Gmail

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Fw: Your Paper on Radio Towers and their hazards to birds

1 message

Jim McMahon <jim_mcmahon_iii@yahoo.com> Thu, Oct 17, 2024 at 6:56 AM
To: "rwgriffitts3@gmail.com" <rwgriffitts3@gmail.com>, "C. T. Martin" <ctmagnetics@aol.com>, Rex Greenslade <greensladerex@gmail.com>, Mark Snyder <snyderhtp@outlook.com>, Marilyn Morehead <morehead.m@gmail.com>, "careycuddeback@gmail.com" <careycuddeback@gmail.com>, Matt Cunningham <trustee2@hayestownshipmi.gov>
Cc: Kristin Baranski <clerk@hayestownshipmi.gov>, Kevin Willis <kwillisc@yahoo.com>

Dear Planning Commission members,

In the mid-2000's, Hayes Township contracted with Michigan Technology University to do some investigation of wind generators and to create a draft ordinance for this technology. The contract was for a somewhat nominal fee. I was the liaison with the university professor and engineering students who worked on this project. This university team visited Hayes Township and met with the township board. A draft ordinance was created, along with their findings, for wind generators. I have looked in my personal files and was unable to locate their work. Perhaps, their completed investigation and work have been stored with the township files.

Many issues were investigated such as setbacks, heights, test wind towers, structure lighting, noise, and bird kill. The university also looked at zoning language in neighboring Wisconsin. Again, a draft ordinance for wind generators was created and reviewed by the Hayes Township attorney. This was preliminary to the final ordinance development. Some of their language was incorporated into the township's ordinance.

Additionally, I had some communication with the State of Michigan regarding towers and bird kill. Attached is an email communication from me to a PhD staff member who had done extensive field research on this important matter. Please refer to the attached email and its attachments.

Here are the five points that I mentioned in the 2nd public comment at the recent October 15, 2024, PC meeting regarding wind generators:

1. Using setbacks from property lines, rather than distances from buildings, is a better requirement.

2. 55 decibels is comparable to normal conversation. That would certainly be quite annoying to a neighbor if it was usually present at an adjacent property line. The use of the word "average" implies that the wind generator sometimes creates sound greater than 55 decibels and sometimes lower than 55 decibels. Both the average and the intermittent highs can be extremely troublesome.

3. Regarding the dark sky requirement, strobe lighting is very annoying at night and hazardous to birds. An intermittent solid red light is less bothersome. Suggest that strobe lighting on the wind generators be prohibited.

4. Hire an independent wind generator engineering consultant to review the township's final ordinance.

5. Require natural, view screening around a wind generator farm and perhaps even a solar panel farm.

Attached below is an email communication with the State of Michigan PhD.

Thank you.

Jim McMahon
phone: 231-347-9829

----- Forwarded Message -----
From: Joelle Gehring <gehringj@michigan.gov>
To: "jim_mcmahon_iii@yahoo.com" <jim_mcmahon_iii@yahoo.com>
Sent: Tuesday, May 2, 2006 at 02:30:37 PM EDT
Subject: Re: Your Paper on Radio Towers and their hazards to birds

Hi Jim,
Thanks for your interest and your email!! I am attaching several reports which you may find useful! Please feel free to contact me if you would like any additional information!

Very Sincerely, Joelle

Joelle Gehring, Ph.D.
Michigan Natural Features Inventory
Stevens T. Mason Building
P.O. Box 30444
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>>> Jim McMahon <jim_mcmahon_iii@yahoo.com> 03/24/2006 11:39 AM >>>
Joelle, my name is Jim McMahon. I'm on the planning commission for Hayes Township, Charlevoix County, MI. It is my understanding that you have done a study and written a paper regarding the hazards of radio transmission towers have for birds. I'd like to read your study. I tried you reach you by phone (using the State of Michigan phone directory) and was unable. Are you no longer with the State of Michigan?

Is your study accessable by the public where I can have access to it? Our township is currently writing an ordinance for wind generators and anemometer towers. I called the DNR in Gaylord regarding avian and bats. I spoke with a DNR supervisor who referred me to your report of which he did not have a copy.

My email address is jim_mcmahon_iii @ yahoo.com. Thank you.

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3 attachments

annual report 2004.doc
222K

Fall 2005 progress report.doc
143K

Spring 2005 progress report.doc
207K

31 January 2005

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Avian collisions with communication towers: a comparison of tower support systems and tower heights.

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Abstract: The U. S. Fish and Wildlife Service (USFWS) estimates that 4-5 million birds per year may collide with and die at communication towers; however, some sources suggest the number could be higher. Despite documented large-scale fatalities of a diversity of bird species, mainly migratory songbirds, little experimental, large-scale research has been conducted to identify tower variables likely to increase the risk of collision. In addition, towers continue to be constructed throughout the USA at a rate of approximately 5,000 per year. The objectives of this study are to determine the relative risks that tower support systems (guy wires or self-support), tower light systems, and tower height categories pose to migratory birds. Data comparing different tower light systems will be collected in 2005 and 2006. Data comparing tower support systems and tower height categories were collected simultaneously in Michigan during 20 days of the peak of songbird migration at 6 towers in September-October 2003, at 23 towers in May 2004, and at 24 towers in September 2004. Towers were systematically and simultaneously searched for bird carcasses. Bird carcass removal or scavenging rates and observer detection rates were measured at each tower. During the 3 20-day sample periods a mean of 7.5 birds per tower were found dead under guyed communication towers 116-146 m Above Ground Level (AGL), while a mean of 0.5 birds per tower were found under unguyed towers 116-146 m AGL. Two 20-day sample periods detected a mean of 32.5 birds per tower under towers >305 m AGL. Using the Mann-Whitney U-test, Kruskal-Wallis test, and Tukey's Honestly Significant Difference multiple comparison procedure I found that towers supported by guy wires directly killed significantly more birds than towers that were self-supported, while guyed towers >305 m AGL killed significantly more birds than both guyed and unguyed towers 116-146 m AGL. With these data, managers and regulators can make appropriate recommendations specific to minimizing or eliminating the collision-related mortality of neotropical migratory birds and therefore improve management practices.

Introduction

Avian mortality has been documented at communication towers for over 50 years (Aronoff 1949, Bernard 1966, Shire at al. 2000). Past research suggests that birds, primarily night migrating, neotropical songbirds, become disoriented when night skies are overcast or cloud/fog enshrouded and are then attracted to the lights of tall structures, such as communication towers (Larkin 2000). Banks (1979) estimated that 1.25 million birds collided with communication towers every year. However, the USFWS conservatively estimates that 4-5 million birds per year collide with and die at communication towers (Manville 2001). Some sources, including the USFWS, suggest the number could be higher (Shire 2000, Manville 2001, Erickson et al. 2001). Several studies have recorded thousands of birds colliding with individual towers during a single night of migration (Breckenridge 1958, Bernard 1966, Kemper 1964). For example, Kemper (1964) estimated that over 13,000 birds died in one night after colliding with a communication tower in Eau Claire, Wisconsin. Shire et al. (2000) compiled documented cases of bird mortalities at communication towers throughout the United States. They found that 230 species of birds, greater than 25% of all bird species in the U.S., are killed at towers.

Although sample sizes of towers were frequently small, several studies have examined the relationship between bird collisions and individual tower variables. Most studies have suggested a relationship between weather patterns and bird fatalities (Caldwell and Wallace 1966, Avery et al. 1976, Larkin and Frase 1988, Kruse 1996). The type of nighttime tower lighting system also appears to be related to the frequency of migratory bird collisions (Cochran and Graber 1958, Avery et al. 1976, Gauthreaux 2000, Larkin 2000). The presence of guy wires and the height of towers are believed to be critical variables related to bird fatalities at communication towers (Kruse 1996, Kerlinger 2000). The location of a tower within the landscape has also been suggested to influence bird collisions (e.g., distance to urban area, or placement on ridge tops) (Caldwell and Wallace 1966, Manville 2000).

Despite the documented mortality of a diversity of bird species, little formal, experimental, large-scale research has been conducted to identify tower variables likely to increase the risk to migrating birds and to statistically test those relationships (Shire et al. 2000). In addition, towers continue to be constructed throughout the U.S. at a rate of approximately 5,000 per year (Shire et al. 2000, Erickson et al. 2001). The increased use of cellular phones via the Personal Communication Service Industry and Congressionally-mandated digital television conversion will continue the need for and construction of these structures. In August 2003 the Federal Communications Commission (FCC) initiated a Notice of Inquiry into the relationship between Communication Towers and migratory bird collisions (FCC 2003). The resulting Notice of Inquiry Comment Review suggested the need for more research on the topics of mitigation and collision prevention methods, including tower support systems (guyed or self-supporting), tower lighting systems, and the relationship between tower height and bird collisions (FCC 2005). This study was specifically designed to address several of the important questions regarding avian mortality at communication towers. By determining which tower characteristics (e.g., methods of support for tower structures, tower height, tower light systems) are related to bird collisions scientifically-based recommendations can be made to decrease the risk to migratory songbirds.

Data collected in 2005 and 2006 will compare bird mortality at towers with different lighting systems. However, data collected in 2003 and 2004 addressed the following predictions:

1. Communication towers supported by guy wires will provide a higher risk to birds than towers lacking guy wires (unguyed, self-supporting).
2. Communication towers approximately 305 m AGL will kill more birds than towers 116-146 m AGL.

Study Area and Methods

Tower selection and description

Research was conducted at communication towers distributed throughout Michigan, USA (between: 46° 33.85'N 90° 25.06' W and 41° 44.48'N 83° 28.51' W). Located in the upper Great Lakes Region, Michigan includes 2 physiographic areas: the Upper Great Lakes Plain and the Boreal Hardwood Transition (Fig. 1). To test for differences in bird mortality at towers of different heights we selected towers within 2 height categories: 116-146 m AGL and >305 m AGL. Towers 116-146 m AGL functioned as part of the Michigan Public Safety Communications System (MPSCS); in addition, several taller (>305 m AGL) television broadcasting towers were included in the study. All of the towers 116-146 m AGL had the same tower lighting systems from dusk to dawn (i.e., E-2 lighting, red strobes at the top and half-way down the tower with red, solid-on, incandescent lights 1/3 and ¾ the height of the tower; FAA 2000). The guyed towers >305 m AGL, had standard, red, blinking incandescent lights combined with solid-on, incandescent lights. Considering that the majority of tower collisions are thought to occur during migration, technicians sampled for 20 consecutive days during the peaks of spring and fall migrations. During the fall 2003 field season (15 September - 4 October) 3 guyed and 3 unguyed 116-146-m AGL MPSCS towers were searched, during the spring 2004 field season (10 – 29 May) 11 guyed and 9 unguyed 116-146-m AGL MPSCS towers, and 3 towers >305 m AGL were searched, and during the fall 2004 field season (7-26 September) 12 guyed and 9 unguyed 116-146-m AGL MPSCS towers and 3 towers >305 m AGL were searched (Fig. 1). The MPSCS towers searched in 2004 were randomly selected from 150 MPSCS towers within the 116-146-m height category, after stratification for tower support system. If a randomly selected tower was within 1 mile of an extensively-lighted area (e.g., large urban area) I eliminated that tower from the sample and randomly selected another tower. This procedure prevented a situation where communication tower lights might be less visible to birds or "washed-out" due to the overwhelming lights of surrounding areas (Caldwell and Wallace 1966). Similarly, I excluded those towers associated with tower farms (additional communication tower(s) within 0.5 miles) and ridge tops to avoid additional confounding variables. Towers >305 m AGL were selected based on the permission of tower owners and engineers to access the site and an effort to disperse the study towers throughout state. Two of the MPSCS towers were selected as a result of the initial motivation for this study's funding; hence, they were not randomly selected. The first of those was located on a site believed to have high intensities of migrating songbirds in its vicinity; thereby increasing the risk to those birds. The second non-randomly selected tower was included after discussions and consultation with members of the Kirtland's Warbler Recovery Team. The Kirtland's

Warbler (*Dendroica kirtlandii*), an endangered species endemic to Michigan, breeds in the east-central portions of the Lower Peninsula of Michigan. As a night-migrating songbird, this species could be attracted to and collide with communication towers in the eastern United States during its biannual flight between Michigan and the Bahamas. Therefore, the second non-randomly selected tower is in close proximity to the Kirtland's Warbler's breeding areas. Randomly selected towers south of these areas will also allow sampling for potential collisions of this endangered species.

Carcass searches

Technicians arrived at the towers at or before dawn in an effort to prevent diurnal and crepuscular scavengers from removing carcasses. Searching the same tower every day, technicians conducted tower searches simultaneously at their designated towers. Using flagged, straight-line transects, technicians walked at a rate of 45-60 m per min and searched for carcasses within 5 m on either side of their transects (Gehring 2004, Erickson et al. 2003). Transects covered a circular area under each tower with a radius equal to 90% the height of the tower. Bird carcasses were placed in plastic bags, and the following information was recorded: tower identification number, date, closest transect, distance from tower, azimuth to the tower, estimated number of days since death, and observer's name. Once bagged and labeled, carcasses were frozen for later identification and verification of species. I maintained the appropriate USFWS and Michigan Department of Natural Resources (MDNR) permits and secured Institutional Animal Care and Use Committee protocol approval (#07-03) via Central Michigan University (CMU).

Observer detection and carcass removal trials

It is inevitable that technicians did not observe all bird carcasses under communication towers due to dense vegetation, observer fatigue, human error, and scavenging by predators. Failure to find bird carcasses could underestimate the documented bird mortality at towers. Therefore, it was necessary to quantify each technician's observer detection rate and the rate of carcass removal (Erickson et al. 2003). Observer detection trials were conducted with technicians at their designated tower 1 time during each field season. By placing 10 bird carcasses within the tower search area, I quantified the proportion of bird carcasses detected by each technician. For observer detection trials I used bird carcasses representing a range in size and colors, but predominantly Brown-headed Cowbirds (*Molothrus ater*) painted to simulate the fall plumage of migrating songbirds. Bird carcasses used for observer detection trials were also painted with an "invisible" paint that glowed fluorescent colors when viewed under a black light. When analyzing the study data, the "invisible" paint prevented any confusion between birds that had collided with the towers and birds placed in the plots for observer detection trials.

Similarly, technicians placed 10-15 Brown-headed Cowbird carcasses near their designated communication tower's search area and monitored the removal (e.g., scavenging) of carcasses daily during the study period. Using these data I calculated a scavenging or removal rate (Erickson et al. 2003). Brown-headed Cowbirds used in the removal trials were not painted, as this foreign scent might have prevented scavengers from removing carcasses. Both observer detection trial birds and removal trial birds were placed in a range of habitats characteristic of the individual tower search area.

Statistical analyses

I used the Mann-Whitney U-test to test for differences in the fall 2003 data, and the Kruskal-Wallis test combined with Tukey's Honestly Significant Difference (HSD) multiple comparison procedure to test for differences within the data from spring and fall 2004 (Zar 1984). Raw data were used when testing for significant differences among tower types, not data adjusted for scavenging and observer detection rates. I used bootstrapping (5,000 iterations) to estimate the mean and standard deviation of the observer detection rates (Erickson et al. 2003, Manly 1997). Using methods developed by W. Erickson (WEST, Inc.), I used the mean observer detection rate and the carcass removal rate specific for each individual tower to calculate adjustment multipliers by which to correct the observed number of birds per tower. This adjustment method considered the probability that carcasses not found on 1 day could be found on the following days, depending on the rate of carcass removal (W. Erickson pers. comm.). These 2 interacting variables were used to determine an average carcass detection probability and the related adjustment multiplier specific to each tower. The statistical software SPSS was used for analysis and $\alpha = 0.05$ (SPSS 2001).

Results

During the 20-day study period in the fall of 2003, searches at 6 towers detected 22 birds comprised of 11 species (mean = 2.00 birds per species; range = 1-3; Table 1 and Appendix 1). In the spring of 2004 searches of 23 towers detected 197 birds representing 47 species (mean = 4.19 birds per species; range = 1-27; Table 2 and Appendix 1). In the fall of 2004 searches at 24 towers detected 156 birds, comprising 42 species (mean = 3.71 birds per species; range = 1-20; Table 3 and Appendix 1). Night-migrating songbirds collided most frequently with communication towers (Appendix 1). In the fall of 2003 Red-eyed Vireos (*Vireo olivaceus*) and Magnolia Warblers (*Dendroica magnolia*) were the most common species found. Similarly, in the spring of 2004 the 2 most common bird species found were Red-eyed Vireos and Ovenbirds (*Seiurus aurocapillus*). In the fall of 2004 Blackpoll Warblers (*Dendroica striata*) and Ovenbirds were the most common tower killed birds.

The mean observer detection rate (via bootstrapping) was 0.48 (SD = 1.10) in the fall of 2003, 0.40 (SD = 0.03) in the spring of 2004, and 0.27 (SD =0.03) in the fall 2004. Carcasses placed near the tower search area for removal trials (e.g., scavenging) remained on the ground a mean of 6.10 days (SD = 2.73) in the fall of 2003, 5.66 days (SD = 2.53) in the spring of 2004, and a mean of 6.89 days (SD = 3.07) in the fall of 2004. Including both observer detection rates and carcass removal rates I estimated the adjustment multipliers specific to each tower to range between 1.76 and 2.04 (mean = 1.92, SD = 0.14) in the fall of 2003, 1.23 and 2.63 (mean = 1.68, SD = 0.37) in the spring of 2004, and 1.24 and 3.41 (mean = 2.00, SD = 0.55) in the fall of 2004.

One of the towers >305 m AGL searched in the spring of 2004 had a unique, antique guy system design that is no longer used when constructing towers. Almost exclusively, American towers of this size have 6 sets of guy wires and guy anchor points instead of the 3 sets supporting this tower (R. Thomas pers. comm.). This tower also presented access difficulties for technicians, and landscape features that prevented adequate carcass searching. Only 3 bird carcasses were found under this unique tower and it was therefore considered an outlier, removed from further statistical analysis and replaced in the fall of 2004 field season with a tower more representative of towers >305 m AGL. Occasionally birds found under towers appeared to have been killed by predators (e.g., Cooper's Hawk, *Accipiter cooperii*) and plucked at the site. If the species of the dead bird was a typical prey item of an avian predator, like the Cooper's Hawk, and if the shafts of the plucked feathers had large beak impressions it was assumed that the bird was killed by a predator and the specimen was removed from further statistical analysis. I included summary statistics of data both with and without these questionable birds (Table 3).

When comparing bird mortality among tower types the 2 previously mentioned outliers were removed (i.e., unique tower >305 m AGL in the spring of 2004, and the 3 predator killed birds under an unguyed tower in the fall of 2004). A Mann-Whitney U-test determined that in the fall of 2003 unguyed towers 116-146 m AGL were associated with lower bird mortality than guyed towers in the same height category ($U = 0.00$, $P = 0.037$). Similarly, Kruskal-Wallis tests found significant differences among tower types in both the spring of 2004 ($\chi^2_2 = 16.839$, $P \leq 0.001$) and the fall of 2004 ($\chi^2_2 = 15.614$, $P \leq 0.001$). In the spring of 2004 all 3 tower types were statistically different from one another. Guyed towers >305 m AGL killed more birds than both guyed ($P \leq 0.001$) and unguyed ($P \leq 0.001$) towers 116-146 m AGL. Similarly, more birds were found under guyed towers 116-146 m AGL than unguyed towers in the same tower height category ($P = 0.01$). Data collected in the fall of 2004 also demonstrated that guyed towers >305 m AGL were associated with higher bird mortality than both guyed ($P \leq 0.001$) and unguyed ($P \leq 0.001$) towers 116-146 m AGL. However, low levels of bird mortality at the majority of towers 116-146 m AGL resulted in no significant differences in bird mortality between guyed and unguyed structures ($P = 0.12$).

Although not included in Table 3, Appendix 1, or the statistical analysis because it was killed prior to the data collection period, a Great Blue Heron (*Ardea herodias*) carcass was found under an unguyed study tower (116-146 m AGL) in the fall of 2004. The degree of tissue decay and scavenging prevented verification of injuries consistent with a tower collision, however the location of the carcass under the tower strongly suggested a tower collision and I believe the evidence supports that suggestion. In addition, 3 bats were found during the fall of 2004 study period. One bat carcass was found at each tower type. The species included: little brown myotis (*Myotis lucifugus*), red bat (*Lasiurus borealis*), and big brown bat (*Eptesicus fuscus*). No bats were included in Table 3, Appendix 1, the descriptive statistics or statistical comparisons.

Table 1. The numbers of bird carcasses found at 6 Michigan communication towers between 15 September and 4 October 2003.

Tower support	Height category AGL	Numbers of towers searched	Numbers of carcasses found
Unguyed	116-146 m	3	0 (mean = 0.0, SE = 0.0)
Guyed	116-146 m	3	22 (mean = 7.3, SE = 1.2)
Total		**6**	**22**

Table 2. The numbers of bird carcasses found at 23 Michigan communication towers between 10 May and 29 May 2004.

Tower support	Height category AGL	Numbers of towers searched	Numbers of carcasses found
Unguyed	116-146 m	9	5 (mean = 0.6, SE = 0.2)
Guyed	116-146 m	11	121 (mean = 11.0, SE = 2.6)
Guyed	$\geq$305 m	3 (2)[a]	71 (mean = 23.7, SE = 11.8) (68; mean = 34.0, SE = 10)[a]
Total		**23** **(22)**[a]	**197** **(194)**[a]

[a] data with outlier tall tower removed

Table 3. The numbers of bird carcasses found at 24 Michigan communication towers between 7 September and 26 September 2004.

Tower support	Height category AGL	Numbers of towers searched	Numbers of carcasses found
Unguyed	116-146 m	9	12 (mean = 1.33, SE = 0.62) 9 (mean = 1.00, SE = 0.33)[a]
Guyed	116-146 m	12	51 (mean = 4.25, SE = 0.65)
Guyed	$\geq$305 m	3	93 (mean = 31.00, SE = 5.86)
Total		**24**	**156** **(153)**[a]

[a] data without birds likely killed and plucked on site by raptor.

Discussion and Management implications

The diversity of species that collided with communication towers in this study was consistent with other similar research (Shire et al. 2000, FCC 2005). Specifically, the majority of carcasses were of the avian order Passeriformes (69%), but also included small representations of Anseriformes (1%), Falconiformes (<1%), Galliformes (<1%), Charadriiformes (<1%), Columbiformes (1%), Cuculiformes (<1%), Caprimulgiformes (<1%), Piciformes (<1%), and the mammalian order Chiroptera (<1%). The high proportions of Red-eyed Vireo, Ovenbird, Swainson's Thrush (*Catharus ustulatus*), and Magnolia Warbler (*Dendroica magnolia*) carcasses observed under towers may be directly related to the high relative densities of these species migrating through the region during the sample periods. It is likely that additional species collided with the study towers but were not detected due to removal of carcasses by scavengers and human error and fatigue (i.e., observer detection rate). In addition, this study was designed to encompass the peak of long-distance songbird migration; thereby, potentially missing the peak migration periods of several species.

During this study, technicians did not observe any large bird kill events under communication towers. Most fatalities involved single individuals on given days. At the extreme, 11 birds were found in one search of a tower >305 m AGL. This may be consistent with the documented decrease in large bird kill events since the early 1980s (Nehring 1998, Morris et al. 2003).

Few other studies of avian collisions with communication towers quantified observer detection rates and carcass removal rates (FCC 2005). However, recent research on avian and bat mortality at wind turbines provides a source of comparison. When considering birds similar in size to those which typically collide with communication towers (e.g., warblers, vireos), Johnson et al. (2002) determined that observers detected a mean of 0.29 of the carcasses and the mean length of time a carcass remained on the ground was 4.69 days. This is very similar to the observer detection and removal rates determined in this study. After additional data have been collected the observer detection rates, carcass removal rates, and resulting multiplier adjustments will be incorporated into the statistical analysis. The numbers of fatalities presented in this report do not reflect these adjustments; however, adjustments for observer detection and scavenging rates will increase the estimates of fatalities at communication towers.

The study results support and are consistent with the prediction that guyed towers are associated with higher bird mortality than unguyed towers. Kruse (1996) intensively studied the location of bird carcasses under 3 guyed communication towers during bird migration. She found a significant positive correlation between the locations of tower guy wires and the locations of bird carcasses, thus supporting the belief that birds collide with the tower guy wires as they are attracted to and flying near lit towers. Although the data from the fall of 2004 supported this trend, the lack of detected difference using multiple comparisons is likely the result of an overall lower tower kill rate at all towers 116-146 m AGL during this field season. Michigan had unusually mild temperatures during this time period, with mostly clear skies and very few foggy nights. According to the National Oceanic and Atmospheric Administration, Michigan's September 2004 was the 2nd driest month in 110 years (www.noaa.gov). Previous research suggests a positive relationship between foggy or cloud-covered nights and bird collisions with communication towers (Avery et al. 1976, Larkin 2000). Therefore, it is possible that this atypically clear Michigan fall resulted in fewer bird-tower interactions than what might have occurred during a more average fall migration season. It is important to consider that although direct bird mortality was much lower at unguyed towers, it is possible that some birds were attracted to and circled around these structures displaying behaviors similar to those observed at guyed towers (Larkin and Frase 1988, Gauthreaux 2000). The implications of this energy-consuming behavior on the survival of individual migrating birds are unknown. Future portions of this study will focus on the relationship between tower light systems and bird fatalities; thereby, providing additional information on possible methods of preventing the attraction of birds to towers, and negative impacts resulting from those light systems (Gehring 2004).

The study data also supported the second prediction, as more avian collisions occurred at taller towers. A long-term study at a communication tower in Florida detected a dramatic decrease in bird fatalities after the tower height was decreased from 308 m to 91 m (Kerlinger 2000). Night-migrating songbirds typically fly between 91m and 610 m, depending on variables such as cloud cover and wind velocity (Kerlinger 1995). It is possible that the study towers >305 m AGL attracted more migrants because their height was well within the core of migration altitude. Whereas, the towers 116-146 m AGL may have only attracted those birds migrating at lower altitudes due to cloud cover or wind velocity. This is supported by the low levels of bird mortality observed at guyed study towers 116-146 m AGL during the unusually clear, cloudless, fall of 2004 field season. The comparison of bird mortality at towers of different height categories may be confounded by the difference in tower lighting systems between the 2 categories. Research planned for the spring and fall of 2005 and the spring of 2006 will compare avian mortality at towers with different lighting systems (Gehring 2004).

Comparisons of bird mortality at towers with different support systems and at towers in different height categories may be confounded by the migration intensity at each site. Using radar ornithology, an index of migration intensity will be determined for each tower site for each field season. Migration intensity indices will be incorporated into subsequent statistical analysis (Diehl et al. 2003, Gauthreaux and Belser 2003, Gehring 2004).

Despite the large number of migratory birds estimated by some to collide with communication towers every year and the potential for that number to increase in the next several years due to further tower construction; little large-scale research on the topic of avian collisions with communication towers has occurred (Shire et al. 2000, Manville 2001, FCC 2005). The FCC has stated a need for additional scientific research on this topic (FCC 2005). This study determined that tower height and tower support systems are related to the number of avian collisions. This information can be directly applied to future tower siting and will likely reduce the possible impact of tower collisions on migratory bird populations. I suggest that unguyed towers be recommended for future tower development. Future data collected in association with this study will address the potential impact of different tower light systems on avian mortality (Gehring 2004).

Acknowledgements

Many dedicated, enthusiastic, and hard working technicians conducted the predawn searches under communication towers. Their efforts made this research possible. The value of this study was greatly enhanced by the tower engineers and owners who have granted permission to access privately owned towers. I appreciate the recruiting and advertising assistance of Michigan organizations and Internet list servers. P. Kerlinger (Curry & Kerlinger, LLC) designed and wrote the original research proposal upon which this study is based. Many individuals regularly provide ideas, suggestions, and support for this project, including but not limited to: P. Kerlinger (Curry & Kerlinger, LLC), A. Manville (USFWS), T. Gehring (CMU), C. Czarnecki (USFWS), S. Lewis (USFWS), C. Mensing (USFWS), B. Fisher (USFWS), G. Winegrad (American Bird Conservancy (ABC)), C. Schumacher (United States Forest Service (USFS)), E. Paul (Ornithological Council), J. Dingledine (USFWS), P. Lederle (MDNR), D. Wang (CMU), R. Rustem (MDNR), M. Herbert (MDNR), and J. Janson (MDNR). The Michigan State Police granted their financial support, permission to access MPSCS tower sites, and tower information. I would like to express my gratitude to the USFWS, the MDNR and the National Fish and Wildlife Foundation (NFWF) for granting additional funds to improve this project. F. Moore (University of Southern Mississippi (USM)), M. Avery (United States Department of Agriculture), G. Winegrad (ABC), R. Rustem (MDNR) and an anonymous reviewer made time to provide official reviews for the NFWF grant proposal procedure. Logistical assistance was provided by the FAA, FCC, I. Lopez (Office of the Michigan Attorney General), and M. Curry (Curry & Kerlinger, LLC). Members of the Communication Tower Working Group and the Kirtland's Warbler Recovery Team provided ideas and suggestions. The Michigan Department of Natural Resources, USFWS, CMU and the USFS provided the permits necessary to complete this research. The avian species identification data were validated by C. Putnam. Central Michigan University provided necessary logistical support. W. Erickson (WEST, Inc.) generously provided suggestions, and advice regarding many aspects of this research. The use of NEXRAD technology is possible via the assistance and knowledge of R. Diehl (USM).

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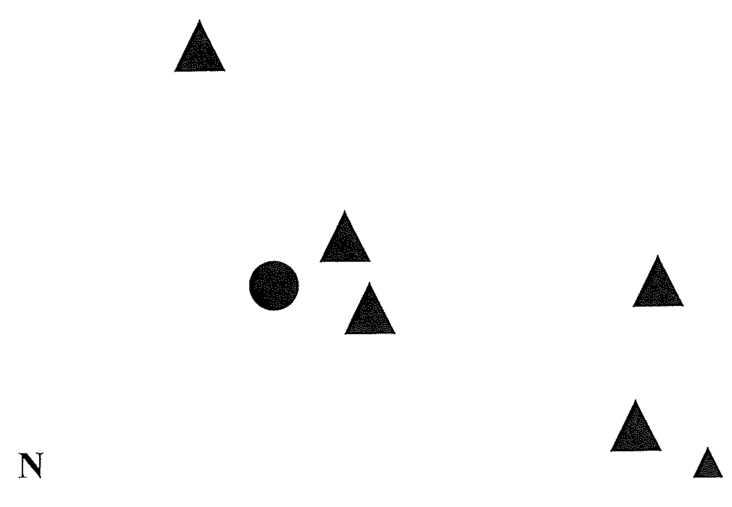
Appendix 1. Avian mortalities (by species) at Michigan communication towers during 20 days of migration.

Bird Species[a] and Number of carcasses found	Fall 2003 (6 towers)	Spring 2004 (23 towers)	Fall 2004 (24 towers)
Long-tailed Duck (*Clangula hyemalis*)		1 (<1%)	
Turkey Vulture (*Cathartes aura*)			2 (1%)
Red-tailed Hawk (*Buteo jamaicensis*)			1 (<1%)
Wild Turkey (*Meleagris gallopavo*)			1 (<1%)
Lesser Yellowlegs (*Tringa flavipes*)		1 (<1%)	
Short-billed Dowitcher (*Limnodromus griseus*)		1 (<1%)	
Herring Gull (*Larus argentatus*)		1 (<1%)	
Mourning Dove (*Zenaida macroura*)		1 (<1%)	4 (3%)
Common Nighthawk (*Chordeiles minor*)		1 (<1%)	
Yellow-billed Cuckoo (*Coccyzus americanus*)			1 (<1%)
Black-billed Cuckoo (*Coccyzus erythropthalmus*)			1 (<1%)
Red-headed Woodpecker (*Melanerpes erythrocephalus*)			1 (<1%)
Northern Flicker (*Colaptes auratus*)		1 (<1%)	1 (<1%)
Eastern Wood-Pewee (*Contopus virens*)		1 (<1%)	
Least Flycatcher (*Empidonax minimus*)		2 (1%)	
Blue Jay (*Cyanocitta cristata*)		1 (<1%)	5 (3%)
Common Raven (*Corvus corax*)			1 (<1%)
Tufted Titmouse (*Baeolophus bicolor*)			2 (1%)
Red-breasted Nuthatch (*Sitta canadensis*)			3 (2%)
Eastern Bluebird (*Sialia sialis*)			1 (<1%)
American Robin (*Turdus migratorius*)		2 (1%)	6 (4%)
Wood Thrush (*Hylocichla mustelina*)		1 (<1%)	
Swainson's Thrush (*Catharus ustulatus*)		13 (7%)	3 (2%)
Gray-cheeked Thrush (*Catharus minimus*)		1 (<1%)	1 (<1%)
Veery (*Catharus fuscescens*)		2 (1%)	1 (<1%)
Gray Catbird (*Dumetella carolinensis*)		4 (2%)	
Ruby-crowned Kinglet (*Regulus calendula*)		1 (<1%)	
European Starling (*Sturnus vulgaris*)		1 (<1%)	3 (2%)
Yellow-throated Vireo (*Vireo flavifrons*)		2 (1%)	
Red-eyed Vireo (*Vireo olivaceus*)	3 (13%)	27 (14%)	6 (4%)
Philadelphia Vireo (*Vireo philadelphicus*)		1 (<1%)	1 (<1%)
Blue-headed Vireo (*Vireo solitarius*)	1 (5%)		1 (<1%)
Cedar Waxwing (*Bombycilla cedrorum*)			1 (<1%)
Black-and-white Warbler (*Mniotilta varia*)		4 (2%)	1 (<1%)
Tennessee Warbler (*Vermivora peregrina*)		1 (<1%)	5 (3%)
Nashville Warbler (*Vermivora ruficapilla*)	1 (5%)	1 (<1%)	6 (4%)
Yellow Warbler (*Dendroica petechia*)		1 (<1%)	
Magnolia Warbler (*Dendroica magnolia*)	3 (13%)	5 (3%)	7 (5%)
Cape May Warbler (*Dendroica tigrina*)	2 (9%)	1 (<1%)	3 (2%)
Black-throated Blue Warbler (*Dendroica*		1 (<1%)	2 (1%)

caerulescens)			
Black-throated Green Warbler (*Dendroica virens*)	2 (9%)	5 (3%)	1 (<1%)
Blackburnian Warbler (*Dendroica fusca*)		3 (2%)	1 (<1%)
Chestnut-sided Warbler (*Dendroica pensylvanica*)		2 (1%)	2 (1%)
Bay-breasted Warbler (*Dendroica castanea*)	1 (5%)	1 (<1%)	2 (1%)
Blackpoll Warbler (*Dendroica striata*)	2 (9%)		20 (13%)
American Redstart (*Setophaga ruticilla*)	2 (9%)		3 (2%)
Pine Warbler (*Dendroica pinus*)			1 (<1%)
Palm Warbler (*Dendroica palmarum*)			1 (<1%)
Ovenbird (*Seiurus aurocapillus*)		18 (9%)	11 (7%)
Northern Waterthrush (*Seiurus noveboracensis*)			1 (<1%)
Connecticut Warbler (*Oporornis agilis*)		1 (<1%)	
Mourning Warbler (*Oporornis philadelphia*)		1 (<1%)	
Common Yellowthroat (*Geothlypis trichas*)		5 (3%)	
Wilson's Warbler (*Wilsonia pusilla*)			1 (<1%)
Canada Warbler (*Wilsonia canadensis*)		2 (1%)	1 (<1%)
Bobolink (*Dolichonyx oryzivorus*)		1 (<1%)	
Brown-headed Cowbird (*Molothrus ater*)		1 (<1%)	
Scarlet Tanager (*Piranga olivacea*)		4 (2%)	
Northern Cardinal (*Cardinalis cardinalis*)			2 (1%)
Rose-breasted Grosbeak (*Pheucticus ludovicianus*)		5 (3%)	
Indigo Bunting (*Passerina cyanea*)		4 (2%)	
Savannah Sparrow (*Passerculus sandwichensis*)	1 (5%)	2 (1%)	
Grasshopper Sparrow (*Ammodramus savannarum*)		1 (<1%)	
Chipping Sparrow (*Spizella passerina*)		1 (<1%)	
White-throated Sparrow (*Zonotrichia albicollis*)	1 (5%)	1 (<1%)	1 (<1%)
Lincoln's Sparrow (*Melospiza lincolnii*)		2 (1%)	
Unknown duck[b]		4 (2%)	
Unknown –crow size[b]		5 (3%)	
Unknown Icteridae[b]	1 (5%)	2 (1%)	
Unknown -thrush size[b]		14 (7%)	17 (11%)
Unknown –warbler/vireo size[b]	2 (9%)	32 (16%)	19 (12%)
Total:	**22**	**197**	**156**

[a] all names of birds follow the *AOU Check-list of North American Birds*
[b] bird carcass heavily scavenged preventing identification of species



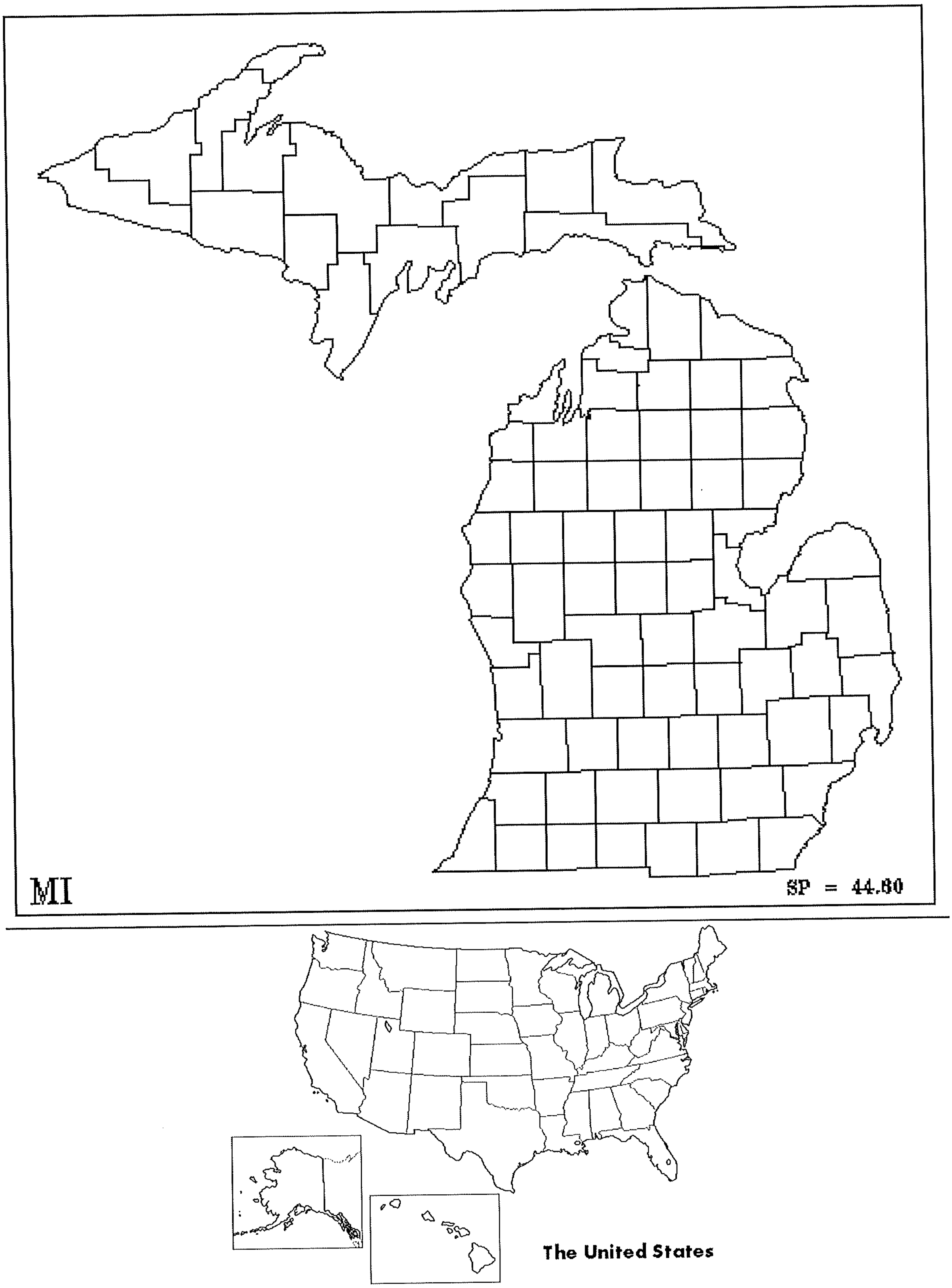


Figure 1. Map of communication towers included in study of avian collisions in Michigan, USA.

Avian Collision Study for the Michigan Public Safety Communications System (MPSCS): Summary of Fall 2005 Field Season

2 December 2005

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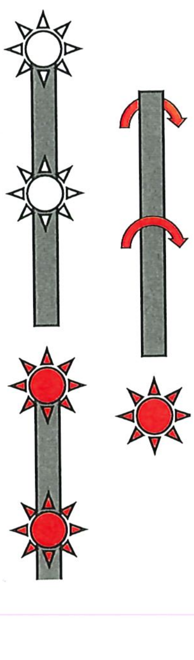
Introduction

This report summarizes the preliminary results of the fall 2005 field season, as well as additional progress towards the study's completion. Tasks and field seasons completed prior to August 2005 were documented in previous progress reports.

Progress

Fall 2005 field season

The study design and field work were completed according to the Avian Collision Study Plan for the Michigan Public Safety Communications System (MPSCS): Assessing the Role of Lighting, Height, and Guy Wires in Avian Mortality Associated with Wireless Communications and Broadcast Towers (revised version: April 27, 2004; Gehring 2004). In summary, 21 MPSCS towers, 116-146 m (380-480 ft) Above Ground Level (AGL), were randomly selected for inclusion in the full study. Additionally, I secured permission to include 3 privately-owned towers ≥ 305 m (>1,000 ft) AGL in the study. One objective of this study is to assess the differences in bird mortality at towers with different lighting systems. The following night-time tower light systems were compared: towers with white strobe lights but no steady-on lights, towers with red strobe lights but no steady-on lights, towers with red, blinking, incandescent lights but no steady-on lights, towers with both red strobe lights and steady-on lights (status quo) (Fig. 1). Nine of the MPSCS towers were self-supporting (no guy wires) and the remaining 12 MPSCS towers were supported by guy wires. As described in the research proposal, each technician was assigned to a designated tower where they systematically searched for bird carcasses every morning starting at dawn for 20 days during the peak of migration for neotropical migrating birds (7 September -26 September) (Gehring 2004).



- 3 guyed towers 116-146 m (380-480 ft) AGL with red, blinking, incandescent lights at the top level and mid level; no steady-on, incandescent lights
- 3 unguyed towers 116-146 m (380-480 ft) AGL with red, blinking, incandescent lights at the top level and mid level; no steady-on, incandescent lights

- 3 guyed towers 116-146 m (380-480 ft) AGL with red strobes at the top level and mid level; *with* steady-on red, incandescent lights at the midpoints between the top-level and mid-level strobes and red steady-on, incandescent

Figure 1. Four different communication tower lighting systems were installed on the Michigan Public Safety Communication System towers. The areas under these towers were simultaneously and systematically searched for bird carcasses during 20 mornings surrounding the peak of songbird migration in the fall 2005. Additional data will be collected in the spring 2006 and possibly the fall 2006. These data will be used to examine the relationships between bird mortality and tower lighting systems and tower support systems.

Over 20 days technicians and I found a total of 173 birds determined to be killed during the study period (53 birds at MPSCS towers) (Table 1). During this field season the maximum number of birds found in 1 morning at 1 tower was 10.

Table 1. The number of bird carcasses found at 24 Michigan communication towers (21 MPSCS towers and 3 privately owned towers) during 20 days in the fall of 2005.

Tower support	**Height category AGL**	**Light System**	**Number of towers searched**	**Number of carcasses found**
Unguyed	116-146 m (380-480 ft)	White strobe	3	2 (mean = 0.67, SE = 0.67)
		Red strobe	3	1 (mean = 0.33, SE = 0.33)
		Red blinking incandescent	3	2 (mean = 0.67, SE = 0.33)
Guyed	116-146 m (380-480 ft)	White strobe	3	8 (mean = 2.67, SE = 2.19)
		Red strobe	3	8 (mean = 2.67, SE = 2.19)
		Red blinking incandescent	3	14 (mean = 4.67, SE = 0.33)
		Status quo (w/ non-blinking lights)	3	18 (mean = 6.00, SE = 2.65)

Guyed	≥305 m (1000 ft) (privately owned towers)	Status quo (w/ non-blinking lights)	3	120 (mean = 40.00, SE = 18.03)
Total	**All towers**		**24**	**173 (53 at MPSCS towers)**

I identified each specimen to taxonomic species when possible (Table 2). The avian species identification data will be validated by Caleb Putnam (Michigan Audubon Society), an experienced ornithologist familiar with the avifauna of Michigan. Forty-two species of birds were collected and identified to have collided with the towers during the study period. The Blackpoll Warbler (*Dendroica striata*) was the most common species observed this field season, with the Mourning Dove (*Zenaida macroura*) as the second most common species detected (Table 2).

Table 2. Avian mortalities (by species) at 24 Michigan communication towers (21 MPSCS towers and 3 privately owned towers) during 20 days in the fall of 2005.

Bird Species[a]	**Numbers of carcasses found (24 towers)**
Ruffed Grouse (*Bonasa umbellus*)	1 (<1%)
Wild Turkey (*Meleagris gallopavo*)	2 (1%)
Mourning Dove (*Zenaida macroura*)	13 (8%)
Northern Flicker (*Colaptes auratus*)	1 (<1%)
Blue Jay (*Cyanocitta cristata*)	1 (<1%)
Red-breasted Nuthatch (*Sitta canadensis*)	1 (<1%)
White-breasted Nuthatch (*Sitta carolinensis*)	1 (<1%)
American Robin (*Turdus migratorius*)	1 (<1%)
Swainson's Thrush (*Catharus ustulatus*)	4 (2%)
Brown Thrasher (*Toxostoma rufum*)	1 (<1%)
Yellow-throated Vireo (*Vireo flavifrons*)	1 (<1%)
Red-eyed Vireo (*Vireo olivaceus*)	12 (7%)
Philadelphia Vireo (*Vireo philadelphicus*)	1 (<1%)
Cedar Waxwing (*Bombycilla cedrorum*)	3 (2%)
Black-and-white Warbler (*Mniotilta varia*)	3 (2%)
Tennessee Warbler (*Vermivora peregrina*)	3 (2%)
Nashville Warbler (*Vermivora ruficapilla*)	10 (6%)
Yellow Warbler (*Dendroica petechia*)	1 (<1%)
Magnolia Warbler (*Dendroica magnolia*)	4 (2%)

Cape May Warbler (*Dendroica tigrina*)	4 (2%)
Black-throated Blue Warbler (*Dendroica caerulescens*)	2 (1%)
Yellow-rumped Warbler (*Dendroica coronata*)	1 (<1%)
Black-throated Green Warbler (*Dendroica virens*)	3 (2%)
Chestnut-sided Warbler (*Dendroica pensylvanica*)	3 (2%)
Bay-breasted Warbler (*Dendroica castanea*)	2 (1%)
Blackpoll Warbler (*Dendroica striata*)	20 (12%)
American Redstart (*Setophaga ruticilla*)	2 (1%)
Pine Warbler (*Dendroica pinus*)	2 (1%)
Ovenbird (*Seiurus aurocapillus*)	5 (3%)
Northern Waterthrush (*Seiurus noveboracensis*)	1 (<1%)
Mourning Warbler (*Oporornis philadelphia*)	3 (2%)
Common Yellowthroat (*Geothlypis trichas*)	4 (2%)
Wilson's Warbler (*Wilsonia pusilla*)	3 (2%)
Scarlet Tanager (*Piranga olivacea*)	1 (<1%)
Rose-breasted Grosbeak (*Pheucticus ludovicianus*)	2 (1%)
Savannah Sparrow (*Passerculus sandwichensis*)	2 (1%)
Chipping Sparrow (*Spizella passerina*)	1 (<1%)
White-throated Sparrow (*Zonotrichia albicollis*)	2 (1%)
White-crowned Sparrow (*Zonotrichia leucophrys*)	1 (<1%)
Lincoln's Sparrow (*Melospiza lincolnii*)	1 (<1%)
Swamp Sparrow (*Melospiza georgiana*)	2 (1%)
Common Grackle (*Quiscalus quiscula*)	1 (<1%)
Unknown duck[b]	1 (<1%)
Unknown –crow size[b]	3 (2%)
Unknown Icteridae[b]	3 (2%)
Unknown -thrush size[b]	13 (8%)
Unknown –warbler/vireo size[b]	21 (12%)
Total:	**173 (53 at MPSCS towers)**

[a] all names of birds follow the *AOU Check-list of North American Birds*
[b] bird carcass heavily scavenged preventing identification of species

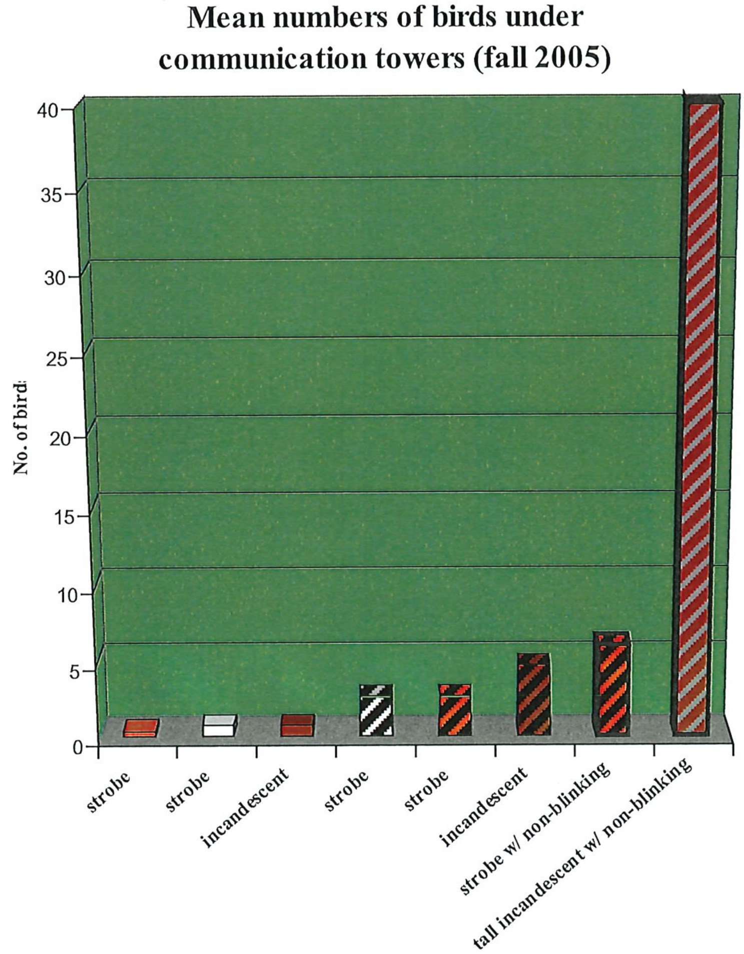
I conducted searcher efficiency (observer detection) trials to quantify the proportion of carcasses found by technicians and the proportion left undetected. By arriving at the site before technicians and placing a known number of bird carcasses within each technician's search area, I was able to quantify the proportion of bird carcasses found or observed by field technicians (Erickson et al. 2003). Chris Mensing, United States Fish and Wildlife Service, provided Brown-headed Cowbird (*Molothrus ater*) carcasses from the Kirtland's Warbler (*Dendroica kirtlandii*) recovery project in Michigan. Before placing the cowbird carcasses under study towers, I painted 80% of the individual cowbird carcasses to include small areas of yellow, red, or blue plumage to better simulate the coloration of many neotropical migrant songbirds. Due to a shortage of Brown-headed Cowbird carcasses additional songbird-sized bird carcasses were also included (i.e., road-killed birds and 2-day old chicks). To ensure the differentiation of observer detection bird carcasses from tower killed birds, I painted all observer detection bird carcasses with a fluorescing paint that was invisible except with the use of a black light. Any questionable carcasses or feather piles were later scanned in the lab to identify their source (i.e., tower kill or observer detection bird). The mean observer detection rate was 0.24 (SD =0.31). I used bootstrapping (5,000 iterations) to estimate the mean and standard deviation of the observer detection rate (Erickson et al. 2003, Manly 1997).

To quantify the rate of carcass scavenging and removal, technicians placed 15 unpainted songbird-sized bird carcasses near the edges of the search areas of their respective communication towers (Erickson et al. 2003). Carcasses were monitored daily for the duration of the study. Carcasses remained on the ground a mean of 6.69 days (SD = 2.98).

I used the mean observer detection rate and the carcass removal rate specific for each individual tower to calculate adjustment multipliers by which to correct the observed number of birds. This adjustment method considered the probability that carcasses not found on 1 day could be found on the following days, depending on the rate of carcass removal (W. Erickson pers. comm.). These 2 interacting variables were used to determine an average carcass detection probability specific to each tower ranging between 1.58 and 5.07 (mean =2.45, SD = 0.87).

Using the Kruskal-Wallis test, I determined that there were significant differences in the numbers of bird carcasses under communication tower types ($P = 0.059$ using raw data, and $P = 0.057$ using data adjusted for carcass detection probability). I used 2 methods of multiple comparisons to determine which tower types were significantly different from one another (Zar 1984). Tukey's Honestly Significant Difference (HSD), considered the more rigorous of the 2 methods, determined that more birds were found under towers $\geq$305 m AGL than at towers 116-146 m AGL. Least Significant Differences (LSD) supported the results of Tukey's HSD (for both raw data and adjusted data). Although trends in bird mortality were present in the remaining tower types, no statistical differences were detected (Fig. 2). It is important to note that these data are still preliminary and additional field seasons of data collection will enhance statistical comparisons. The statistical software SPSS was used for analysis and $\alpha = 0.10$ (SPSS 2001).

Bird migration intensity data were collected on each night of the field season, via NEXt generation RADar (NEXRAD) (Diehl et al. 2003, Gauthreaux and Belser 2003). These data will be analyzed within the next several months and included in analysis when possible. It is expected that the inclusion of NEXRAD bird migration intensities as a covariate will improve the future comparisons of bird mortality among tower-type categories. The use of covariates as well as at least 1 additional field season will likely decrease the variance observed in these preliminary data from both privately owned and MPSCS guyed towers (Table 1).



Mean numbers of birds under communication towers (fall 2005)
No. of bird
40
35
30
25
20
15
10
5
0
strobe
strobe
incandescent
strobe
strobe
incandescent
strobe w/ non-blinking
tall incandescent w/ non-blinking

Meetings and workshops

In August 2005 I presented at the meeting of the American Ornithologists' Union (contributed paper presentation). I was invited to serve on a panel at the September 2005 annual *PCIA-The wireless Infrastructure Association* meeting, where the topic was "Avian Mortality Issues: Potential Impact on Planned and Existing Wireless Infrastructures." The Bird Conservation Alliance also requested my participation in a panel on avian hazards. This study received substantial interest and support from the ornithological and wildlife management communities as well as the stakeholders present at the meetings. In December 2005 I will be presenting at the Midwest meeting of The Wildlife Society.

Current objectives

I will be continuing the process of NEXRAD data analysis. With the collaboration of radar ornithologist, Dr. Robb Diehl, the NEXRAD data will provide indices of migration intensity at communication towers included in the study. Given the time-consuming nature of examining and quantifying the large quantity of NEXRAD images collected during each field season, I will be working on this portion of the study whenever possible for the duration of the study.

I will continue to seek additional funding sources to further enhance this study. I will explore the benefits and costs of adding field seasons to the study.

In early 2006 I will write an annual report summarizing the findings of 2005. The annual report will include additional statistical comparisons of bird mortality at different tower types. In February I will begin recruiting and preparing for the spring 2006 field season. I am hopeful that many of the previous technicians can be retained for the spring 2006 field season. However, due to changing jobs and school schedules I will need to recruit new technicians for several of the towers.

Acknowledgments

This study could not be completed without the dedication, enthusiasm, and hard work of the technicians who conducted the early morning searches under communication towers -regardless of rainy and cold conditions. I appreciate the recruiting and advertising assistance of Michigan organizations and Internet list servers. This study is greatly enhanced by the inclusion of towers greater than $\geq$305 m (1000 ft) AGL. I owe a great amount of thanks to the private tower owners and engineers who by allowing us access to their sites, are taking important steps towards learning more about the issue of bird collisions with communication towers. The support of the Federal Aviation Administration (FAA) and Federal Communication Commission has allowed us to enhance this study via changing tower light systems. W. Erickson (WEST, Inc.) generously provided assistance and formats for calculating average detection probabilities considering both removal and observer detection rates. The interpretation and applicability of this study is greatly enhanced by his shared expertise. C. Mensing (United States Fish and Wildlife Service (USFWS)), and his technicians generously provided Brown-headed Cowbird carcasses. The use of NEXRAD is made possible by R. Diehl's (University of Southern Mississippi (USM)) interest and assistance. Many individuals regularly provide ideas, suggestions, and support for this project, including but not limited to: P. Kerlinger (Curry & Kerlinger, LLC), A. Manville (USFWS), C.

Czarnecki (USFWS), S. Lewis (USFWS), G. Winegrad (American Bird Conservancy (ABC)), C. Schumacher (United States Forest Service (USFS)), E. Paul (Ornithological Council), B. Fisher (USFWS), J. Dingledine (USFWS), P. Lederle (Michigan Department of Natural Resources (MDNR)), R. Rustem (MDNR), M. Herbert (MDNR), T. Gehring (Central Michigan University (CMU)), and J. Janson (MDNR). I would like to express my gratitude to the USFWS, the MDNR and the NFWF for granting additional funds to improve this project. The views and conclusions contained in this document are those of the author and should not be interpreted as representing the opinions or policies of the U.S. Government or the National Fish and Wildlife Foundation. Mention of trade names or commercial products does not constitute their endorsement by the U.S. Government or the National Fish and Wildlife Foundation. F. Moore (USM), M. Avery (United States Department of Agriculture), G. Winegrad (ABC), R. Rustem (MDNR) and an anonymous reviewer made time to provide official reviews for the NFWF grant proposal procedure. Central Michigan University and the USFS provide greatly appreciated logistical support for this research. The majority of the funding for this research is provided by the Michigan State Police. They have also allowed access to their towers and made possible the tower light system changes. A special thanks to those individuals who were involved in changing the MPSCS tower lighting systems. They frequently worked on weekends in order to complete the job. J. Zerlaut (MPSCS), T. Thompson (MPSCS), T. Shinew (MSPCS/ Michigan State Police), M. Scieszka (MSPCS/ Michigan State Police), I. Lopez (Office of the Michigan Attorney General), P. Ryan (Perkins Coie), F. Souchet (FAA), V. Vilaro (FAA), R. Matthews (FAA), K. Haggerty (FAA), F. Souchet (FAA), and M. Curry (Curry & Kerlinger, LLC) provide important logistical support for the study.

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Avian Collision Study for the Michigan Public Safety Communications System (MPSCS): Summary of Spring 2005 Field Season

16 August 2005

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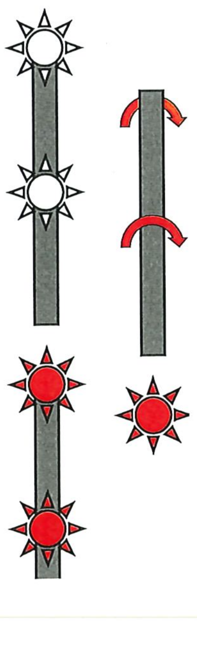
Introduction

This report summarizes the preliminary results of the spring 2005 field season, as well as additional progress towards the study's completion. Tasks and field seasons completed prior to December 2004 were documented in previous progress reports.

Progress

Spring 2005 field season

The study design and field work were completed according to the Avian Collision Study Plan for the Michigan Public Safety Communications System (MPSCS): Assessing the Role of Lighting, Height, and Guy Wires in Avian Mortality Associated with Wireless Communications and Broadcast Towers (revised version: April 27, 2004; Gehring 2004). In summary, 21 MPSCS towers, 116-146 m (380-480 ft) Above Ground Level (AGL), were randomly selected for inclusion in the full study. Additionally, I secured permission to search 3 privately-owned towers ≥ 305 m (>1,000 ft) AGL. One objective of this study is to assess the differences in bird mortality at towers with different lighting systems. The following night-time tower light systems were compared: towers with white strobe lights but no solid-on lights, towers with red strobe lights but no solid-on lights, towers with red, blinking, incandescent lights but no solid-on lights, towers with both red strobe lights and solid-on lights (status quo) (Fig. 1). Nine of the MPSCS towers were self-supporting (no guy wires) and the remaining 12 MPSCS towers were supported by guy wires. As described in the research proposal, each technician was assigned to a designated tower where they systematically searched for bird carcasses every morning starting at dawn for 20 days during the peak of migration for neotropical migrating birds (10 May -29 May) (Gehring 2004).



- 3 guyed towers 116-146 m (380-480 ft) AGL with red, blinking, incandescent lights at the top level and mid level; no solid-on, incandescent lights
- 3 unguyed towers 116-146 m (380-480 ft) AGL with red, blinking, incandescent lights at the top level and mid level; no solid-on, incandescent lights

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- 3 guyed towers 116-146 m (380-480 ft) AGL with red strobes
- 3 guyed towers 116-146 m (380-480 ft) AGL with red strobes at the top level and mid level; *with* solid-on red, incandescent lights at the midpoints between the top-level and mid-level strobes and red solid-on, incandescent lights

Figure 1. Four different communication tower lighting systems were installed on the Michigan Public Safety Communication System towers. The areas under these towers were simultaneously and systematically searched for bird carcasses during 20 mornings surrounding the peak of songbird migration in the spring 2005. Additional data will be collected in the fall 2005, spring 2006 and possibly the fall 2006. These data will be used to examine the relationships between bird mortality and tower lighting systems and tower support systems.

Over 20 days technicians and I found a total of 203 birds determined to be killed during the study period (Table 1). During this field season the maximum number of birds found in 1 morning at 1 tower was 16.

Table 1. The number of bird carcasses found at 24 Michigan communication towers (21 MPSCS towers and 3 privately owned towers) during 20 days in the spring of 2005.

Tower support	**Height category AGL**	**Light System**	**Number of towers searched**	**Number of carcasses found**
Unguyed	116-146 m (380-480 ft)	White strobe	3	3 (mean = 1.00, SE = 1.00)
		Red strobe	3	4 (mean = 1.33, SE = 0.88)
		Red blinking incandescent	3	4 (mean = 1.33, SE = 0.67)
Guyed	116-146 m (380-480 ft)	White strobe	3	3 (mean = 1.00, SE = 0.58)
		Red strobe	3	12 (mean = 4.00, SE = 1.00)
		Red blinking incandescent	3	8 (mean = 2.67, SE = 0.33)
		Status quo (w/ non-blinking lights)	3	37 (mean = 12.3, SE = 4.84)

Guyed	$\geq$305 m (1000 ft) (privately owned towers)	Status quo (w/ non-blinking lights)	3	132 (mean = 44.00, SE = 11.55)
Total	**All towers**		**24**	**203 (71 at MPSCS towers)**

I identified each specimen to taxonomic species when possible (Table 2). The avian species identification data will be validated by Caleb Putnam (Michigan Audubon Society), an experienced ornithologist familiar with the avifauna of Michigan. Forty-seven species of birds were collected and identified to have collided with the towers during the study period. The Red-eyed Vireo (*Vireo olivaceus*) was the most common species observed this field season, with the Gray Catbird (*Dumetella carolinensis*) as the second most common species detected (Table 2). Raptors typically do not collide with communication towers (Shire et al. 2000). However, this spring a technician documented 1 Turkey Vulture (*Cathartes aura*) under a guyed MPSCS tower. However, the degree of tissue decay and scavenging prevented verification of injuries consistent with a collision. Because the bird's death occurred previous to the study period, it was not included in any analysis, Tables 1 or 2.

Table 2. Avian mortalities (by species) at 24 Michigan communication towers (21 MPSCS towers and 3 privately owned towers) during 20 days in the spring of 2005.

Bird Species[a]	**Number of carcasses found**
Wild Turkey (*Meleagris gallopavo*)	2 (<1%)
Ruffed Grouse (*Bonasa umbellus*)	3 (1%)
Ring-necked Pheasant (*Phasianus colchicus*)	1 (<1%)
Mourning Dove (*Zenaida macroura*)	1 (<1%)
Hairy Woodpecker (*Picoides villosus*)	1 (<1%)
Red-eyed Vireo (*Vireo olivaceus*)	26 (13%)
Philadelphia Vireo (*Vireo philadelphicus*)	1 (<1%)
Yellow-throated Vireo (*Vireo flavifrons*)	1 (<1%)
Yellow-bellied Flycatcher (*Empidonax flaviventris*)	2 (<1%)
Blue Jay (*Cyanocitta cristata*)	3 (1%)
House Wren (*Troglodytes aedon*)	2 (<1%)
Winter Wren (*Troglodytes troglodytes*)	1 (<1%)
Marsh Wren (*Cistothorus palustris*)	1 (<1%)
American Robin (*Turdus migratorius*)	4 (2%)
Wood Thrush (*Hylocichla mustelina*)	5 (3%)
Swainson's Thrush (*Catharus ustulatus*)	3 (1%)
Veery (*Catharus fuscescens*)	6 (3%)
Gray Catbird (*Dumetella carolinensis*)	22 (11%)

Cedar Waxwing (*Bombycilla cedrorum*)	1 (<1%)
Black-and-white Warbler (*Mniotilta varia*)	1 (<1%)
Tennessee Warbler (*Vermivora peregrina*)	1 (<1%)
Hooded Warbler (*Wilsonia citrina*)	1 (<1%)
Yellow Warbler (*Dendroica petechia*)	12 (6%)
Magnolia Warbler (*Dendroica magnolia*)	2 (<1%)
Yellow-rumped Warbler (*Dendroica coronata*)	1 (<1%)
Black-throated Blue Warbler (*Dendroica caerulescens*)	1 (<1%)
Cerulean Warbler (*Dendroica cerulean*)	1 (<1%)
Black-throated Green Warbler (*Dendroica virens*)	1 (<1%)
Blackburnian Warbler (*Dendroica fusca*)	1 (<1%)
Chestnut-sided Warbler (*Dendroica pensylvanica*)	5 (3%)
Bay-breasted Warbler (*Dendroica castanea*)	1 (<1%)
Ovenbird (*Seiurus aurocapillus*)	17 (8%)
Common Yellowthroat (*Geothlypis trichas*)	15 (7%)
Canada Warbler (*Wilsonia canadensis*)	2 (<1%)
American Redstart (*Setophaga ruticilla*)	5 (3%)
Baltimore Oriole (*Icterus galbula*)	2 (<1%)
Brown-headed Cowbird (*Molothrus ater*)	2 (<1%)
Rose-breasted Grosbeak (*Pheucticus ludovicianus*)	6 (3%)
Indigo Bunting (*Passerina cyanea*)	3 (1%)
House Finch (*Carpodacus mexicanus*)	1 (<1%)
Savannah Sparrow (*Passerculus sandwichensis*)	3 (1%)
Chipping Sparrow (*Spizella passerine*)	3 (1%)
Lincoln's Sparrow (*Melospiza lincolnii*)	1 (<1%)
White-throated Sparrow (*Zonotrichia albicollis*)	1 (<1%)
White-crowned Sparrow (*Zonotrichia leucophrys*)	1 (<1%)
Swamp Sparrow (*Melospiza georgiana*)	1 (<1%)
Unknown -Rail[b]	1 (<1%)
Unknown –woodpecker[c]	1 (<1%)
Unknown -thrush size[c]	14 (7%)
Unknown –warbler/vireo size[c]	9 (4%)
Total:	**203 (71 at MPSCS towers)**

[a] all names of birds follow the *AOU Check-list of North American Birds*
[b] bird lodged high in tree preventing identification of species
[c] bird carcass heavily scavenged preventing identification of species

I conducted searcher efficiency (observer detection) trials to quantify the proportion of carcasses found by technicians and the proportion left undetected. By arriving at the site before technicians and placing a known number of bird carcasses within each technician's search area, I was able to quantify the proportion of bird carcasses found or observed by field technicians (Erickson et al. 2003). Chris Mensing, United States Fish and Wildlife Service, provided Brown-headed Cowbird (*Molothrus* *ater*) carcasses from the Kirtland's Warbler (*Dendroica kirtlandii*) recovery project in Michigan. Before placing the cowbird carcasses under study towers, I painted 80% of the individual cowbird carcasses to include small areas of yellow, red, or blue plumage to better simulate the coloration of many neotropical migrant songbirds. To ensure the differentiation of planted bird carcasses from tower killed birds, I painted all observer detection bird carcasses with a fluorescing paint that was invisible except with the use of a black light. Any questionable carcasses or feather piles were later scanned in the lab to identify their source (i.e., tower kill or observer detection bird). The mean observer detection rate was 0.31 (SD =0.04). I used bootstrapping (5,000 iterations) to estimate the mean and standard deviation of the observer detection rate (Erickson et al. 2003, Manly 1997).

To quantify the rate of carcass scavenging and removal, technicians placed 15 unpainted cowbird carcasses near the edges of the search areas of their respective communication towers (Erickson et al. 2003). Carcasses were monitored daily for the duration of the study. Carcasses remained on the ground a mean of 8.61 days (SD = 4.88).

I used the mean observer detection rate and the carcass removal rate specific for each individual tower to calculate adjustment multipliers by which to correct the observed number of birds. This adjustment method considered the probability that carcasses not found on 1 day could be found on the following days, depending on the rate of carcass removal (W. Erickson pers. comm.). These 2 interacting variables were used to determine an average carcass detection probability specific to each tower ranging between 1.18 and 2.83 (mean =1.74, SD = 0.52).

Using the Kruskal-Wallis test, I determined that there were significant differences in the numbers of bird carcasses under communication tower types ($P = 0.015$). I used 2 methods of multiple comparisons to determine which tower types were significantly different from one another (Zar 1984). Tukey's Honestly Significant Difference (HSD), considered the more rigorous of the 2 methods, determined that more birds were found under towers $\geq$305 m AGL than at towers 116-146 m AGL. Least Significant Differences (LSD) supported the results of Tukey's HSD but also detected differences among the towers 116-146 m AGL. Specifically, LSD determined that more bird carcasses were under the MPSCS towers with the status quo lighting systems (red strobes at the top level and mid level; *with* non-blinking red, incandescent lights 1/3 and ¾ height, Fig. 1) than under both guyed and unguyed towers with white strobes. Although trends in bird mortality were present in the remaining tower types, no statistical differences were detected (Fig. 2). It is important to note that these data are still preliminary and additional field seasons of data collection will enhance statistical comparisons. Raw data were used when testing for significant differences among tower types, not data adjusted for scavenging and observer detection rates. The statistical software SPSS was used for analysis and $\alpha = 0.10$ (SPSS 2001).

Bird migration intensity data were collected on each night of the field season, via NEXt generation RADar (NEXRAD) (Diehl et al. 2003, Gauthreaux and Belser 2003). These data will be analyzed within the next several months and included in analysis when possible. It is expected that the inclusion of NEXRAD bird migration intensities as a covariate will improve the future comparisons of bird mortality among tower-type categories. The use of covariates as well as at least 2 additional field seasons will likely decrease the variance observed in these preliminary data from both privately owned and MPSCS guyed towers (Table 1).

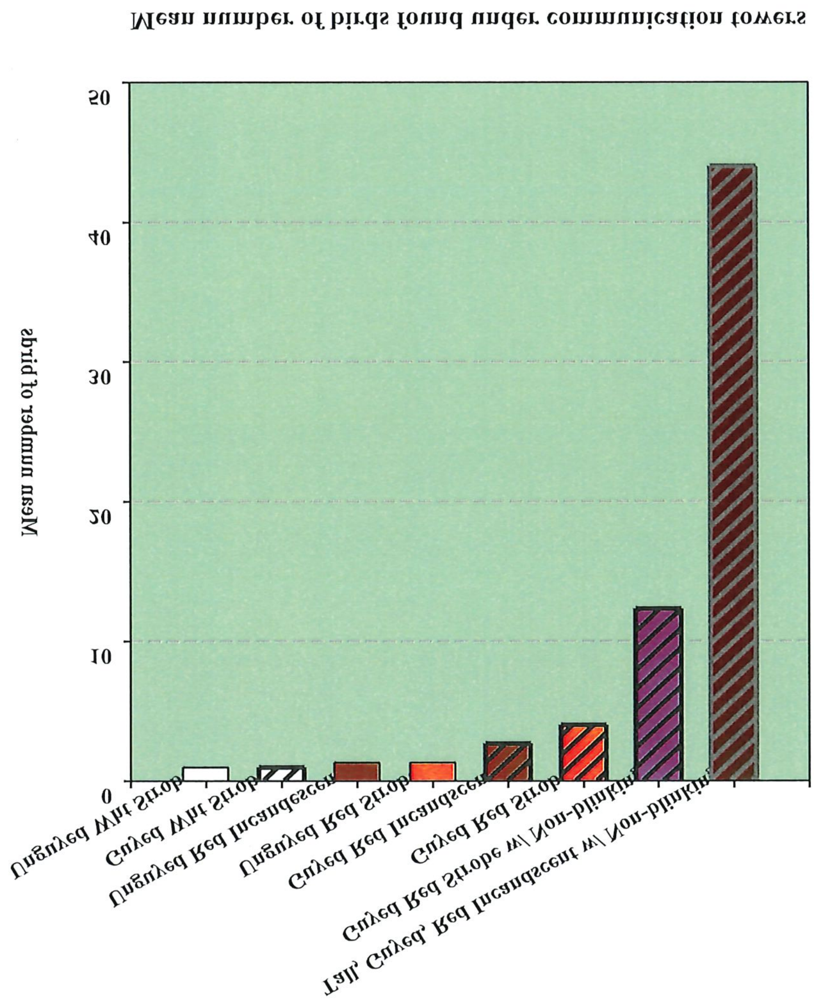

Figure 2. Bird carcass count data were compared at 8 different communication tower types during the spring of 2005 in Michigan towers. The bars delineated by striped patterns represent towers supported by guy wires; black outlines with no pattern represent unguyed towers. The bar with a gray striped pattern represents towers >305 m Above

Ground Level (AGL), while all other towers were 116-146 m AGL. The areas under towers were simultaneously and systematically searched for bird carcasses during 20 mornings surrounding the peak of songbird migration. Additional data will be collected in the fall 2005, spring 2006 and possibly the fall 2006.

Meetings and workshops

In April 2005 I presented the results of the spring and fall 2004 field seasons and plans for future work to the Communication Tower Working Group – Research Subcommittee and later at the joint meetings of the Wilson Ornithological Society and the Association of Field Ornithologists. I also presented information to local Audubon groups and at the annual meeting of the Michigan Audubon Society (March 2005). This study received substantial interest and support from the ornithological and wildlife management communities present at the meetings. In mid-August 2005 I will be presenting at the meeting of the American Ornithologists' Union (contributed paper presentation). I have been asked to serve on a panel at the annual *PCIA-The wireless Infrastructure Association* meeting in September 2005, where the topic will be "Avian Mortality Issues: Potential Impact On Planned and Existing Wireless Infrastructures."

Current objectives

I will be continuing the process of NEXRAD data analysis. With the collaboration of radar ornithologist, Dr. Robb Diehl, the NEXRAD data will provide indices of migration intensity at communication towers included in the study. Given the time-consuming nature of examining and quantifying the large quantity of NEXRAD images collected during each field season, I will be working on this portion of the study whenever possible for the duration of the study.

I will continue to seek additional funding sources to further enhance this study. I will explore the benefits and costs of adding field seasons to the study, as well as adding privately-owned towers shorter than the current study's shortest height category, 116-146 m AGL.

I am currently recruiting and preparing for the fall 2005 field season. I am hopeful that many of the previous technicians can be retained for the fall 2005 field season. However, due to changing jobs and school schedules I will need to recruit new technicians for several of the towers.

Acknowledgments

This study could not be completed without the dedication, enthusiasm, and hard work of the technicians who conducted the early morning searches under communication towers -regardless of rainy and cold conditions. I appreciate the recruiting and advertising assistance of Michigan organizations and Internet list servers. This study is greatly enhanced by the inclusion of towers greater than $\geq$305 m (1000 ft) AGL. I owe a great amount of thanks to the private tower owners and engineers who by allowing us access to their sites, are taking important steps towards learning more about the issue of bird collisions with communication towers. The support of the Federal Aviation Administration (FAA) and Federal Communication Commission has allowed us to enhance this study via changing tower light systems. W. Erickson (WEST, Inc.) generously provided assistance and formats for calculating average detection probabilities considering both removal and observer detection rates. The interpretation and applicability of this study is greatly enhanced by his shared expertise. C. Mensing (United States Fish and Wildlife Service (USFWS)), and his technicians generously provided Brown-headed Cowbird carcasses. The use of NEXRAD is made possible by R. Diehl's (University of Southern Mississippi (USM)) interest and assistance. Many individuals regularly provide ideas, suggestions, and support for this project, including but not limited to: P. Kerlinger (Curry & Kerlinger, LLC), A. Manville (USFWS), C. Czarnecki (USFWS), S. Lewis (USFWS), G. Winegrad (American Bird Conservancy (ABC)), C. Schumacher (United States Forest Service (USFS)), E. Paul (Ornithological Council), B. Fisher (USFWS), J. Dingledine (USFWS), P. Lederle (Michigan Department of Natural Resources (MDNR)), R. Rustem (MDNR), M. Herbert (MDNR), T. Gehring (Central Michigan University (CMU)), and J. Janson (MDNR). I would like to express my gratitude to the USFWS, the MDNR and the NFWF for granting additional funds to improve this project. F. Moore (USM), M. Avery (United States Department of Agriculture), G. Winegrad (ABC), R. Rustem (MDNR) and an anonymous reviewer made time to provide official reviews for the NFWF grant proposal procedure. Central Michigan University and the USFS provide greatly appreciated logistical support for this research. The majority of the funding for this research is provided by the Michigan State Police. They have also allowed access to their towers and made possible the tower light system changes. A special thanks to those individuals who were involved in changing the MPSCS tower lighting systems. They frequently worked on weekends in order to complete the job. T. Shinew (MSPCS/ Michigan State Police), M. Scieszka (MSPCS/ Michigan State Police), I. Lopez (Office of the Michigan Attorney General), P. Ryan (Perkins Coie), F. Souchet (FAA), V. Vilaro (FAA), R. Matthews (FAA), K. Haggerty (FAA), F. Souchet (FAA), and M. Curry (Curry & Kerlinger, LLC) provide important logistical support for the study.

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