Studies of avian collisions with communication towers: a quantification of bird night flight calls at towers with different structural supports and the use of acoustics as an index of tower fatalities

2012 Progress Report

Prepared By:
Joelle Gehring, Ph.D.-Senior Conservation Scientist-Zoology Section
and
Kristen Walter-Zoology Research Assistant
Michigan State University, Michigan Natural Features Inventory
P.O. Box 30444 Lansing, MI 48909-7944

Prepared For:
Division of Migratory Bird Management,
United States Fish and Wildlife Service,
4401 N. Fairfax Dr., MBSP-4107, Arlington, VA 22203

15 December 2012

MNFI Report Number: 2012-29

MICHIGAN STATE UNIVERSITY EXTENSION

Executive Summary

Since the late 1960s researchers have documented avian collisions with communication towers (Avery et al. 1976, Caldwell and Wallace 1966, Cochran and Graber 1958, Gehring et al. 2009). Their findings suggest that birds, primarily night migrating, neotropical songbirds, are attracted to communication tower lights during inclement weather and then collide with the tower structure or the guy wires supporting the tower (Gehring et al. 2009 and 2011). The United States Fish and Wildlife Service (USFWS) conservatively estimates that 4-50 million birds collide with communication towers every year in the United States (Manville 2005) and recent statistical meta-analysis supports an estimate within that range with an annual collision rate of 6.8 million in North America (Longcore et al. 2012).

Extinguishing non-blinking, red tower lights has been determined to not only reduces avian collisions with towers by 70% but also financially and logistically benefits tower owners, as it reduces construction, maintenance and utility costs. The recent FAA report on minimizing bird collisions with communication towers recommends non-blinking, red lights to be extinguished on most towers >350 ft. AGL (Patterson 2012). Given their mandate for air safety, the FAA has conducted proper tests of tower visibility or conspicuity to pilots to ensure that their changes continue to promote airspace safety for pilots as well as effective options for tower companies.

The objectives of this study were to:

1. quantify and compare the frequency of avian acoustic detections at guyed and unguyed towers > 500 ft AGL which are lit with the same lighting systems; specifically, red blinking lights combined with non-blinking lights.
2. quantify the relationship between the numbers of avian acoustic detections and avian carcasses detected under communication towers.
3. delineate the areas in the United States with frequent periods of foggy conditions and low visibility coinciding with the primary months of avian migration.

We quantified the number of bird detections using SongMeter 2+ units and night flight call microphone plates. The units were programmed to start recording 30 minutes

before sunset until 30 minutes after sunrise, thereby focusing on the nightly periods of migratory songbird activity. The WAV files collected during deployment were analyzed using the software, Raven (Cornell Laboratory of Ornithology, Cornell University). Background noise was filtered out from the calls of night migrating birds and the numbers of calls were quantified by night and tower specifications.

Acoustic monitoring under both guyed and unguyed towers reveals that although very few direct avian fatalities occur at unguyed towers (Gehring et al. 2011), they attract as many birds as guyed towers of similar height and the same lighting systems. Given that migration is a physiological and energetically taxing event for birds, it is likely that prolonged deviations from the migratory path could lead to wasted fat reserves and reduced migration survival as well as reduce productivity on the breeding grounds (Norris and Taylor 2006). These carry-over effects can then affect bird species at the population level. While extinguishing non-flashing lights on guyed towers is logical and important for reducing direct avian fatalities, our research indicates the need to extinguish non-flashing lights on unguyed towers as well. Given that eliminating non-flashing lights reduces maintenance and energy costs for tower operators, it is beneficial to both bird conservation and the communication tower industry.

Using acoustic monitoring under communication towers we also determined another potential, cost effective method to determine the relative effects of tower variables on bird attraction. Previous research on bird collisions at communication towers involved searching tower sites for bird carcasses. Although effective, this technique is challenged by carcass scavengers and observer detection limitations. This technique can also be cost-prohibitive due to observer hours and travel, this particular challenge is magnified when sampling and comparing many towers during the same time period. We found acoustic monitoring to be useful for comparing the relative numbers of birds attracted to towers with different tower lighting systems, tower locations, tower heights, etc. Although there is an initial investment in acoustic equipment and a subsequent investment in data processing, the units require only two visits to the tower site (deployment and retrieval) and acoustic data can be analyzed throughout the year after the initial collection period. Acoustic data are species specific and allow the detection of rare species, although a small proportion of species don’t call during migration (e.g., Red-eyed Vireos). Preliminary data suggest that acoustic monitoring is overall effective at quantifying relative numbers of birds at towers without collecting carcasses. Considering the potential carry-over effects of attraction to (vs. collision with) communication towers, the relative numbers of birds at towers is a variable worth quantifying.

Examination of the fog maps for the lower 48 states revealed that some areas of the contiguous U.S. likely experience more bird fatalities at communication towers than other areas, due to high frequency of fog during the months of bird migration. Considering that fog tends to increase the numbers of avian collisions with communication towers, it is important to understand which areas of the contiguous U.S. should be prioritized for light changes on communication towers (elimination of non-flashing lights). For example, the Gulf Coast in April is an area where tower light changes should be a high priority as millions of migratory birds are moving through this foggy area on their way to breeding areas farther north.

Avian collisions with towers can be reduced by as much as 70% using methods that are simple, safe, and financially beneficial to tower owners. These tower light changes should be pursued on both guyed and unguyed towers, especially in areas of the world with a high incidence of fog during the primary months of migration.

Table of contents **Page**

Introduction

For decades researchers have documented avian fatalities at lit towers. Their findings suggest that birds, primarily night migrating, neotropical songbirds, are either attracted to or disoriented by communication tower lights, especially when night skies are overcast, foggy, or when there is precipitation (e.g., Avery et al. 1976, Caldwell and Wallace 1966, Cochran and Graber 1958). Researchers have documented that the type of tower lighting system can be related to the numbers of avian collisions. Specifically, Gehring et al. (2009 and 2010) found significantly more avian fatalities under towers that were lit at night with systems that included non-blinking, red lights than at towers lit with only blinking lights. Gauthreaux and Belser (2006) used a marine radar to demonstrate that more night migrants flew in circular flight patterns near a guyed communication tower (>305 m AGL) with red blinking lights combined with red non-blinking lights than near a guyed tower of similar height equipped only with white strobe lights. Similarly, a study by Kerlinger et al. (in review) at several wind power installations showed that there was no detectable difference in avian fatality rates between wind turbines marked with red blinking lights and turbines with no lights.

Upon attraction to towers birds fly in close proximity to the structure, making them more vulnerable to collisions with the tower or the guy wires supporting the tower. Previous research has demonstrated higher frequencies of avian fatalities at towers supported by guy wires than at self-supported towers and higher frequencies of collisions at towers > 277 m AGL compared to shorter towers (Gehring et al. 2011). Although birds may not collide with unguyed communication towers as often as with guyed towers it is likely that they are still attracted to and disoriented by the non-flashing tower lights. It is probable that night migrating birds spend valuable migration time and energy circling unguyed towers but not suffering direct fatalities from collisions. It is important to document this likely attraction to determine the need to change tower lights (i.e., removing non-flashing lights) even when a tower lacks guy wires.

It is important to use the most effective and efficient method of collecting data on bird attraction to communication towers. Given the numbers of hours it takes to effectively search the areas under communication towers, the frequently low detection rates, and high carcass removal rates (Gehring et al. 2009), we explored the potential of using acoustic monitoring for bird night flight calls under communication towers to provide a relative umber of avian collisions.

As mentioned, the presence of heavy fog is believed to increase the risk of night migrating birds colliding with towers. Areas that frequently have foggy nights should be prioritized for tower light deviations to remove the L-810, non-flashing lights.

The objectives of this study were to:

1. quantify and compare the frequency of avian acoustic detections at guyed and unguyed towers > 500 ft AGL which are lit with the same lighting systems; specifically, towers lit with red blinking lights combined with non-blinking lights.
2. quantify the relationship between the numbers of avian acoustic detections and avian carcasses detected under communication towers.
3. delineate the areas in the United States with frequent periods of foggy conditions and low visibility as towers in these areas may be more likely to be involved in avian collisions.

The study of these issues will allow us to better understand the relationship between tower specifications and avian attraction and provide direction to altering existing communication towers to reduce those collisions. Similarly, the increased understanding of regions with high frequency of foggy nights can be useful when prioritizing tower light changes. Our research also provides an evaluation of the use of acoustical monitoring techniques in efforts to monitor the impacts of communication towers on birds. This report summarizes the results of the 2012 field season.

Study Area and Methods

Research was conducted at five communication towers with three in the lower peninsula of Michigan, USA and 2 in Cape May, New Jersey, USA. Towers were selected based on existing tower support systems, tower height, tower lighting systems, and their proximity to one another in the study area (Fig. 1 and 2). All towers were lit at night with red blinking lights (L-864) combined with red non-blinking lights (L-810; Fig. 3).

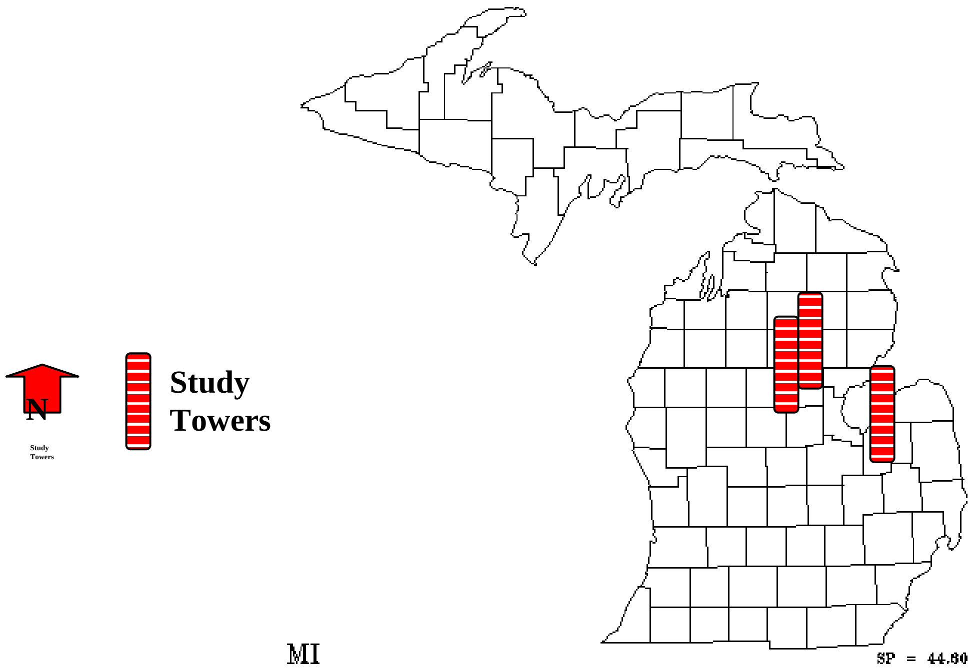


Figure 1. Three communication towers located in the lower Peninsula of Michigan were included in a study of avian flight call detections. Acoustical monitoring equipment was placed under these towers to detect the frequency of bird detections during fall 2012 migration to compare the relationships between avian call frequencies (i.e., attraction) and tower support systems. We also compared the relationship between avian call frequencies and the number of avian carcasses collected under the most southeastern tower.

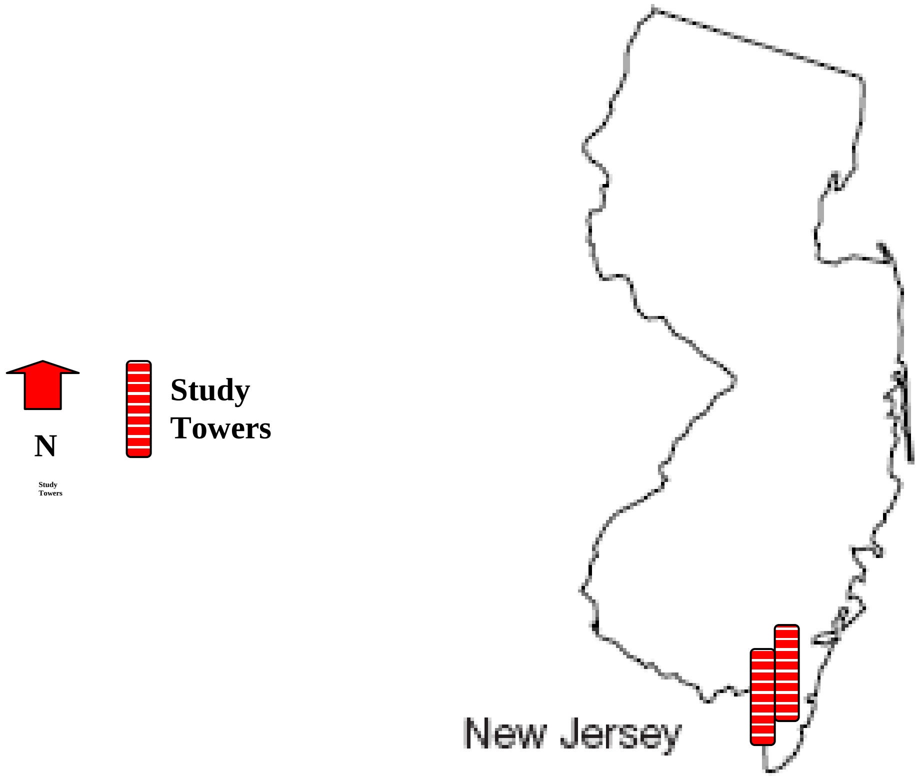
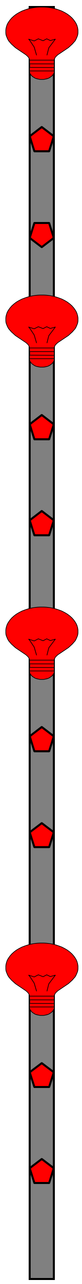


Figure 2. Two communication towers located in the Cape May New Jersey were included in a study of avian flight call detections. Acoustical monitoring equipment was placed under these towers to detect the frequency of bird detections during fall 2012 migration to compare the relationships between avian call frequencies (i.e., attraction) and tower support systems.



2 guyed towers and 2 unguyed towers 253-499 ft. AGL with red blinking incandescent lights (L-864) at multiple levels alternating with non-blinking incandescent lights (L-810)

1 guyed towers 1,048 ft. AGL also with red blinking incandescent lights (L-864) at multiple levels alternating with non-blinking incandescent lights (L-810)

Figure 3. Communication tower lighting system on towers used in 2012 study. Acoustical monitoring equipment was placed under these towers to detect the frequency of bird detections during fall 2012 migration and to compare the relationships between avian call frequencies (i.e., attraction) and tower support systems, as well as avian call frequencies and the number of carcasses detected under the tower.

Bird acoustic data collection

We collected acoustic data on the number of avian night flight calls using a SongMeter 2 and a microphone plate (Fig. 4; Wildlife Acoustics, Inc). Units collected a mean of 19 nights of data throughout the fall migration season and were programmed to start recording 30 minutes before sunset until 30 minutes after sunrise, thereby focusing on the nightly periods of migratory songbird activity. The units were secured and weatherized within 30 meters of the base of the tower in plastic containers and the microphones were attached to fence posts 3 feet above the ground.

Figure 4. Acoustical monitoring equipment was placed under towers to detect the frequency of bird detections during the fall 2012 migration in order to compare the relationships between avian night flight call frequencies (i.e., attraction) and tower support systems, as well as to compare avian carcass counts under a tower to the number of avian night flight calls.

Bird acoustic data analysis

The WAV files collected during deployment were analyzed using the software, RavenPro 1.5 (Cornell Laboratory of Ornithology, Cornell University). Background noise was filtered out from the calls of night migrating birds and the numbers of calls were quantified by night and by frequency range (low frequency thrushes and higher frequency warblers and sparrows).

Carcass searches

The tower 1048 ft. AGL was searched 16 September – 5 October 2012. The technician arrived at the towers as early in the day as possible in an effort to prevent diurnal and crepuscular scavengers from removing carcasses. Using flagged, straight-line transects, the technician walked at a rate of 45-60 m per min and searched for carcasses within 5 m on either side of each transect (Gehring 2010, Erickson et al. 2003). Transects covered a circular area under each tower with a radius of 100 m from the base of the tower. Bird carcasses were placed in plastic bags, and the following data were 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. We compared the daily numbers of bird carcasses to the number of night flight calls detected the previous night using linear correlation.

Delineation of foggy regions in the U.S

We used data and the analytical options of the National Climatic Data Center's Summary of the Day First Order (TD-3210) database to describe the foggy regions of the U.S. According to the website, "The monthly values were computed by taking the 30-year mean of the number of days with at least one occurrence of heavy fog for a given month. The daily values included observations for the 24-hour period ending at the time of observation for a given station. Heavy fog is defined as reducing visibility to 0.25 mile or less." (http://cdo.ncdc.noaa.gov/cgi-bin/climaps/climaps.pl accessed

12/15/2012). We selected the months of the year when most birds are migrating through the U.S.: April, May, August, September, and October.

Results and Discussion

Avian acoustic detections between different tower support systems

Between 19 September and 14 October 2012 we detected a total of 847 bird calls during 75 sampling night at 4 acoustic monitors at 4 towers, 253-499 ft. AGL (Table 1). A mean of 12 bird calls per night was detected over a mean of 19 sampling nights per tower. The number of bird acoustic detections per night was not significantly different between towers with guy wires and towers without guy wires (P=0.48, Table 1, Fig. 5). Species identification of the calls is currently underway but not complete at this time.

Table 1. The numbers of bird night flight call detections at 4 communication towers during the fall of 2012.

Tower location	Tower support system	Tower height (ft.)	Number of avian night flight call detections
Michigan	Guyed	499	159 (mean = 10.6 bird detections per night)
Michigan	Unguyed	499	140 (mean = 9.3 detections per night)
New Jersey	Guyed	253	230 (mean = 7.4 bird detections per night)
New Jersey	Unguyed	350	318 (mean = 22.7 detections per night)

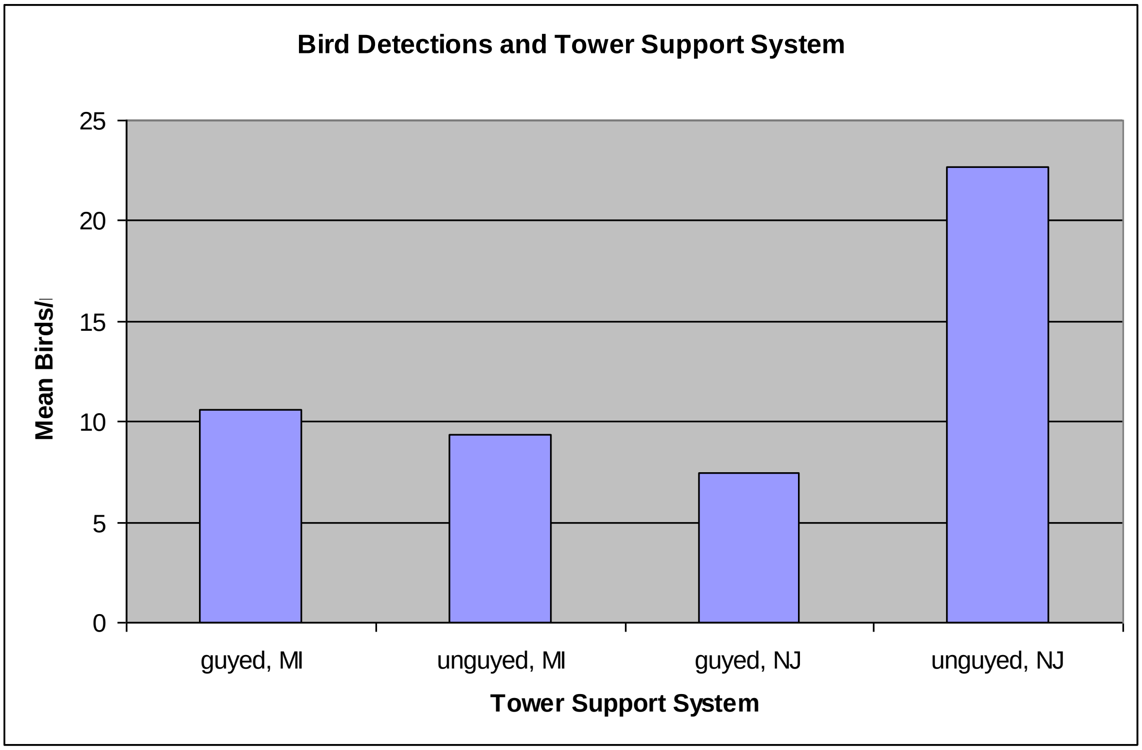


Figure 5. Acoustical monitoring equipment was placed under towers to detect the frequency of bird detections during the fall 2012 migration in order to compare the relationships between avian night flight call frequencies (i.e., attraction) and tower support systems.

Avian acoustic detections compared to carcass detection

We detected a total of 1,764 bird calls during 18 sampling nights at the 1,048 ft. AGL tower using an acoustic monitor between 17 September and 14 October 2012, with a mean of 98 bird calls per night. Species identification of the calls is currently underway but at this time is not complete.

Over 19 days in the fall of 2012 technicians and I found a total of 9 birds determined to be killed during the study period (Table 2). I identified each specimen to taxonomic species when possible. Six species of birds were collected and identified to have collided with the towers during the fall 2012 study periods. The Golden-crowned Kinglet was the most common species observed (Table 2). The numbers of flight calls were temporally correlated with the numbers of bird carcasses detected under the tower and a significant amount of variation in the numbers of carcasses was explained by the number of night flight call ($r = 0.84$, $r^2 = 0.71$; Figs. 6 and 7).

Table 2. Avian fatalities (by species) at one Michigan communication tower during 20 days in the fall of 2012 (including day without acoustic data used above).

Bird Species[a]	**Numbers of carcasses found**
Red-breasted Nuthatch (*Sitta canadensis*)	2 (18%)
Blackpoll Warbler (*Dendroica striata*)	1 (9%)
Common Yellowthroat (*Geothlypis trichas*)	1 (9%)
Yellow-rumped Warbler (*D. coronata*)	2 (18%)
Golden-crowned Kinglet (*Regulus satrapa*)	4 (36%)
White-throated Sparrow (*Zonotrichia albicollis*)	1 (9%)
Total	11

[a] all names of birds follow the *AOU Check-list of North American Birds*

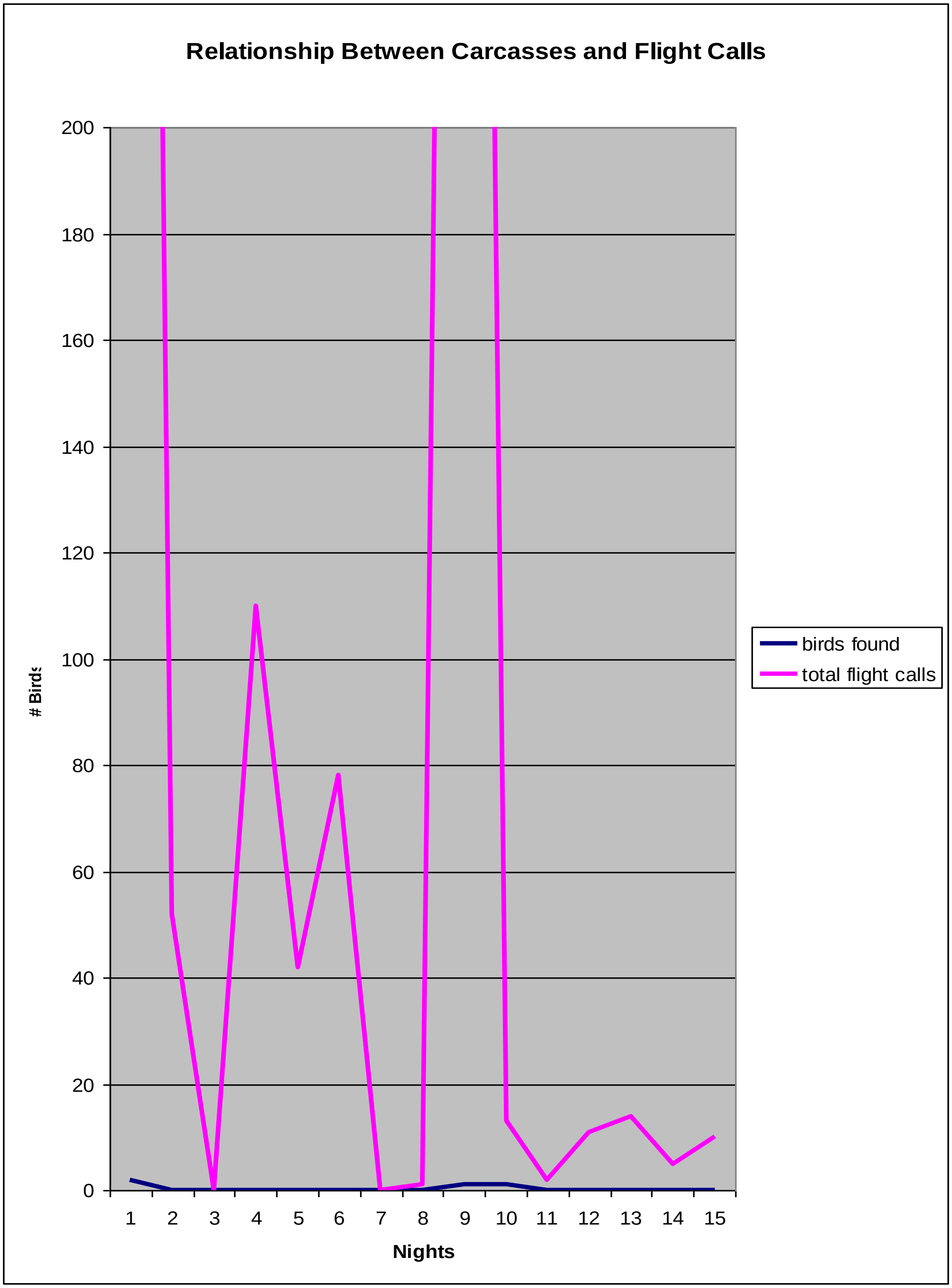


Figure 6. Acoustical monitoring equipment was placed under a tower to detect the frequency of bird detections during the fall 2012 migration in order to compare the relationships between avian night flight call frequencies (i.e., attraction) and the numbers of bird carcasses detected.

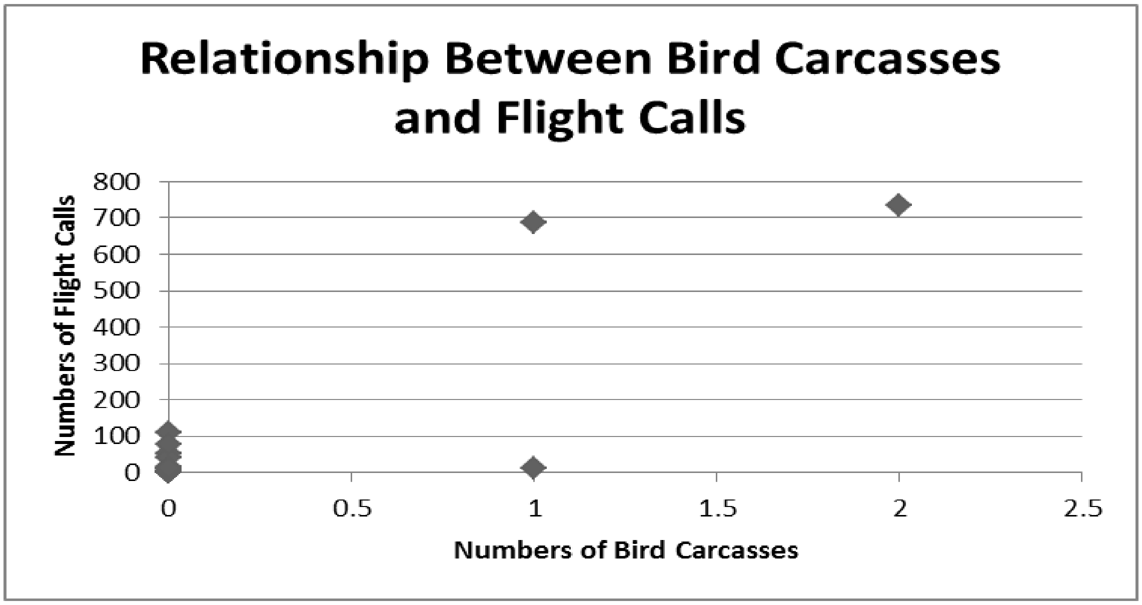


Figure 7. Acoustical monitoring equipment was placed under a tower to detect the frequency of bird detections during the fall 2012 migration in order to compare the relationships between avian night flight call frequencies (i.e., attraction) and the numbers of bird carcasses detected.

Delineation of foggy regions in the contiguous U.S.

Appendices 1-5 present the maps for the following months, respectively, April, May, August, September, and October. In April the Gulf Coast area of the U.S. has relatively more periods of fog than the majority of the U.S. In May, August, and September southern Ohio, western West Virginia, and Maine are the foggiest areas of the contiguous U.S. However, in October western Washington is foggier than the majority of the contiguous U.S.

Summary

Extinguishing non-blinking, red lights not only reduces avian collisions with towers by 70% but it also financially and logistically benefits tower owners, as it reduces construction, maintenance and utility costs. The recent FAA report on minimizing bird collisions with communication towers recommends non-blinking, red lights to be extinguished on most towers >350 ft. AGL (Patterson 2012). Given their mandate for air safety, the FAA has conducted proper tests of tower visibility or conspicuity to pilots to ensure that their changes continue to promote airspace safety for pilots as well as effective options for tower companies.

We determined, via acoustic monitoring, that although very few direct avian fatalities occur at unguyed towers (Gehring et al. 2011), they attract as many birds as guyed towers of similar height and the same lighting systems. Given that migration is a physiological and energetically taxing event for birds, it is likely that prolonged deviations from the migratory path could lead to wasted fat reserves and reduced migration survival. Norris and Taylor (2006) quantified how migration and overwintering stress can subsequently reduce productivity on the breeding grounds. These carry-over effects can then affect bird species at the population level. While extinguishing non-flashing lights on guyed towers is logical and important for reducing direct avian fatalities, our research indicates the need to extinguish non-flashing lights on unguyed towers as well. Although unguyed towers may not cause direct, on-site avian fatalities, birds attracted to these towers may have lower survival and decreased nesting productivity. Given that eliminating non-flashing lights reduces maintenance and energy costs for tower operators, it is beneficial to both bird conservation and the communication tower industry.

Using acoustic monitoring under communication towers we also determined another potential, cost effective method to determine the relative effects of tower variables on bird attraction. Previous research on bird collisions at communication towers involved searching tower sites for bird carcasses. Although effective, this technique is challenged by carcass scavengers and observer detection limitations. This technique can also be cost-prohibitive due to observer hours and travel, this particular challenge is magnified when sampling and comparing many towers during the same time period. We found acoustic monitoring to be useful for comparing the relative numbers of birds attracted to towers with different tower lighting systems, tower locations, tower heights, etc. Although there is an initial investment in acoustic equipment and a subsequent investment in data processing, the units require only two visits to the tower site (deployment and retrieval) and acoustic data can be analyzed throughout the year after the initial collection period. Acoustic data are also species specific and allows the detection of rare species, although a small proportion of species don't call during migration (e.g., Red-eyed Vireos). Preliminary data suggest that acoustic monitoring is overall effective at quantifying relative numbers of birds at towers without collecting carcasses. Considering the potential carry-over effects of attraction to communication towers, the relative numbers of birds at towers is a variable worth quantifying.

Examination of the fog maps for the lower 48 states revealed that some areas of the contiguous U.S. likely experience more bird fatalities at communication towers than other areas, due to high frequency of fog during the months of bird migration. Considering that fog tends to increase the numbers of avian collisions with communication towers, it is important to understand which areas of the contiguous U.S. should be prioritized for light changes on communication towers (elimination of non-flashing lights). For example, the Gulf Coast in April is an area where tower light changes should be a high priority as millions of migratory birds are moving through this foggy area on their way to breeding areas farther north.

Avian collisions with towers can be reduced by as much as 70% using methods that are simple, safe, and financially beneficial to tower owners. These tower light changes should be pursued on both guyed and unguyed towers, especially in areas of the world with a high incidence of fog during the primary months of migration.

Acknowledgments

This study could not be completed without the dedication, enthusiasm, and hard work of Kristen Walter. The Cornell Laboratory of Ornithology made this research possible by loaning equipment, conducting analysis, and providing training (specifically Michael Powers, Andrew Farnsworth, and Anne Klingensmith). The USCG is commended and thanked for making this important and unique study possible with their funding and support. This study is made possible by the inclusion of towers greater than > 277 m AGL. I owe a large 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 and cost-effective methods to reduce the collisions. Many individuals provided ideas, suggestions, and support for this project and similar previous projects, including but not limited to: A. Manville (USFWS), and P. Kerlinger (Curry & Kerlinger, LLC). Several agencies and organizations provided support and collaboration: Michigan Department of Natural Resources (MDNR), Federal Aviation Administration, FCC. I would like to express my gratitude to the USCG, USFWS, and the National Fish and Wildlife Foundation (NFWF) for granting funds to improve this and previous projects. 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. Michigan Natural Features Inventory and Michigan State University provided greatly appreciated logistical support for this research. My colleagues at the Michigan Natural Features Inventory provide both logistical and technical support; especially H. Enander, B. Klatt, S. Ridge, N. Toben, and J. Kline.

Literature Cited and Related Literature

Avery, M., P. Springer, and J. Cassel. 1976. The effects of a tall tower on nocturnal bird migration- a portable ceilometer study. Auk 93:281-291.

Caldwell, L. and G. Wallace. 1966. Collections of migrating birds at Michigan television towers. The Jack-Pine Warbler 44:117-123.

Cochran, W. and R. Graber. 1958. Attraction of nocturnal migrants by lights on a television tower. Wilson Bulletin 70:378-380.

Federal Aviation Administration (FAA). 2000. Obstruction Marking and Lighting. AC 70/7460-1K.

Gauthreaux, Jr., S. and C. Belser. 2006. Effects of artificial night lighting on migrating birds. Pp. 67- 93 in C. Rich and T. Longcore (editors), Ecological Consequences of Artificial Night Lighting, Island Press, Washington.

Gehring, J. L. 2010. Studies of avian collisions with communication towers: a quantification of fatalities at a self-supported Rescue 21 tower and a test of different tall tower lighting systems. 2008 and 2009 Progress Report for funders.

Gehring, J. L., P. Kerlinger, and A. Manville II. 2009. Communication towers, lights, and birds: successful methods of reducing the frequency of avian collisions. Ecological Applications 19: 505-514.

Gehring, J. L., P. Kerlinger, and A. Manville. 2011. The Role of Tower height and Guy Wires on Avian Collisions with Communication Towers. Journal of Wildlife Management 75:848-855.

Kerlinger, P., J. Gehring, W.P. Erickson, and R. Curry. In Review. Federal Aviation Administration obstruction lighting and night migrant fatalities at wind turbines in North America: A review of data from existing studies.

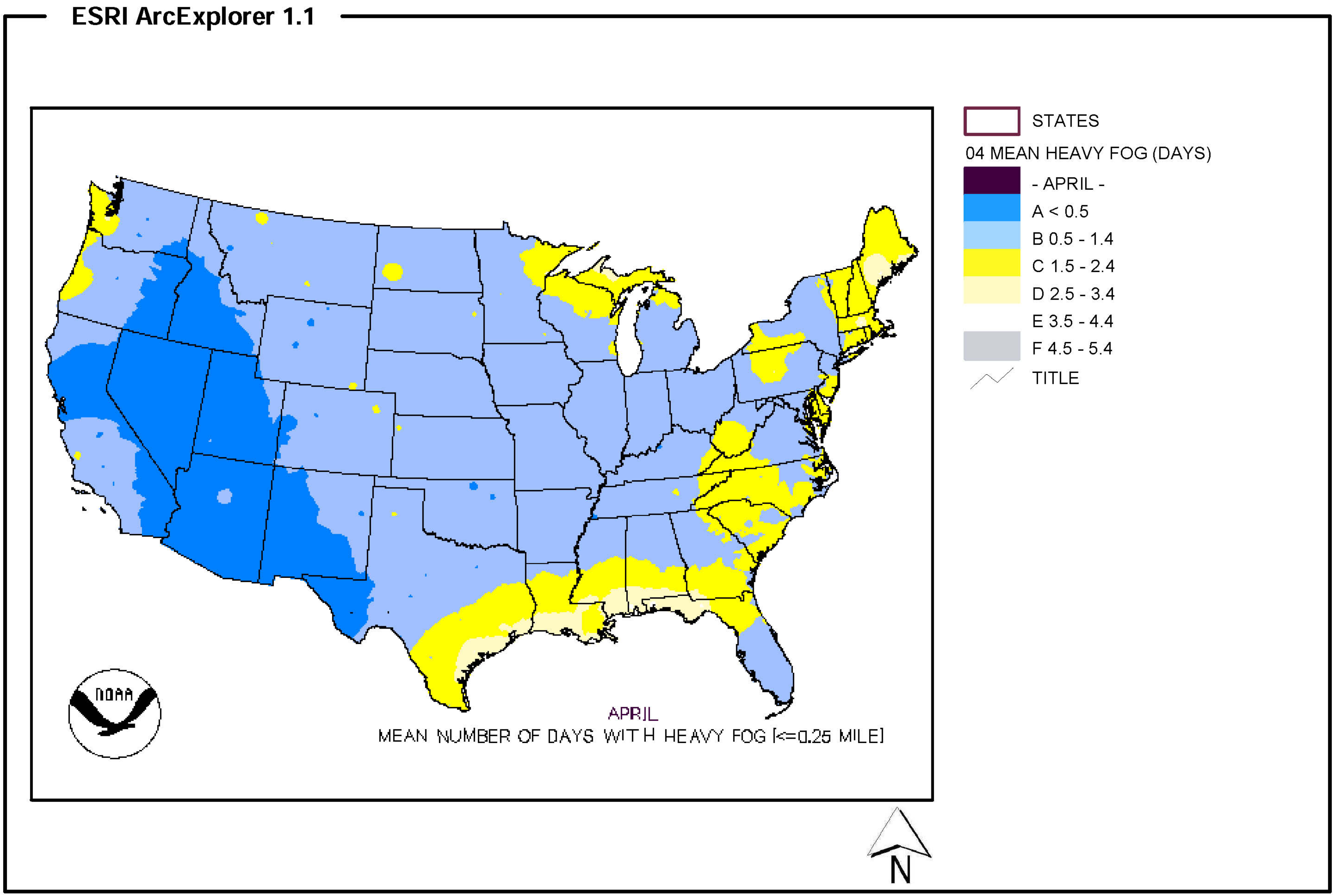
Longcore T, Rich C, Mineau P, MacDonald B, Bert DG, et al. (2012) An Estimate of Avian Mortality at Communication Towers in the United States and Canada. PLoS ONE 7(4): e34025.

Manville, A.M., II. 2005. Bird strikes and electrocutions at power lines, communication towers, and wind turbines: state of the art and state of the science – next steps toward mitigation. Bird Conservation Implementation in the Americas: Proceedings 3rd International Partners in Flight Conference 2002, C.J. Ralph and T.D. Rich (eds.). U.S.D.A. Forest Service General Technical Report PSW-GTR-191, Pacific Southwest Research Station, Albany, CA: 1051-1064.

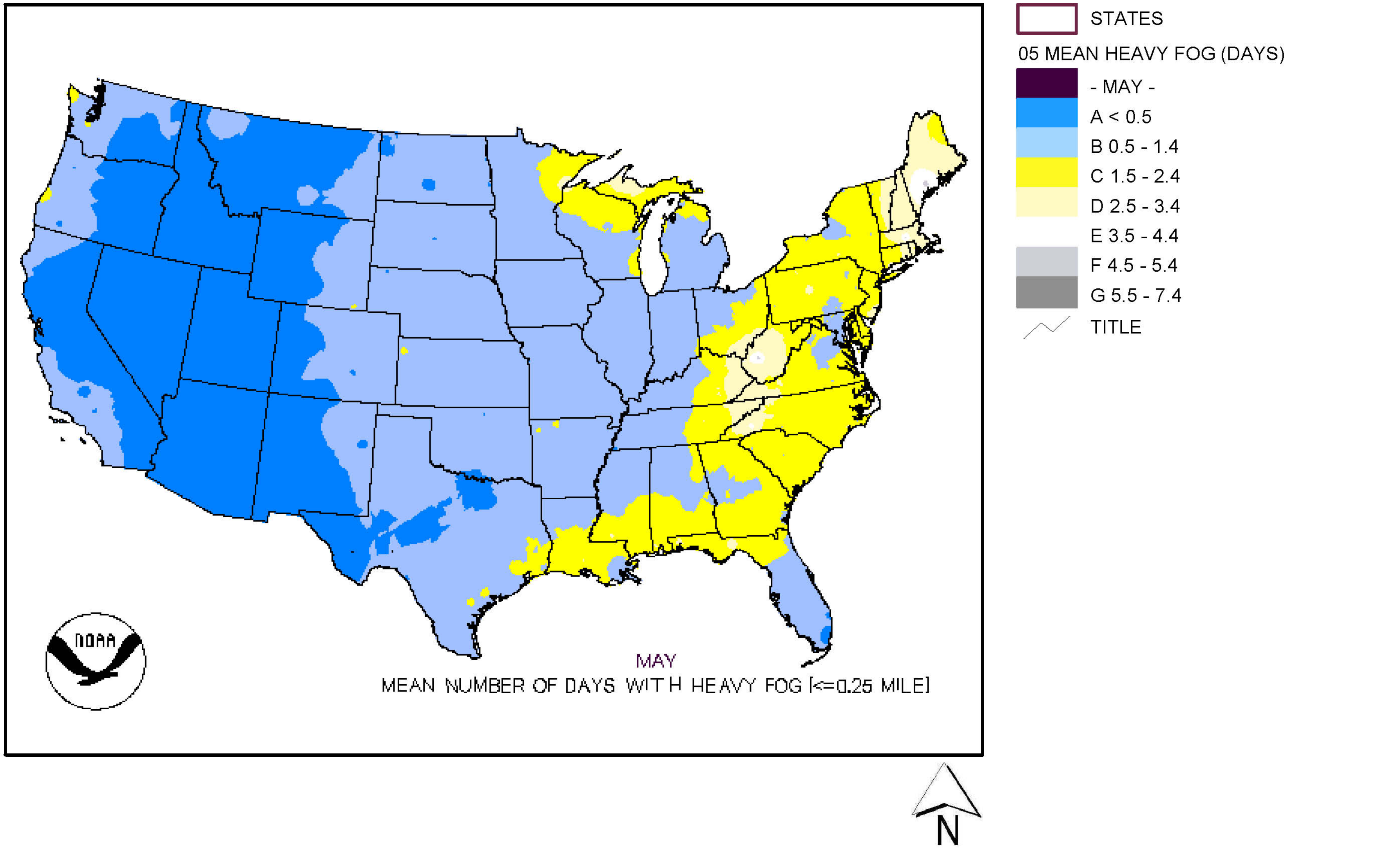
Norris, D. R. and C. M. Taylor. 2006. Predicting the consequences of carry-over effects for migratory populations. Biology Letters 2006 (2): 148-151.

R Statistical computing. 2009. Version 2.10.0. R Foundation for Statistical Computing, Vienna, Austria.

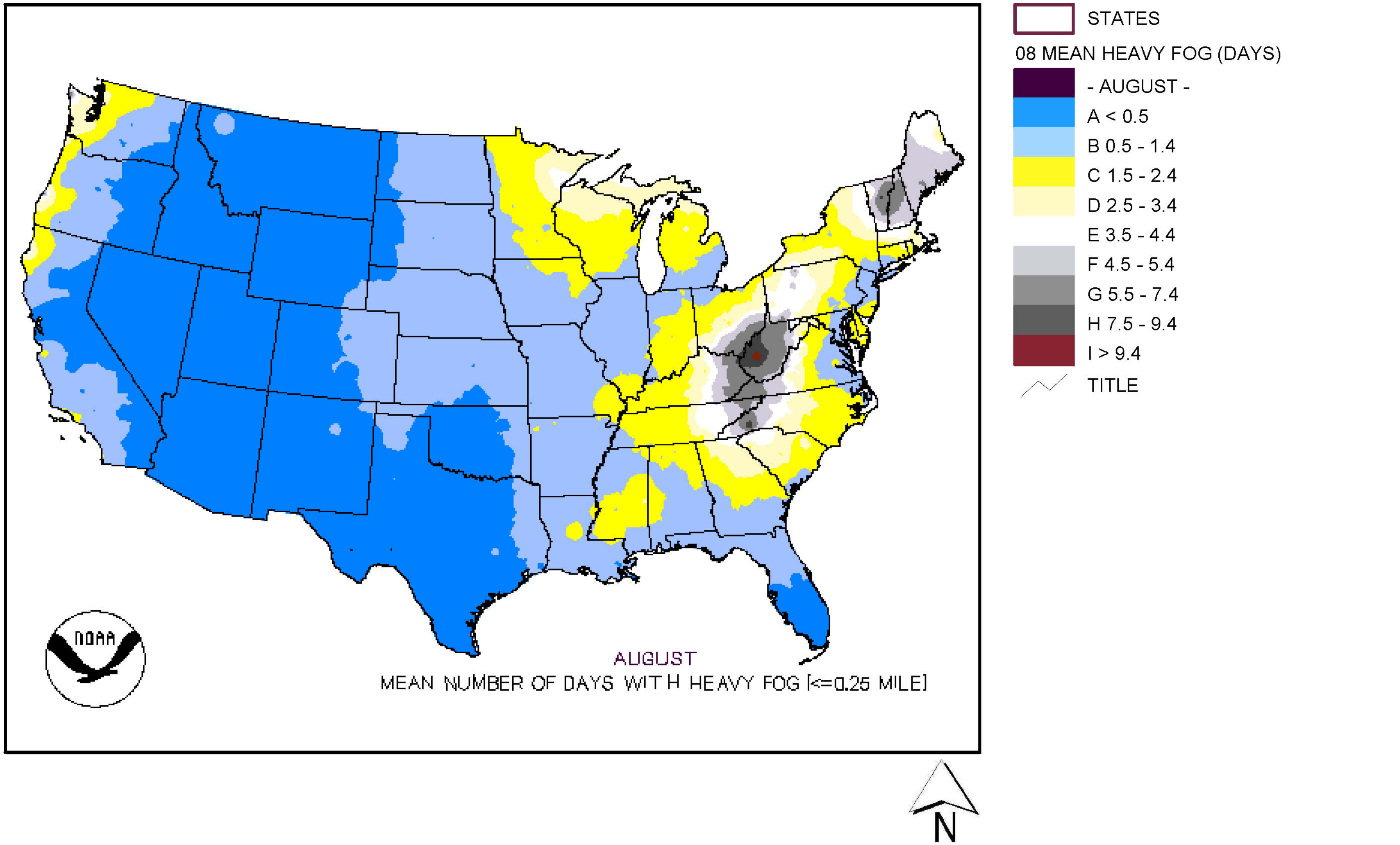
Zar, J. 1998. Biostatistical Analysis. Prentice Hall, Englewood Cliffs, NJ.


ESRI ArcExplorer 1.1
STATES
04 MEAN HEAVY FOG (DAYS)
- APRIL -
A < 0.5
B 0.5 - 1.4
C 1.5 - 2.4
D 2.5 - 3.4
E 3.5 - 4.4
F 4.5 - 5.4
TITLE
NOAA
APRIL
MEAN NUMBER OF DAYS WITH HEAVY FOG [<=0.25 MILE]
N

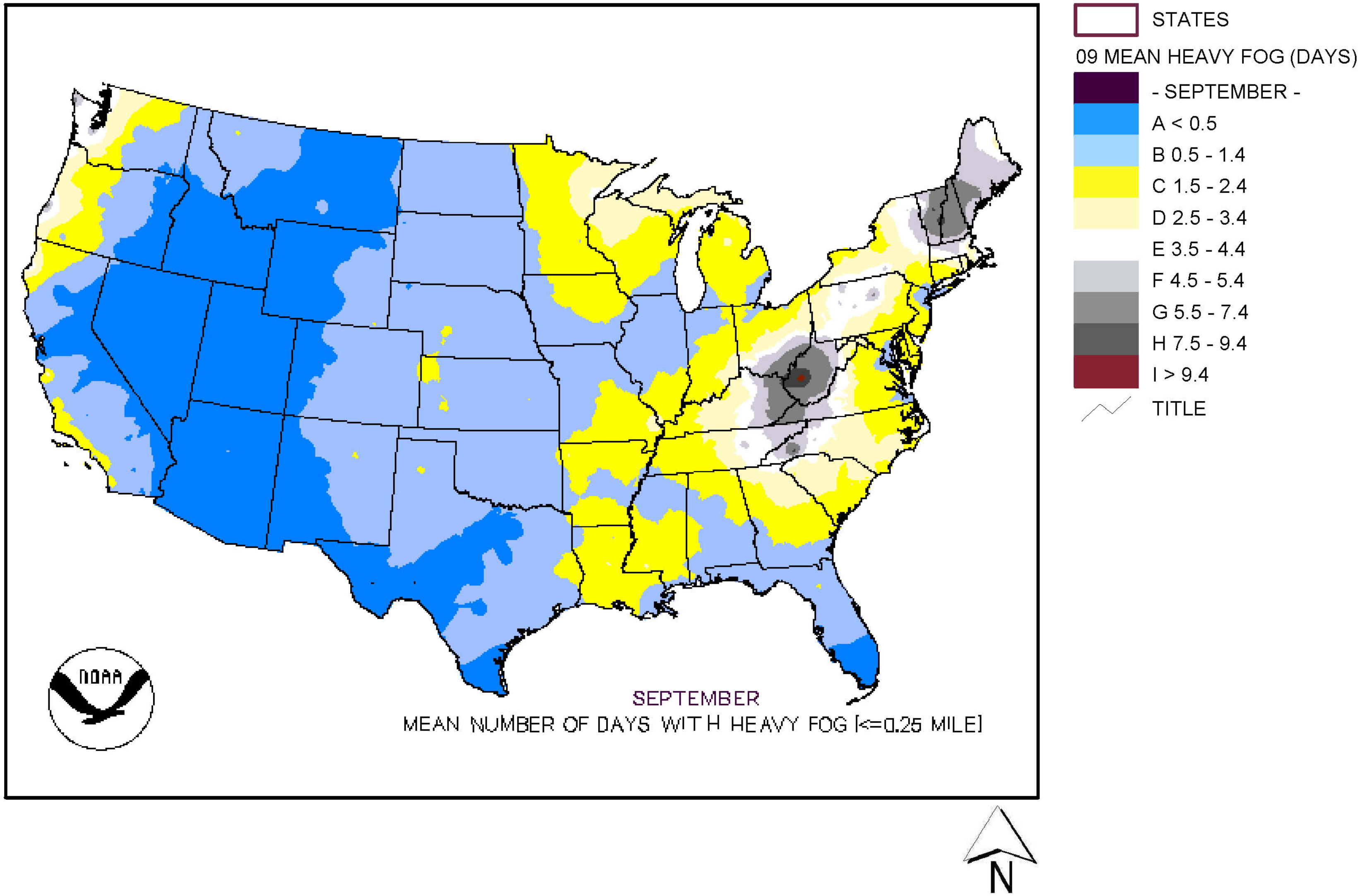
ESRI ArcExplorer 1.1



ESRI ArcExplorer 1.1



ESRI ArcExplorer 1.1



ESRI ArcExplorer 1.1