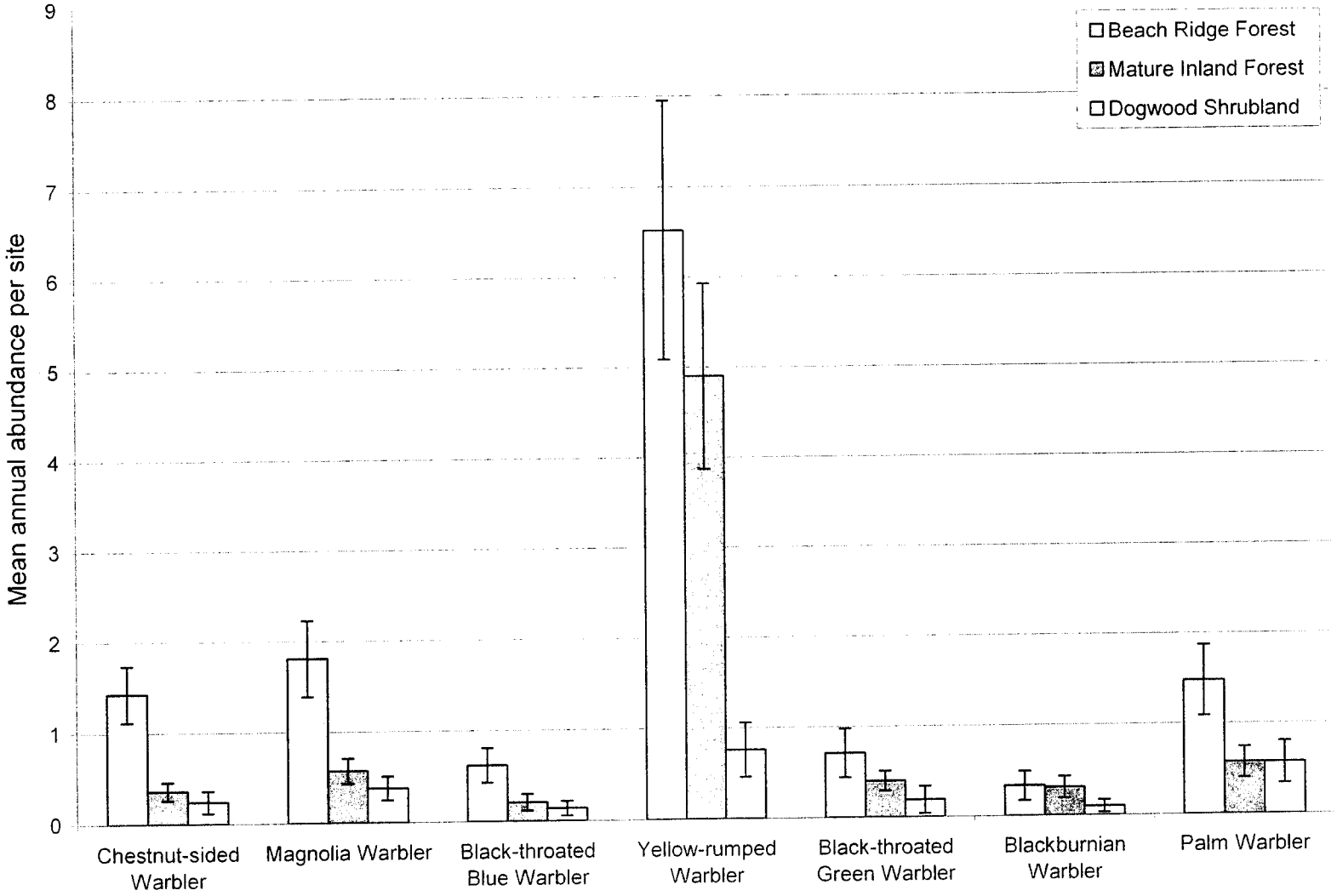


Figure 6C. Mean (± SE) annual abundance for 7 species of stopover migrant landbirds recorded in 3 habitat types in Lucas and Ottawa counties of northwestern Ohio, mid April to late May, 2003-2005. Means calculated by summing abundances over all visits to each site within each year and then calculating means by habitat over sites and years.

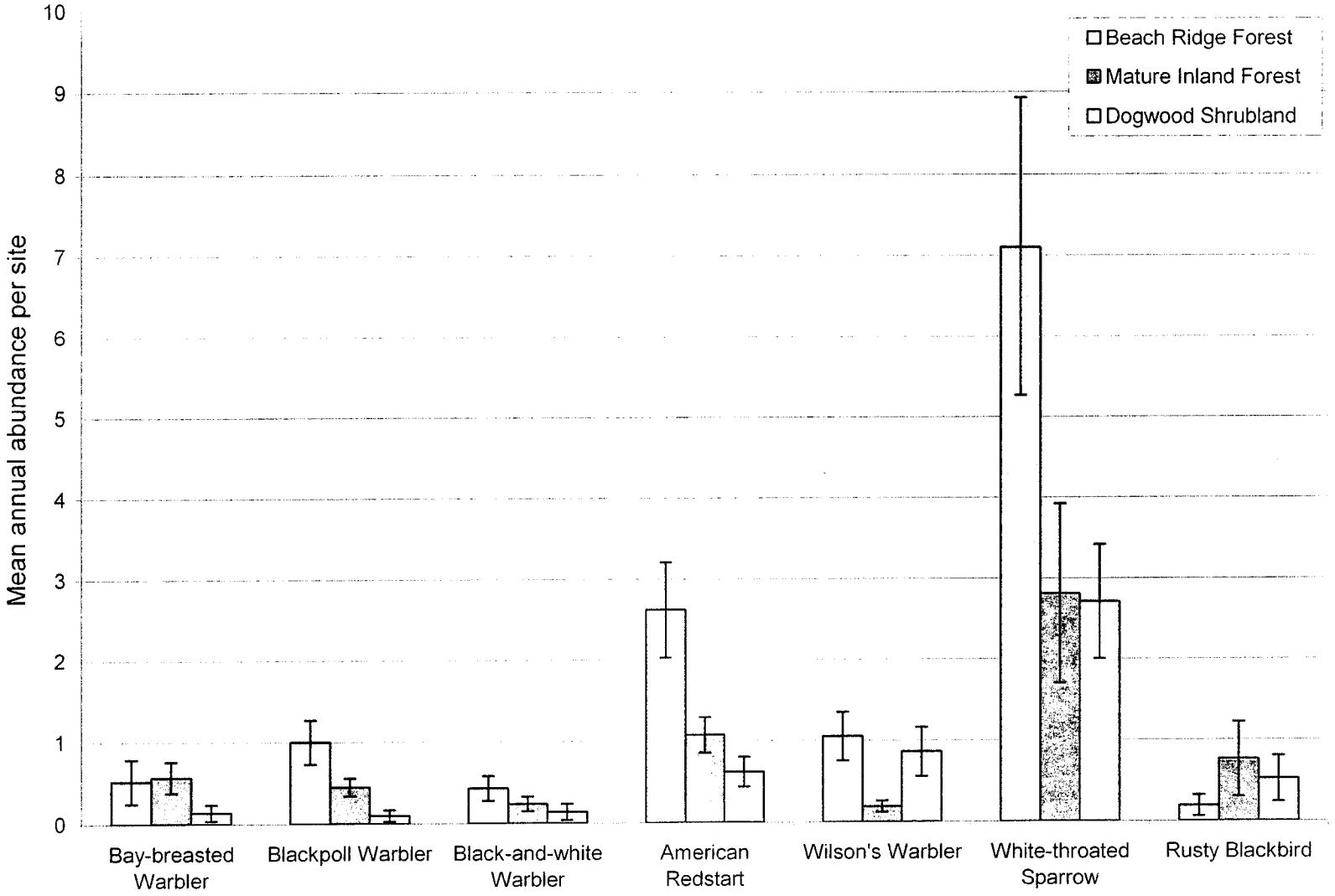


Figure 7A. Mean (± SE) capture rate per 100 mist-net-hours for 8 species of stopover migrant landbirds captured in 3 habitat types in Lucas and Ottawa counties of northwestern Ohio, mid April to late May, 2003-2005. Means calculated by summing abundances (per 100 mist-net-hours) over all visits to each site within each year and then calculating means by habitat over sites and years.

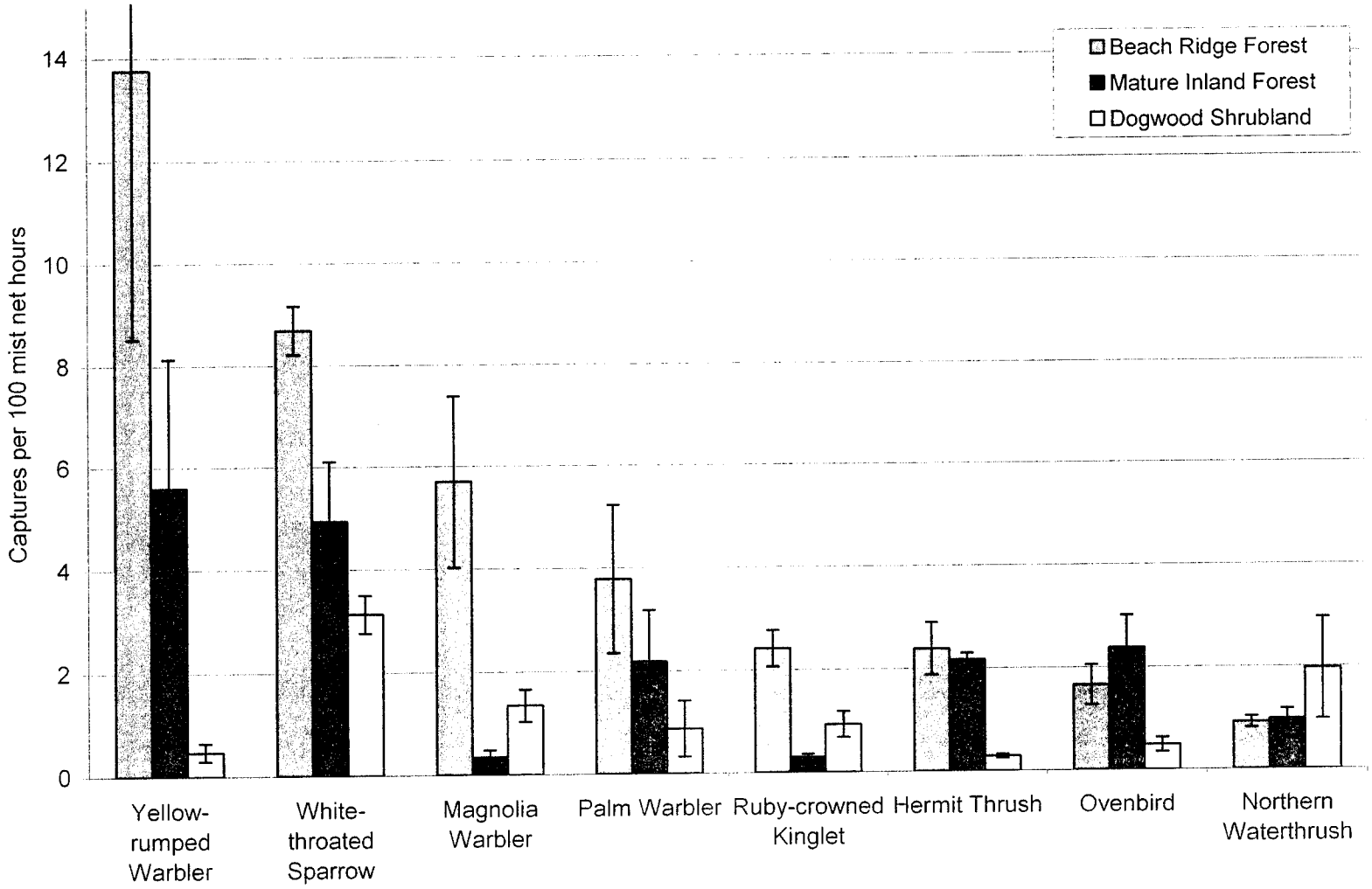


Figure 7B. Mean (± SE) capture rate per 100 mist-net-hours for 8 species of stopover migrant landbirds captured in 3 habitat types in Lucas and Ottawa counties of northwestern Ohio, mid April to late May, 2003-2005. Means calculated by summing abundances (per 100 mist-net-hours) over all netting visits to each site within each year and then calculating means by habitat over sites and years.

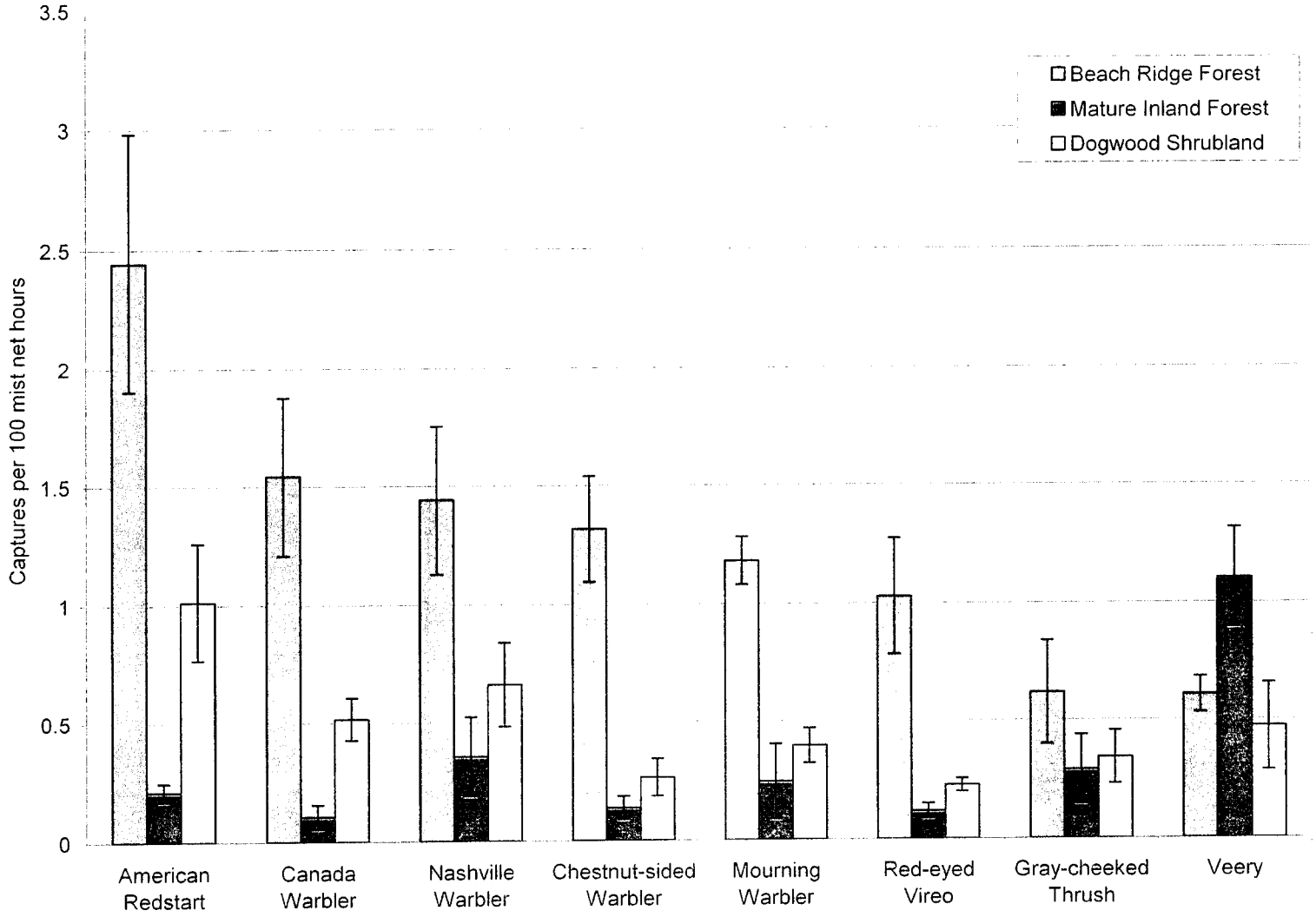


Figure 8. Relationship between distance to lake (km) and abundance [square root (abundance+0.5)] for 65 species of stopover migrants recorded during point counts at 28 forest sites, Lucas and Ottawa counties, northwestern Ohio, mid April to late May, 2003-2005. Black diamonds represent beach ridge forest ($n$ = 7 sites), red diamonds are mature inland forest ($n$ = 14 sites), and green diamonds are dogwood shrubland ($n$ = 7 sites).

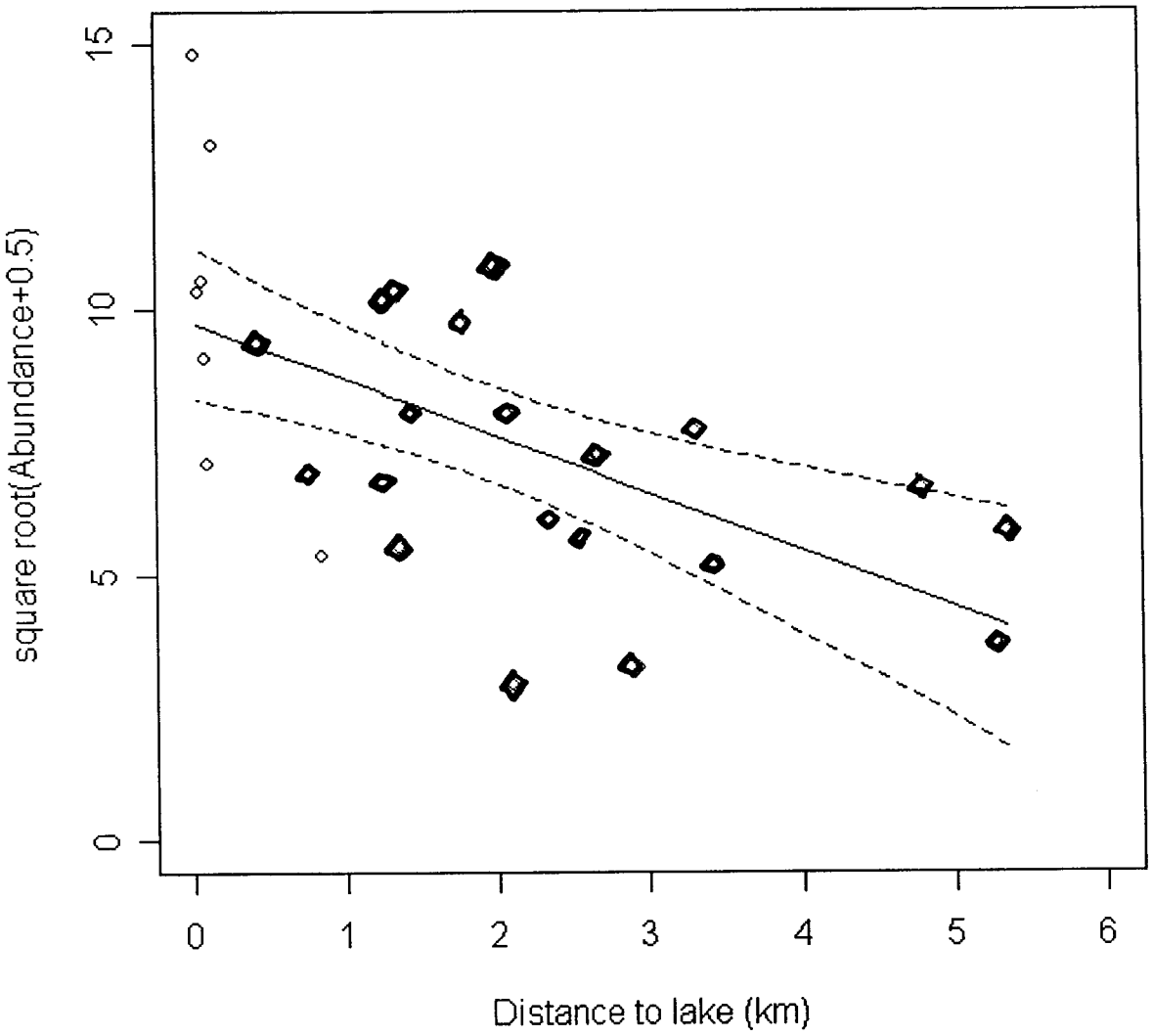


Figure 9. Relationship between Trees 23-38 cm dbh (Size4 Trees) and mean annual abundance of 65 species of stopover migrant landbirds recorded during point counts in 7 beach ridge forest sites, Lucas and Ottawa counties, northwestern Ohio, mid April to late May, 2003-2005.

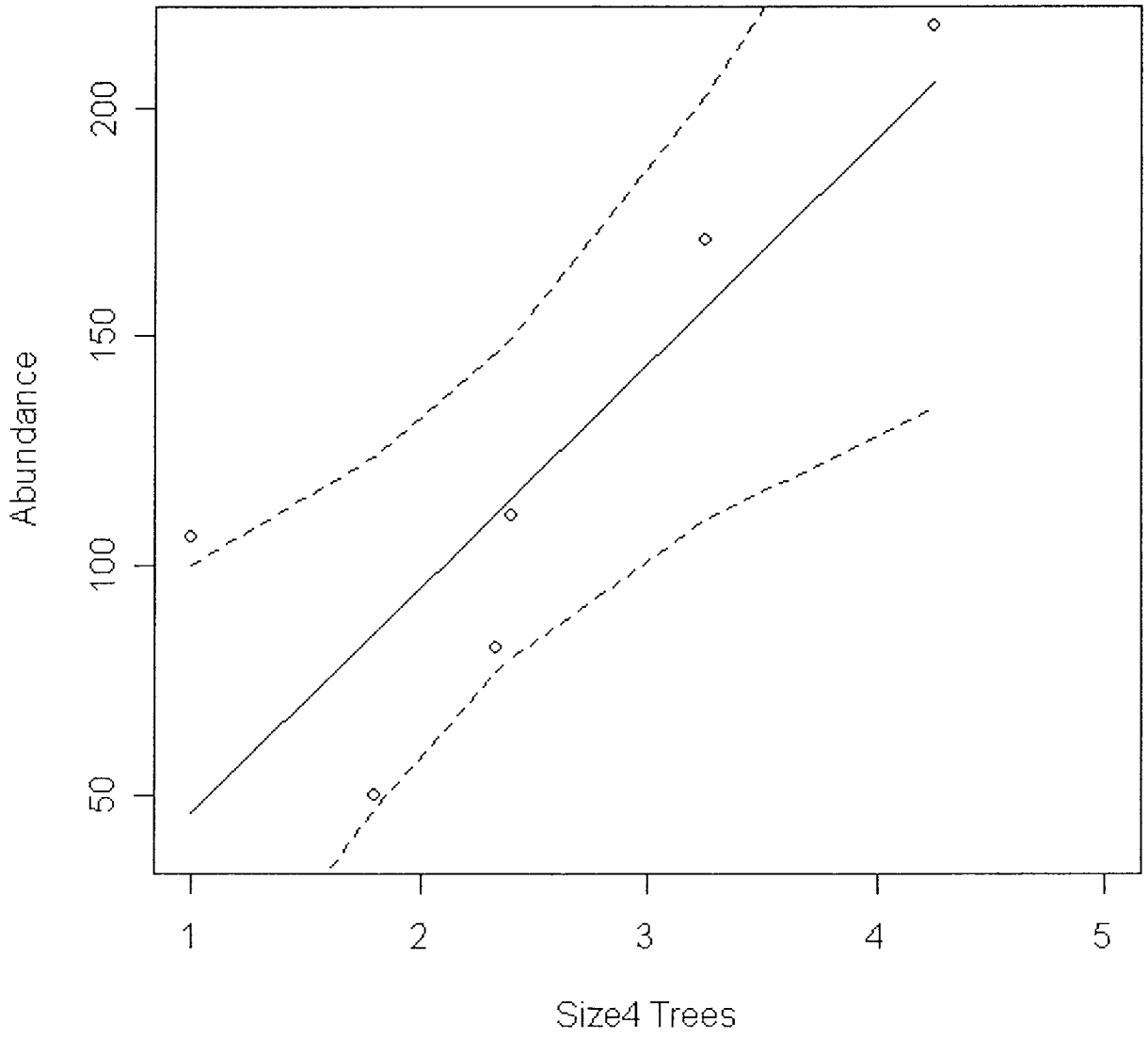
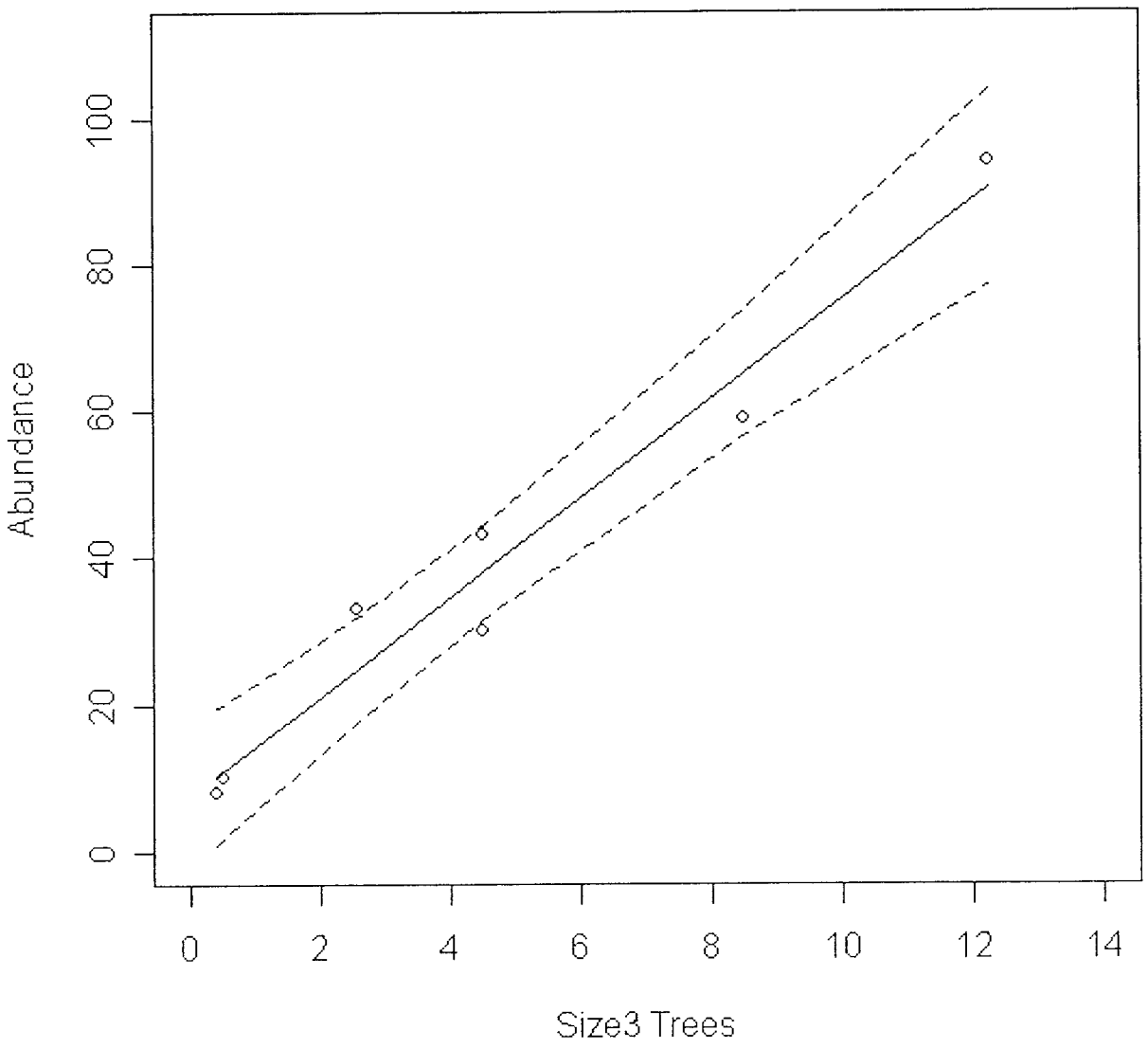


Figure 10. Relationship between Trees 8-23 cm dbh (Size3 Trees) and mean annual abundance of 65 species of stopover migrant landbirds recorded during point counts in 7 dogwood shrubland sites, Lucas and Ottawa counties, northwestern Ohio, mid April to late May, 2003-2005.



Appendix 1. Total abundance, mean, and SE from point count surveys conducted in 3 habitat types in Lucas and Ottawa counties of northwestern Ohio, mid April to late May, 2003-2005.

| *Appendix 1. cont.* | Beach Ridge Forest | | | Mature Inland Forest | | | Dogwood Shrubland | | |
|---|---|---|---|---|---|---|---|---|---|
| Species | Total | Mean | SE | Total | Mean | SE | Total | Mean | SE |
| Wood Duck | 0 | 0 | 0.00 | 5 | 0.12 | 0.07 | 2 | 0.1 | 0.10 |
| Ring-necked Pheasant | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 1 | 0.05 | 0.05 |
| Sharp-shinned Hawk | 1 | 0.05 | 0.05 | 2 | 0.05 | 0.05 | 1 | 0.05 | 0.05 |
| Solitary Sandpiper | 0 | 0 | 0.00 | 1 | 0.02 | 0.02 | 0 | 0 | 0.00 |
| American Woodcock | 1 | 0.05 | 0.05 | 0 | 0 | 0.00 | 0 | 0 | 0.00 |
| Black-billed Cuckoo | 0 | 0 | 0.00 | 1 | 0.02 | 0.02 | 1 | 0.05 | 0.05 |
| Yellow-billed Cuckoo | 2 | 0.1 | 0.07 | 3 | 0.07 | 0.04 | 0 | 0 | 0.00 |
| Great Horned Owl | 0 | 0 | 0.00 | 1 | 0.02 | 0.02 | 0 | 0 | 0.00 |
| Whip-poor-will | 1 | 0.05 | 0.05 | 0 | 0 | 0.00 | 0 | 0 | 0.00 |
| Ruby-throated Hummingbird | 2 | 0.1 | 0.07 | 2 | 0.05 | 0.03 | 4 | 0.19 | 0.11 |
| Red-headed Woodpecker | 0 | 0 | 0.00 | 4 | 0.1 | 0.06 | 0 | 0 | 0.00 |
| Red-bellied Woodpecker | 3 | 0.14 | 0.08 | 18 | 0.43 | 0.10 | 0 | 0 | 0.00 |
| Yellow-bellied Sapsucker | 0 | 0 | 0.00 | 4 | 0.1 | 0.05 | 1 | 0.05 | 0.05 |
| Downy Woodpecker | 18 | 0.86 | 0.26 | 36 | 0.86 | 0.19 | 0 | 0 | 0.00 |
| Hairy Woodpecker | 0 | 0 | 0.00 | 2 | 0.05 | 0.03 | 0 | 0 | 0.00 |
| Northern Flicker | 9 | 0.43 | 0.16 | 15 | 0.36 | 0.12 | 5 | 0.24 | 0.12 |
| Eastern Wood-Pewee | 1 | 0.05 | 0.05 | 8 | 0.19 | 0.08 | 0 | 0 | 0.00 |
| Yellow-bellied Flycatcher | 5 | 0.24 | 0.10 | 3 | 0.07 | 0.04 | 0 | 0 | 0.00 |
| Acadian Flycatcher | 0 | 0 | 0.00 | 2 | 0.05 | 0.03 | 0 | 0 | 0.00 |
| Alder Flycatcher | 2 | 0.1 | 0.07 | 0 | 0 | 0.00 | 3 | 0.14 | 0.08 |
| Willow Flycatcher | 1 | 0.05 | 0.05 | 0 | 0 | 0.00 | 12 | 0.57 | 0.21 |
| Least Flycatcher | 12 | 0.57 | 0.21 | 13 | 0.31 | 0.10 | 10 | 0.48 | 0.27 |
| Great-crested Flycatcher | 4 | 0.19 | 0.09 | 11 | 0.26 | 0.09 | 0 | 0 | 0.00 |
| Eastern Kingbird | 7 | 0.33 | 0.22 | 3 | 0.07 | 0.05 | 3 | 0.14 | 0.10 |
| White-eyed Vireo | 1 | 0.05 | 0.05 | 0 | 0 | 0.00 | 1 | 0.05 | 0.05 |
| Yellow-throated Vireo | 0 | 0 | 0.00 | 1 | 0.02 | 0.02 | 0 | 0 | 0.00 |
| Blue-headed Vireo | 5 | 0.24 | 0.10 | 4 | 0.1 | 0.06 | 1 | 0.05 | 0.05 |
| Warbling Vireo | 31 | 1.48 | 0.39 | 18 | 0.43 | 0.19 | 6 | 0.29 | 0.12 |
| Philadelphia Vireo | 0 | 0 | 0.00 | 2 | 0.05 | 0.03 | 1 | 0.05 | 0.05 |
| Red-eyed Vireo | 21 | 1 | 0.31 | 31 | 0.74 | 0.14 | 3 | 0.14 | 0.10 |
| Blue Jay | 26 | 1.24 | 0.37 | 91 | 2.17 | 0.35 | 15 | 0.71 | 0.22 |
| Black-capped Chickadee | 0 | 0 | 0.00 | 2 | 0.05 | 0.05 | 0 | 0 | 0.00 |

*Appendix 1. cont.*

| | Beach Ridge Forest | | | Mature Inland Forest | | | | Dogwood Shrubland | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | Mean | SE | Species | Total | Mean | SE | Species | Total |
| Tufted Titmouse | 0 | 0 | 0.00 | 2 | 0.05 | 0.05 | 0 | 0 | 0.00 |
| White-breasted Nuthatch | 0 | 0 | 0.00 | 5 | 0.12 | 0.06 | 0 | 0 | 0.00 |
| Brown Creeper | 0 | 0 | 0.00 | 2 | 0.05 | 0.03 | 0 | 0 | 0.00 |
| Carolina Wren | 7 | 0.33 | 0.15 | 1 | 0.02 | 0.02 | 0 | 0 | 0.00 |
| House Wren | 44 | 2.1 | 0.44 | 56 | 1.33 | 0.24 | 5 | 0.24 | 0.15 |
| Winter Wren | 3 | 0.14 | 0.11 | 3 | 0.07 | 0.05 | 0 | 0 | 0.00 |
| Golden-crowned Kinglet | 1 | 0.05 | 0.05 | 12 | 0.29 | 0.12 | 0 | 0 | 0.00 |
| Ruby-crowned Kinglet | 43 | 2.05 | 0.48 | 51 | 1.21 | 0.26 | 21 | 1 | 0.31 |
| Blue-gray Gnatcatcher | 50 | 2.38 | 0.87 | 34 | 0.81 | 0.20 | 10 | 0.48 | 0.16 |
| Veery | 2 | 0.1 | 0.07 | 5 | 0.12 | 0.05 | 2 | 0.1 | 0.07 |
| Gray-cheeked Thrush | 2 | 0.1 | 0.07 | 2 | 0.05 | 0.03 | 0 | 0 | 0.00 |
| Swainson's Thrush | 7 | 0.33 | 0.15 | 12 | 0.29 | 0.10 | 3 | 0.14 | 0.10 |
| Hermit Thrush | 10 | 0.48 | 0.14 | 8 | 0.19 | 0.09 | 0 | 0 | 0.00 |
| Wood Thrush | 0 | 0 | 0.00 | 11 | 0.26 | 0.12 | 0 | 0 | 0.00 |
| Gray Catbird | 47 | 2.24 | 0.49 | 18 | 0.43 | 0.11 | 58 | 2.76 | 0.47 |
| Brown Thrasher | 4 | 0.19 | 0.12 | 5 | 0.12 | 0.06 | 8 | 0.38 | 0.13 |
| Cedar Waxwing | 80 | 3.81 | 2.86 | 19 | 0.45 | 0.26 | 3 | 0.14 | 0.14 |
| Blue-winged Warbler | 0 | 0 | 0.00 | 1 | 0.02 | 0.02 | 0 | 0 | 0.00 |
| *Brewster's Warbler* | 1 | 0.05 | 0.05 | 0 | 0 | 0.00 | 0 | 0 | 0.00 |
| Tennessee Warbler | 7 | 0.33 | 0.18 | 9 | 0.21 | 0.07 | 4 | 0.19 | 0.11 |
| Orange-crowned Warbler | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 1 | 0.05 | 0.05 |
| Nashville Warbler | 14 | 0.67 | 0.23 | 21 | 0.5 | 0.13 | 10 | 0.48 | 0.21 |
| Northern Parula | 2 | 0.1 | 0.07 | 2 | 0.05 | 0.03 | 0 | 0 | 0.00 |
| Yellow Warbler | 62 | 2.95 | 0.94 | 33 | 0.79 | 0.25 | 174 | 8.29 | 1.29 |
| Chestnut-sided Warbler | 30 | 1.43 | 0.32 | 15 | 0.36 | 0.10 | 5 | 0.24 | 0.12 |
| Magnolia Warbler | 38 | 1.81 | 0.44 | 24 | 0.57 | 0.14 | 8 | 0.38 | 0.13 |
| Cape May Warbler | 1 | 0.05 | 0.05 | 1 | 0.02 | 0.02 | 3 | 0.14 | 0.10 |
| Black-throated Blue Warbler | 13 | 0.62 | 0.20 | 9 | 0.21 | 0.10 | 3 | 0.14 | 0.08 |
| Yellow-rumped Warbler | 137 | 6.52 | 1.50 | 206 | 4.9 | 1.04 | 16 | 0.76 | 0.30 |
| Black-throated Green Warbler | 15 | 0.71 | 0.30 | 17 | 0.4 | 0.11 | 4 | 0.19 | 0.15 |
| Blackburnian Warbler | 7 | 0.33 | 0.17 | 13 | 0.31 | 0.12 | 2 | 0.1 | 0.07 |
| Yellow-throated Warbler | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 1 | 0.05 | 0.05 |
| Pine Warbler | 1 | 0.05 | 0.05 | 2 | 0.05 | 0.03 | 1 | 0.05 | 0.05 |
| Palm Warbler | 31 | 1.48 | 0.42 | 24 | 0.57 | 0.18 | 12 | 0.57 | 0.24 |
| Bay-breasted Warbler | 11 | 0.52 | 0.29 | 24 | 0.57 | 0.20 | 3 | 0.14 | 0.10 |

*Appendix 1. cont.*

| | Beach Ridge Forest | | | Mature Inland Forest | | | | Dogwood Shrubland | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | Mean | SE | Species | Total | Mean | SE | Species | Total |
| Blackpoll Warbler | 21 | 1 | 0.28 | 19 | 0.45 | 0.12 | 2 | 0.1 | 0.07 |
| Cerulean Warbler | 0 | 0 | 0.00 | 1 | 0.02 | 0.02 | 0 | 0 | 0.00 |
| Black-and-white Warbler | 9 | 0.43 | 0.16 | 10 | 0.24 | 0.09 | 3 | 0.14 | 0.10 |
| American Redstart | 55 | 2.62 | 0.62 | 45 | 1.07 | 0.23 | 13 | 0.62 | 0.17 |
| Worm-eating Warbler | 1 | 0.05 | 0.05 | 0 | 0 | 0.00 | 0 | 0 | 0.00 |
| Ovenbird | 7 | 0.33 | 0.15 | 4 | 0.1 | 0.05 | 2 | 0.1 | 0.07 |
| Northern Waterthrush | 2 | 0.1 | 0.07 | 6 | 0.14 | 0.07 | 7 | 0.33 | 0.14 |
| Mourning Warbler | 5 | 0.24 | 0.12 | 0 | 0 | 0.00 | 4 | 0.19 | 0.11 |
| Common Yellowthroat | 14 | 0.67 | 0.28 | 12 | 0.29 | 0.10 | 35 | 1.67 | 0.34 |
| Hooded Warbler | 0 | 0 | 0.00 | 1 | 0.02 | 0.02 | 0 | 0 | 0.00 |
| Wilson's Warbler | 22 | 1.05 | 0.31 | 8 | 0.19 | 0.07 | 18 | 0.86 | 0.30 |
| Canada Warbler | 7 | 0.33 | 0.17 | 4 | 0.1 | 0.06 | 8 | 0.38 | 0.17 |
| Yellow-breasted Chat | 1 | 0.05 | 0.05 | 0 | 0 | 0.00 | 0 | 0 | 0.00 |
| Scarlet Tanager | 5 | 0.24 | 0.16 | 3 | 0.07 | 0.05 | 2 | 0.1 | 0.10 |
| Eastern Towhee | 0 | 0 | 0.00 | 3 | 0.07 | 0.04 | 0 | 0 | 0.00 |
| Chipping Sparrow | 0 | 0 | 0.00 | 1 | 0.02 | 0.02 | 1 | 0.05 | 0.05 |
| Field Sparrow | 2 | 0.1 | 0.10 | 1 | 0.02 | 0.02 | 0 | 0 | 0.00 |
| Fox Sparrow | 1 | 0.05 | 0.05 | 2 | 0.05 | 0.05 | 0 | 0 | 0.00 |
| Lincoln's Sparrow | 1 | 0.05 | 0.05 | 1 | 0.02 | 0.02 | 1 | 0.05 | 0.05 |
| Swamp Sparrow | 1 | 0.05 | 0.05 | 2 | 0.05 | 0.05 | 1 | 0.05 | 0.05 |
| White-throated Sparrow | 149 | 7.1 | 1.92 | 118 | 2.81 | 1.12 | 57 | 2.71 | 0.71 |
| White-crowned Sparrow | 0 | 0 | 0.00 | 4 | 0.1 | 0.07 | 6 | 0.29 | 0.20 |
| Dark-eyed Junco | 1 | 0.05 | 0.05 | 1 | 0.02 | 0.02 | 1 | 0.05 | 0.05 |
| Rose-breasted Grosbeak | 3 | 0.14 | 0.08 | 13 | 0.31 | 0.09 | 0 | 0 | 0.00 |
| Indigo Bunting | 21 | 1 | 0.27 | 44 | 1.05 | 0.26 | 10 | 0.48 | 0.20 |
| Bobolink | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 1 | 0.05 | 0.05 |
| Rusty Blackbird | 4 | 0.19 | 0.14 | 32 | 0.76 | 0.47 | 11 | 0.52 | 0.28 |
| Orchard Oriole | 0 | 0 | 0.00 | 1 | 0.02 | 0.02 | 8 | 0.38 | 0.23 |
| Baltimore Oriole | 25 | 1.19 | 0.28 | 51 | 1.21 | 0.21 | 20 | 0.95 | 0.24 |
| Purple Finch | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 1 | 0.05 | 0.05 |
| American Goldfinch | 19 | 0.9 | 0.38 | 35 | 0.83 | 0.20 | 52 | 2.48 | 0.60 |

[a] Mean abundance calculated by summing abundances over all visits to each site within each year and then calculating means by habitat over sites and years.

[b] Twenty eight sites (14 mature inland forest, 7 beach ridge forest, 7 dogwood shrubland) were surveyed 5 times each in spring 2003, 6 times in spring 2004, and 6 times in spring 2005 (see Table 1 for more detailed information).

Appendix 2. Total captures, mean capture rate per 100 mist-net-hours, and SE of stopover migrants caught in 3 habitat types in Lucas and Ottawa counties of northwestern Ohio, mid April to late May, 2003-005.

| | Beach Ridge Forest | | | Mature Inland Forest | | | Dogwood Shrubland | | |
|---|---|---|---|---|---|---|---|---|---|
| Species | Total | Mean[a] | SE | Total | Mean | SE | Total | Mean | SE |
| Sharp-shinned Hawk | 1 | 0.019 | 0.033 | 2 | 0.037 | 0.065 | 4 | 0.075 | 0.027 |
| American Woodcock | 0 | 0.000 | 0.000 | 0 | 0.000 | 0.000 | 6 | 0.120 | 0.113 |
| Yellow-billed Cuckoo | 1 | 0.019 | 0.033 | 0 | 0.000 | 0.000 | 3 | 0.059 | 0.063 |
| Black-billed Cuckoo | 1 | 0.018 | 0.032 | 0 | 0.000 | 0.000 | 5 | 0.089 | 0.154 |
| Red-bellied Woodpecker | 0 | 0.000 | 0.000 | 2 | 0.041 | 0.036 | 0 | 0.000 | 0.000 |
| Yellow-bellied Sapsucker | 1 | 0.018 | 0.032 | 4 | 0.082 | 0.048 | 0 | 0.000 | 0.000 |
| Downy Woodpecker | 13 | 0.255 | 0.065 | 32 | 0.592 | 0.401 | 8 | 0.138 | 0.100 |
| Hairy Woodpecker | 0 | 0.000 | 0.000 | 5 | 0.094 | 0.108 | 0 | 0.000 | 0.000 |
| Northern Flicker | 6 | 0.124 | 0.109 | 4 | 0.088 | 0.107 | 0 | 0.000 | 0.000 |
| *Yellow x Red-shafted intergrade* | 0 | 0.000 | 0.000 | 1 | 0.019 | 0.032 | 0 | 0.000 | 0.000 |
| Ruby-throated Hummingbird | 51 | 1.074 | 0.748 | 7 | 0.139 | 0.086 | 8 | 0.157 | 0.156 |
| Olive-sided Flycatcher | 1 | 0.023 | 0.040 | 0 | 0.000 | 0.000 | 0 | 0.000 | 0.000 |
| Eastern Wood-Pewee | 6 | 0.118 | 0.150 | 5 | 0.096 | 0.023 | 3 | 0.054 | 0.053 |
| Yellow-bellied Flycatcher | 53 | 1.046 | 0.384 | 2 | 0.035 | 0.061 | 7 | 0.128 | 0.119 |
| Acadian Flycatcher | 1 | 0.019 | 0.033 | 2 | 0.042 | 0.037 | 0 | 0.000 | 0.000 |
| Traill's (Willow/Alder) Flycatcher | 138 | 2.783 | 1.146 | 1 | 0.019 | 0.032 | 123 | 2.271 | 1.495 |
| Least Flycatcher | 35 | 0.692 | 0.064 | 5 | 0.094 | 0.108 | 25 | 0.489 | 0.283 |
| Eastern Phoebe | 0 | 0.000 | 0.000 | 3 | 0.065 | 0.069 | 0 | 0.000 | 0.000 |
| Great Crested Flycatcher | 6 | 0.120 | 0.056 | 3 | 0.055 | 0.056 | 3 | 0.054 | 0.053 |
| Eastern Kingbird | 1 | 0.018 | 0.032 | 0 | 0.000 | 0.000 | 4 | 0.071 | 0.123 |
| White-eyed Vireo | 5 | 0.099 | 0.118 | 1 | 0.023 | 0.040 | 3 | 0.056 | 0.054 |
| Blue-headed Vireo | 10 | 0.208 | 0.121 | 4 | 0.092 | 0.159 | 9 | 0.180 | 0.171 |
| Warbling Vireo | 38 | 0.795 | 0.508 | 2 | 0.035 | 0.061 | 7 | 0.139 | 0.101 |
| Philadelphia Vireo | 11 | 0.225 | 0.151 | 0 | 0.000 | 0.000 | 7 | 0.132 | 0.078 |
| Red-eyed Vireo | 50 | 1.028 | 0.425 | 6 | 0.118 | 0.054 | 12 | 0.228 | 0.049 |
| Blue Jay | 13 | 0.257 | 0.191 | 85 | 1.607 | 1.684 | 43 | 0.803 | 0.310 |
| Tree Swallow | 21 | 0.421 | 0.116 | 3 | 0.065 | 0.069 | 3 | 0.055 | 0.057 |
| Black-capped Chickadee | 2 | 0.037 | 0.032 | 0 | 0.000 | 0.000 | 7 | 0.132 | 0.228 |
| Red-breasted Nuthatch | 0 | 0.000 | 0.000 | 1 | 0.018 | 0.031 | 1 | 0.018 | 0.031 |
| Brown Creeper | 5 | 0.087 | 0.107 | 15 | 0.295 | 0.110 | 0 | 0.000 | 0.000 |
| Carolina Wren | 18 | 0.363 | 0.077 | 15 | 0.288 | 0.287 | 0 | 0.000 | 0.000 |

*Appendix 2. cont.*

| | Beach Ridge Forest | | | Mature Inland Forest | | | Dogwood Shrubland | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | Mean | SE | Species | Total | Mean | SE | Species | Total |
| House Wren | 81 | 1.564 | 0.648 | 82 | 1.605 | 0.378 | 13 | 0.245 | 0.051 |
| Winter Wren | 1 | 0.000 | 0.000 | 8 | 0.169 | 0.154 | 1 | 0.019 | 0.033 |
| Marsh Wren | 1 | 0.018 | 0.032 | 0 | 0.000 | 0.000 | 0 | 0.000 | 0.000 |
| Golden-crowned Kinglet | 6 | 0.018 | 0.032 | 1 | 0.023 | 0.040 | 0 | 0.000 | 0.000 |
| Ruby-crowned Kinglet | 122 | 2.414 | 0.618 | 15 | 0.302 | 0.102 | 49 | 0.937 | 0.435 |
| Blue-gray Gnatcatcher | 27 | 0.536 | 0.133 | 4 | 0.088 | 0.107 | 5 | 0.091 | 0.082 |
| Veery | 30 | 0.607 | 0.132 | 58 | 1.104 | 0.364 | 24 | 0.472 | 0.318 |
| Gray-cheeked Thrush | 32 | 0.618 | 0.383 | 16 | 0.291 | 0.253 | 18 | 0.343 | 0.194 |
| Swainson's Thrush | 116 | 2.294 | 0.359 | 77 | 1.452 | 0.674 | 40 | 0.761 | 0.124 |
| Hermit thrush | 121 | 2.386 | 0.883 | 110 | 2.170 | 0.213 | 15 | 0.288 | 0.066 |
| Wood Thrush | 16 | 0.307 | 0.147 | 59 | 1.164 | 0.327 | 5 | 0.095 | 0.084 |
| American Robin | 57 | 1.017 | 0.027 | 79 | 1.533 | 0.473 | 56 | 1.053 | 0.297 |
| Gray Catbird | 311 | 6.103 | 1.396 | 97 | 1.863 | 0.618 | 326 | 6.235 | 1.553 |
| Brown Thrasher | 21 | 0.423 | 0.083 | 5 | 0.102 | 0.090 | 26 | 0.484 | 0.327 |
| European Starling | 1 | 0.019 | 0.033 | 3 | 0.059 | 0.008 | 0 | 0.000 | 0.000 |
| Cedar Waxwing | 7 | 0.148 | 0.114 | 0 | 0.000 | 0.000 | 2 | 0.042 | 0.072 |
| Blue-winged Warbler | 2 | 0.041 | 0.036 | 2 | 0.037 | 0.065 | 4 | 0.078 | 0.040 |
| *Brewster's Warbler* | 2 | 0.042 | 0.037 | 0 | 0.000 | 0.000 | 0 | 0.000 | 0.000 |
| *Lawrence's Warbler* | 1 | 0.019 | 0.033 | 0 | 0.000 | 0.000 | 0 | 0.000 | 0.000 |
| Golden-winged Warbler | 1 | 0.019 | 0.033 | 0 | 0.000 | 0.000 | 2 | 0.039 | 0.034 |
| Tennessee Warbler | 16 | 0.329 | 0.137 | 4 | 0.083 | 0.073 | 4 | 0.079 | 0.069 |
| Orange-crowned Warbler | 4 | 0.076 | 0.088 | 1 | 0.018 | 0.031 | 7 | 0.140 | 0.159 |
| Nashville Warbler | 71 | 1.441 | 0.541 | 17 | 0.357 | 0.289 | 34 | 0.660 | 0.309 |
| Northern Parula | 3 | 0.064 | 0.069 | 2 | 0.036 | 0.032 | 1 | 0.021 | 0.036 |
| Yellow Warbler | 194 | 3.859 | 1.133 | 3 | 0.069 | 0.119 | 631 | 12.097 | 1.391 |
| Chestnut-sided Warbler | 65 | 1.317 | 0.385 | 7 | 0.139 | 0.086 | 14 | 0.266 | 0.136 |
| Magnolia Warbler | 282 | 5.709 | 2.903 | 18 | 0.346 | 0.236 | 71 | 1.351 | 0.543 |
| Cape May Warbler | 6 | 0.129 | 0.127 | 2 | 0.037 | 0.065 | 2 | 0.042 | 0.072 |
| Black-throated Blue Warbler | 25 | 0.508 | 0.204 | 9 | 0.178 | 0.025 | 3 | 0.060 | 0.063 |
| Yellow-rumped Warbler | 677 | 13.753 | 9.067 | 269 | 5.600 | 4.397 | 24 | 0.470 | 0.305 |
| Black-throated Green Warbler | 24 | 0.494 | 0.245 | 5 | 0.091 | 0.082 | 0 | 0.000 | 0.000 |
| Blackburnian Warbler | 10 | 0.216 | 0.232 | 0 | 0.000 | 0.000 | 1 | 0.019 | 0.033 |
| Pine Warbler | 1 | 0.018 | 0.032 | 3 | 0.060 | 0.057 | 1 | 0.021 | 0.036 |
| Palm Warbler (Western race) | 191 | 3.787 | 2.496 | 105 | 2.183 | 1.719 | 44 | 0.878 | 0.946 |

*Appendix 2. cont.*

| | Beach Ridge Forest | | | Mature Inland Forest | | | Dogwood Shrubland | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | Mean | SE | | Total | Mean | SE | | Total |
| Bay-breasted Warbler | 14 | 0.294 | 0.218 | 3 | 0.056 | 0.097 | 2 | 0.036 | 0.062 |
| Blackpoll Warbler | 27 | 0.549 | 0.155 | 0 | 0.000 | 0.000 | 8 | 0.153 | 0.038 |
| Cerulean Warbler | 1 | 0.018 | 0.032 | 1 | 0.023 | 0.040 | 0 | 0.000 | 0.000 |
| Black-and-white Warbler | 47 | 0.957 | 0.292 | 6 | 0.120 | 0.060 | 7 | 0.140 | 0.159 |
| American Redstart | 119 | 2.443 | 0.935 | 11 | 0.209 | 0.065 | 52 | 1.013 | 0.428 |
| Prothonotary Warbler | 2 | 0.036 | 0.063 | 0 | 0.000 | 0.000 | 0 | 0.000 | 0.000 |
| Worm-eating Warbler | 4 | 0.076 | 0.088 | 0 | 0.000 | 0.000 | 0 | 0.000 | 0.000 |
| Ovenbird | 86 | 1.662 | 0.668 | 124 | 2.377 | 1.087 | 25 | 0.488 | 0.246 |
| Northern Waterthrush | 47 | 0.926 | 0.194 | 49 | 0.986 | 0.338 | 100 | 1.966 | 1.709 |
| Louisiana Waterthrush | 1 | 0.019 | 0.033 | 1 | 0.018 | 0.031 | 0 | 0.000 | 0.000 |
| Connecticut Warbler | 6 | 0.117 | 0.052 | 1 | 0.019 | 0.032 | 6 | 0.110 | 0.095 |
| Mourning Warbler | 59 | 1.182 | 0.174 | 13 | 0.246 | 0.275 | 21 | 0.397 | 0.126 |
| Common Yellowthroat | 110 | 2.172 | 0.799 | 35 | 0.661 | 0.430 | 182 | 3.433 | 0.732 |
| Hooded Warbler | 10 | 0.189 | 0.239 | 6 | 0.120 | 0.060 | 1 | 0.021 | 0.036 |
| Wilson's Warbler | 116 | 2.303 | 1.166 | 1 | 0.023 | 0.040 | 55 | 1.050 | 0.083 |
| Canada Warbler | 76 | 1.543 | 0.578 | 5 | 0.105 | 0.088 | 27 | 0.517 | 0.155 |
| Yellow-breasted Chat | 2 | 0.042 | 0.037 | 0 | 0.000 | 0.000 | 4 | 0.072 | 0.081 |
| Scarlet Tanager | 3 | 0.064 | 0.069 | 5 | 0.097 | 0.063 | 0 | 0.000 | 0.000 |
| Eastern Towhee | 3 | 0.060 | 0.008 | 1 | 0.019 | 0.032 | 1 | 0.018 | 0.031 |
| American Tree Sparrow | 0 | 0.000 | 0.000 | 0 | 0.000 | 0.000 | 2 | 0.036 | 0.062 |
| Field Sparrow | 3 | 0.064 | 0.069 | 0 | 0.000 | 0.000 | 36 | 0.691 | 0.267 |
| Savannah Sparrow | 0 | 0.000 | 0.000 | 0 | 0.000 | 0.000 | 4 | 0.076 | 0.032 |
| Song Sparrow | 43 | 0.784 | 0.156 | 17 | 0.313 | 0.216 | 63 | 1.194 | 0.302 |
| Lincoln's Sparrow | 26 | 0.515 | 0.032 | 22 | 0.447 | 0.215 | 35 | 0.654 | 0.306 |
| Swamp Sparrow | 55 | 1.038 | 0.250 | 9 | 0.177 | 0.056 | 42 | 0.791 | 0.362 |
| White-throated Sparrow | 439 | 8.691 | 0.820 | 244 | 4.943 | 2.024 | 163 | 3.131 | 0.639 |
| White-crowned Sparrow | 25 | 0.533 | 0.529 | 3 | 0.0636 | 0.0695 | 13 | 0.243 | 0.113 |
| *Gambel's White-crowned Sparrow* | 0 | 0.000 | 0.000 | 1 | 0.018 | 0.031 | 0 | 0.000 | 0.000 |
| White-crowned Sparrow | 16 | 0.368 | 0.637 | 2 | 0.046 | 0.080 | 3 | 0.058 | 0.057 |
| Dark-eyed Junco | 4 | 0.078 | 0.082 | 7 | 0.128 | 0.116 | 3 | 0.055 | 0.057 |
| Northern Cardinal | 62 | 1.277 | 0.916 | 18 | 0.392 | 0.458 | 51 | 0.985 | 0.726 |
| Rose-breatsed Grosbeak | 4 | 0.079 | 0.031 | 7 | 0.132 | 0.055 | 1 | 0.018 | 0.031 |
| Indigo Bunting | 72 | 1.419 | 0.758 | 45 | 0.893 | 0.385 | 53 | 1.012 | 0.289 |
| Red-winged Blackbird | 120 | 2.232 | 1.007 | 49 | 0.878 | 1.032 | 111 | 2.091 | 0.468 |

*Appendix 2. cont.*

| | Beach Ridge Forest | | | Mature Inland Forest | | | Dogwood Shrubland | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | Mean | SE | | Total | Mean | SE | | Total |
| Rusty Blackbird | 2 | 0.041 | 0.036 | 19 | 0.339 | 0.449 | 2 | 0.040 | 0.034 |
| Common Grackle | 30 | 0.591 | 0.213 | 27 | 0.511 | 0.247 | 20 | 0.377 | 0.208 |
| Brown-headed Cowbird | 25 | 0.496 | 0.046 | 7 | 0.143 | 0.080 | 14 | 0.253 | 0.267 |
| Orchard Oriole | 0 | 0.000 | 0.000 | 0 | 0.000 | 0.000 | 8 | 0.154 | 0.042 |
| Baltimore Oriole | 54 | 1.102 | 0.370 | 15 | 0.278 | 0.181 | 26 | 0.500 | 0.242 |
| American Goldfinch | 30 | 0.544 | 0.718 | 2 | 0.036 | 0.032 | 194 | 3.719 | 0.777 |

[a] Means calculated by summing abundances (per 100 mist-net-hours) over all netting visits to each site within each year and then calculating means by habitat over sites and years.

[b] Each of 12 sites (4 beach ridge forest, 4 mature inland forest, 4 dogwood shrubland) was surveyed with 7-12 mistnets operated 7 hours daily on 8 mornings per year.

Appendix 3. Mean (SD) capture rate per 100 mist-net-hours for stopover migrants within 12 study sites in Lucas and Ottawa counties of northwestern Ohio, mid April to late May, 2003-2005.

| | Beach Ridge Forest Sites | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Darby West | | Darby East | | Crane Ck Pool 1 | | Lamb's Woods | |
| Species | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| Acadian Flycatcher | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | 0.14 |
| American Goldfinch | 0.64 | 0.90 | 0.17 | 0.30 | 0.24 | 0.42 | 1.07 | 1.23 |
| American Redstart | 0.86 | 1.09 | 1.46 | 1.21 | 1.90 | 1.55 | 5.37 | 3.56 |
| American Robin | 1.18 | 0.51 | 0.85 | 0.61 | 2.03 | 1.13 | 0.37 | 0.22 |
| American Woodcock | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| American Tree Sparrow | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Baltimore Oriole | 0.17 | 0.29 | 0.51 | 0.17 | 2.68 | 0.64 | 1.59 | 1.36 |
| Black-and-white Warbler | 0.53 | 0.29 | 1.17 | 1.02 | 0.82 | 0.25 | 1.32 | 0.64 |
| Black-billed Cuckoo | 0.00 | 0.00 | 0.00 | 0.00 | 0.12 | 0.21 | 0.00 | 0.00 |
| Bay-breasted Warbler | 0.08 | 0.14 | 0.09 | 0.15 | 0.41 | 0.44 | 0.64 | 0.74 |
| Black-capped Chickadee | 0.00 | 0.00 | 0.11 | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 |
| Blue-gray Gnatcatcher | 0.15 | 0.13 | 0.12 | 0.20 | 0.48 | 0.27 | 1.45 | 0.38 |
| Brown-headed Cowbird | 0.44 | 0.42 | 0.66 | 0.13 | 0.35 | 0.05 | 0.47 | 0.26 |
| Blue-headed Vireo | 0.17 | 0.15 | 0.06 | 0.10 | 0.48 | 0.27 | 0.23 | 0.24 |
| Blackburnian Warbler | 0.08 | 0.14 | 0.06 | 0.10 | 0.12 | 0.21 | 0.57 | 0.98 |
| Blue Jay | 0.45 | 0.42 | 0.46 | 0.26 | 0.00 | 0.00 | 0.00 | 0.00 |
| Blackpoll Warbler | 0.25 | 0.43 | 0.06 | 0.10 | 0.73 | 0.73 | 1.23 | 1.11 |
| Brown Creeper | 0.32 | 0.39 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Brown Thrasher | 0.25 | 0.25 | 0.49 | 0.21 | 0.61 | 0.49 | 0.39 | 0.16 |
| Black-throated Blue Warbler | 0.22 | 0.21 | 0.37 | 0.13 | 0.31 | 0.29 | 1.00 | 0.87 |
| Black-throated Green Warbler | 0.24 | 0.03 | 0.43 | 0.31 | 0.32 | 0.30 | 0.94 | 0.45 |
| Blue-winged Warbler | 0.00 | 0.00 | 0.00 | 0.00 | 0.13 | 0.23 | 0.07 | 0.12 |
| *Brewster's Warbler* | 0.00 | 0.00 | 0.06 | 0.10 | 0.13 | 0.23 | 0.00 | 0.00 |
| *Lawrence's Warbler* | 0.00 | 0.00 | 0.06 | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 |
| Carolina Wren | 0.31 | 0.27 | 0.14 | 0.13 | 0.91 | 0.15 | 0.32 | 0.37 |
| Canada Warbler | 0.39 | 0.13 | 1.26 | 0.77 | 0.22 | 0.19 | 3.95 | 1.80 |
| Cedar Waxwing | 0.00 | 0.00 | 0.09 | 0.15 | 0.24 | 0.42 | 0.32 | 0.37 |
| Cerulean Warbler | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 | 0.12 |
| Cape May Warbler | 0.00 | 0.00 | 0.00 | 0.00 | 0.22 | 0.19 | 0.32 | 0.56 |

*Appendix 3 cont.*

| | Beach Ridge Forest Sites | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Darby West | | | | Darby West | | | |
| | Mean | Species | Mean | Species | Mean | Species | Mean | Species |
| Common Grackle | 0.75 | 0.50 | 0.11 | 0.20 | 0.86 | 0.54 | 0.75 | 0.44 |
| Connecticut Warbler | 0.00 | 0.00 | 0.06 | 0.10 | 0.00 | 0.00 | 0.38 | 0.12 |
| Common Yellowthroat | 0.38 | 0.22 | 0.80 | 0.37 | 3.23 | 2.99 | 4.64 | 0.68 |
| Chestnut-sided Warbler | 0.36 | 0.43 | 0.80 | 0.39 | 1.21 | 0.51 | 2.91 | 1.80 |
| Dark-eyed Junco | 0.14 | 0.24 | 0.00 | 0.00 | 0.13 | 0.23 | 0.07 | 0.12 |
| Downy Woodpecker | 0.31 | 0.27 | 0.17 | 0.30 | 0.00 | 0.00 | 0.46 | 0.41 |
| Eastern Kingbird | 0.00 | 0.00 | 0.00 | 0.00 | 0.12 | 0.21 | 0.00 | 0.00 |
| Eastern Phoebe | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Eastern Towhee | 0.00 | 0.00 | 0.06 | 0.10 | 0.25 | 0.22 | 0.00 | 0.00 |
| Eastern Wood-Pewee | 0.00 | 0.00 | 0.00 | 0.00 | 0.10 | 0.17 | 0.40 | 0.49 |
| European Starling | 0.00 | 0.00 | 0.00 | 0.00 | 0.10 | 0.17 | 0.00 | 0.00 |
| Field Sparrow | 0.00 | 0.00 | 0.09 | 0.15 | 0.13 | 0.23 | 0.07 | 0.12 |
| Great Crested Flycatcher | 0.07 | 0.12 | 0.06 | 0.10 | 0.12 | 0.21 | 0.24 | 0.24 |
| Golden-crowned Kinglet | 0.07 | 0.12 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Gray-cheeked Thrush | 0.32 | 0.39 | 0.35 | 0.46 | 0.57 | 0.17 | 1.29 | 0.58 |
| Gray Catbird | 2.47 | 1.34 | 4.14 | 1.92 | 11.60 | 5.06 | 8.58 | 4.49 |
| Golden-winged Warbler | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | 0.14 |
| Hairy Woodpecker | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Hermit Thrush | 1.05 | 0.85 | 2.12 | 0.50 | 2.34 | 3.44 | 3.97 | 3.57 |
| Hooded Warbler | 0.00 | 0.00 | 0.52 | 0.76 | 0.12 | 0.21 | 0.00 | 0.00 |
| House Wren | 0.31 | 0.27 | 1.37 | 0.16 | 2.76 | 1.07 | 2.34 | 1.74 |
| Indigo Bunting | 0.68 | 0.40 | 0.97 | 0.60 | 3.28 | 3.57 | 1.31 | 0.44 |
| Least Flycatcher | 0.15 | 0.14 | 0.68 | 0.45 | 0.66 | 0.25 | 1.29 | 0.73 |
| Lincoln's Sparrow | 0.14 | 0.24 | 0.31 | 0.40 | 1.01 | 0.20 | 0.82 | 0.29 |
| Louisiana Waterthrush | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | 0.14 |
| Magnolia Warbler | 1.27 | 0.42 | 4.95 | 1.22 | 2.35 | 1.76 | 13.31 | 9.83 |
| Marsh Wren | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 | 0.12 |
| Mourning Warbler | 0.08 | 0.14 | 0.86 | 0.61 | 0.70 | 0.97 | 2.93 | 0.91 |
| Nashville Warbler | 0.73 | 0.29 | 0.54 | 0.42 | 3.59 | 2.64 | 1.84 | 0.52 |
| Northern Cardinal | 1.51 | 1.41 | 0.98 | 0.78 | 1.36 | 0.87 | 1.25 | 1.02 |
| Northern Flicker | 0.07 | 0.12 | 0.28 | 0.26 | 0.13 | 0.23 | 0.00 | 0.00 |
| *Yellow x Red-shafted Flicker* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Northern Parula | 0.00 | 0.00 | 0.09 | 0.15 | 0.00 | 0.00 | 0.15 | 0.13 |

*Appendix 3 cont.*

| | Beach Ridge Forest Sites | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Darby West | | | | Darby West | | | |
| | Mean | Species | Mean | Species | Mean | Species | Mean | Species |
| Northern Waterthrush | 1.21 | 0.59 | 0.46 | 0.10 | 1.13 | 0.33 | 1.06 | 0.14 |
| Orange-crowned Warbler | 0.00 | 0.00 | 0.06 | 0.10 | 0.00 | 0.00 | 0.24 | 0.41 |
| Orchard Oriole | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Olive-sided Flycatcher | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | 0.14 |
| Ovenbird | 0.72 | 0.86 | 1.87 | 1.53 | 2.35 | 1.06 | 1.76 | 0.38 |
| Palm Warbler | 2.25 | 2.88 | 0.72 | 1.04 | 4.90 | 3.76 | 8.75 | 9.05 |
| Philadelphia Vireo | 0.00 | 0.00 | 0.23 | 0.26 | 0.48 | 0.84 | 0.24 | 0.24 |
| Pine Warbler | 0.07 | 0.12 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Prothonotary Warbler | 0.00 | 0.00 | 0.00 | 0.00 | 0.12 | 0.21 | 0.07 | 0.12 |
| Rose-breasted Grosbeak | 0.17 | 0.29 | 0.00 | 0.00 | 0.00 | 0.00 | 0.15 | 0.13 |
| Red-breasted Nuthatch | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Red-bellied Woodpecker | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ruby-crowned Kinglet | 0.76 | 1.32 | 2.26 | 0.49 | 2.67 | 3.18 | 3.99 | 3.10 |
| Red-eyed Vireo | 0.34 | 0.29 | 0.37 | 0.39 | 1.36 | 1.08 | 2.26 | 1.42 |
| Ruby-throated Hummingbird | 0.14 | 0.24 | 0.09 | 0.15 | 0.54 | 0.29 | 3.37 | 2.59 |
| Rusty Blackbird | 0.07 | 0.12 | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | 0.14 |
| Red-winged Blackbird | 2.04 | 2.05 | 0.66 | 0.35 | 3.92 | 2.91 | 2.93 | 1.99 |
| Savannah Sparrow | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Scarlet Tanager | 0.07 | 0.12 | 0.00 | 0.00 | 0.13 | 0.23 | 0.08 | 0.14 |
| Song Sparrow | 0.73 | 0.29 | 0.26 | 0.26 | 1.14 | 0.92 | 1.29 | 0.34 |
| Sharp-shinned Hawk | 0.00 | 0.00 | 0.06 | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 |
| Swamp Sparrow | 0.17 | 0.15 | 0.28 | 0.49 | 0.61 | 0.49 | 3.07 | 0.98 |
| Swainson's Thrush | 1.29 | 1.26 | 1.54 | 0.02 | 3.34 | 2.88 | 3.56 | 1.29 |
| Tennessee Warbler | 0.14 | 0.24 | 0.00 | 0.00 | 0.36 | 0.40 | 0.86 | 0.41 |
| Tree Swallow | 0.00 | 0.00 | 0.06 | 0.10 | 0.59 | 0.43 | 1.15 | 0.27 |
| Traill's (Willow/Alder) Flycatcher | 0.29 | 0.31 | 0.49 | 0.25 | 1.38 | 1.22 | 8.88 | 4.71 |
| Veery | 0.32 | 0.39 | 0.92 | 0.44 | 0.74 | 0.72 | 0.40 | 0.51 |
| Warbling Vireo | 0.07 | 0.12 | 0.23 | 0.26 | 1.65 | 0.62 | 1.56 | 1.17 |
| White-crowned Sparrow | 0.08 | 0.15 | 0.00 | 0.00 | 1.60 | 1.17 | 0.88 | 1.35 |
| *Gambel's White-crowned Sparrow* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 | 0.12 |
| White-eyed Vireo | 0.00 | 0.00 | 0.26 | 0.26 | 0.00 | 0.00 | 0.08 | 0.14 |
| Worm-eating Warbler | 0.08 | 0.14 | 0.12 | 0.20 | 0.12 | 0.21 | 0.00 | 0.00 |
| Wilson's Warbler | 0.00 | 0.00 | 1.66 | 0.86 | 1.40 | 0.82 | 6.12 | 4.94 |
| Winter Wren | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wood Thrush | 0.00 | 0.00 | 0.23 | 0.40 | 1.08 | 0.97 | 0.23 | 0.24 |
| White-throated Sparrow | 1.06 | 0.68 | 3.21 | 2.40 | 9.73 | 6.40 | 22.15 | 7.87 |
| Yellow-breasted Chat | 0.00 | 0.00 | 0.06 | 0.10 | 0.13 | 0.23 | 0.00 | 0.00 |
| Yellow-billed Cuckoo | 0.00 | 0.00 | 0.00 | 0.00 | 0.10 | 0.17 | 0.00 | 0.00 |
| Yellow-bellied Flycatcher | 0.00 | 0.00 | 0.17 | 0.30 | 0.23 | 0.20 | 3.73 | 1.93 |
| Yellow-bellied Sapsucker | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 | 0.12 |
| Yellow-rumped Warbler | 7.78 | 10.58 | 0.97 | 1.39 | 24.72 | 24.80 | 29.20 | 31.43 |
| Yellow Warbler | 1.19 | 1.86 | 0.58 | 0.61 | 6.07 | 3.52 | 8.75 | 2.89 |

| | Mature Inland Forest | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Darby Pool 2 | | Kurdy House | | Turtle Creek | | Maumee Bay | |
| Species | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| Acadian Flycatcher | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 | 0.13 | 0.10 | 0.17 |
| American Goldfinch | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 | 0.13 | 0.07 | 0.12 |
| American Redstart | 0.00 | 0.00 | 0.58 | 0.51 | 0.07 | 0.13 | 0.20 | 0.35 |
| American Robin | 1.88 | 0.64 | 1.30 | 0.51 | 1.63 | 0.31 | 1.31 | 0.52 |
| American Woodcock | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| American Tree Sparrow | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Baltimore Oriole | 0.35 | 0.32 | 0.38 | 0.48 | 0.22 | 0.38 | 0.17 | 0.15 |
| Black-and-white Warbler | 0.18 | 0.31 | 0.23 | 0.40 | 0.07 | 0.13 | 0.00 | 0.00 |
| Black-billed Cuckoo | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Bay-breasted Warbler | 0.00 | 0.00 | 0.23 | 0.40 | 0.00 | 0.00 | 0.00 | 0.00 |
| Black-capped Chickadee | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Blue-gray Gnatcatcher | 0.33 | 0.41 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Brown-headed Cowbird | 0.23 | 0.21 | 0.07 | 0.12 | 0.25 | 0.27 | 0.00 | 0.00 |
| Blue-headed Vireo | 0.00 | 0.00 | 0.18 | 0.32 | 0.18 | 0.31 | 0.00 | 0.00 |
| Blackburnian Warbler | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Blue Jay | 0.93 | 0.86 | 2.26 | 2.63 | 2.49 | 4.08 | 0.78 | 0.45 |
| Blackpoll Warbler | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Brown Creeper | 0.56 | 0.80 | 0.00 | 0.00 | 0.59 | 0.68 | 0.00 | 0.00 |
| Brown Thrasher | 0.00 | 0.00 | 0.24 | 0.23 | 0.16 | 0.14 | 0.00 | 0.00 |
| Black-throated Blue Warbler | 0.00 | 0.00 | 0.29 | 0.25 | 0.32 | 0.18 | 0.10 | 0.17 |
| Black-throated Green Warbler | 0.00 | 0.00 | 0.29 | 0.25 | 0.07 | 0.13 | 0.00 | 0.00 |
| Blue-winged Warbler | 0.00 | 0.00 | 0.15 | 0.27 | 0.00 | 0.00 | 0.00 | 0.00 |

*Appendix 3 cont.*

| | Mature Inland Forest | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Darby Pool 2 | | | | Darby Pool 2 | | | |
| Species | Mean | Species | Mean | Species | Mean | Species | Mean | Species |
| *Brewster's Warbler* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Lawrence's Warbler* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Carolina Wren | 0.28 | 0.24 | 0.47 | 0.60 | 0.39 | 0.46 | 0.00 | 0.00 |
| Canada Warbler | 0.00 | 0.00 | 0.27 | 0.47 | 0.15 | 0.13 | 0.00 | 0.00 |
| Cedar Waxwing | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Cerulean Warbler | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.10 | 0.17 |
| Cape May Warbler | 0.00 | 0.00 | 0.15 | 0.27 | 0.00 | 0.00 | 0.00 | 0.00 |
| Common Grackle | 0.42 | 0.36 | 0.08 | 0.13 | 0.46 | 0.21 | 1.11 | 1.06 |
| Connecticut Warbler | 0.00 | 0.00 | 0.08 | 0.13 | 0.00 | 0.00 | 0.00 | 0.00 |
| Common Yellowthroat | 0.21 | 0.21 | 1.00 | 1.32 | 1.21 | 0.59 | 0.24 | 0.22 |
| Chestnut-sided Warbler | 0.00 | 0.00 | 0.31 | 0.53 | 0.25 | 0.27 | 0.00 | 0.00 |
| Dark-eyed Junco | 0.35 | 0.43 | 0.14 | 0.24 | 0.00 | 0.00 | 0.00 | 0.00 |
| Downy Woodpecker | 0.93 | 0.61 | 0.35 | 0.43 | 0.66 | 0.65 | 0.42 | 0.18 |
| Eastern Kingbird | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Eastern Phoebe | 0.25 | 0.27 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Eastern Towhee | 0.00 | 0.00 | 0.08 | 0.13 | 0.00 | 0.00 | 0.00 | 0.00 |
| Eastern Wood-Pewee | 0.00 | 0.00 | 0.17 | 0.15 | 0.15 | 0.13 | 0.07 | 0.12 |
| European Starling | 0.16 | 0.14 | 0.00 | 0.00 | 0.07 | 0.13 | 0.00 | 0.00 |
| Field Sparrow | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Great Crested Flycatcher | 0.07 | 0.12 | 0.08 | 0.13 | 0.07 | 0.13 | 0.00 | 0.00 |
| Golden-crowned Kinglet | 0.00 | 0.00 | 0.00 | 0.00 | 0.09 | 0.15 | 0.00 | 0.00 |
| Gray-cheeked Thrush | 0.21 | 0.36 | 0.08 | 0.13 | 0.73 | 0.67 | 0.14 | 0.25 |
| Gray Catbird | 1.88 | 1.88 | 3.40 | 1.25 | 1.52 | 0.54 | 0.55 | 0.53 |
| Golden-winged Warbler | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Hairy Woodpecker | 0.09 | 0.15 | 0.07 | 0.12 | 0.22 | 0.38 | 0.00 | 0.00 |
| Hermit Thrush | 1.52 | 0.67 | 1.73 | 1.66 | 4.44 | 3.43 | 0.85 | 0.55 |
| Hooded Warbler | 0.00 | 0.00 | 0.17 | 0.15 | 0.16 | 0.14 | 0.16 | 0.28 |
| House Wren | 0.86 | 1.08 | 2.42 | 0.49 | 2.17 | 0.94 | 0.98 | 0.65 |
| Indigo Bunting | 0.28 | 0.48 | 2.80 | 0.98 | 0.47 | 0.23 | 0.00 | 0.00 |
| Least Flycatcher | 0.07 | 0.12 | 0.07 | 0.12 | 0.14 | 0.25 | 0.10 | 0.17 |
| Lincoln's Sparrow | 0.16 | 0.14 | 0.93 | 0.19 | 0.52 | 0.71 | 0.17 | 0.15 |
| Louisiana Waterthrush | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 | 0.13 | 0.00 | 0.00 |
| Magnolia Warbler | 0.16 | 0.14 | 0.77 | 1.33 | 0.22 | 0.38 | 0.28 | 0.30 |

*Appendix 3 cont.*

| | Mature Inland Forest | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Darby Pool 2 | | | | Darby Pool 2 | | | |
| Species | Mean | Species | Mean | Species | Mean | Species | Mean | Species |
| Marsh Wren | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mourning Warbler | 0.21 | 0.21 | 0.24 | 0.23 | 0.52 | 0.72 | 0.00 | 0.00 |
| Nashville Warbler | 0.27 | 0.46 | 0.41 | 0.36 | 0.66 | 0.67 | 0.07 | 0.12 |
| Northern Cardinal | 0.87 | 1.32 | 0.43 | 0.41 | 0.24 | 0.23 | 0.00 | 0.00 |
| Northern Flicker | 0.00 | 0.00 | 0.17 | 0.15 | 0.18 | 0.31 | 0.00 | 0.00 |
| *Yellow x Red-shafted Flicker* | 0.07 | 0.12 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Northern Parula | 0.00 | 0.00 | 0.08 | 0.13 | 0.07 | 0.13 | 0.00 | 0.00 |
| Northern Waterthrush | 0.23 | 0.03 | 0.79 | 0.94 | 2.82 | 1.25 | 0.07 | 0.12 |
| Orange-crowned Warbler | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 | 0.13 | 0.00 | 0.00 |
| Orchard Oriole | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Olive-sided Flycatcher | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ovenbird | 0.49 | 0.53 | 4.03 | 5.07 | 4.82 | 0.74 | 0.21 | 0.37 |
| Palm Warbler | 3.48 | 4.62 | 0.89 | 0.92 | 1.24 | 1.00 | 3.17 | 3.60 |
| Philadelphia Vireo | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Pine Warbler | 0.23 | 0.21 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Prothonotary Warbler | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Rose-breasted Grosbeak | 0.00 | 0.00 | 0.39 | 0.26 | 0.14 | 0.25 | 0.00 | 0.00 |
| Red-breasted Nuthatch | 0.00 | 0.00 | 0.07 | 0.12 | 0.00 | 0.00 | 0.00 | 0.00 |
| Red-bellied Woodpecker | 0.16 | 0.14 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ruby-crowned Kinglet | 0.30 | 0.11 | 0.23 | 0.40 | 0.59 | 0.68 | 0.07 | 0.12 |
| Red-eyed Vireo | 0.00 | 0.00 | 0.08 | 0.13 | 0.22 | 0.38 | 0.20 | 0.35 |
| Ruby-throated Hummingbird | 0.14 | 0.12 | 0.26 | 0.27 | 0.15 | 0.26 | 0.00 | 0.00 |
| Rusty Blackbird | 0.91 | 1.24 | 0.00 | 0.00 | 0.44 | 0.57 | 0.00 | 0.00 |
| Red-winged Blackbird | 1.47 | 2.03 | 0.00 | 0.00 | 1.18 | 1.02 | 0.85 | 1.47 |
| Savannah Sparrow | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Scarlet Tanager | 0.00 | 0.00 | 0.30 | 0.35 | 0.09 | 0.15 | 0.00 | 0.00 |
| Song Sparrow | 1.00 | 0.64 | 0.15 | 0.13 | 0.07 | 0.13 | 0.00 | 0.00 |
| Sharp-shinned Hawk | 0.00 | 0.00 | 0.08 | 0.13 | 0.00 | 0.00 | 0.08 | 0.14 |
| Swamp Sparrow | 0.32 | 0.19 | 0.23 | 0.21 | 0.15 | 0.13 | 0.00 | 0.00 |
| Swainson's Thrush | 0.63 | 0.63 | 2.08 | 0.44 | 2.42 | 1.28 | 0.65 | 0.76 |
| Tennessee Warbler | 0.07 | 0.12 | 0.08 | 0.13 | 0.18 | 0.31 | 0.00 | 0.00 |
| Tree Swallow | 0.00 | 0.00 | 0.00 | 0.00 | 0.25 | 0.27 | 0.00 | 0.00 |
| Traill's (Willow/Alder) Flycatcher | 0.07 | 0.12 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

*Appendix 3 cont.*

| | Mature Inland Forest | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Darby Pool 2 | | | | Darby Pool 2 | | | |
| Species | Mean | Species | Mean | Species | Mean | Species | Mean | Species |
| Veery | 0.30 | 0.11 | 1.16 | 0.41 | 2.82 | 1.34 | 0.14 | 0.25 |
| Warbling Vireo | 0.00 | 0.00 | 0.00 | 0.00 | 0.14 | 0.25 | 0.00 | 0.00 |
| White-crowned Sparrow | 0.00 | 0.00 | 0.09 | 0.16 | 0.16 | 0.14 | 0.00 | 0.00 |
| *Gambel's White-crowned Sparrow* | 0.07 | 0.12 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| White-eyed Vireo | 0.00 | 0.00 | 0.09 | 0.16 | 0.00 | 0.00 | 0.00 | 0.00 |
| Worm-eating Warbler | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Wilson's Warbler | 0.00 | 0.00 | 0.00 | 0.00 | 0.09 | 0.15 | 0.00 | 0.00 |
| Winter Wren | 0.32 | 0.28 | 0.00 | 0.00 | 0.34 | 0.41 | 0.00 | 0.00 |
| Wood Thrush | 0.98 | 0.13 | 0.85 | 0.18 | 2.68 | 0.96 | 0.10 | 0.17 |
| White-throated Sparrow | 1.23 | 1.23 | 6.04 | 6.10 | 10.22 | 11.01 | 2.09 | 1.76 |
| Yellow-breasted Chat | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Yellow-billed Cuckoo | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Yellow-bellied Flycatcher | 0.00 | 0.00 | 0.14 | 0.24 | 0.00 | 0.00 | 0.00 | 0.00 |
| Yellow-bellied Sapsucker | 0.16 | 0.14 | 0.08 | 0.13 | 0.09 | 0.15 | 0.00 | 0.00 |
| Yellow-rumped Warbler | 9.20 | 10.36 | 5.13 | 5.55 | 1.65 | 1.25 | 6.43 | 3.93 |
| Yellow Warbler | 0.09 | 0.15 | 0.09 | 0.16 | 0.00 | 0.00 | 0.10 | 0.17 |

| | Dogwood Shrubland | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Little Portage | | Woodies Roost | | Mini Marsh | | FU 11 | |
| Species | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| Acadian Flycatcher | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| American Goldfinch | 4.98 | 1.44 | 3.34 | 1.19 | 3.85 | 2.59 | 2.92 | 1.27 |
| American Redstart | 0.68 | 0.22 | 1.37 | 1.05 | 0.80 | 1.15 | 1.22 | 1.05 |
| American Robin | 1.98 | 0.60 | 0.70 | 0.24 | 0.83 | 0.52 | 0.68 | 0.32 |
| American Woodcock | 0.09 | 0.15 | 0.00 | 0.00 | 0.08 | 0.13 | 0.27 | 0.31 |
| American Tree Sparrow | 0.07 | 0.12 | 0.07 | 0.12 | 0.00 | 0.00 | 0.00 | 0.00 |
| Baltimore Oriole | 0.23 | 0.03 | 0.93 | 0.45 | 0.24 | 0.23 | 0.54 | 0.42 |
| Black-and-white Warbler | 0.09 | 0.15 | 0.09 | 0.16 | 0.08 | 0.13 | 0.27 | 0.31 |
| Black-billed Cuckoo | 0.14 | 0.24 | 0.00 | 0.00 | 0.23 | 0.39 | 0.00 | 0.00 |
| Bay-breasted Warbler | 0.07 | 0.12 | 0.07 | 0.12 | 0.00 | 0.00 | 0.00 | 0.00 |
| Black-capped Chickadee | 0.21 | 0.36 | 0.14 | 0.24 | 0.00 | 0.00 | 0.14 | 0.24 |

*Appendix 3 cont.*

| | Dogwood Shrubland | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Little Portage | | | | Little Portage | | | |
| Species | Mean | Species | Mean | Species | Mean | Species | Mean | Species |
| Blue-gray Gnatcatcher | 0.07 | 0.12 | 0.07 | 0.12 | 0.08 | 0.13 | 0.14 | 0.24 |
| Brown-headed Cowbird | 0.35 | 0.32 | 0.28 | 0.48 | 0.18 | 0.16 | 0.21 | 0.36 |
| Blue-headed Vireo | 0.40 | 0.33 | 0.26 | 0.28 | 0.09 | 0.16 | 0.00 | 0.00 |
| Blackburnian Warbler | 0.00 | 0.00 | 0.00 | 0.00 | 0.10 | 0.18 | 0.00 | 0.00 |
| Blue Jay | 1.05 | 0.21 | 1.32 | 1.62 | 0.08 | 0.13 | 0.61 | 0.35 |
| Blackpoll Warbler | 0.09 | 0.15 | 0.23 | 0.21 | 0.27 | 0.04 | 0.07 | 0.12 |
| Brown Creeper | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Brown Thrasher | 0.16 | 0.14 | 0.44 | 0.54 | 0.17 | 0.15 | 1.10 | 0.67 |
| Black-throated Blue Warbler | 0.00 | 0.00 | 0.07 | 0.12 | 0.00 | 0.00 | 0.13 | 0.23 |
| Black-throated Green Warbler | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Blue-winged Warbler | 0.00 | 0.00 | 0.00 | 0.00 | 0.09 | 0.16 | 0.20 | 0.00 |
| *Brewster's Warbler* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Lawrence's Warbler* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Carolina Wren | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Canada Warbler | 0.98 | 0.74 | 0.21 | 0.21 | 0.10 | 0.18 | 0.68 | 0.46 |
| Cedar Waxwing | 0.00 | 0.00 | 0.09 | 0.16 | 0.00 | 0.00 | 0.07 | 0.12 |
| Cerulean Warbler | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Cape May Warbler | 0.00 | 0.00 | 0.09 | 0.16 | 0.00 | 0.00 | 0.07 | 0.12 |
| Common Grackle | 0.59 | 0.22 | 0.28 | 0.48 | 0.18 | 0.32 | 0.41 | 0.21 |
| Connecticut Warbler | 0.07 | 0.12 | 0.00 | 0.00 | 0.18 | 0.16 | 0.21 | 0.21 |
| Common Yellowthroat | 2.98 | 2.15 | 1.33 | 0.43 | 6.74 | 1.75 | 3.35 | 0.80 |
| Chestnut-sided Warbler | 0.07 | 0.12 | 0.26 | 0.28 | 0.29 | 0.28 | 0.48 | 0.48 |
| Dark-eyed Junco | 0.14 | 0.12 | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 | 0.12 |
| Downy Woodpecker | 0.30 | 0.11 | 0.00 | 0.00 | 0.00 | 0.00 | 0.20 | 0.35 |
| Eastern Kingbird | 0.00 | 0.00 | 0.00 | 0.00 | 0.30 | 0.52 | 0.00 | 0.00 |
| Eastern Phoebe | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Eastern Towhee | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | 0.13 | 0.00 | 0.00 |
| Eastern Wood-Pewee | 0.00 | 0.00 | 0.07 | 0.12 | 0.08 | 0.13 | 0.07 | 0.12 |
| European Starling | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Field Sparrow | 0.21 | 0.36 | 0.21 | 0.21 | 0.39 | 0.46 | 1.70 | 0.96 |
| Great Crested Flycatcher | 0.07 | 0.12 | 0.00 | 0.00 | 0.00 | 0.00 | 0.14 | 0.24 |
| Golden-crowned Kinglet | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Gray-cheeked Thrush | 0.35 | 0.32 | 0.16 | 0.15 | 0.48 | 0.64 | 0.41 | 0.20 |

*Appendix 3 cont.*

| | Dogwood Shrubland | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Little Portage | | | | Little Portage | | | |
| Species | Mean | Species | Mean | Species | Mean | Species | Mean | Species |
| Gray Catbird | 7.15 | 3.53 | 6.18 | 0.78 | 3.89 | 2.41 | 7.16 | 3.05 |
| Golden-winged Warbler | 0.00 | 0.00 | 0.00 | 0.00 | 0.17 | 0.15 | 0.00 | 0.00 |
| Hairy Woodpecker | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Hermit Thrush | 0.47 | 0.28 | 0.42 | 0.36 | 0.18 | 0.32 | 0.07 | 0.12 |
| Hooded Warbler | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 | 0.12 |
| House Wren | 0.24 | 0.26 | 0.07 | 0.12 | 0.10 | 0.18 | 0.55 | 0.32 |
| Indigo Bunting | 0.68 | 0.23 | 0.44 | 0.34 | 0.18 | 0.16 | 2.45 | 0.73 |
| Least Flycatcher | 0.28 | 0.24 | 0.61 | 0.72 | 0.25 | 0.23 | 0.75 | 0.82 |
| Lincoln's Sparrow | 0.93 | 0.72 | 0.63 | 0.36 | 0.40 | 0.46 | 0.62 | 0.42 |
| Louisiana Waterthrush | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Magnolia Warbler | 1.44 | 1.69 | 1.63 | 0.68 | 0.55 | 0.33 | 1.63 | 1.22 |
| Marsh Wren | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mourning Warbler | 0.49 | 0.68 | 0.07 | 0.12 | 0.10 | 0.18 | 0.82 | 0.34 |
| Nashville Warbler | 0.70 | 0.31 | 0.33 | 0.20 | 0.63 | 0.19 | 0.95 | 0.51 |
| Northern Cardinal | 1.42 | 1.19 | 0.70 | 0.43 | 0.67 | 0.59 | 1.09 | 0.77 |
| Northern Flicker | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Yellow x Red-shafted Flicker* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Northern Parula | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 | 0.12 |
| Northern Waterthrush | 1.68 | 1.30 | 2.14 | 2.35 | 1.38 | 1.09 | 2.44 | 3.21 |
| Orange-crowned Warbler | 0.00 | 0.00 | 0.00 | 0.00 | 0.09 | 0.16 | 0.41 | 0.40 |
| Orchard Oriole | 0.07 | 0.12 | 0.00 | 0.00 | 0.44 | 0.16 | 0.13 | 0.23 |
| Olive-sided Flycatcher | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ovenbird | 0.42 | 0.42 | 0.26 | 0.28 | 0.10 | 0.18 | 1.02 | 0.72 |
| Palm Warbler | 0.66 | 0.77 | 0.88 | 1.19 | 1.34 | 1.18 | 0.68 | 1.00 |
| Philadelphia Vireo | 0.07 | 0.12 | 0.21 | 0.36 | 0.29 | 0.28 | 0.00 | 0.00 |
| Pine Warbler | 0.09 | 0.15 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Prothonotary Warbler | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Rose-breasted Grosbeak | 0.07 | 0.12 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Red-breasted Nuthatch | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | 0.13 | 0.00 | 0.00 |
| Red-bellied Woodpecker | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ruby-crowned Kinglet | 1.65 | 1.05 | 0.00 | 0.00 | 0.80 | 1.01 | 1.23 | 0.21 |
| Red-eyed Vireo | 0.00 | 0.00 | 0.47 | 0.23 | 0.25 | 0.23 | 0.20 | 0.00 |
| Ruby-throated Hummingbird | 0.07 | 0.12 | 0.00 | 0.00 | 0.33 | 0.29 | 0.20 | 0.35 |

*Appendix 3 cont.*

| | Dogwood Shrubland | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Little Portage | | | | Little Portage | | | |
| Species | Mean | Species | Mean | Species | Mean | Species | Mean | Species |
| Rusty Blackbird | 0.16 | 0.14 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Red-winged Blackbird | 0.61 | 0.35 | 3.52 | 2.09 | 3.15 | 1.68 | 1.23 | 1.08 |
| Savannah Sparrow | 0.00 | 0.00 | 0.23 | 0.21 | 0.08 | 0.13 | 0.00 | 0.00 |
| Scarlet Tanager | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Song Sparrow | 1.67 | 0.88 | 0.30 | 0.11 | 1.37 | 0.75 | 1.36 | 0.82 |
| Sharp-shinned Hawk | 0.16 | 0.14 | 0.00 | 0.00 | 0.00 | 0.00 | 0.14 | 0.12 |
| Swamp Sparrow | 1.09 | 0.73 | 0.14 | 0.12 | 1.15 | 0.86 | 0.75 | 0.42 |
| Swainson's Thrush | 0.70 | 0.61 | 0.82 | 0.25 | 0.58 | 0.82 | 0.88 | 0.84 |
| Tennessee Warbler | 0.00 | 0.00 | 0.09 | 0.16 | 0.20 | 0.35 | 0.07 | 0.12 |
| Tree Swallow | 0.00 | 0.00 | 0.00 | 0.00 | 0.28 | 0.31 | 0.00 | 0.00 |
| Traill's (Willow/Alder) Flycatcher | 1.07 | 0.82 | 1.93 | 0.86 | 3.12 | 2.17 | 3.23 | 3.70 |
| Veery | 0.73 | 0.46 | 0.14 | 0.24 | 0.19 | 0.17 | 0.68 | 0.84 |
| Warbling Vireo | 0.14 | 0.12 | 0.16 | 0.15 | 0.00 | 0.00 | 0.20 | 0.35 |
| White-crowned Sparrow | 0.45 | 0.05 | 0.35 | 0.43 | 0.00 | 0.00 | 0.14 | 0.12 |
| *Gambel's White-crowned Sparrow* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| White-eyed Vireo | 0.00 | 0.00 | 0.09 | 0.16 | 0.00 | 0.00 | 0.14 | 0.24 |
| Worm-eating Warbler | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Wilson's Warbler | 0.95 | 0.39 | 0.61 | 0.21 | 1.07 | 0.77 | 1.49 | 0.99 |
| Winter Wren | 0.07 | 0.12 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Wood Thrush | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 | 0.13 | 0.27 | 0.24 |
| White-throated Sparrow | 5.70 | 3.20 | 0.35 | 0.32 | 0.57 | 0.55 | 5.33 | 1.40 |
| Yellow-breasted Chat | 0.14 | 0.24 | 0.00 | 0.00 | 0.10 | 0.18 | 0.07 | 0.12 |
| Yellow-billed Cuckoo | 0.00 | 0.00 | 0.00 | 0.00 | 0.18 | 0.32 | 0.07 | 0.12 |
| Yellow-bellied Flycatcher | 0.14 | 0.12 | 0.00 | 0.00 | 0.00 | 0.00 | 0.34 | 0.43 |
| Yellow-bellied Sapsucker | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Yellow-rumped Warbler | 0.45 | 0.05 | 0.42 | 0.42 | 0.33 | 0.34 | 0.61 | 0.88 |
| Yellow Warbler | 6.50 | 2.32 | 15.82 | 2.10 | 18.19 | 4.08 | 8.76 | 5.10 |

[a] Means calculated by summing abundances (per 100 mist-net-hours) over all netting visits to each site within each year and then calculating means by habitat over sites and years.
[b] Each of 12 sites (4 beach ridge forest, 4 mature inland forest, 4 dogwood shrubland) was surveyed with 7-12 mistnets operated 7 hours daily on 8 mornings per year.

Appendix 4. Sixty-five species of migratory birds recorded during point count surveys in Lucas and Ottawa counties of northwestern Ohio, mid April-May, 2003-2005 and classified as transient (non-breeding) stopover migrants. This species group was used in analyses examining relationships between their abundance and site characteristics.

Black-billed Cuckoo (*Coccyzus erythropthalmus*)
Ruby-throated Hummingbird (*Archilochus colubris*)
Yellow-bellied Sapsucker (*Sphyrapicus varius*)
Eastern Wood-Pewee (*Contopus virens*)
Yellow-bellied Flycatcher (*Empidonax flaviventris*)
Acadian Flycatcher (*Empidonax virescens*)
Alder Flycatcher (*Empidonax alnorum*)
Least Flycatcher (*Empidonax minimus*)
Eastern Phoebe (*Sayornis phoebe*)
Yellow-throated Vireo (*Vireo flavifrons*)
Blue-headed Vireo (*Vireo solitarius*)
Philadelphia Vireo (*Vireo philadelphicus*)
Red-eyed Vireo (*Vireo olivaceus*)
Red-breasted Nuthatch (*Sitta canadensis*)
Brown Creeper (*Certhia americana*)
Winter Wren (*Troglodytes troglodytes*)
Ruby-crowned Kinglet (*Regulus calendula*)
Golden-crowned Kinglet (*Regulus satrapa*)
Blue-gray Gnatcatcher (*Polioptila caerulea*)
Veery (*Catharus fuscescens*)
Gray-cheeked Thrush (*Catharus minima*)
Swainson's Thrush (*Catharus ustulatus*)
Hermit Thrush (*Catharus guttatus*)
Blue-winged Warbler (*Vermivora pinus*)
Tennessee Warbler (*Vermivora peregrina*)
Orange-crowned Warbler (*Vermivora celata*)
Nashville Warbler (*Vermivora ruficapilla*)
Northern Parula (*Parula americana*)
Chestnut-sided Warbler (*Dendroica pensylvanica*)
Magnolia Warbler (*Dendroica magnolia*)
Cape May Warbler (*Dendroica tigrina*)
Black-throated Blue Warbler (*Dendroica caerulescens*)
Yellow-rumped Warbler (*Dendroica coronata*)
Black-throated Green Warbler (*Dendroica virens*)
Blackburnian Warbler (*Dendroica fusca*)
Yellow-throated Warbler (*Dendroica dominica*)
Pine Warbler (*Dendroica pinus*)
Prairie Warbler (*Dendroica discolor*)
Palm Warbler (*Dendroica palmarum*)
Bay-breasted Warbler (*Dendroica castanea*)

*Appendix 4. cont.*

Blackpoll Warbler (*Dendroica striata*)
Cerulean Warbler (*Dendroica cerulea*)
Black-and-white Warbler (*Mniotilta varia*)
American Redstart (*Setophaga ruticilla*)
Worm-eating Warbler (*Helmitheros vermivorus*)
Ovenbird (*Seiurus aurocapillus*)
Northern Waterthrush (*Seiurus noveboracensis*)
Connecticut Warbler (*Oporornis agilis*)
Mourning Warbler (*Oporornis philadelphia*)
Hooded Warbler (*Wilsonia citrina*)
Canada Warbler (*Wilsonia canadensis*)
Wilson's Warbler (*Wilsonia pusilla*)
Yellow-breasted Chat (*Icteria virens*)
Summer Tanager (*Piranga rubra*)
Scarlet Tanager (*Piranga olivacea*)
Eastern Towhee (*Pipilo erythropthalmus*)
Chipping Sparrow (*Spizella passerina*)
Fox Sparrow (*Passerella iliaca*)
Lincoln's Sparrow (*Melospiza lincolnii*)
White-throated Sparrow (*Zonotrichia albicollis*)
White-crowned Sparrow (*Zonotrichia leucophrys*)
Rose-breasted Grosbeak (*Pheucticus ludovicianus*)
Rusty Blackbird (*Euphagus carolinus*)
Orchard Oriole (*Icterus spurius*)
Purple Finch (*Carpodacus purpureus*)

Appendix 5. Bird species mist-netted or surveyed during spring 2003-2005 in the Ottawa National Wildlife Refuge and Cedar Point National Wildlife Refuge and considered Priority Species by the U.S. Fish and Wildlife Service, Region 3.

Black-billed Cuckoo
Whip-poor-will
Red-headed Woodpecker
Northern Flicker
Olive-sided Flycatcher
Acadian Flycatcher
Wood Thrush
Blue-winged Warbler
Golden-winged Warbler
Cape May Warbler
Black-throated Blue Warbler
Cerulean Warbler
Prothonotary Warbler
Worm-eating Warbler
Louisiana Waterthrush
Kentucky Warbler
Connecticut Warbler
Canada Warbler
Field Sparrow
Grasshopper Sparrow
Rusty Blackbird
Orchard Oriole