**ANNUAL REPORT**

# The Effect of Cell Towers on Birds and Bats at Rock Creek Park, Washington, D.C.

**SUBMITTED TO**

Ken Ferebee
Resource Management Specialist
Rock Creek Park, National Park Service
3545 Williamsburg Lane, NW
Washington, D.C. 20008

**SUBMITTED BY**

Stephanie D. Dickey and J. Edward Gates
University of Maryland Center for Environmental Science
Appalachian Laboratory
Frostburg, MD 21532
Phone: (301) 873-5445
Email: sdickey@al.umces.edu

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**Abstract**

This report details the first year of a three-year study on the potential effects of two existing telecommunication towers on migratory birds and bats in Rock Creek Park, Washington, D.C. The impact of tall towers (≥200 ft [61 m]) with obstruction lighting and guy wires on these species has been well documented, but shorter, monopole tower designs remain largely uninvestigated. The towers in Rock Creek Park are of this shorter, monopole design and lack obstruction lighting and guy wires. Mortality surveys were conducted on a daily basis during spring and fall migration periods, and weekly surveys were conducted during the summer. Preliminary results suggest that short, unlit, unguyed towers do not pose a significant threat to migratory birds and bats in this area.

## Introduction

Migratory birds must navigate across a landscape dominated by man-made structures as they move between wintering and breeding grounds and back again each year. Collision deaths associated with such structures have been documented in the United States since the late 1800's (Avery 1979), and efforts continue to quantify the magnitude of these losses today. A conservative estimate for avian fatalities due to communication towers ranges from 4-5 million per year (Erickson et al. 2005), but a more realistic estimate could range from 40-50 million tower kills per year (Manville 2001).

Beginning in the 1950's, and extending through the 60's and 70's, several investigators began conducting detailed studies of bird kills at individual communication towers. As the field began to widen, it soon became evident that several factors were involved including tower characteristics such as height, the presence of guy lines, and lighting scheme, as well as weather conditions, bird behavior at towers, and peak migration periods for nocturnal migrants. Insights into the mechanisms by which birds are killed at communication towers are now being used to make recommendations to curb the number of birds killed at these structures, as well as to develop monitoring guidelines to assist in on-going research.

### *Tower Height*

Most studies concerning the impact of telecommunication towers on migratory birds have focused almost exclusively on tall towers (Weir 1976, Avery et al. 1978, Avery et al. 1980, Trapp 1998, Derby et al. 2002, Johnson et al. 2000). In a 29-year period, approximately 44,007 birds were killed at a 204 m television tower in northern Leon County, Florida (Crawford and Engstrom 2001). This study was able to isolate tower height from all other factors by examining the same tower at three different heights. The tower was lengthened from its original 204 m height (1956-1959) to 308 m (1960-1963) and then shortened again to 94 m (1999). No significant difference was found between the numbers of birds killed when the tower was 204 m versus 308 m. When the number of bird kills in October 1999 and October 2000 at 94 m (no scavenger control) were compared with the 13 years of data from Octobers 1968-1973 and 1977-1983 (no scavenger control), the number of bird kills was lowered by a factor of 32 compared to when the tower was 308 m (Crawford and Engstrom 2001). Likewise, a west central

Wisconsin TV tower at its original 500 m height produced no recorded casualties, but when it was replaced with a 1000 m tower in 1957, 121,560 birds were killed over a 38-year period (Kemper 1996). In general, as tower height increases, so does its potential as a hazard to migrating birds.

***Tower Lighting, Guy Lines, and Bird Behavior at Towers***

Along with tower height itself, mortality is influenced by the infrastructure associated with tall towers: the stabilizing guy lines and the Federal Aviation Administration (FAA) lighting scheme. The placement of guy lines and the distance they extend from the tower has been shown to affect bird mortality (Avery et al. 1977). The 366 m Omega tower, stabilized by three sets of five guy lines anchored at 122 m, 213 m, and 297 m from the tower, was searched for carcasses with special attention directed toward the area directly under the guy lines. Overall, losses on overcast nights were concentrated near the tower, whereas losses on non-overcast nights were more evenly distributed. When comparing seasonal losses, the numbers of losses in spring were generally less than the fall losses closer to the tower, but exceeded fall losses farther out on both overcast and non-overcast nights. On overcast nights, large numbers of fall migrants are aloft and congregate around the tower, colliding with the structure itself, the guy lines, and other birds (Avery et al. 1977). Spring migrants tended to be aloft when winds were favorable for migration regardless of cloud cover; so much of the mortality took place on clear nights. On such nights, the birds seemed to avoid the tower itself, but sizeable losses still occurred via collision with outlying guy lines and transmitting cables (Avery et al. 1977).

Another killing potential of guy lines is their placement from tower to ground. In many tower constructions, the guy lines terminate at a common point some distance away from the base of the tower. This was the situation at a Nashville, Tennessee, site where a lower tower (247 ft [75 m]) and a higher tower (940 ft [287 m]) were compared. The largest numbers of casualties were found near and beyond two groups of guy cables which the migrants meet before reaching the high tower or the set of cables extending south as they fly from the north in the fall (Laskey 1960). Bierly (1968) suggested that the greater the angle of the wire from the vertical tower, the greater the amount of exposed wire at higher elevations and the greater the probability of tower casualties; therefore, an alternate construction is the connection of each individual cable to the ground at expanding intervals. Regardless, the presence of guy lines in any form is highly dangerous to migrants. There have been no studies published documenting bird kills at unguyed communication towers (Kerlinger 2004).

The lighting scheme interacts with guy line presence to compound the danger to nocturnally migrating birds. The FAA considers any tower 200 ft (61 m) or higher as a potential aviation hazard (Harden 2002), and as tower height increases so does the amount of obstruction lighting. The FAA requests three flashing red lights and four to six steady-burning red sidelights on communication towers 351-700 ft (107-213 m) tall, and five to seven flashing red lights and nine to twelve steady-burning red sidelights on towers 1,000-1,400 ft (305-427 m) tall (Kerlinger 2004). Tower lighting colors (red/white lights, ultraviolet, or specific wavelengths) and the duration of light (strobes, flashing lights, or steady lights) both affect the attraction of birds (Beason 2000), and attracted birds are reluctant to leave the lighted area. Migrants respond to lights by

following a circular flight pattern, flying through the tower framework to the edge of the lighted area, only to double-back toward the light and inevitably strike the guy lines (Graber 1968, Larkin 2000). Furthermore, the proportion of birds showing curved, circling, or hovering behavior is significantly higher in response to red lights than to white strobe lights (Gauthreaux 2000). However, the strobe effect may be more important than the color of the light itself. The longer the "off" phase between the flashes, the less likely birds are attracted to the lighting (Manville 2000).

***Weather and Migration Periods***

The majority of bird-tower kill studies specifically address the interaction of inclement weather conditions during the spring/fall migration periods with the hazardous tower characteristics discussed above. For instance, fall losses occur primarily under overcast skies associated with the passage of cold fronts; spring losses are characterized by smaller, more evenly distributed kills throughout the season (Avery et al. 1977). In central Illinois, 5,465 birds were collected on 13 dates between 2 September and 12 November 1972 on mornings following nights with reduced visibility from fog/precipitation, or with low cloud cover, or both. Interestingly, over 93% of all birds killed occurred on three nights in September and one night in October, following the passage of cold fronts with low ceilings of ≤550 m and reduced visibility of <8 km (Seets and Bohlen 1977). At an east-central Illinois tower, birds were killed on nights with 80-100% cloud cover, a ceiling of 400-1,600 ft (122-488 m), and obscured visibility (Brewer and Ellis 1958).

Although the number of birds killed by towers peaks during the migration months, the fall season tends to be the most deadly. In some instances, the fall migration period has been recorded to be ten times greater in mortality than the spring (Brewer and Ellis 1958). In the north Florida television tower study, about 20% of the total number of birds killed was during a two-month period in the spring and 65% occurred during a two-month period in the fall (Engstrom 2000). Of the 121,560 birds killed at a west central Wisconsin tower between 1957 and 1995, the compacted spring season (~75 days from April to June) produced more than 20 days with over 100 kills, while the extended fall season (mid-July to mid-November) produced much greater losses including "mega-kills" of up to 12,000 birds on a single night (Kemper 1996).

Southern New Mexico does not typically experience low visibility and fog conditions (Ginter and Desmond 2004) and, therefore, towers in this part of the country may not produce large bird kill events. Avian mortality investigated at six radio towers along the Rio Grande corridor in southern New Mexico, ranging in height from 265 m to 805 m and including guy lines and night lighting, produced only six specimens from 1 August-30 October 2001: four migrant passerines, one partial-carcass of a migrant passerine, and one migrant raptor (Ginter and Desmond 2004). Although this site was only monitored for a single fall season and other factors may have been involved resulting in so few carcasses retrieved, it is possible that more studies of bird casualties at communication towers in the southwestern United States could conclusively identify weather as the single most important factor in bird kills at towers.

***Rock Creek Park Project***

The current project concerning the effects of cell towers on birds and bats at Rock Creek Park, Washington, D.C., is one of the few studies to examine the effect of unlit (no obstruction lighting present, although one tower has a mounted light associated with the tennis facility), unguyed "short towers" (<200 ft [61 m]) on avian mortality. The insufficient Environmental Assessment (EA) filed by the National Park Service, resulting in the right-of-way permit for Bell Atlantic Mobile, Inc. (now Verizon Wireless) to construct the cell phone towers, was based on the misconception that short towers do not pose a threat to migratory birds. On 2 July 2002, the court ruled that the National Park Service must develop and adopt a program to monitor the impact of the existing telecommunications facilities on migratory birds. The University of Maryland Center for Environmental Science, Appalachian Laboratory, was contracted to conduct a three-year study, with each year consisting of a spring and fall assessment that coincides with bird and bat migrations and an abbreviated summer assessment. This report describes the results for the 2006 season.

## Methods

To determine the number of birds killed as a result of collision with the Rock Creek Park cell towers, the areas surrounding the towers were searched for carcasses from 24 May-15 November 2006. The tower adjacent to the tennis courts (TC tower) is 100 ft (30 m) in height (Figure 1) and is located within a row of light posts that illuminate the outdoor tennis courts. No FAA obstruction lighting is present on this tower, but a light has been mounted on the pole at the same height as the light posts. The TC tower is also near to a grassy picnic area with clumps of tall deciduous trees (e.g., *Fagus grandifolia, Quercus alba, Carya* sp., *Liriodendron tulipifera*) and shorter shrubby vegetation (e.g., *Smilax* sp., *Ampelopsis brevipedunculata, Lonicera* sp., *Toxicodendron radicans*), and various saplings. There is also a large paved parking lot and a larger tennis arena that fall within the search area of this particular tower. Many of the lights at the larger arena are significantly taller than the TC tower (Figure 2). The tower at the maintenance yard (MY tower) is 130 ft (40 m) in height (Figure 3) and is located on the sloping edge of a deciduous forest, consisting of oaks (*Quercus* sp.) and some of the same species noted near the TC tower. Scattered areas of undergrowth (e.g., *Polygonum cuspidatum, Vitus* sp., *Parthenocissus quinquefolia*, *Wisteria* sp., *Rubus phoenicolasius*) are also present. The park maintenance yard, as well as park offices, equipment, and a large paved parking lot, are prominent features at this site. Both towers lack obstruction lighting and are unguyed.

A double sampling approach was used for this study involving both ground and net sampling, as suggested by Manville (2002). Net sampling, similar to the method of Avery et al. (1978) and Avery and Beason (2000), allows for adjustment of the ground sampling estimates by correcting for carcass removal by scavengers and searcher efficiency bias based on the relative ratio of the number of carcasses found per unit area using the two sampling methods.

***Ground Sampling***

The search grids for each tower consisted of 21 N-S transect lines 100 m in length centered on the tower, forming a 100 m × 100 m square (prior to 2 June, the grid was 50 m × 50 m). Each transect was 5 m apart, yielding a 2.5 m search width on either side. Avery et al. (1978) found 63% of all the carcasses at their study site within 300 ft (91 m) of the 1,210 ft (369 m) guyed tower. Based on the relationship between the distance that a carcass is found from the tower and the tower height, we expected to find most carcasses in our study within 40 ft (12 m) of the towers, e.g., 1,210 ft/300 ft (369 m/91 m) is equivalent to 130 ft/33 ft (40 m/10 m). Ground searches were conducted daily at each tower site from 24 May- 15 November 2006, except for a one-month summer period (15 June-15 July) when searches were performed once per week. The entire ground area within the grid was searched as well as any rooftops falling inside the search area.

Notes: Due to the Mason-Legg/U.S. Open Tennis Tournament held near the TC tower from 29 July-6 August, as well as the week preceding and following, ground searches were more or less restricted to the southern half of the grid. From 17 September 2005 until mid-May 2006, a tennis bubble dome was in place over the tennis courts near the TC tower (see Figure 1).

***Net Sampling***

In addition to the daily ground searches, two 25 ft × 25 ft (7.62 m × 7.62 m) nylon nets were also erected at each tower site in order to catch any birds that might collide with the towers. The two nets were placed as close to the tower as possible, adjusting for the terrain and vegetation cover at each site. Due to a delay in delivery by the manufacturer, we were only able to monitor the nets during the fall migration period in 2006 (15 July-15 November). The two nets at the MY tower went up on 12 July, and the first net at the TC tower went up on 14 July and the second net on 8 September.

***Data Collection***

Carcass searches began at dawn (30 minutes before sunrise) in all seasons. Searches were conducted daily from 24 May to 15 June for the spring migration, and from 15 July to 15 November for the fall migration. During the summer season, 15 June-15 July, searches were conducted once per week. We tried to select nights with low ceiling height (cloud cover) and poor visibility for our weekly summertime searches whenever possible.

Each day that a tower was examined, beginning and ending time of each search, time spent searching, time since last search, and weather data were recorded. Weather data were recorded at the beginning of the search, for the previous night, and for the last 24 hours (including temperature, wind direction/speed, cloud cover %, ceiling height, barometric pressure, relative humidity, precipitation, and front activity). Current temperature, wind, cloud cover, and relative humidity were all recorded at the time of the search using a Kestrel (WeatherEssentials, Chandler, AZ) hand-held weather meter, while all other weather variables were taken from KDCA weather station at Reagan National Airport. All bird carcasses discovered during the searches were collected,

numbered, and placed in the freezer, and the species, date, exact location, distance from tower, perpendicular distance from nearest transect, body condition, probable cause of death, and any evidence of scavenging were recorded. Live birds observed in the area were also noted on datasheets.

### *Statistics*

In order to determine whether the bird casualties found during this study were likely due to collision with the tower, the mean distance of the carcasses from the towers was compared to the mean distance expected by chance using a Monte Carlo simulation. The null hypothesis for this test is that carcasses discovered during daily searches are incidental and so are randomly distributed throughout the search area. The alternate hypothesis is that carcasses are due to tower collision deaths and therefore are distributed closer to the tower than expected by chance. In the future, this test will be refined to accommodate searcher efficacy (i.e., high/low visibility) and missing parts of the search space (i.e., inaccessible parts of grid).

## Results

Between 24 May and 15 November 2006, transect searches produced a total of three dead birds, one partial carcass (wing), and five feather spots beneath the cell towers at Rock Creek Park during 151 daily searches and 432.5 search hours (Table 1). Net searches were also conducted from 15 July to 15 November 2006, during 124 search days. No birds were collected from the nets. No bat carcasses were found on the transect searches or in the nets during the 2006 season of the study. All fatalities occurred between 1 June and 25 July 2006, except for one feather spot found on 27 October 2006. Interestingly, virtually all mortalities at the Rock Creek Park towers occurred during the summer months, unlike most other studies where fall is the deadliest season. Furthermore, none of the birds or bird remains found were Neotropical migrants, despite their presence in the area (Table 2).

### *TC Tower*

A total of 163 search hours were spent at the TC tower. The highest number of casualties took place at this site, with three feather spots, one partial carcass, and one complete carcass being collected. The feather spots were identified as a gray catbird (*Dumetella carolinensis*) on 8 June, an American robin (*Turdus migratorius*) on 7 July, and a northern cardinal (*Cardinalis cardinalis*) on 25 July, found at 46 m, 47 m, and 28.5 m from the tower, respectively. The partial carcass found on 1 June, 4.7 m from the tower, consisted of a wing fragment possibly from a house sparrow (*Passer domesticus*). All of the feather spots appeared to have been the result of predation rather than scavenging, but this assessment has yet to be verified. The wing fragment, however, did appear to belong to a scavenged carcass, whether it was originally from predation or a tower kill is unknown, although it was not produced from a recent kill based on its condition. The complete carcass was a juvenile house sparrow (*Passer domesticus*) found 42.5 m from the tower on June 15. This bird appeared to have died from exposure and was found on

the sidewalk just outside the fence surrounding the tennis courts. None of the casualties suffered at this site were significantly closer to the tower than would be expected by chance (*P* (feather piles) = 0.499, *P* (feather piles + partial carcass) = 0.290, *P* (complete carcass) = 0.50, *P* (all carcass types) = 0.320) and, therefore, were unlikely to have been killed by striking the tower.

***MY Tower***

This site suffered slightly fewer casualties than did the TC site. A total of two feather spots and two complete carcasses were retrieved. The two feather spots were identified as rufous-sided towhees (*Pipilo erythrophthalmus)* on 17 July and 27 October 2006, and were located 62 m and 10 m away from the tower, respectively. Both feather spots appeared to be the result of predation, possibly by hawks. The two complete carcasses were both juvenile American robins (*Turdus migratorius*) found on 17 July and 24 July, located 1.36 m and 53 m from the tower, respectively. The robin found directly under the tower at 1.36 m is the only casualty that may have resulted from actually colliding with the tower. The other robin, found farther away, likely collided with the NPS office building next to which it was collected. None of the casualties suffered at this site were significantly closer to the tower than would be expected by chance (*P* (feather piles) = 0.448, *P* (complete carcass) = 0.258, *P* (all carcass types) = 0.351) and, therefore, were unlikely to have been killed by striking the tower.

**Discussion**

Telecommunication towers are a hazard to nocturnally migrating birds, especially those which are >200 ft (61 m) in height, guyed, and lighted. The spring and fall migration periods produce the most losses, and the birds most impacted are Neotropical migrants. While each of these factors presents their own dangers, it is their interaction that produces large, spectacular kills. The "worst case" scenario develops when nocturnally migrating birds are aloft on nights with low visibility and cloud cover associated with passing cold fronts, in the vicinity of a tall communication tower. Their celestial cues obstructed, the birds hone in on the lights of the tower and gravitate toward it. Once inside the halo of the tower's light, the birds are reluctant to leave it and inevitably some will strike the guy lines or the tower itself.

The effect of short (≤200 ft [61 m]) towers remains largely uninvestigated, along with the interactions between guy lines, weather, and lighting of these shorter towers. However, the preliminary data from this study suggest that the short monopole tower construction is not obstructive to migratory birds in this location. Overall, only three carcasses were collected during the study and six partial carcass/feather spots. With the exception of one bird at the MY site (juvenile American robin), all fatalities appeared to be unconnected to the towers. The TC tower which occurs within a string of lights for the tennis court, and even has lights mounted on it, failed to show any differences with the MY tower. However, there is night security lighting in the maintenance yard itself, near the MY tower.

Although this study had a truncated spring season (24 May-15 June vs. 15 April-15 June), it is unlikely that this resulted in the retrieval of significantly fewer carcasses,

because the fall months tend to be the deadliest in other studies. This study did have a complete fall season (15 July-15 November), during which only a single feather pile was found (27 October). Searcher efficiency is presumed to have been high, as no birds were found in the nets, suggesting that there was minimal scavenging bias.

It may not be appropriate, however, to generalize the results of this study across all short towers at this time. It is possible that some location effects are involved, and that the same towers in a different location (e.g., on a ridge top or near wetlands) might actually produce some kills. For instance, the height at which migrating birds in ROCR fly has not been documented, and therefore may be different from the height migrants fly elsewhere. Most passerine nocturnal migrants fly <1,000 m (Able 1973), but migration height can vary anywhere from <500 m to 3,000 m (Harper 1958, Tedd and Lack 1958, Graber and Cochran 1959, Hassler et al. 1963, Griffin 1973). Furthermore, it is possible that the interaction between the towers and weather conditions were just not right to produce kills during the 2006 season, and continued monitoring might reveal that fatalities do indeed occur.

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### Literature Cited

Able, K. P. 1973. The role of weather variables and flight direction in determining the magnitude of nocturnal bird migration. Ecology 54:1031-1041.

Avery, M. L. 1979. Review of avian mortality due to collisions with manmade structures. Wildlife Damage Management, Internet Center for Bird Control Seminars Proceedings, University of Nebraska, Lincoln, Nebraska, USA.

Avery, M. L., and R. C. Beason. 2000. Avian mortality at short (<120m) communication towers. Pilot Study Research Proposal to the Communication Tower Working Group. 7 pp. (unpublished manuscript).

Avery, M. L., P. F. Springer, and J. F. Cassel. 1977. Weather influences on nocturnal bird mortality at a North Dakota tower. Wilson Bulletin 89:291-299.

Avery, M.L. 1978. The composition and seasonal variation of bird losses at a tall tower in southeastern North Dakota. American Birds 32:1114-1121.

Avery, M. L., P. F. Springer, and N. S. Dailey. 1980. Avian mortality at man-made structures: an annotated bibliography (revised from 1978 edition). U.S. Fish and Wildlife Service, Biological Services Program, National Power Plant Team, FWS/OBS-80/54.

Beason, R. 2000. The bird brain: magnetic cues, visual cues, and radio frequency (RF) effects. *In* W.R. Evans and A.M. Manville, II, editors. Avian mortality at communication towers. Transcripts of Proceedings of the Workshop on Avian

Mortality at Communication Towers, August 11, 1999, Cornell University, Ithaca, New York, USA.

Bierly, M. L. 1968. 1968. Birmingham tower casualties. Alabama Birdlife 17:46-49.

Brewer, R., and J. A. Ellis. 1958. An analysis of migrating birds killed at a television tower in east-central Illinois, September 1955-May 1957. Auk 75:400-414.

Crawford, R. L., and R. T. Engstrom. 2001. Characteristics of avian mortality at a north Florida television tower: a 29-year study. Journal of Field Ornithology 72:380-388.

Derby, C., W. P. Erickson, and M. D. Strickland. 2002. Protocol for monitoring impacts of seven un-guyed, unlit cellular telecommunication towers on migratory birds and bats within the Coconino and Prescott National Forests, Arizona. Western EcoSystems Technology (WEST), Inc., Cheyenne, Wyoming, USA.

Engstrom, R. T. 2000. Lights, towers, and avian mortality: where is the science? *In* W. R. Evans and A. M. Manville, II, editors. Avian mortality at communication towers. Transcripts of Proceedings of the Workshop on Avian Mortality at Communication Towers, August 11, 1999, Cornell University, Ithaca, New York, USA.

Erickson, W. P., G. D. Johnson, and D. P. Young, Jr. 2005. A summary and comparison of bird mortality from anthropogenic causes with an emphasis on collisions. U.S. Department of Agriculture, Forest Service, Gen. Tech. Rep.191:1029-1042.

Gauthreaux, S. 2000. The behavioral responses of migrating birds to different lighting systems on tall towers. *In* W. R. Evans and A. M. Manville, II, editors. Avian mortality at communication towers. Transcripts of Proceedings of the Workshop on Avian Mortality at Communication Towers, August 11, 1999, Cornell University, Ithaca, New York, USA.

Ginter, D. L., and M. J. Desmond. 2004. Avian mortality during fall 2001 migration at communication towers along the Rio Grande corridor in southern New Mexico. Southwestern Naturalist 49:414-417.

Graber, R. R. 1968. Nocturnal migration in Illinois - different points of view. Wilson Bulletin 80:36-71.

Graber, R. R., and W. W. Cochran. 1959. An audio technique for the study of nocturnal migration of birds. Wilson Bulletin 71:220-236.

Griffin, D. R. 1973. Oriented bird migration in or between opaque cloud layers. Proceedings of the American Philosophical Society 117:117-141.

Harden, J. 2002. An overview of anthropogenic causes of avian mortality. Journal of Wildlife Rehabilitation 25:4-11.

Harper, W. G. 1958. Detection of bird migration by centimetric radar--a cause of radar 'angels'. Proceedings of the Royal Society of London, Series B, Biological Sciences 149:484-502.

Hassler, S. S., R. R. Graber, and F. C. Bellrose. 1963. Fall migration and weather, a radar study. Wilson Bulletin 75:56-77.

Johnson, G. D., W. P. Erickson, M. D. Strickland, M. F. Shepherd, and D. A. Shepherd. 2000. Final report, avian monitoring studies at the Buffalo Ridge, Minnesota Wind Resource Area: results of a four-year study. WEST, Inc., Cheyenne, Wyoming, USA.

Kemper, C. 1996. A study of bird mortality at a west central Wisconsin TV tower from 1957-1995. Passenger Pigeon 58:219-235.

Kerlinger, P. 2004. What have studies of communication towers suggested regarding the impact of guy wires and lights on birds and bats? Pages 74-77 *in* S. S. Schwartz, editor. Proceedings of the wind energy and birds/bats: understanding and resolving bird and bat impacts, Washington, D.C., May 18-19, 2004. Prepared by RESOLVE, Inc., Washington, D.C., September 2004.

Larkin, R. 2000. Investigating the behavioral mechanisms of tower kills. *In* W. R. Evans and A. M. Manville, II, editors. Avian mortality at communication towers. Transcripts of Proceedings of the Workshop on Avian Mortality at Communication Towers, August 11, 1999, Cornell University, Ithaca, New York, USA.

Laskey, A. R. 1960. Bird migration casualties and weather conditions, autumns 1958-1959-1960. Migrant 31:61-65.

Manville, A. M., II. 2000. The ABCs of avoiding bird collisions at communication towers: the next steps. Proceedings of the Avian Interactions Workshop, December 2, 1999, Charleston, South Carolina, Electric Power Research Institute, Palo Alto, California, USA.

Manville, A. M., II. 2001. Avian mortality at communication towers: steps to alleviate a growing problem. Pages 75-86 *in* B. B. Levitt, editor. Cell towers - wireless convenience? or environmental hazard? Proceedings of the "Cell Towers Forum," State of the Science/State of the Law, December 2, 2000, Litchfield, Connecticut. New Century Publishing 2000, Markham, Ontario, Canada.

Manville, A. M., II. 2002. Protocol for monitoring the impact of cellular telecommunication towers on migratory birds in Coconino, Kaibab, and Prescott National Forest, Arizona. Protocol developed for United States Forest Service.

Seets, J. W., and H. D. Bohlen. 1977. Comparative mortality of birds at television towers in central Illinois. Wilson Bulletin 89:422-433.

Tedd, J. G., and D. Lack. 1958. The detection of bird migration by high-power radar. Proceedings of the Royal Society of London, Series B, Biological Sciences 149:503-510.

Trapp, J. L. 1998. Bird kills at towers and other human-made structures: an annotated partial bibliography (1960-1998). U.S. Fish and Wildlife Service, Office of Migratory Bird Management, Arlington, Virginia, USA. http://www.fws.tgov/migratorybirds/issues/tower.html

Weir, R. D. 1976. Annotated bibliography of bird kills at man-made obstacles: a review of the state of the art and solutions. Canadian Wildlife Service, Ontario Region, Ottawa, Canada.

Table 1. Avian casualties recorded at cell towers in Rock Creek Park, Washington, D.C., from 24 May-15 November 2006.

| Common name | Scientific name | Family | Date | Distance (m) from tower | Type |
|---|---|---|---|---|---|
| House sparrow? | *Passer domesticus* | Passeridae | June 1 | 4.7 | Partial |
| Gray catbird? | *Dumetella carolinensis* | Paridae | June 8 | 46 | Feather spot |
| House sparrow | *Passer domesticus* | Passeridae | June 15 | 42.5 | Complete |
| American robin? | *Turdus migratorius* | Muscicapidae sub. Turdinae | July 7 | 47 | Feather spot |
| Rufous-sided towhee | *Pipilo erythrophthalmus* | Emberizidae Sub. Emberizinae | July 17 | 62 | Feather spot |
| American robin | *Turdus migratorius* | Muscicapidae sub. Turdinae | July 17 | 1.36 | Complete |
| American robin | *Turdus migratorius* | Muscicapidae sub. Turdinae | July 24 | 53 | Complete |
| Northern cardinal | *Cardinalis cardinalis* | Emberizidae sub. Cardinalinae | July 25 | 28.5 | Feather spot |

| Common name | Scientific name | Family | Date | Distance (m) from tower | Type |
|---|---|---|---|---|---|
| Rufous-sided towhee | *Pipilo erythrophthalmus* | Emberizidae sub. Emberizinae | October 27 | 10 | Feather spot |

Table 2. Live birds observed[1] and/or heard during carcass searches at Rock Creek Park, Washington, D.C., from 24 May-15 November 2006.

| Common name | Scientific name | Family | No. observations[2] |
|---|---|---|---|
| American crow | *Corvus brachyrhyncos* | Corvidae | 91 |
| American goldfinch | *Carduelis tristis* | Fringillidae | 5 |
| American redstart | *Setophaga ruticilla* | Emberizidae, sub. Parulinae | 2 |
| American robin | *Turdus migratorius* | Muscicapidae, sub. Turdinae | 124 |
| Black-and-white warbler | *Mniotilta varia* | Emberizidae, sub. Parulinae | 1 |
| Black-throated Green warbler | *Dendroica caerulescens* | Emberizidae, sub. Parulinae | 1 |
| Blue jay | *Cyanocitta cristata* | Corvidae | 68 |
| Blue-gray gnatcatcher | *Piloptila caerulea* | Muscicapidae, sub. Sylviinae | 1 |
| Brown creeper | *Certhia americana* | Certhiidae | 3 |
| Brown thrasher | *Toxostoma rufrum* | Mimidae | 40 |
| Brown-headed cowbird | *Molothrus ater* | Emberizidae, sub. Icterinae | 14 |
| Canada goose | *Branta canadensis* | Anatidae | 5 |
| Carolina chickadee | *Parus carolinensis* | Paridae | 21 |

| Common name | Scientific name | Family | No. observations[2] |
|---|---|---|---|
| Carolina wren | *Thryothorus ludovivicanus* | Troglodytidae | 112 |
| Cedar waxwing | *Bombycilla cedrorum* | Bombycillidae | 1 |
| Common grackle | *Quiscalis quiscula* | Emberizidae, sub. Icterinae | 33 |
| Common yellowthroat | *Geothlypis trichas* | Emberizidae, sub. Parulinae | 8 |
| Downy woodpecker | *Picoides pubescens* | Picidae | 16 |
| Eastern phoebe | *Sayornis phoebe* | Tyrannidae | 3 |
| Eastern wood-peewee | *Contopus virens* | Tyrannidae | 2 |
| European starling | *Sturnus vulgaris* | Sturnidae | 82 |
| Fish crow | *Corvus ossifragus* | Corvidae | 2 |
| Golden-crowned kinglet | *Regulus satrapa* | Muscicapidae, sub. Sylviinae | 1 |
| Gray catbird | *Dumetella carolinensis* | Mimidae | 116 |
| Hairy woodpecker | *Picoides villosus* | Picidae | 4 |
| Hermit thrush | *Catharus guttatus* | Muscicapidae, sub. Turdinae | 4 |
| House finch | *Carpodacus mexicanus* | Fringillidae | 5 |
| House sparrow | *Passer domesticus* | Passeridae | 84 |

| Common name | Scientific name | Family | No. observations[2] |
|---|---|---|---|
| House wren | *Troglodytes aedon* | Troglodytidae | 5 |
| Mourning dove | *Zenaida macroura* | Columbidae | 43 |
| Northern cardinal | *Cardinalis cardinalis* | Emberizidae, sub. Cardinalinae | 113 |
| Northern mockingbird | *Mimus polyglottos* | Mimidae | 23 |
| Ovenbird | *Seiurus aurocapillus* | Emberizidae, sub. Parulinae | 5 |
| Pileated woodpecker | *Dryocopus pileatus* | Picidae | 6 |
| Red-bellied woodpecker | *Melanerpes carolinus* | Picidae | 32 |
| Red-tailed hawk | *Buteo jamaicensis* | Accipitridae | 1 |
| Ruby-crowned kinglet | *Regulus calendula* | Muscicapidae, sub. Sylviinae | 13 |
| Rufous-sided towhee | *Pipilio erythrophthalmus* | Emberizidae, sub. Emberizinae | 74 |
| Scarlet tanager | *Piranga rubra* | Emberizidae, sub. Thraupinae | 3 |
| Slate-colored junco | *Juncus hyemalis* | Emberizidae, sub. Emberizinae | 19 |
| Song sparrow | *Melospiza melodia* | Emberizidae, sub. Emberizinae | 9 |
| Tufted titmouse | *Parus bicolor* | Paridae | 60 |
| Turkey vulture | *Cathartes aura* | Cathartidae | 1 |

| Common name | Scientific name | Family | No. observations[2] |
|---|---|---|---|
| White-breasted nuthatch | *Sitta carolinensis* | Sittidae | 51 |
| White-throated sparrow | *Zonotrichia albicollis* | Emberizidae, sub. Emberizinae | 25 |
| Winter wren | *Troglodytes troglodytes* | Troglodytidae | 3 |
| Wood thrush | *Hylocichla mustelina* | Muscicapidae, sub. Turdinae | 17 |
| Yellow-shafted flicker | *Colaptes auratus* | Picidae | 19 |

[1] Live birds observed is not an exhaustive list and is limited to those birds identifiable by the searcher.
[2] Number of observations refers to the number of days a particular species was observed within 151 search days.

Figure 1. Tennis court (TC) tower located in Rock Creek Park, Washington, D.C., on 29 April 2006. Note the lights low on the tower and the white bubble dome over the tennis courts in the background.

Figure 2. TC tower located north of the tennis facility in Rock Creek Park, Washington, D.C., on 29 April 2006. The black arrow indicates the position of the tower. Note that several lights surrounding the tennis arena are taller in comparison to the TC tower.

Figure 3. Maintenance yard (MY) tower located in Rock Creek Park, Washington, D.C., on 29 April 2006.

**ANNUAL REPORT 2007**

# The Effect of Cell Towers on Birds and Bats at Rock Creek Park, Washington, D.C.

**SUBMITTED TO**

Ken Ferebee
Resource Management Specialist
National Park Service, Rock Creek Park
3545 Williamsburg Lane, NW
Washington, D.C. 20008

**SUBMITTED BY**

Stephanie D. Dickey and J. Edward Gates
University of Maryland Center for Environmental Science
Appalachian Laboratory
301 Braddock Road
Frostburg, Maryland 21532
Phone: (301) 873-5445
Email: sdickey@al.umces.edu

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## Abstract

This report details the second year of a three-year study on the potential effects of two existing telecommunication towers on migratory birds and bats in Rock Creek Park, Washington, D.C. The impact of tall towers (≥200 ft [61 m]) with obstruction lighting and guy wires on these species has been well documented, but shorter, monopole tower designs remain largely uninvestigated. The towers in Rock Creek Park are of this shorter, monopole design and lack obstruction lighting and guy wires. Mortality surveys were conducted on a daily basis during spring and fall migration periods, and weekly surveys were conducted during the summer. Preliminary results from the first two years suggest that short, unlit, unguyed towers do not pose a significant threat to migratory birds and bats in this area.

## Introduction

Migratory birds must navigate across a landscape dominated by man-made structures as they move between wintering and breeding grounds and back again each year. Collision deaths associated with such structures have been documented in the United States since the late 1800's (Avery 1979), and efforts continue to quantify the magnitude of these losses today. A conservative estimate for avian fatalities due to communication towers ranges from 4-5 million per year (Erickson et al. 2005), but a more realistic estimate could range from 40-50 million tower kills per year (Manville 2001).

Beginning in the 1950's, and extending through the 60's and 70's, several investigators began conducting detailed studies of bird kills at individual communication towers. As the field began to widen, it became evident that several factors were involved including tower characteristics such as height, the presence of guy lines, and lighting scheme, as well as weather conditions, bird behavior at towers, and peak migration periods for nocturnal migrants. Insights into the mechanisms by which birds are killed at communication towers are now being used to make recommendations to curb the number of birds killed at these structures, as well as to develop monitoring guidelines to assist in on-going research.

### *Rock Creek Park Project*

The current project concerning the effects of cell towers on birds and bats at Rock Creek Park, Washington, D.C., is one of the few studies to examine the effect of unlit (no obstruction lighting present, although one tower has a mounted light associated with a tennis facility), unguyed "short towers" (<200 ft [61 m]) on avian mortality. The insufficient Environmental Assessment (EA) filed by the National Park Service, resulting in the right-of-way permit for Bell Atlantic Mobile, Inc. (now Verizon Wireless) to construct the cell phone towers, was based on the belief that short towers do not pose a threat to migratory birds. On 2 July 2002, the court ruled that the National Park Service must develop and adopt a program to monitor the impact of the existing telecommunications facilities on migratory birds. The University of Maryland Center for Environmental Science, Appalachian Laboratory, was contracted to conduct a three-year study, with each year consisting of a spring and fall assessment that coincides with bird

and bat migrations and an abbreviated summer assessment. This report describes the results for the 2007 season.

## Methods

To determine the number of birds killed as a result of collisions with the Rock Creek Park cell towers, the areas surrounding the towers were searched for carcasses from 15 April-15 November 2007 (Figure 1). A control plot grid and transect lines were added on 29 May 2007; this area was searched for carcasses from 29 May-15 November 2007 (Figure 1). The tower adjacent to the tennis courts (TC tower) is 100 ft (30 m) in height (Figure 2) and is located within a row of light posts that illuminate the outdoor tennis courts. No FAA obstruction lighting is present on this tower, but a light has been mounted on the pole at the same height as the light posts. The TC tower is also near to a grassy picnic area with clumps of tall deciduous trees (e.g., *Fagus grandifolia, Quercus alba, Carya* sp., *Liriodendron tulipifera*) and shorter shrubby vegetation (e.g., *Smilax* sp., *Ampelopsis brevipedunculata, Lonicera* sp., *Toxicodendron radicans*), and various saplings. There is also a large paved parking lot and a larger tennis arena that fall within the search area of this particular tower. Many of the lights at the larger arena are significantly taller than the TC tower. The tower at the maintenance yard (MY tower) is 130 ft (40 m) in height (Figure 3) and is located on the sloping edge of a deciduous forest, consisting of oaks (*Quercus* sp.) and some of the same species noted near the TC tower. Scattered areas of undergrowth (e.g., *Polygonum cuspidatum, Vitus* sp., *Parthenocissus quinquefolia*, *Wisteria* sp., *Rubus phoenicolasius*) are also present. The park maintenance yard, as well as park offices, equipment, and a large paved parking lot, are prominent features at this site. Both towers lack obstruction lighting and are unguyed, however, there is night security lighting in the maintenance yard proper The Nature Center control plot (NC) (Figure 4) is located along the same ridge as the MY tower, and is separated from the MY area by the Horse Center. This site is characterized by the Nature Center building, a wooden walkway/observation area, an upper and lower paved parking lot with an island of deciduous forest and picnic area in between, and a larger expanse of forest and trails extend beyond the Nature Center proper (the Nature Center building and observation area are not located within the search area).

A double sampling approach was used for this study involving both ground and net sampling, as suggested by Manville (2002). Net sampling, similar to the method of Avery (1978) and Avery and Beason (2000), allows for adjustment of the ground sampling estimates by correcting for carcass removal by scavengers and searcher efficiency bias based on the relative ratio of the number of carcasses found per unit area using the two sampling methods.

### *Ground Sampling*

The search grids for each tower consisted of 21 N-S transect lines 100 m in length centered on the tower, forming a 100 m × 100 m square (i.e., 10,000 $m^2$). Each transect was 5 m apart, yielding a 2.5 m search width on either side. Where necessary, plastic stakes, spray paint, or vinyl flagging were used to indicate direction, distance, and end points. Ground searches were conducted daily at each tower site from 15 April-15

November 2007, except for a one-month summer period (15 June-15 July) when searches were performed once per week. The entire ground area within the grid was searched as well as any rooftops falling inside the search area; however, approximately 2,500 $m^2$ of the MY grid falls within the MY proper and is inaccessible for searches.

In 2007, a control plot (no tower) was added to the study (Figure 4). The ROCR Nature Center and the surrounding area were chosen for the control site because it lies on the same ridge as the MY tower, and encompasses the same relief and structural elements as the other sites: parking lot, wooded areas, buildings, etc. The search grid for the control plot consisted of 21 NW-SE transect lines, 100 m in length, forming a 100 m × 100 m square. Each transect was 5 m apart, yielding a 2.5 m search width on either side. Where necessary, plastic stakes, spray paint, or vinyl flagging were used to indicate direction, distance, and end points.

Avery (1978) found 63% of all the carcasses at their study site within 300 ft (91 m) of a 1,210 ft (369 m) guyed tower. Based on the relationship between the distance that a carcass is found from the tower and the tower height, we expected to find most carcasses in our study within 40 ft (12 m) of the towers, e.g., 1,210 ft/300 ft (369 m/91 m) is equivalent to 130 ft/33 ft (40 m/10 m).

Notes: Due to the Legg Mason Tennis Classic held near the TC tower from 28 July-5 August, as well as the week preceding and following, ground searches were more or less restricted to the southern half of the grid. From 18 September 2007 until mid-May 2008, a tennis bubble dome was in place over the tennis courts near the TC tower (see Figure 2).

***Net Sampling***

In addition to the daily ground searches, two 25 ft × 25 ft (7.62 m × 7.62 m) nylon nets were also erected at each tower site in order to catch any birds that might collide with the towers. The two nets were placed as close to the tower as possible, adjusting for the terrain and vegetation cover at each site. Net searches were conducted daily at each tower site from 15 April-15 November 2007, except for the one-month summer period (15 June-15 July) when searches were performed once per week. No nets were erected in the control plot, as there was no tower at this site.

***Data Collection***

Carcass searches began at dawn (30 minutes before sunrise) in all seasons. Searches were conducted daily from 15 April to 15 June for the spring migration, and from 15 July to 15 November for the fall migration. During the summer season, 15 June-15 July, searches were conducted once per week. We tried to select nights with low ceiling height (cloud cover) and poor visibility for our weekly summertime searches whenever possible.

Each day that a tower was examined, beginning and ending time of each search, time spent searching, time since last search, and weather data were recorded. Weather data were recorded at the beginning of the search, for the previous night, and for the last

24 hours (including temperature, wind direction/speed, cloud cover %, ceiling height, barometric pressure, relative humidity, precipitation, and front activity). Current temperature, wind, cloud cover, and relative humidity were all recorded at the time of the search using a Kestrel (WeatherEssentials, Chandler, AZ) hand-held weather meter, while all other weather variables were taken from KDCA weather station at Reagan National Airport. All bird carcasses discovered during the searches were collected, numbered, and placed in the freezer, and the species, date, exact location, distance from tower, perpendicular distance from nearest transect, body condition, probable cause of death, and any evidence of scavenging were recorded. Live birds observed in the area were also noted on datasheets.

### *Statistics*

In order to determine whether the bird casualties found during this study were likely due to collision with the tower, the mean distance of the carcasses from the towers was compared to the mean distance expected by chance using a Monte Carlo simulation. The null hypothesis for this test is that carcasses discovered during daily searches are incidental and so are randomly distributed throughout the search area. The alternate hypothesis is that carcasses are due to tower collision deaths and therefore are distributed closer to the tower than expected by chance. For the 2007 season, partial and complete carcass types were pooled together for the TC tower and the NC plot due to insufficient values for statistical analysis (n = 1 for each carcass type at each site).

### *Search Area Images*

Images of the search areas in Rock Creek Park were created using 2007 Google Earth software.

## Results

Between 15 April and 15 November 2007, or 29 May and 15 November 2007 for the control plot, transect searches produced a total of two dead birds, two partial carcasses, and ten feather spots beneath the cell towers and within the control plot at Rock Creek Park during 189 daily searches and 729.5 search hours (Table 1). Net searches were also conducted in this time frame, but no birds were collected from the nets. No bat carcasses were found on the transect searches or in the nets during the 2007 season of the study. Fatalities occurred during every month of the survey except for June (searches were conducted daily in June until 15 June, which began the summer period where searches were conducted weekly). All search areas, including the control plot, suffered losses. Interestingly, the spring and summer months resulted in virtually the same number of fatalities (6) as the fall months (8), unlike most other studies where fall is the deadliest season. Furthermore, none of the birds or bird remains found were Neotropical migrants, despite their presence in the area (Table 2).

***TC Tower***

A total of 212 search hours were spent at the TC tower. The fewest number of casualties took place at this site, with one feather spot, one partial carcass, and one complete carcass being collected. The feather spot found on 28 October 2007 was unable to be identified, and was collected 4.25 m from the tower. This fatality appeared to have been the result of predation, despite its proximity to the tower, but this assessment could not be verified. The unidentified partial carcass found on 23 July 2007, 55 m from the tower, just outside the search area, consisted of feathers and several wing fragments. The partial carcass appeared to have been scavenged due to the fragments of wing tissue accompanying the feathers, but whether it was originally generated from predation or a tower kill is unknown. The complete carcass, found on 13 November 2007, was that of a slate-colored junco (*Junco hyemalis*) collected 47.2 m from the tower. This bird did not have any visible injuries, and there was no indication of cause of death. None of the casualties at this site were significantly closer to the tower than would be expected by chance ($P$ (partial + complete carcasses) = 0.903, $P$ (feather spots) = NA due to insufficient values (n = 1), $P$ (all carcass types) = 0.360) and, therefore, were unlikely to have been killed by striking the tower.

Compilation of the TC data for both 2006 and 2007 shows a similar trend as the two years separately. None of the carcass types occurred closer to the tower than expected by chance ($P$ (feather spots) = 0.176, $P$ (partial carcasses) = 0.205, $P$ (complete carcasses) = 0.722, $P$ (all carcass types) = 0.223).

***MY Tower***

This site suffered the highest number of casualties of all three sites. A total of seven feather spots were retrieved, but no partial or complete carcasses were found. The first feather spot was an unidentifiable species found on 17 April 2007, 24 m from the tower. Two more unidentified feather spots were found on 21 September and 1 October 2007, lying 6.75 m and 38.5 m way from the tower, respectively. Those feather spots that were identifiable (4 total) were all mourning doves (*Zenaida macroura*). Two were found on 11 May 2007 at 30.5 m and 26 m away from the tower, one on 29 October 2007 at 25 m away, and another on 11 November 2007 at 25.5 m away from the tower, respectively. All feather spots at this location appeared to be the result of predation, possibly by hawks. The casualties suffered at this site were significantly closer to the tower than would be expected by chance ($P$ (feather spots) = 0.010). Despite these fatalities being closer to the tower, the significance of carcass position in relation to the tower is more likely due to the topography of the maintenance yard and not due to the presence of the tower itself (the MY tower is positioned at the edge of the parking lot on one side and the ground slopes down into deciduous forest on the other side). Mourning doves, contributing to more than half the number of feather spots, are not as agile as smaller birds and are easy prey for raptors in this flat, open space at the yard. Once more, none of the casualties at the MY tower were Neotropical migrants.

Compilation of the MY data for both 2006 and 2007, shows a similar trend as the 2007 season alone. Partial and complete carcass types either did not occur or did not occur significantly closer to the tower ($P$ (partial carcasses) = NA due to insufficient

values (n = 0), *P* (complete carcasses) = 0.141), but feather spots were significantly closer to the tower (*P* (feather spots) = 0.013). The significance of the pooled data, however, is obviously driven by the difference in numbers of observations for feather spots between the two years (n = 2 in 2006 and n = 7 in 2007), and so is disproportionately reflective of the 2007 season. In the 2006 season, none of the carcass types were significantly closer to the tower than expected.

***NC Control Plot***

The NC control plot experienced at least one of all three types of fatalities: two feather spots, one partial carcass, and one complete carcass. The first feather spot was found 4 October 2007 at 45 m away from the center of the plot, and was identified as the remnants of a common grackle (*Quiscalus quiscula*). The second feather spot was collected on 12 November 2007 at 54.5 m away from the center, and identified as a mourning dove (*Zenaida macroura*). Both feather spots were most likely due to predation, possibly by raptors, based on the location of the spots and the amount/distribution of feathers. The partial carcass was unable to be identified and was collected on 31 August 2007, 60.96 m from the center of the plot. The complete carcass found on 30 July 2007, was identified as a white-breasted nuthatch (*Sittia sitta*) and was collected 52.38 m from the center. None of the casualties suffered at this site were significantly closer to the center of the plot than would be expected by chance (*P* (feather spots) = 0.877, *P* (partial + complete carcasses) = 0.976, *P* (all carcass types) = 0.990), and none of the casualties were identified as Neotropical migrants.

**Discussion**

Telecommunication towers are a hazard to nocturnally migrating birds, especially those which are >200 ft (61 m) in height, guyed, and lighted. The spring and fall migration periods produce the most losses, and the birds most impacted are Neotropical migrants. While each of these factors presents their own dangers, it is their interaction that produces large, spectacular kills. The "worst case" scenario develops when nocturnally migrating birds are aloft on nights with low visibility and cloud cover associated with passing cold fronts, in the vicinity of a tall communication tower. Their celestial cues obstructed, the birds hone in on the lights of the tower and gravitate toward it. Once inside the halo of the tower's light, the birds are reluctant to leave it and inevitably some will strike the guy lines or the tower itself.

The effect of short (≤200 ft [61 m]) towers remains largely uninvestigated, along with the interactions between guy lines, weather, and lighting of these shorter towers. However, the preliminary data from this study suggest that the short monopole tower construction is not obstructive to migratory birds in this location. Overall, only two carcasses (resident birds or short-distance migrants) were collected during the study, in addition to two partial carcass and ten feather spots. With the exception of the feather spots at the MY site (primarily remnants of mourning doves), all fatalities appeared to be unconnected to the towers. Furthermore, the MY feather spots were most likely the result of the topography surrounding the tower; this ridge-top location with flat, open areas might encourage predation by raptors. A pair of red-shouldered hawks (*Buteo lineatus*)

are known to nest somewhere between the maintenance yard and the Nature Center, and are frequently observed at both locations along with other Accipiters. Searcher efficiency is presumed to have been high, as no birds were found in the nets, suggesting that there was minimal scavenging bias.

As alluded to in the MY Results section, compilation of data from the 2006 and 2007 seasons may not be a useful type of analysis unless numbers of observations can be controlled or adjusted. For the TC site, the number of observations for each carcass type were fairly comparable (2006 feather spots n = 3, 2006 partial carcasses n = 1, 2006 complete carcasses n = 1 vs. 2007 feather spots n = 1, 2007 partial carcasses n = 1, 2007 complete carcasses n = 1), but at the MY site there were no partial or complete carcasses in 2007 (versus n = 0 and n = 2 in 2006, respectively), and the number of feather spots was more than triple (n = 2 for 2006 and n = 7 for 2007). This resulted in the pooled data for the MY to be overly representative of the 2007 season.

It may not be appropriate, however, to generalize the results of this study across all short towers at this time. It is possible that some location effects are involved, and that the same towers in a different location (e.g., on a ridge top or near wetlands) might actually produce some kills. For instance, the height at which migrating birds in ROCR fly has not been documented, and therefore may be different from the height migrants fly elsewhere. Most passerine nocturnal migrants fly <1,000 m (Able 1973), but migration height can vary anywhere from <500 m to 3,000 m (Harper 1958, Tedd and Lack 1958, Graber and Cochran 1959, Hassler et al. 1963, Griffin 1973). Furthermore, it is possible that the interaction between the towers and weather conditions were just not right to produce kills during the 2007 season, and continued monitoring might reveal that fatalities do indeed occur.

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## Literature Cited

Able, K. P. 1973. The role of weather variables and flight direction in determining the magnitude of nocturnal bird migration. Ecology 54:1031-1041.

Avery, M. L. 1979. Review of avian mortality due to collisions with manmade structures. Wildlife Damage Management, Internet Center for Bird Control Seminars Proceedings, University of Nebraska, Lincoln, Nebraska, USA.

Avery, M. L., and R. C. Beason. 2000. Avian mortality at short (<120m) communication towers. Pilot Study Research Proposal to the Communication Tower Working Group. 7 pp. (unpublished manuscript).

Avery, M.L. 1978. The composition and seasonal variation of bird losses at a tall tower in southeastern North Dakota. American Birds 32:1114-1121.

Erickson, W. P., G. D. Johnson, and D. P. Young, Jr. 2005. A summary and comparison of bird mortality from anthropogenic causes with an emphasis on collisions. U.S. Department of Agriculture, Forest Service, Gen. Tech. Rep.191:1029-1042.

Graber, R. R., and W. W. Cochran. 1959. An audio technique for the study of nocturnal migration of birds. Wilson Bulletin 71:220-236.

Griffin, D. R. 1973. Oriented bird migration in or between opaque cloud layers. Proceedings of the American Philosophical Society 117:117-141.

Harper, W. G. 1958. Detection of bird migration by centimetric radar--a cause of radar 'angels'. Proceedings of the Royal Society of London, Series B, Biological Sciences 149:484-502.

Hassler, S. S., R. R. Graber, and F. C. Bellrose. 1963. Fall migration and weather, a radar study. Wilson Bulletin 75:56-77.

Manville, A. M., II. 2001. Avian mortality at communication towers: steps to alleviate a growing problem. Pages 75-86 *in* B. B. Levitt, editor. Cell towers - wireless convenience? or environmental hazard? Proceedings of the "Cell Towers Forum," State of the Science/State of the Law, December 2, 2000, Litchfield, Connecticut. New Century Publishing 2000, Markham, Ontario, Canada.

Manville, A. M., II. 2002. Protocol for monitoring the impact of cellular telecommunication towers on migratory birds in Coconino, Kaibab, and Prescott National Forest, Arizona. Protocol developed for United States Forest Service.

Tedd, J. G., and D. Lack. 1958. The detection of bird migration by high-power radar. Proceedings of the Royal Society of London, Series B, Biological Sciences 149:503-510.

Table 1. Avian casualties recorded at cell towers in Rock Creek Park, Washington, D.C., from 15 April-15 November 2007.

| Common name | Scientific name | Family | Tower | Date | Distance (m) from tower | Type |
|---|---|---|---|---|---|---|
| Unknown | *Unknown* | Unknown | MY | April 17 | 24 | Feather spot |
| Mourning dove | *Zenaida macroura* | Columbidae | MY | May 11 | 30.5 | Feather spot |
| Mourning dove | *Zenaida macroura* | Columbidae | MY | May 11 | 26 | Feather spot |
| Unknown | *Unknown* | Unknown | TC | July 23 | 55 | Feather spot |
| White-breasted nuthatch | *Sitta carolinensis* | Sittidae | NC | July 30 | 52.38 | Complete |
| Unknown | *Unknown* | Uknown | NC | August 31 | 60.96 | Partial |
| Uknown | *Unknown* | Uknown | MY | September 21 | 6.75 | Feather spot |
| Unknown | *Unknown* | Unknown | MY | October 1 | 38.5 | Feather spot |
| Common grackle | *Quiscalus quiscula* | Emberizidae, sub. Icterinae | NC | October 4 | 45 | Feather spot |
| Unknown | *Unknown* | Unknown | TC | October 28 | 4.25 | Feather spot |
| Mourning dove | *Zenaida macroura* | Columbidae | MY | October 29 | 25 | Feather spot |
| Mourning dove | *Zenaida macroura* | Columbidae | MY | November 11 | 25.5 | Feather spot |

Table 1. Continued.

| Common name | Scientific name | Family | Tower | Date | Distance (m) from tower | Type |
|---|---|---|---|---|---|---|
| Mourning dove | *Zenaida macroura* | Columbidae | NC | November 12 | 54.5 | Feather spot |
| Slate-colored junco | *Junco hyemalis* | Emberizidae, sub. Emberizinae | TC | November 13 | 47.2 | Complete |

Table 2. Live birds observed[1] and/or heard during carcass searches at Rock Creek Park, Washington, D.C., from 15 April-15 November 2007.

| Common name | Scientific name | Family | No. observations[2] |
|---|---|---|---|
| Acadian flycatcher | *Empidonax virescens* | Tyrannidae | 57 |
| American crow | *Corvus brachyrhyncos* | Corvidae | 222 |
| American goldfinch | *Carduelis tristis* | Fringillidae | 30 |
| American redstart | *Setophaga ruticilla* | Emberizidae, sub. Parulinae | 15 |
| American robin | *Turdus migratorius* | Muscicapidae, sub. Turdinae | 421 |
| Baltimore oriole | *Icterus galbula* | Emberizidae, sub. Icterinae | 27 |
| Barred owl | *Strix varia* | Strigidae | 3 |
| Black-and-white warbler | *Mniotilta varia* | Emberizidae, sub. Parulinae | 11 |
| Black-throated Blue warbler | *Dendroica caerulescens* | Emberizidae, sub. Parulinae | 3 |
| Black-throated Green warbler | *Dendroica caerulescens* | Emberizidae, sub. Parulinae | 4 |
| Blue-winged warbler | *Vermivora pinus* | Emberizidae, sub. Parulinae | 4 |
| Blackpoll warbler | *Dendroica striata* | Emberizidae, sub. Parulinae | 14 |
| Blue jay | *Cyanocitta cristata* | Corvidae | 256 |

Table 2. Continued.

| Common name | Scientific name | Family | No. observations[2] |
|---|---|---|---|
| Blue-gray gnatcatcher | *Piloptila caerulea* | Muscicapidae, sub. Sylviinae | 36 |
| Brown creeper | *Certhia americana* | Certhiidae | 1 |
| Brown thrasher | *Toxostoma rufrum* | Mimidae | 104 |
| Brown-headed cowbird | *Molothrus ater* | Emberizidae, sub. Icterinae | 66 |
| Canada goose | *Branta canadensis* | Anatidae | 8 |
| Canada warbler | *Wilsonia candensis* | Emberizidae, sub. Parulinae | 4 |
| Carolina chickadee | *Parus carolinensis* | Paridae | 228 |
| Carolina wren | *Thryothorus ludovivicanus* | Troglodytidae | 214 |
| Chestnut-sided warbler | *Dendrocia pensylvanica* | Emberizidae, sub. Parulinae | 1 |
| Chipping sparrow | *Spizella passerina* | Emberizidae, sub. Emberizinae | 18 |
| Cape May warbler | *Dendroica tigrina* | Emberizidae, sub. Parulinae | 2 |
| Common grackle | *Quiscalis quiscula* | Emberizidae, sub. Icterinae | 70 |
| Common yellowthroat | *Geothlypis trichas* | Emberizidae, sub. Parulinae | 18 |
| Downy woodpecker | *Picoides pubescens* | Picidae | 88 |

Table 2. Continued.

| Common name | Scientific name | Family | No. observations[2] |
|---|---|---|---|
| Eastern bluebird | *Sialia sialis* | Muscicapidae, sub. Turdinae | 4 |
| Eastern kingbird | *Tyrannus tyrannus* | Tyrannidae | 1 |
| Eastern phoebe | *Sayornis phoebe* | Tyrannidae | 19 |
| Eastern wood-peewee | *Contopus virens* | Tyrannidae | 139 |
| European starling | *Sturnus vulgaris* | Sturnidae | 133 |
| Fish crow | *Corvus ossifragus* | Corvidae | 42 |
| Golden-crowned kinglet | *Regulus satrapa* | Muscicapidae, sub. Sylviinae | 5 |
| Gray catbird | *Dumetella carolinensis* | Mimidae | 265 |
| Great blue heron | *Ardea herodias* | Fregatidae | 3 |
| Hairy woodpecker | *Picoides villosus* | Picidae | 12 |
| Hermit thrush | *Catharus guttatus* | Muscicapidae, sub. Turdinae | 3 |
| House finch | *Carpodacus mexicanus* | Fringillidae | 3 |
| House sparrow | *Passer domesticus* | Passeridae | 221 |
| House wren | *Troglodytes aedon* | Troglodytidae | 42 |

Table 2. Continued.

| Common name | Scientific name | Family | No. observations[2] |
|---|---|---|---|
| Indigo bunting | *Passerina cyanea* | Emberizidae, sub. Cardinalinae | 5 |
| Magnolia warbler | *Dendroica magnolia* | Emberizidae, sub. Parulinae | 7 |
| Mallard | *Anas platyrhynchos* | Anatidae | 1 |
| Mourning dove | *Zenaida macroura* | Columbidae | 176 |
| Northern cardinal | *Cardinalis cardinalis* | Emberizidae, sub. Cardinalinae | 419 |
| Northern mockingbird | *Mimus polyglottos* | Mimidae | 27 |
| Northern parula | *Parula americana* | Emberizidae, sub. Parulinae | 6 |
| Ovenbird | *Seiurus aurocapillus* | Emberizidae, sub. Parulinae | 19 |
| Palm warbler | *Dendroica palmarum* | Emberizidae, sub. Parulinae | 3 |
| Pileated woodpecker | *Dryocopus pileatus* | Picidae | 18 |
| Prairie warbler | *Dendroica discolor* | Emberizidae, sub. Parulinae | 1 |
| Purple finch | *Carpodacus purpureus* | Fringillidae | 2 |
| Red-bellied woodpecker | *Melanerpes carolinus* | Picidae | 208 |
| Red-eyed vireo | *Vireo olivaceus* | Vireonidae | 17 |

Table 2. Continued.

| Common name | Scientific name | Family | No. observations[2] |
|---|---|---|---|
| Red-shouldered hawk | *Buteo lineatus* | Accipitridae | 22 |
| Red-tailed hawk | *Buteo jamaicensis* | Accipitridae | 4 |
| Rose-breasted grosbeak | *Pheucticus ludovicianus* | Emberizidae, sub. Cardinalinae | 3 |
| Rough-winged swallow | *Stelgidopteryx serripennis* | Hirundinidae | 21 |
| Ruby-crowned kinglet | *Regulus calendula* | Muscicapidae, sub. Sylviinae | 12 |
| Ruby-throated hummingbird | *Archilochus colubris* | Trochilidae | 27 |
| Rufous-sided towhee | *Pipilio erythrophthalmus* | Emberizidae, sub. Emberizinae | 272 |
| Scarlet tanager | *Piranga rubra* | Emberizidae, sub. Thraupinae | 10 |
| Slate-colored junco | *Juncus hyemalis* | Emberizidae, sub. Emberizinae | 56 |
| Solitary vireo | *Vireo solitarius* | Vireonidae | 4 |
| Song sparrow | *Melospiza melodia* | Emberizidae, sub. Emberizinae | 11 |
| Swainson's thrush | *Catharus ustulatus* | Muscicapidae, sub. Turdinae | 2 |
| Swamp sparrow | *Melospiza georgiana* | Emberizidae, sub. Emberizinae | 2 |
| Tufted titmouse | *Parus bicolor* | Paridae | 313 |

Table 2. Continued.

| Common name | Scientific name | Family | No. observations[2] |
|---|---|---|---|
| Turkey vulture | *Cathartes aura* | Cathartidae | 3 |
| Veery | *Catharus fuscescens* | Muscicapidae, sub. Turdinae | 8 |
| White-breasted nuthatch | *Sitta carolinensis* | Sittidae | 306 |
| White-eyed vireo | *Vireo griseus* | Vireonidae | 1 |
| White-throated sparrow | *Zonotrichia albicollis* | Emberizidae, sub. Emberizinae | 100 |
| Winter wren | *Troglodytes troglodytes* | Troglodytidae | 2 |
| Wood thrush | *Hylocichla mustelina* | Muscicapidae, sub. Turdinae | 73 |
| Worm-eating warbler | *Helmintheros vermivorus* | Emberizidae, sub. Parulinae | 1 |
| Yellow-bellied sapsucker | *Sphyrapicus varius* | Picidae | 5 |
| Yellow-billed cuckoo | *Coccyzus americanus* | Cuculidae | 18 |
| Yellow-rumped warbler | *Dendroica coronata* | Emberizidae, sub. Parulinae | 30 |
| Yellow-shafted flicker | *Colaptes auratus* | Picidae | 68 |
| Yellow-throated vireo | *Vireo flavifrons* | Vireonidae | 1 |

[1] Live birds observed is not an exhaustive list and is limited to those birds identifiable by the searcher.

[2] Number of observations refers to the number of days a particular species was observed within 189 search days.


Figure 1. Aerial view of search grids and cell towers located in Rock Creek Park, Washington, D.C.


Figure 2. Tennis court (TC) tower located in Rock Creek Park, Washington, D.C. Scale bar represents 50 m.


Figure 3. Maintenance yard (MY) tower located in Rock Creek Park, Washington, D.C. Scale bar represents 50 m.


Figure 4. Nature Center (NC) control plot located in Rock Creek Park, Washington, D.C. Scale bar represents 50 m.

Note: There is no actual tower at this site.