# ELF COMMUNICATIONS SYSTEM ECOLOGICAL MONITORING PROGRAM: BIRD SPECIES AND COMMUNITIES

FINAL REPORT: 1994

SUBCONTRACT NUMBER: DO6205-93-C-008

JoAnn M. Hanowski

Gerald J. Niemi

John G. Blake

Center for Water and the Environment
Natural Resources Research Institute
5013 Miller Trunk Highway
University of Minnesota, Duluth
Duluth, Minnesota 55811

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Gerald J. Niemi
Gerald J. Niemi
Co-principal Investigator

JoAnn M. Hanowski
JoAnn M. Hanowski
Co-principal Investigator

Denise Endicott
Denise Endicott
Accounting Supervisor

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## SUMMARY

This investigation was designed to detect effects of electromagnetic (EM) fields produced by extremely low frequency (ELF) antenna systems on bird species breeding in or migrating through northern Wisconsin and northern Michigan. Specifically, we asked whether bird species richness and abundance differed between areas that were close to the antenna and those that were far enough away to be unaffected by EM fields produced by the antenna. We pursued this question at both the community and species level. Characteristics examined included total species richness and abundance, abundances of common bird species, and abundances of birds within selected guilds. Our monitoring program included bird censuses in both states over a five month period from May to September, from 1986 onwards. Additional data were collected in August-September 1984 and in June 1985, in both states. Bird censuses were terminated in Wisconsin after 1989 and in 1993 in Michigan. Final results were reported previously for the Wisconsin study.

Interpretations of ELF EM field effects in the Michigan study reported here, were based on significance of the interaction term in a repeated measures analysis of variance. For this analysis we were not interested in whether bird abundance varied annually (year effect), but whether bird abundance varied over time in the same manner in treatment and reference study areas. No significant interactions found at the community, species, or guild levels were consistent in any season. The number of significant interactions found at many levels of the analyses were not greater than the number expected by chance alone and therefore were unlikely attributable to EM fields produced by the ELF antenna.

## ABSTRACT

This investigation was designed to isolate effects of electromagnetic (EM) fields produced by extremely low frequency (ELF) antenna systems on bird species breeding in or migrating through northern Wisconsin and northern Michigan. Our null hypothesis was that there were no differences in bird species richness and abundance between areas that were close to the antenna and areas that were far enough away to be unaffected by the antenna. We pursued this question at both the community and species level. Characteristics examined include total species richness and abundance, abundances of common bird species, and abundances of birds within selected foraging, nesting, migration, and habitat guilds. Our monitoring program included bird censuses over a five month period from May to September (1986-1993). Additional data were collected in both states during August and September of 1984 and during June of 1985. Research in Wisconsin was completed in 1989 (Hanowski et al. 1991) and in Michigan in 1993.

The Michigan transmitter began 150 amp tuning and testing intermittently in the first part of May 1989. On 14 May, the transmitter began continuous 150 amp operation for 16 hrs/day on weekdays and all day on weekends. On 7 October 1989, the Michigan transmitter began continuous operation at full power. Because of the manner in which the antenna was tested prior to becoming fully operational, we assigned bird census period and year(s) into levels of EM field exposure based on level (amps) at which the antenna was operated and the number of hours it was operated. Three exposure levels were identified for the spring migration and breeding season: 1986, 1987, 1988 = low amps and low hours, 1989 = high amps and low hours, and 1990, 1991, 1992, 1993 = operational (high amps and high hours). A fourth exposure period was identified for the fall migration period. Here we specified that 1988 was a medium amp and low hour exposure period.

To investigate possible effects of ELF EM fields, we analyzed changes in species abundances over time on treatment and reference segments using a repeated measures ANOVA. The repeated measures ANOVA incorporates data from all years and compares changes in abundance in bird parameters over time throughout the different EM field exposure periods. For this test, a significant interaction would indicate that changes in bird abundance over time were not equal in treatment and reference areas.

We recorded a total of 51,286 birds during the entire study, 27,212 on treatment and 26,774 on reference segments. A total of 140 species were observed over all years and seasons; 21 were counted only on reference and 5 only on treatment transects. No species observed either exclusively in reference or treatment areas was common in the study area in any season or year (from 1 to 7 total observations).

Numbers of individuals and species observed in all seasons have fluctuated annually. Annual variation in abundance was greatest during both migration periods, the time when birds are moving through the study areas. A significant interaction ($P < 0.03$) was found for both numbers of species and individuals during the fall migration period and for number of species during the spring migration period. Numbers of individuals and species observed during spring migration reflected patterns found during the breeding season; numbers were consistently higher in reference than in treatment study areas in all years. Although a significant interaction in number of species observed in the spring migration was found between reference and treatment study areas, the trend has been for numbers observed to converge over time. Numbers of species and individuals observed in reference areas during fall migration have fluctuated more widely than numbers observed in the treatment areas. Examination of abundance patterns over time for these community patterns did not indicate that changes were due to electromagnetic fields.

Three of nine tests of migration guild parameters (three types X three seasons) indicated a significant interaction ($P < 0.05$) in the repeated measure ANOVA. No consistent patterns emerged for any migration group across seasons nor were there patterns of change among treatment or reference areas over years that would suggest that differences detected were due to electromagnetic field exposure. For example, changes in numbers of long-distant migrants over years was not the same ($P < 0.01$) on reference and treatment transects during spring migration. A significant interaction ($P < 0.04$) was found for permanent resident species during the breeding season, and during fall migration, a difference ($P < 0.04$) in number of short distant migrants.

Examination of birds within five feeding guilds over three seasons (15 total tests) indicated only two significant interactions in changes in numbers over time within treatment and reference areas. Numbers of foliage insectivores have declined overall in both control and treatment areas during migration but have fluctuated more widely in treatment areas. Number of bark insect foraging species also showed a significant interaction ($P < 0.03$) in numbers over time during the breeding season, but in contrast overall numbers have increased in both reference and treatment areas from 1986 to 1993. Neither of these significant differences could be attributed to electromagnetic fields.

A small percentage of significant tests among nesting guilds was found (2 of 18). Number of birds that nest in cavities was consistently higher in reference than treatment areas over all years, but numbers in treatment areas fluctuated more over years, especially from 1990 to 1991. Overall numbers, however, have increased from 1986 to 1993 in both reference and treatment areas during the breeding season. Number of ground nesting birds observed during fall migration have declined in both reference and treatment areas over time, but numbers on treatment transects have fluctuated more widely during this time period than numbers counted in reference areas. Examination of abundance patterns over time for these groups did not suggest that changes were due to electromagnetic fields.

One of 18 tests among habitat guilds indicated that changes in abundance over time in treatment and reference areas differed. For this guild group, numbers of birds that prefer mixed forests showed a significant interaction ($P < 0.01$) during spring migration. Overall, numbers have declined in both treatment and reference areas from 1986 to 1993 but the magnitude of declines have been higher in reference than treatment areas. Again, this pattern does not suggest a negative electromagnetic field exposure affect.

Three of 38 species (8%) species tested in the spring migration season indicated a significant interaction in abundance over years ($P < 0.05$) between reference and treatment study areas. Patterns of species abundance over years in treatment and reference areas for these three species showed two different patterns. For one species, the Black-and-white Warbler, abundance in treatment and reference areas have tracked fairly well with treatment transects showing a slightly larger change in abundance over time. Abundance patterns for two species, the Rose-breasted Grosbeak and Song Sparrow varied considerably but not consistently in treatment and reference areas over years. For these species, however, abundance declined more in reference than in treatment areas from pre to post-impact years. Patterns of change in these species abundance over time do not indicate a negative affect of exposure to electromagnetic fields.

Three of 54 (5%) species tested indicated that change in abundance over years was significantly ($P < 0.05$) different between reference and treatment study areas in the breeding season. Patterns of changes in abundance for all three species; Red-breasted Nuthatch, Great Crested Flycatcher, and Chipping Sparrow have been highly variable in both treatment and reference areas over years. However, relative abundance patterns in pre-treatment years and in post-treatment years on treatment and reference areas have been fairly consistent. This suggests that electromagnetic fields had no negative impact on these bird species.

Six percent (2 of 33) species tested in the fall migration period indicated a significant difference ($P < 0.05$) in abundance over years in treatment and reference study areas. Abundance patterns for these species, Golden-crowned Kinglet and American Woodcock have declined more overall in treatment than reference study areas over years. The greatest decline in number for both species occurred prior to the antenna becoming fully operational. Patterns of change on treatment and reference transects abundance patterns have been similar since 1990.

No consistent patterns were evident to demonstrate that changes in bird abundance differ between treatment relative to reference segments in Michigan after the antenna became operational. No significant interactions found at the community or species level were consistent in subsequent seasons. In addition, interactions in guild or individual species abundance patterns that existed between treatment and reference areas in any season were not repeated in subsequent seasons. Number of significant interactions found at many levels of the analyses were not greater than the number expected by chance alone and were unlikely attributable to electromagnetic fields.

# INTRODUCTION

Effects of exposure to extremely low frequency (ELF) electromagnetic (EM) fields (other than the earth's), and the mechanisms by which bird behavior, reproduction, or migration may be affected by exposure are largely unknown (National Academy of Sciences 1977; Lee et al. 1979). Some birds are known to be able to detect slight changes in magnetic fields (Semm and Beason 1990) and use the earth's magnetic field for orientation during migration (Wiltschko and Wiltschko 1988). An ability to detect ELF electric or magnetic fields does not, however, imply an adverse biological effect (American Institute of Biological Sciences 1985). Data obtained from laboratory studies suggest that ELF EM fields may affect animals either by covert biochemical or physiological changes that may alter chances of survival (e.g., mutations, changes in hormone or enzyme levels), or overt behavioral responses resulting from detection and reaction to ELF EM fields (American Institute of Biological Sciences 1985). Most previous field investigations have attempted to document overt behavioral responses resulting from the combined effects of habitat alteration and EM fields and to determine how those responses may affect the structure and composition of bird communities (Anderson et al. 1977; Anderson 1979; Meyers and Provost 1979; Stapleton and Kiviat 1979; Bell 1980; Bramble et al. 1984; Niemi and Hanowski 1984). Others have focused on effects of rights-of-way (ROW) (Chasko and Gates 1982; Kroodsma 1982), on collision with lines and structures (Avery et al. 1980), and on audible noise generated by a transmission line (Lee and Griffith 1978). To our knowledge, our recently completed study on effects on birds of EM fields produced by the US Navy's ELF transmission facility in Wisconsin (Hanowski et al. 1991), was the first that attempted to separate effects of EM fields on bird species and communities from effects due to habitat changes along the ROW. That study produced no convincing evidence that birds were either attracted to or repelled by EM fields produced by the antenna.

Our investigations in Michigan and Wisconsin (Hanowski et al. 1993) were designed to isolate effects of EM fields produced by ELF antenna systems on bird species breeding in or migrating through northern Wisconsin and northern Michigan. Our goal was to determine if distribution and abundance of bird species differed between areas that were close to the antenna and those that were far enough away to be unaffected by EM fields produced by the antenna. Our study included periods during spring migration (May), breeding season (June and July), and fall migration (August and September). Potential effects of the ELF antenna on birds may vary among seasons. During migration, birds may be present on study areas for only brief periods. Conversely, breeding birds remain on territories longer (1-3 months), increasing their exposure to EM fields.

To assess effects of the ELF antenna on bird communities we can either: (1) compare the affected area (treatment) with a similar reference area; or (2) conduct a before-and-after study on both reference and treatment plots. The former approach was used in Wisconsin because the antenna already was in operation at the start of our study. Research in Michigan was, in contrast, initiated before the antenna began full operation. By following changes in bird numbers over time on areas affected by the antenna and on unaffected areas, we can separate effects of the antenna on birds from effects of more regional variables (e.g., annual variation in rainfall) and from effects arising from differences in vegetation structure between reference and treatment areas. In the following we summarize our research activities in Michigan where data have been collected for eight years during the spring and fall migration and breeding seasons.

## METHODS

***Study areas.*** Starting points and direction of travel along five treatment and five reference transects were randomly determined (see Hanowski et al. 1990) (Figure 1). Each 4.35 km transect was divided into eight 500 m segments each separated by a 50 m buffer (total N = 40 in each reference and treatment group). The 50 m buffer was included to assure that adjacent segments were independent.

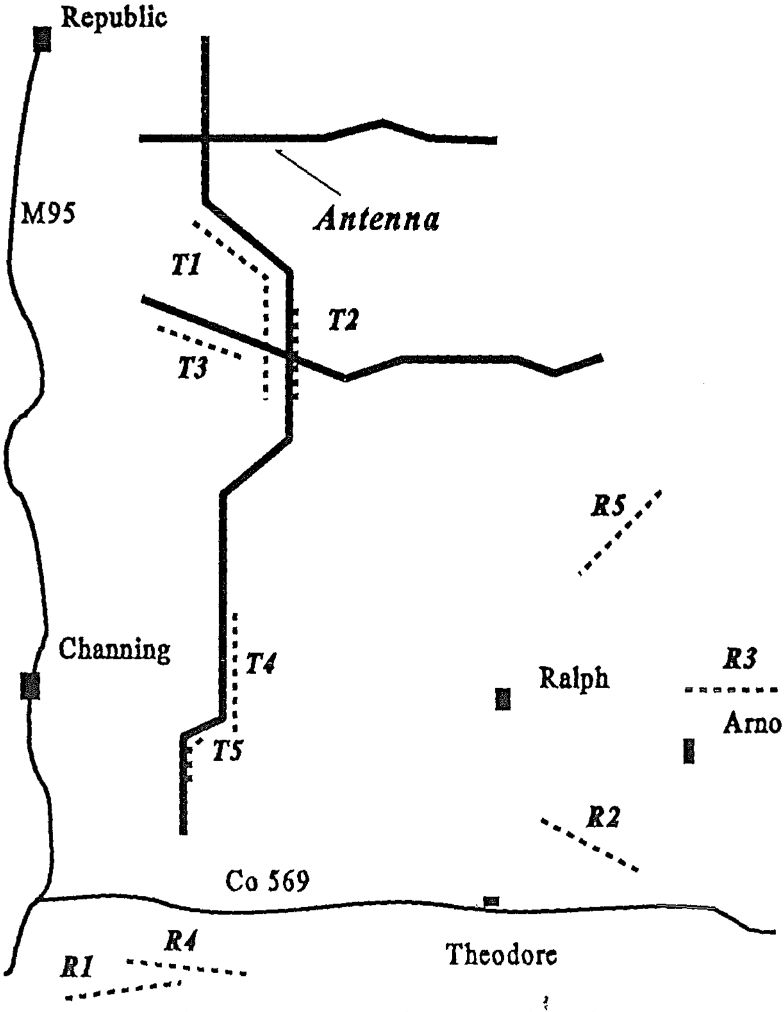

**Figure 1.** Location of reference (R1 to R5) and treatment (T1 to T5) transects in Michigan.

Spatial autocorrelation tests (Moran's I statistic; Sokal and Oden 1978) indicated that a 50 m buffer was sufficient for considering each 500 m segment as an independent experimental unit (Hanowski et al. 1990). Treatment transects were placed 125 m away from and parallel to the antenna ROW to reduce possible edge effects; the ROW was not sampled. Reference transects were located more than 10 km from the antenna where EM field magnitudes were at least an order of magnitude lower than the treatment sites.

Some 500 m transect segments in Michigan have been partially logged since this study started. The Michigan Department of Natural Resources agreed to delay most additional logging until 1994. Analyses of annual variation in bird community composition revealed that segments logged <20% of their total length showed no greater difference in bird populations between years than did unlogged sites. Segments that were logged > 20% of their length showed significantly greater differences in bird species composition between years than did unlogged segments. Consequently, our analyses of bird distribution patterns between years omits segments logged over more than 20% of their length. Sample sizes used in final analyses were 36 reference transects and 33 treatment transects.

***EM Fields.*** EM fields were measured at the beginning, at some intermediate points, and at the end of each 500 m segment by IIT Research Institute engineers (Haradem et al. 1989). EM fields produced by the ELF communication system include: (1) essentially identical air and earth magnetic fields generated by the electrical current in the antenna and ground terminals; (2) an electric field in the earth that is the sum of the fields induced by the magnetic field and the current from the buried ground terminals; and (3) an electric field in the air that is produced as a result of the difference in potential between the antenna element and the earth (Haradem et al. 1989). All possible reference-treatment pairs (each combination of individual 500 m transects) were required to meet EM exposure criteria that assured that 76 Hz EM fields at treatment sites were at least an order of magnitude higher than those at reference sites. In addition, to isolate effects of 76 Hz fields from those of 60 Hz fields (i.e., regular power distribution utilities), 76 Hz field intensities at treatment sites had to be at least an order of magnitude greater than EM fields produced by 60 Hz powerlines at both treatment and reference sites. Moreover, 60 Hz fields between reference and treatment sites could not be significantly different (Haradem et al. 1989).

We assigned bird census period and year(s) into three levels of EM exposure based on levels at which the antenna was operated (Figure 2) and the number of hours it was operated (Figure 3). Three exposure levels were identified for the spring migration and breeding seasons: 1986, 1987, 1988 = low amps and low hours, 1989 = high amps and low hours, and 1990, 1991, 1992, 1993 = operational phase. A fourth exposure period was identified for the fall migration season. Here we specified 1988 as a medium amp and low hour exposure period. We also calculated the number of times the antenna was turned on and off in each season and year (Figure 4).

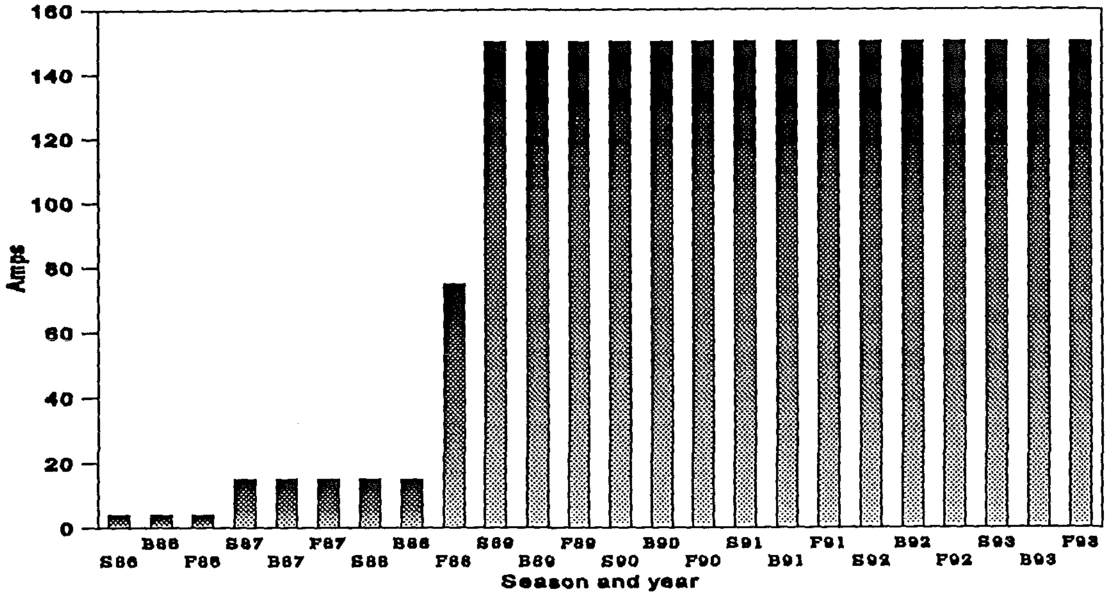

**Figure 2.** Number of amps the antenna was operated during spring (S), breeding (B), and fall migration (F) periods from 1986 to 1993.

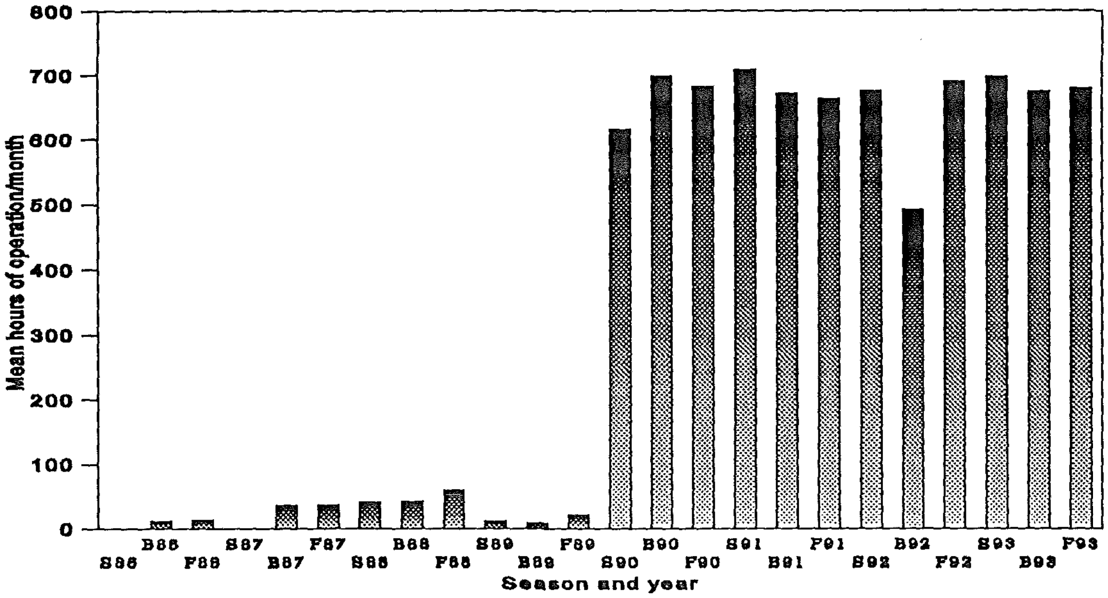

**Figure 3.** Mean number of hours the antenna was operated during spring (S), breeding (B), and fall migration (F) periods from 1986 to 1993.

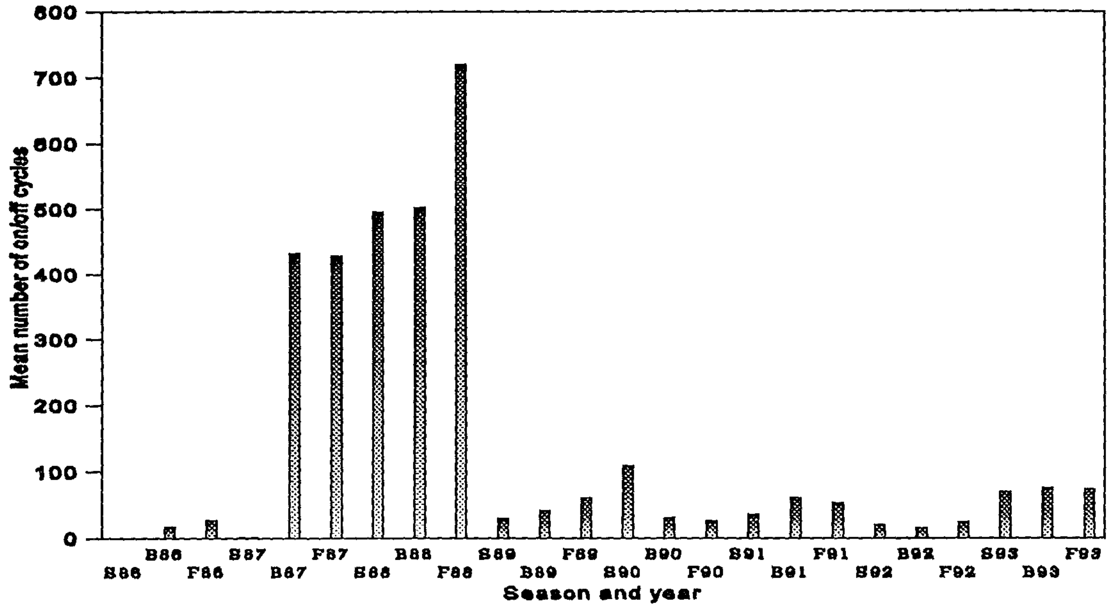

**Figure 4.** Mean number of times the antenna was cycled during spring (S), breeding (B), and fall migration (F) periods from 1986 to 1993.

***Bird counts.*** We counted birds on line transects (Järvinen and Väisänen 1975; Hanowski et al. 1990) five times each year (May through September 1986-1993). Censusing was completed between 0.5 hr before and 4.5 hrs after sunrise on days with little wind (< 15 km/hr) and no precipitation. Reference and treatment transects were sampled simultaneously by each of two observers to control for possible temporal variation in bird activity between areas. All observers were experienced in the identification of birds by sight and sound; training sessions were conducted prior to censusing to standardize recording methods. Each observer walked at a rate of 1 km/hr and recorded the identity for each bird detected and its location along and perpendicular to the transect (up to 100 m from the transect center line). Birds flying over the canopy were not counted.

We used the maximum number of individuals for each species observed during two breeding (June and July) and two fall migration counts (August and September) along each transect in all data analyses instead of attempting to calculate a density value for each species. We considered the May census as spring migration. With this method we attempted to record the maximum number of breeding or migrating individuals to partially control for annual differences in phenology of breeding or migration seasons. For example, if two Ovenbirds were counted on one transect in

June and three were observed in July, we used three in the data analysis for that transect segment for the breeding period.

Density could be calculated with a variety of formulae (Emlen 1971, 1977; Järvinen and Väisänen 1975; Burnham et al. 1981; Buckland 1985), but there are several assumptions that must be met before these methods can be used. A critical assumption is that distances are measured accurately. These measurements are difficult to obtain when birds are heard but not seen; most bird recorded during counts were only heard. Without accurate distance estimates these methods do not provide valid density estimates. Hence, density estimates may provide an index that may be no better than the actual counts (Wilson and Bart 1985). In addition, absolute density calculations are not needed in most investigations, especially when comparisons of "relative density" are less costly and allow the investigator to meet the objectives of the experiment (see Verner 1985). Here, we assumed that number of birds recorded was related to bird density in an area (see Raphael 1987) and that bird detectability was similar between reference and treatment areas.

***Bird guilds.*** We classified each species by (1) nesting area, (2) food or foraging type, (3) breeding habitat preference, and (4) migration strategy (Appendix 1), using published sources (see Hanowski et al. 1993) and personal observations. Individual statistical tests were used to compare numbers of individuals within different guild groups between treatment and reference study areas.

***Statistical analyses.*** We used a repeated measures analysis of variance (ANOVA) to test for differences in bird abundance between reference and treatment transects within each season. This procedure is relevant when several measurements (e.g., multiple years) are taken on each experimental unit and the measurements are correlated. The test is essentially a multivariate technique which accounts for correlations among the dependent variables while testing for treatment effects (Freund et al. 1986). A two-factor repeated measures ANOVA was done. The between subject factor was area (treatment versus reference), the within subject factor was year (1986 to 1993), and the dependent variable was bird abundance. The two-way interaction of area-by-year was also included in the model. Multiple contrasts reflecting years of different levels of EM exposure (3 for the spring migration and breeding seasons and 6 for the fall migration period) were done for any parameter that showed an overall treatment by year interaction (see page 5 for definition of exposure periods).

Data were examined separately for each species (in each season), provided that at least five individuals were observed in any one year. At total of 54 species were tested in the breeding season, 38 in the spring migration period, and 33 species during fall migration. Because of differences in detectability of birds in different seasons, no between season comparisons were completed.

Annual differences and treatment effects were also examined for each season with repeated measures ANOVA for total number of species observed in a 500 m segment and total number of individuals observed in a 500 m segment. The same model used for individual species (two-factor repeated measures ANOVA, see above) was used for these tests. The only difference was that we used a univariate test for these tests, not the multivariate test that we used for individual species. We did this because we were able to meet assumptions of the univariate test for these variables, and when assumptions are met, it is more powerful than the multivariate test (Freund et al. 1986). All variables were examined for normality and homoscedasticity of variances prior to statistical analyses (Sokal and Rohlf 1981) and were transformed when necessary (e.g., logarithmic, square root) to reduce skewness, kurtosis, and heterogeneity of variances.

One assumption of repeated measures ANOVA (for multivariate test) is that dependent variables in the model have a multivariate normal distribution with a common covariance matrix across the between-subject effects (treatments) (Freund et al. 1986). However, if groups have relatively equal sample sizes, the analysis is insensitive to departures from this assumption (Hand and Taylor 1987). In addition, with the exception of independent sampling, assumptions become less important for larger sample sizes. We have used a large and almost equal sample size in our analyses, therefore we conducted the repeated measures ANOVA (only the multivariate test) on some species regardless of whether the homogeneity assumption was met (see LaTour and Miniard 1983). We do not report results from tests where the univariate test was significant if the sphericity assumption was violated.

We used SOLO power analysis (BMDP 1992) to calculate the power of a univariate repeated measures analysis of variance (treatment by year interaction). Coefficients of variation (CV's) were first calculated for each community, guild, and individual species parameters in each season. We then computed the power for the range of CV's for three levels of change (a 10%, 25%, and 50% difference) in the parameter of interest.

## RESULTS

The repeated measures analyses includes tests for differences among years, among treatments, and an interaction term. Interpretations of ELF effects in parameters tested here were based on significance of the interaction term. For this analysis we were not interested in whether bird abundance varied annually (year effect) or whether treatment and reference sites were different (treatment effect). Because we used a before-and-after design in this study, we were interested in determining whether bird abundance varied over time equally in treatment and reference areas. A significant interaction term (interaction effect) would indicate that a change in abundance pattern on treatment and reference areas was not the same over time (e.g., before-and-after the antenna was operated). To analyze potential differences in bird responses to exposure duration (amount of time the antenna was operated) and strength (number of amps), multiple contrasts were conducted for those bird parameters that showed a significant treatment by year interaction.

***Electromagnetic fields.*** Electric fields (76 Hz) measured in the earth were 0.99 mV/m (range 0.02 - 2.7 mV/m) on reference and 62.8 mV/m (range 21 - 112 mV/m) on treatment sites. Mean 76 Hz magnetic flux densities were 0.01 mG on reference (range 0.001 - 0.07 mG) and 2.9 mG on treatment sites (range 0.9 - 15.0 mG). Electric fields in the air (76 Hz) were not measurable on reference sites and were 0.16 mV/m on treatment sites (range 0.02 - 0.13 mV/m) (Haradem et al. 1993).

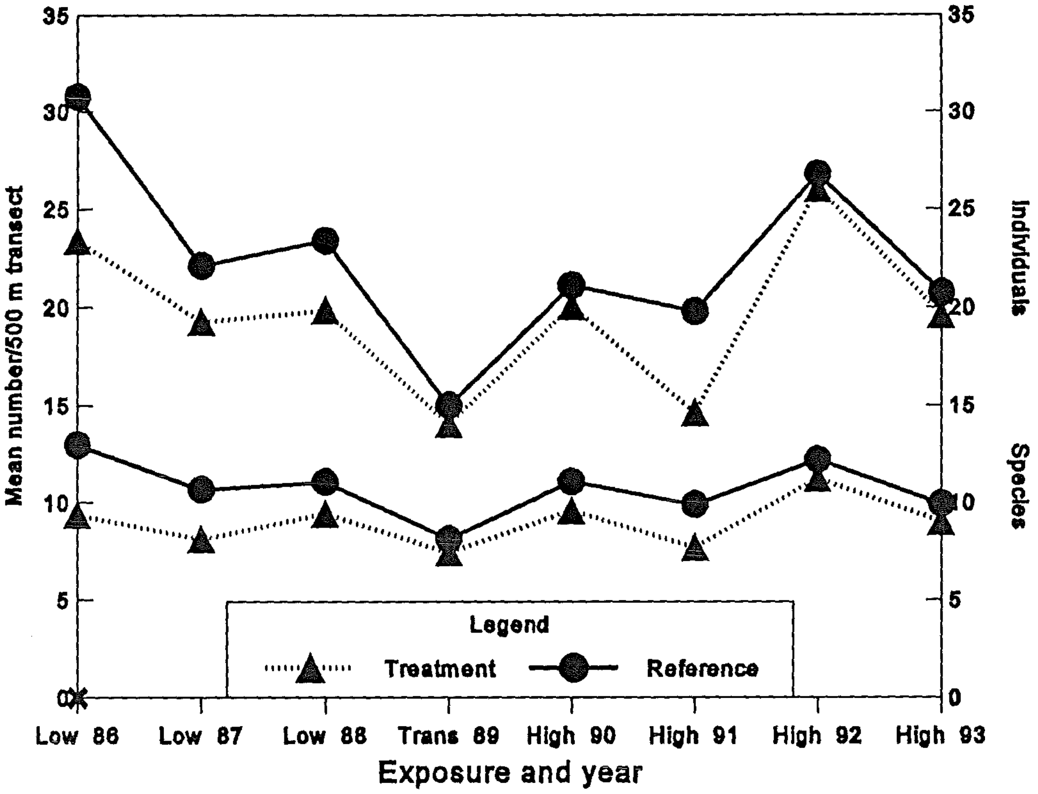

**Figure 5.** Mean number/500 m of individuals (top) and species (bottom) observed in treatment or reference study areas from 1986 to 1993 during the spring migration period.

***Community parameters.*** We recorded a total of 51,286 birds during the entire study, 27,212 on treatment and 26,774 on reference segments (Table 1, p 9). A total of 140 species were observed over all years and seasons; 21 were counted only on reference transects and 5 only on treatment transects (Appendix 2, 3, 4). Most species counted only on reference transects were those associated with small ponds or riparian areas (e.g., Great Blue Heron, Pied-billed Grebe, Wilson's Warbler (scientific names are in Appendix 1). Species observed either exclusively in reference or treatment areas were not common in the study area in any season or year (from 1 to 7 total observations in all years together).

Table 1. Total numbers of individuals and species observed in treatment (T) and reference (R) transects in Michigan, 1986-1993. A combined species total for treatment and reference segments is in parentheses.

| | | Spring Migration | | | Breeding | | | Fall Migration | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Parameter | Year | T | | R | T | | R | T | | R |
| Total individuals | 1986 | 949 | | 1210 | 1604 | | 1734 | 682 | | 978 |
| | 1987 | 775 | | 888 | 1776 | | 1850 | 1129 | | 936 |
| | 1988 | 815 | | 939 | 1494 | | 1538 | 882 | | 882 |
| | 1989 | 570 | | 607 | 1550 | | 1573 | 1122 | | 838 |
| | 1990 | 847 | | 858 | 1324 | | 1378 | 635 | | 741 |
| | 1991 | 578 | | 778 | 1371 | | 1557 | 1001 | | 901 |
| | 1992 | 1045 | | 1060 | 1638 | | 1700 | 741 | | 737 |
| | 1993 | 795 | | 836 | 1412 | | 1516 | 666 | | 739 |
| Total no. species | 1986 | 54 | (76) | 69 | 73 | (91) | 81 | 63 | (70) | 59 |
| | 1987 | 50 | (69) | 62 | 80 | (95) | 86 | 69 | (81) | 64 |
| | 1988 | 53 | (68) | 56 | 82 | (104) | 87 | 63 | (81) | 67 |
| | 1989 | 44 | (62) | 46 | 76 | (93) | 81 | 70 | (80) | 59 |
| | 1990 | 65 | (80) | 65 | 79 | (90) | 76 | 52 | (68) | 55 |
| | 1991 | 55 | (76) | 62 | 75 | (90) | 80 | 61 | (78) | 61 |
| | 1992 | 66 | (83) | 69 | 76 | (89) | 74 | 57 | (70) | 57 |
| | 1993 | 54 | (73) | 59 | 72 | (87) | 76 | 53 | (69) | 51 |

Numbers of individuals and species observed in all seasons have fluctuated annually. Annual variation in abundance was greatest during both migration periods, the time when birds are moving through the study areas (Figures 5, 6, 7: pgs 8, 10, 12). A significant interaction ($P < 0.03$) was found for both numbers of species and individuals during the fall migration period (Table 2, p 11). Although numbers observed in reference areas during fall migration have been fairly consistent over time, numbers observed on treatment transects have varied dramatically, being higher than reference areas in three years, lower in three years, and equal to reference in one year. An overall downward trend in numbers is evident in both areas. However, reference areas have shown a more negative trend than treatment areas (Figure 7).

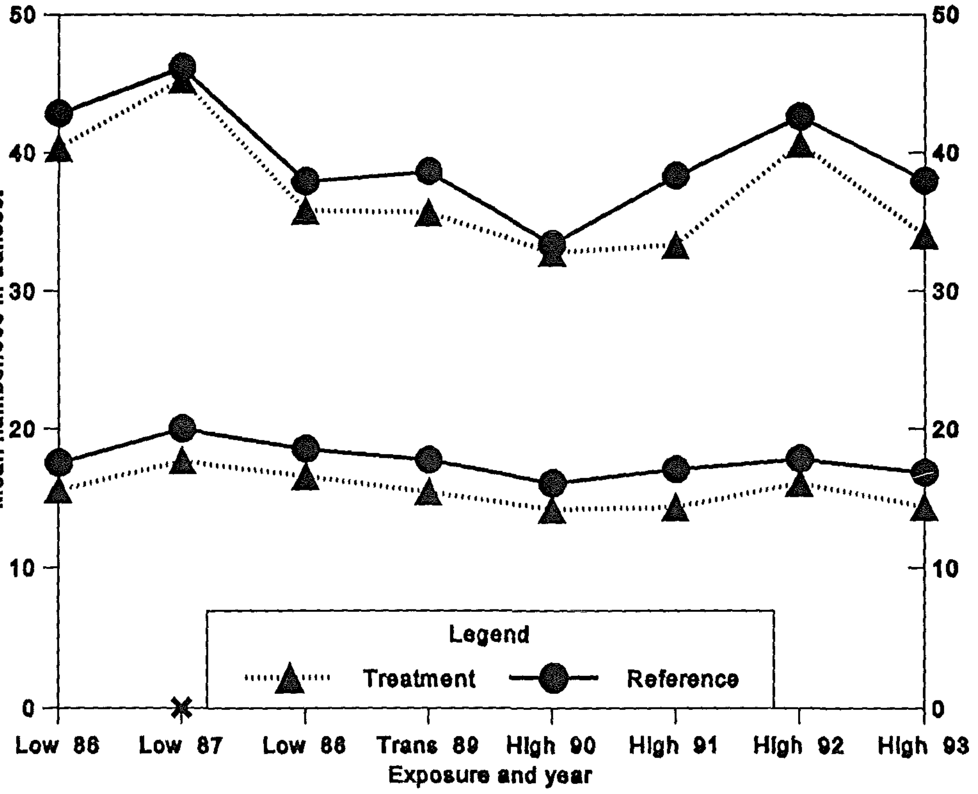

**Figure 6.** Number of individuals (top) and species observed/500 m transect on treatment and reference transects during the breeding season 1986 to 1993.

Number of individuals and species observed during spring migration were consistently higher in reference than in treatment study areas in all years (Figure 5). Although a significant interaction in number of species observed in the spring migration was found between reference and treatment study areas, the trend has been for number of species observed to converge over time (see Figure 5).

Table 2. Mean number (per 500 m transect) and standard error of total number of species and individuals. A significant interaction (repeated measures ANOVA) was found between reference and treatment for numbers of species in the spring and fall migration periods and for number of individuals in the fall migration period.

| | | Spring Migration | | | | Breeding | | | | Fall Migration | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Treatment | | Reference | | Treatment | | Reference | | Treatment | | Reference | |
| Parameter | Year | Mean | SE | Mean | SE | Mean | SE | Mean | SE | Mean | SE | Mean | SE |
| Total individuals | 1986 | 23.39 | 1.39 | 30.78 | 1.37 | 40.33 | 1.82 | 42.83 | 1.93 | 16.67 | 1.58 | 23.92 | 2.60 |
| | 1987 | 19.27 | 1.60 | 22.11 | 1.71 | 45.30 | 2.30 | 46.17 | 2.18 | 27.00 | 2.30 | 23.53 | 1.81 |
| | 1988 | 19.85 | 1.56 | 23.39 | 1.36 | 35.82 | 1.90 | 37.94 | 1.71 | 19.21 | 1.87 | 22.06 | 1.96 |
| | 1989 | 14.03 | 1.57 | 15.00 | 1.21 | 35.67 | 1.92 | 38.64 | 1.67 | 27.24 | 3.01 | 21.33 | 2.03 |
| | 1990 | 20.06 | 1.92 | 21.11 | 1.22 | 32.79 | 1.97 | 33.39 | 1.59 | 13.58 | 1.00 | 18.22 | 1.31 |
| | 1991 | 14.61 | 1.54 | 19.81 | 1.66 | 33.33 | 1.80 | 38.33 | 1.59 | 25.12 | 2.74 | 22.36 | 1.11 |
| | 1992 | 26.03 | 1.75 | 26.78 | 1.79 | 40.61 | 1.69 | 42.58 | 1.87 | 18.15 | 1.53 | 18.25 | 1.32 |
| | 1993 | 19.61 | 1.47 | 20.75 | 1.27 | 34.03 | 1.78 | 37.97 | 1.50 | 15.91 | 1.32 | 18.42 | 1.07 |
| Total no. species | 1986 | 9.36 | 0.49 | 12.97 | 0.61 | 15.58 | 0.73 | 17.53 | 0.83 | 7.42 | 0.66 | 9.33 | 0.65 |
| | 1987 | 8.09 | 0.59 | 10.67 | 0.58 | 17.70 | 0.96 | 20.03 | 0.93 | 10.36 | 0.79 | 9.92 | 0.69 |
| | 1988 | 9.42 | 0.58 | 11.06 | 0.59 | 16.58 | 0.85 | 18.56 | 0.81 | 8.24 | 0.53 | 9.25 | 0.73 |
| | 1989 | 7.42 | 0.67 | 8.11 | 0.55 | 15.45 | 0.73 | 17.75 | 0.90 | 10.18 | 0.87 | 9.33 | 0.54 |
| | 1990 | 9.58 | 0.76 | 11.08 | 0.62 | 14.18 | 0.69 | 16.08 | 0.67 | 7.12 | 0.50 | 8.89 | 0.55 |
| | 1991 | 7.67 | 0.76 | 9.89 | 0.73 | 14.33 | 0.79 | 17.06 | 0.78 | 8.91 | 0.74 | 10.17 | 0.49 |
| | 1992 | 11.24 | 0.59 | 12.22 | 0.75 | 16.06 | 0.76 | 17.83 | 0.76 | 8.03 | 0.63 | 8.03 | 0.50 |
| | 1993 | 9.00 | 0.59 | 9.92 | 0.57 | 14.36 | 0.78 | 16.83 | 0.76 | 6.58 | 0.57 | 7.25 | 0.46 |

***Guild parameters.*** Examination of birds within five feeding guilds over three seasons (15 total tests) indicated only two significant interactions in changes in numbers over time within treatment and reference areas (Table 3, p 13). Numbers of foliage insectivores have declined overall in both reference and treatment areas during fall migration, but have fluctuated more widely in treatment areas (Table 3, also Figure 18, p 33). Overall declines have been greater in magnitude on reference than on treatment transects over the years. Two contrasts were significant for this group, one between the low and transitional period and one between the transitional and high exposure periods. Number of bark insect foraging species also showed a significant interaction ($P < 0.03$) in numbers over time during the breeding season, but overall numbers have increased in both reference and treatment areas from 1986 to 1993 (Table 3; Figure 19, p 34). Contrasts for this measure indicated a difference between the low and high exposure periods.

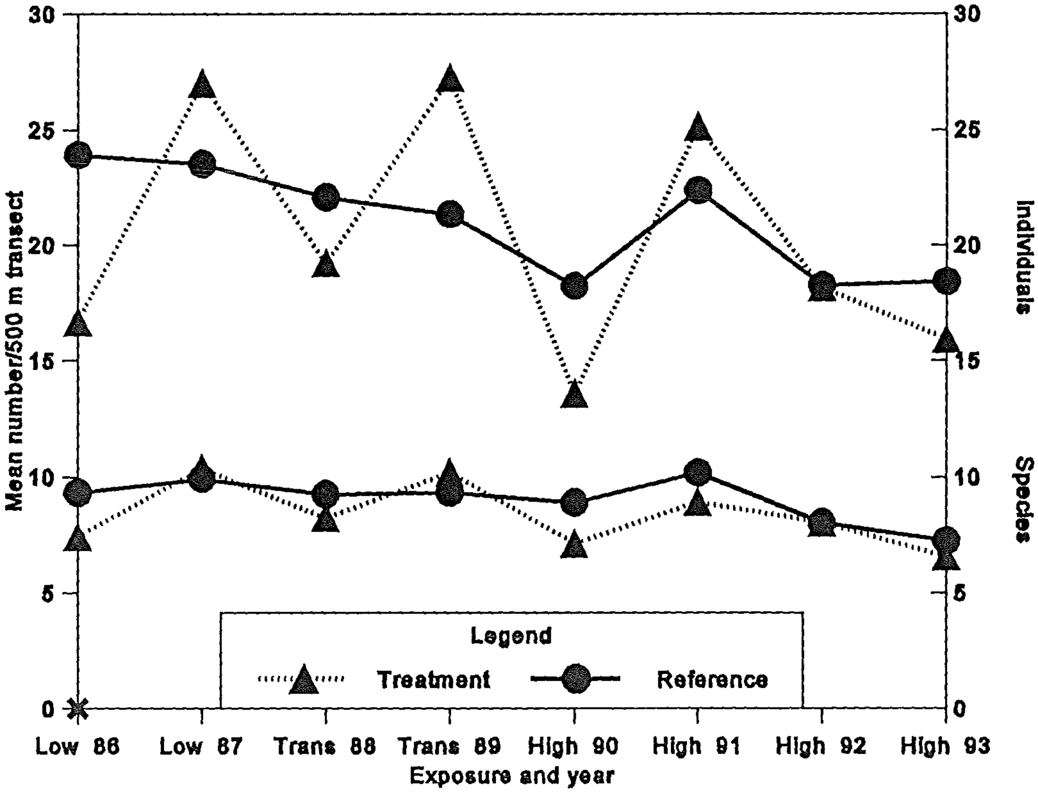

**Figure 7.** Number of individuals (top) and species observed/500 m transect on treatment and reference transects during the fall migration period 1986 to 1993.

Table 3 (continued)

| | | Spring Migration | | | |
|---|---|---|---|---|---|
| | | Treatment | | Reference | |
| Guild | Year | Mean | SE | Mean | SE |
| Mixed coniferous[S] and deciduous | 1986 | 2.91 | 0.41 | 4.81 | 0.59 |
| | 1987 | 1.52 | 0.25 | 3.22 | 0.58 |
| | 1988 | 2.27 | 0.32 | 2.69 | 0.45 |
| | 1989 | 1.82 | 0.30 | 1.42 | 0.27 |
| | 1990 | 2.58 | 0.45 | 3.19 | 0.46 |
| | 1991 | 1.18 | 0.20 | 3.17 | 0.56 |
| | 1992 | 3.27 | 0.43 | 3.36 | 0.40 |
| | 1993 | 2.27 | 0.36 | 2.83 | 0.44 |
| Permanent res.[B] | 1986 | 3.00 | 0.48 | 3.39 | 0.43 |
| | 1987 | 1.94 | 0.32 | 2.86 | 0.49 |
| | 1988 | 4.48 | 0.51 | 5.28 | 0.49 |
| | 1989 | 3.85 | 0.45 | 3.61 | 0.48 |
| | 1990 | 3.06 | 0.39 | 4.19 | 0.54 |
| | 1991 | 2.91 | 0.45 | 2.61 | 0.31 |
| | 1992 | 3.58 | 0.47 | 3.69 | 0.40 |
| | 1993 | 4.76 | 0.53 | 4.86 | 0.42 |

| Breeding | | | | Fall Migration | | | |
|---|---|---|---|---|---|---|---|
| Treatment | | Reference | | Treatment | | Reference | |
| Mean | SE | Mean | SE | Mean | SE | Mean | SE |
| 4.79 | 0.37 | 4.89 | 0.54 | 1.09 | 0.27 | 1.42 | 0.27 |
| 4.85 | 0.43 | 5.86 | 0.56 | 1.45 | 0.28 | 1.42 | 0.27 |
| 4.09 | 0.41 | 4.92 | 0.44 | 1.52 | 0.28 | 1.89 | 0.38 |
| 4.91 | 0.57 | 6.03 | 0.53 | 2.64 | 0.39 | 2.81 | 0.32 |
| 4.55 | 0.46 | 5.11 | 0.48 | 1.39 | 0.22 | 1.50 | 0.25 |
| 4.94 | 0.42 | 5.17 | 0.55 | 1.48 | 0.29 | 2.03 | 0.27 |
| 5.45 | 0.56 | 6.69 | 0.59 | 1.39 | 0.25 | 1.39 | 0.26 |
| 4.79 | 0.33 | 5.64 | 0.63 | 0.70 | 0.18 | 0.86 | 0.17 |
| 3.82 | 0.52 | 4.25 | 0.62 | 5.15 | 0.70 | 8.92 | 1.11 |
| 5.03 | 0.61 | 7.28 | 0.81 | 9.67 | 0.94 | 10.36 | 0.83 |
| 3.58 | 0.51 | 5.69 | 0.75 | 7.97 | 1.46 | 8.19 | 0.99 |
| 3.85 | 0.51 | 4.69 | 0.47 | 11.24 | 1.74 | 8.64 | 1.07 |
| 4.97 | 0.71 | 3.86 | 0.48 | 5.42 | 0.57 | 7.00 | 0.69 |
| 3.79 | 0.58 | 4.92 | 0.54 | 10.36 | 1.15 | 8.64 | 0.80 |
| 7.39 | 1.09 | 6.25 | 0.77 | 7.39 | 0.68 | 7.69 | 0.66 |
| 5.09 | 0.68 | 5.31 | 0.53 | 6.42 | 0.75 | 7.28 | 0.63 |

Table 3. Mean number (per 500 m transect) and standard error of individuals in habitat, nest, migration, and foraging guilds that showed a significant interaction in abundance over years (repeated measures ANOVA) between treatment and reference. Superscript letters indicate season where a difference was detected (S=spring migration, B=breeding, F=fall migration).

| | | Spring Migration | | | | Breeding | | | | Fall Migration | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Treatment | | Reference | | Treatment | | Reference | | Treatment | | Reference | |
| Guild | Year | Mean | SE | Mean | SE | Mean | SE | Mean | SE | Mean | SE | Mean | SE |
| Foliage insects$^F$ | 1986 | 13.27 | 1.09 | 16.44 | 0.72 | 21.88 | 0.97 | 23.03 | 1.01 | 6.79 | 0.82 | 10.94 | 2.19 |
| | 1987 | 10.39 | 1.15 | 10.42 | 1.02 | 24.55 | 1.44 | 22.97 | 1.07 | 10.58 | 1.38 | 8.92 | 1.02 |
| | 1988 | 8.00 | 0.94 | 9.11 | 0.90 | 20.06 | 1.02 | 19.58 | 1.12 | 7.18 | 0.91 | 8.72 | 0.86 |
| | 1989 | 5.48 | 0.76 | 5.39 | 0.59 | 19.30 | 1.05 | 20.72 | 0.94 | 10.55 | 1.11 | 8.94 | 1.06 |
| | 1990 | 11.15 | 1.15 | 10.42 | 0.76 | 17.97 | 1.09 | 18.86 | 1.09 | 6.24 | 0.67 | 8.28 | 0.88 |
| | 1991 | 8.39 | 1.02 | 10.22 | 1.24 | 20.15 | 1.04 | 22.44 | 1.14 | 6.94 | 0.71 | 6.94 | 0.44 |
| | 1992 | 16.12 | 1.14 | 15.81 | 0.97 | 25.06 | 1.25 | 25.11 | 1.01 | 5.88 | 0.52 | 6.31 | 0.63 |
| | 1993 | 8.45 | 0.70 | 10.00 | 0.97 | 21.15 | 0.97 | 23.69 | 1.31 | 4.82 | 0.49 | 6.11 | 0.65 |
| Bark insects$^B$ | 1986 | 1.21 | 0.21 | 1.78 | 0.28 | 1.30 | 0.22 | 1.94 | 0.28 | 1.58 | 0.30 | 2.69 | 0.43 |
| | 1987 | 0.48 | 0.12 | 1.14 | 0.24 | 1.94 | 0.30 | 3.14 | 0.44 | 3.21 | 0.54 | 4.08 | 0.55 |
| | 1988 | 1.45 | 0.20 | 2.14 | 0.42 | 1.36 | 0.26 | 3.22 | 0.40 | 2.64 | 0.41 | 3.53 | 0.52 |
| | 1989 | 0.88 | 0.20 | 1.61 | 0.25 | 1.61 | 0.24 | 2.25 | 0.29 | 3.88 | 0.74 | 3.42 | 0.46 |
| | 1990 | 1.42 | 0.28 | 2.03 | 0.28 | 1.85 | 0.30 | 1.81 | 0.25 | 1.36 | 0.22 | 2.03 | 0.29 |
| | 1991 | 0.67 | 0.14 | 1.78 | 0.33 | 1.33 | 0.28 | 2.03 | 0.33 | 3.76 | 0.57 | 3.25 | 0.39 |
| | 1992 | 1.76 | 0.29 | 2.00 | 0.28 | 2.91 | 0.39 | 3.17 | 0.48 | 3.21 | 0.50 | 3.36 | 0.43 |
| | 1993 | 1.52 | 0.30 | 1.92 | 0.29 | 2.03 | 0.35 | 2.39 | 0.33 | 2.36 | 0.32 | 2.72 | 0.32 |

Table 3 (continued)

| | | Spring Migration | | | |
|---|---|---|---|---|---|
| | | Treatment | | Reference | |
| Guild | Year | Mean | SE | Mean | SE |
| Short-distance migrants[F] | 1986 | 9.39 | 0.83 | 11.33 | 1.11 |
| | 1987 | 10.33 | 1.16 | 11.25 | 1.19 |
| | 1988 | 11.73 | 1.20 | 13.22 | 1.07 |
| | 1989 | 9.94 | 1.29 | 11.03 | 1.02 |
| | 1990 | 8.45 | 1.04 | 8.64 | 0.84 |
| | 1991 | 7.36 | 0.95 | 9.22 | 0.89 |
| | 1992 | 8.45 | 1.10 | 8.19 | 0.86 |
| | 1993 | 10.03 | 1.23 | 10.03 | 0.87 |
| Long-distance migrants[S] | 1986 | 10.48 | 0.88 | 15.44 | 0.87 |
| | 1987 | 6.33 | 0.74 | 7.03 | 0.75 |
| | 1988 | 2.70 | 0.44 | 4.14 | 0.51 |
| | 1989 | 0.03 | 0.03 | 0.22 | 0.07 |
| | 1990 | 8.15 | 1.08 | 7.44 | 0.64 |
| | 1991 | 4.06 | 0.86 | 7.75 | 1.54 |
| | 1992 | 13.27 | 1.45 | 14.08 | 1.40 |
| | 1993 | 3.55 | 0.59 | 4.47 | 0.91 |

| Breeding | | | | Fall Migration | | | |
|---|---|---|---|---|---|---|---|
| Treatment | | Reference | | Treatment | | Reference | |
| Mean | SE | Mean | SE | Mean | SE | Mean | SE |
| 11.97 | 1.20 | 11.75 | 1.40 | 6.58 | 0.88 | 7.42 | 1.00 |
| 14.09 | 1.78 | 13.28 | 1.32 | 10.61 | 1.57 | 6.83 | 0.89 |
| 11.36 | 1.08 | 10.67 | 0.91 | 6.36 | 0.82 | 6.69 | 0.94 |
| 11.24 | 1.22 | 11.14 | 1.23 | 9.15 | 1.49 | 6.11 | 0.85 |
| 9.30 | 0.98 | 8.97 | 1.00 | 3.58 | 0.58 | 4.67 | 0.70 |
| 9.64 | 0.90 | 10.72 | 1.08 | 4.55 | 0.66 | 5.61 | 0.57 |
| 9.82 | 0.94 | 10.14 | 0.89 | 4.73 | 0.79 | 3.94 | 0.60 |
| 9.33 | 1.13 | 11.69 | 1.09 | 3.21 | 0.57 | 3.36 | 0.41 |
| 23.03 | 1.18 | 25.19 | 1.19 | 2.76 | 0.59 | 4.97 | 1.11 |
| 24.09 | 1.47 | 23.61 | 1.26 | 3.30 | 0.52 | 3.58 | 0.69 |
| 19.76 | 1.17 | 20.42 | 1.24 | 2.36 | 0.34 | 4.39 | 0.60 |
| 19.55 | 1.28 | 21.89 | 1.18 | 4.70 | 0.79 | 4.72 | 0.59 |
| 17.73 | 1.46 | 19.83 | 1.21 | 3.33 | 0.44 | 4.81 | 0.54 |
| 19.15 | 1.02 | 21.97 | 1.34 | 3.82 | 0.55 | 4.06 | 0.36 |
| 22.61 | 1.27 | 25.33 | 1.26 | 2.85 | 0.42 | 3.28 | 0.48 |
| 18.82 | 0.98 | 20.44 | 1.24 | 1.76 | 0.30 | 2.67 | 0.37 |

Table 3 (continued)

| | | Spring Migration | | | |
|---|---|---|---|---|---|
| | | Treatment | | Reference | |
| Guild | Year | Mean | SE | Mean | SE |
| Ground nest[F] | 1986 | 10.82 | 1.05 | 12.39 | 0.86 |
| | 1987 | 9.06 | 1.07 | 7.33 | 0.62 |
| | 1988 | 5.76 | 0.75 | 6.81 | 0.71 |
| | 1989 | 3.64 | 0.65 | 2.83 | 0.38 |
| | 1990 | 8.82 | 1.30 | 7.14 | 0.72 |
| | 1991 | 5.58 | 0.86 | 6.22 | 0.79 |
| | 1992 | 11.18 | 1.16 | 10.28 | 0.81 |
| | 1993 | 6.67 | 0.88 | 6.11 | 0.63 |
| Cavity nest[B] | 1986 | 2.48 | 0.32 | 3.53 | 0.60 |
| | 1987 | 1.88 | 0.29 | 3.81 | 0.59 |
| | 1988 | 4.73 | 0.41 | 6.64 | 0.73 |
| | 1989 | 3.94 | 0.56 | 5.61 | 0.50 |
| | 1990 | 2.91 | 0.38 | 4.50 | 0.45 |
| | 1991 | 2.94 | 0.39 | 4.19 | 0.57 |
| | 1992 | 3.24 | 0.43 | 4.58 | 0.49 |
| | 1993 | 4.64 | 0.49 | 5.31 | 0.51 |

| Breeding | | | | Fall Migration | | | |
|---|---|---|---|---|---|---|---|
| Treatment | | Reference | | Treatment | | Reference | |
| Mean | SE | Mean | SE | Mean | SE | Mean | SE |
| 17.36 | 1.22 | 14.47 | 1.08 | 3.24 | 0.56 | 4.33 | 0.87 |
| 18.27 | 1.20 | 14.67 | 0.95 | 4.70 | 0.86 | 2.47 | 0.46 |
| 14.79 | 1.04 | 13.53 | 0.98 | 3.52 | 0.49 | 3.42 | 0.43 |
| 16.21 | 1.23 | 15.11 | 0.92 | 6.21 | 1.21 | 3.44 | 0.42 |
| 13.30 | 1.12 | 11.61 | 0.84 | 2.06 | 0.30 | 2.83 | 0.39 |
| 13.97 | 1.17 | 13.31 | 0.83 | 3.21 | 0.46 | 3.39 | 0.40 |
| 15.09 | 0.90 | 15.00 | 0.84 | 2.27 | 0.38 | 2.03 | 0.36 |
| 14.97 | 1.04 | 13.03 | 0.76 | 1.06 | 0.22 | 1.33 | 0.21 |
| 4.36 | 0.51 | 5.03 | 0.59 | 5.03 | 0.72 | 8.42 | 1.12 |
| 4.45 | 0.53 | 8.47 | 0.91 | 7.82 | 0.89 | 10.03 | 1.01 |
| 3.70 | 0.56 | 6.31 | 0.70 | 6.24 | 0.66 | 8.47 | 0.99 |
| 3.12 | 0.36 | 5.39 | 0.43 | 8.85 | 1.17 | 8.22 | 1.07 |
| 4.18 | 0.66 | 4.28 | 0.46 | 4.09 | 0.51 | 5.97 | 0.58 |
| 3.67 | 0.56 | 5.25 | 0.51 | 7.73 | 0.91 | 7.61 | 0.66 |
| 6.36 | 0.69 | 7.33 | 0.87 | 6.88 | 0.67 | 7.97 | 0.68 |
| 4.52 | 0.62 | 5.75 | 0.58 | 6.33 | 0.70 | 7.39 | 0.67 |

One of 18 tests among habitat guilds indicated that changes in abundance over time in treatment and reference areas differed (Table 3; Figure 17, p 31). For this guild group, numbers of birds that prefer mixed forests showed a significant interaction ($P < 0.01$) during spring migration. Overall, numbers have declined in both treatment and reference areas from 1986 to 1993 but the magnitude of declines have been higher in reference than treatment areas (Table 3). A significant contrast was detected between the low and transitional exposure periods.

Three of nine tests of migration guild parameters (three types X three seasons) indicated a significant interaction ($P < 0.05$) in the repeated measure ANOVA (Table 3). No consistent patterns emerged for any migration group across seasons. For example, changes in numbers of long-distant migrants over years was not the same ($P < 0.01$) on reference and treatment transects during spring migration (Figure 17). Significant interactions ($P < 0.04$) were found for permanent resident species during the breeding season (Figure 19). During fall migration, a significant interaction was found for number of short distant migrants ($P < 0.04$) (Figure 18). Significant contrasts were detected for short distance migrants between the low and high exposure years and between the transitional and high exposure periods.

A small percentage of significant tests among nesting guilds was found (2 of 18) (Table 3). Number of birds that nest in cavities were consistently higher in reference than treatment areas over all years (Figure 19). However, numbers in treatment areas fluctuated more over years than numbers in reference areas, especially from 1990 to 1991 (Table 3). Overall numbers, however, have increased from 1986 to 1993 in both reference and treatment areas during the breeding season. Number of ground nesting birds observed during fall migration have declined in both reference and treatment areas over time, but numbers on treatment transects have fluctuated more widely during this time period than numbers counted in reference areas (Table 3). A significant contrast was detected for ground nesting birds between the transitional and high exposure years (Figure 18).

***Individual species.*** Three of 38 species (8%) tested in the spring migration season indicated a significant interaction in abundance over years ($P < 0.05$) between reference and treatment study areas (Table 4, p 18). Patterns of species abundance over years in treatment and reference areas for these three species showed two different patterns. For one species, the Black-and-white Warbler abundance in treatment and reference areas have varied similarly over time (Figure 8, p 23). Abundance patterns for two species, the Rose-breasted Grosbeak (Figure 9, p 23) and Song Sparrow (Figure 10, p 24) varied considerably but not consistently in treatment and reference areas over years (Table 4). For these species, however the number observed has declined more in reference than in treatment areas from pre to post-impact years. Two significant contrasts were observed for the Black-and-white Warbler, one between the low and transitional impact periods, and the other between the transitional and high impact years. The Rose-breasted Grosbeak indicated a significant difference in change in abundance between treatment and reference from the low to transitional years.

Table 4. Mean number (per 500 m transect) and standard error of species that showed a significant interaction in abundance over years (repeated measures ANOVA) between treatment and reference. Superscript letter indicates season where significant difference was found (S=spring migration, B=breeding, F=fall migration).

| | | Spring Migration | | | | Breeding | | | | Fall Migration | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Treatment | | Reference | | Treatment | | Reference | | Treatment | | Reference | |
| Parameter | Year | Mean | SE | Mean | SE | Mean | SE | Mean | SE | Mean | SE | Mean | SE |
| Great Crested Flycatcher$^{B}$ | 1986 | 0.09 | 0.05 | 0.17 | 0.07 | 0.39 | 0.11 | 0.72 | 0.13 | 0.06 | 0.04 | 0.08 | 0.05 |
| | 1987 | 0.00 | 0.00 | 0.06 | 0.04 | 0.39 | 0.13 | 0.92 | 0.17 | 0.06 | 0.06 | 0.08 | 0.05 |
| | 1988 | 0.03 | 0.03 | 0.19 | 0.08 | 0.33 | 0.09 | 0.56 | 0.15 | 0.03 | 0.03 | 0.06 | 0.04 |
| | 1989 | 0.00 | 0.00 | 0.06 | 0.04 | 0.12 | 0.06 | 0.78 | 0.14 | 0.03 | 0.03 | 0.06 | 0.06 |
| | 1990 | 0.09 | 0.05 | 0.19 | 0.07 | 0.12 | 0.07 | 0.53 | 0.14 | 0.00 | 0.00 | 0.03 | 0.03 |
| | 1991 | 0.03 | 0.03 | 0.11 | 0.05 | 0.39 | 0.14 | 0.39 | 0.11 | 0.03 | 0.03 | 0.19 | 0.07 |
| | 1992 | 0.06 | 0.04 | 0.25 | 0.10 | 0.18 | 0.07 | 0.64 | 0.16 | 0.03 | 0.03 | 0.14 | 0.07 |
| | 1993 | 0.03 | 0.03 | 0.06 | 0.04 | 0.30 | 0.10 | 0.36 | 0.10 | 0.00 | 0.00 | 0.14 | 0.06 |
| American Woodcock$^{F}$ | 1986 | 0.06 | 0.04 | 0.00 | 0.00 | 0.06 | 0.04 | 0.17 | 0.09 | 0.12 | 0.07 | 0.00 | 0.00 |
| | 1987 | 0.00 | 0.00 | 0.03 | 0.03 | 0.12 | 0.09 | 0.28 | 0.14 | 0.18 | 0.08 | 0.08 | 0.05 |
| | 1988 | 0.00 | 0.00 | 0.00 | 0.00 | 0.12 | 0.06 | 0.11 | 0.05 | 0.36 | 0.16 | 0.03 | 0.03 |
| | 1989 | 0.03 | 0.03 | 0.03 | 0.03 | 0.15 | 0.09 | 0.08 | 0.06 | 0.21 | 0.08 | 0.14 | 0.07 |
| | 1990 | 0.12 | 0.07 | 0.03 | 0.03 | 0.09 | 0.07 | 0.00 | 0.00 | 0.06 | 0.04 | 0.08 | 0.05 |
| | 1991 | 0.03 | 0.03 | 0.00 | 0.00 | 0.06 | 0.04 | 0.17 | 0.08 | 0.03 | 0.03 | 0.08 | 0.05 |
| | 1992 | 0.00 | 0.00 | 0.08 | 0.06 | 0.03 | 0.03 | 0.06 | 0.04 | 0.06 | 0.04 | 0.03 | 0.03 |
| | 1993 | 0.06 | 0.04 | 0.00 | 0.00 | 0.12 | 0.09 | 0.03 | 0.03 | 0.03 | 0.03 | 0.11 | 0.05 |