NOTICE OF INQUIRY COMMENT REVIEW

AVIAN / COMMUNICATION TOWER COLLISIONS

FINAL

Prepared for

FEDERAL COMMUNICATIONS COMMISSION

Submitted by

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SECTION 1

INTRODUCTION

1.1 STATEMENT OF THE PROBLEM

As the nation's demand for wireless communication has increased the need for additional telecommunication towers, the potential for bird collisions and the impact on the avian populations have become increasing concerns. As part of its regulatory mandate, the Federal Communications Commission (FCC) is required "*to manage the expansion of the communications infrastructure in a way that best preserves environmental resources*." Collisions of migratory birds with communication towers and ancillary structures and consequent mortality have been recorded both through observation and anecdotal information (Manville, 2000 a, b; Kerlinger and Curry, 2000). Estimates of tower-related avian mortality vary widely. In part, the uncertainty associated with mortality estimates and the effect on migratory bird populations reflects the challenge of monitoring bird strikes as well as the lack of uniform monitoring procedures and a clearinghouse for these data. In recognition of the need for increased surveillance and better monitoring procedures, industry, agency, and concerned citizen stakeholders and investigators have initiated the development of consistent procedures by which verifiable data can be obtained and evaluated.

On August 20, 2003, the FCC initiated a Notice of Inquiry (NOI) into the *Effects of Communications Towers on Migratory Birds*, FCC 03-205. A summary of the NOI was published in the Federal Register on September 12, 2003. The FCC issued this NOI "*to gather comment and information on the impact that telecommunications towers may have on migratory birds.*" Specifically, information was requested to better determine:

1) the number of migratory bird collisions with communications towers, and

2) the role that specific physical landscape, tower structure, meteorological and other factors may play in the incidence of bird collisions.

In addition, FCC requested comments on mitigating measures that may be considered to reduce or eliminate collisions. As a result of this inquiry, the FCC received approximately 265 comments and responses of varied technical breadth from a variety of commenting agencies, telecommunication and infrastructure support companies, environmental groups, trade associations and concerned citizens. In May 2004, the FCC retained the Avatar Environmental Team, consisting of Avatar Environmental LLC, EDM International, Inc. and Pandion Systems Inc., to review the comments received in response to the NOI with several specific objectives.

1.2 OBJECTIVES

The objectives for this report were outlined in FCC's scope of work for this assignment. To the extent that information was presented in the NOI comments and response to comments, the objectives include:

- *Review and evaluate the available, technically supportable information documenting the number of migratory bird collisions with telecommunications towers*;
- *Review and evaluate the available, technically supportable information available regarding the role that specific factors may increase or decrease the incidence of such collisions*.
- *Recommend actions aimed at obtaining additional data and information necessary to reduce the uncertainty regarding the factors may cause bird collisions and to mitigate potential tower collisions.*
- *Recommend actions aimed at obtaining additional data and information necessary to reduce the uncertainty regarding the factors may cause bird collisions and to mitigate potential tower collisions.*

1.3 GENERAL CAVEATS

In addressing these objectives, this report incorporates only that information that was provided in the comments received in response to the NOI. To the extent these comments incorporated references to studies, these studies were obtained and reviewed to determine the extent to which the results and conclusions of the referenced studies were accurately and adequately characterized.

Also, this review is limited to a review of the scientific and technical information provided in the comments and referenced studies. It was not within the purview of this document to evaluate statements made regarding the regulatory jurisdiction, legal bearing, policy or administrative requirements of the FCC in response to avian collisions with telecommunications towers.

This report is organized in the following sections:

Section 1. Introduction – provides the background information, report objectives and discussion of any limitations regarding the expectations of the report.

Section 2. Technical Approach – presents the methodology by which the objectives were met including the selection of comments and cited studies for inclusion in the report, the approach by which the reviews were conducted, and the method by which data included in the comments and studies were developed and recorded.

Section 3. Bird Collisions with Telecommunications Towers, **NOI Comment Review and Study Application -** this section of the report provides the information and data presented in the NOI comments and cited studies regarding the degree to which telecommunication structures have resulted in the collision and consequent mortality of migrating birds. It discusses the consistency of the information provided and the confounding factors associated with the estimates.

This section also presents and discusses the extent to which information provided in the comments to the NOI indicates the role that specific physical landscape, tower structure, meteorological, and other factors may play in the incidence of bird collisions. This section discusses the responses to specific questions that FCC raised in its NOI. It summarizes the available information provided by the respondents in their comments and cited studies. The section also presents a summary of the individual respondent's comments on a specific issue.

Section 4. –Section 4 presents data needs, current state-of-the-art mitigation methods and approaches, and information regarding potential mitigation measures that may be considered in reducing bird collisions with towers and guyed wires.

Section 5. Conclusions and Recommendations – presents the report conclusions and recommendations for further actions by the FCC.

Section 6. References. The references used in preparing this report are listed in this section.

SECTION 2
TECHNICAL APPROACH

2.1 COMMENT REVIEW PROCESS

Each of the comments and responses received in response to the NOI were reviewed initially for technical content and comprehensiveness. In addition, the comments were also reviewed for issue redundancy. When the same technical issue was raised in numerous comments, those comments that provided the greatest technical support to a position were selected for a comprehensive review.

2.1.1 Comment Review and Selection Process

Based on the review of approximately 265 comments and responses, this report focused its review and analysis on those comments deemed to be of sufficient technical substance to merit a comprehensive evaluation. The FCC provided these specific comments and reply comments for review and analysis. The comments selected for review are listed in Table 2-1.

2.2 STUDY/CITATION REVIEW PROCESS

Section 3 of this report provides an assessment of the NOI comments and the various studies referenced in those comments. Following the review of the comment documents, a list of select studies and reports cited in each of the comments listed in Table 2-1 was prepared for review and analysis. This initial list was based largely on a cited study's perceived technical substance and the level of dependence on which the commentor's conclusion drew its weight-of evidence from that study. In addition, other ancillary studies were reviewed, based on associated subjects and research focus.

As part of the literature review process (hereafter referred to as "study or studies"), recommended studies were initially segregated into either peer-reviewed or incidental reports/observations categories. Studies cited in peer-reviewed journals were given greater weight for consideration in subsequent discussions in Section 3. A study ranking hierarchy was employed that incorporated a weight-of-evidence system based on the availability of information provided on key attributes. The availability and the degree of treatment of those attributes determined which studies merited greatest consideration for review and inclusion in this report.

TABLE 2-1

COMMENTS SELECTED FOR COMPREHENSIVE REVIEW

▪ Comments of the Cellular Telecommunications & Internet Association and National Association of Broadcasters	12 November 2003
▪ Comments of the PCIA – The Wireless Infrastructure Association	12 November 2003
▪ Comments of the American Bird Conservancy/ Forest Conservation Council/ Friends of the Earth	11 November 2003
▪ Comments of the U.S. Fish and Wildlife Service	7 November 2003
▪ Comments of the National Association of Tower Erectors	Date not provided
▪ Comments of the Sprint Corporation	12 November 2003
▪ Comments of Cingular Wireless LLC and SBC Communications, Inc	11 December 2003
▪ Joint Written Comments of Don Schellhardt, Esquire and Nickolaus E. Leggett	7 November 2003
▪ Comments of the Chickasaw Nation	Date not provided
▪ Reply Comments of the Cellular Telecommunications and Internet association	11 December 2003
▪ Reply Comments of National Association of Broadcasters	11 December 2003
▪ Reply Comments of National Association for Amateur Radio	1 December 2003

Key study attributes were recorded and maintained in a matrix that allowed for quick overviews, information analysis and sorting. Within each study category, the attributes used in evaluating the usefulness of publications and reports on bird-tower interactions as cited in the comments are presented in Table 2-2. As part of the review process, data for each study was developed using a primary reference review sheet (Table 2-3). Completed review sheets are presented in Appendix A.

Based on the review process, the cited studies used in reviewing the NOI comments are listed in Table 2-4.

TABLE 2-2

ATTRIBUTES EVALUATED
AS PART OF THE CITED STUDY ANALYSES

Attribute	Review Characteristics of Attribute
1. Source of Publication	• Is the paper in a peer-reviewed technical journal? • Is it an agency report, or part of an edited conference proceedings? Greatest weight will be given to peer-reviewed papers although many local and regional publications contain important, useful information.
2. Duration of Study	Variability is inherent in bird movements, weather conditions and other natural processes. Characterization of avian-tower interactions at a given site should therefore incorporate some appreciation for year-to year variation and should also recognize seasonal variability between spring and fall migration. Thus, the greatest weight will be given to multi-year studies and those that incorporate spring and fall data.
3. Carcass search methods	Methods used to document numbers of dead birds at towers vary considerably. • Were carcass searches conducted daily or only after nights with overcast and low ceiling? • Were searches conducted only in the fall, or during both spring and fall? Were attempts made to correct the carcass search data for observer bias and/or for scavenger activity? • Was the actual area searched defined or described? Greatest weight will be given to studies that included daily searches, spring and fall, and to studies that evaluated search biases.
4. Number of tower sites	Historically, few studies actually documented consistent bird mortality at more than one tower site. Some papers do incorporate data from multiple sites, however, and provided the data collection methods are consistent and reliable, such multi-site studies will be given greater weight.

TABLE 2-2, CONTINUED

ATTRIBUTES EVALUATED AS PART OF THE CITED STUDY ANALYSES

Attribute	Review Characteristics of Attribute
5. Behavioral observations at the tower	Ideally, a study of avian mortality at a tower will include more than just numbers of dead birds. In particular, behavioral data gathered in a consistent regular manner are preferred. Even opportunistic and irregular observations can be useful, but most weight will be given to studies that included behavioral observations in the design.
6. Documentation of weather factors	Weather is a critical component of avian mortality at towers. The most informative data are those from the actual tower site. Understanding avian mortality at towers requires knowledge of how weather affects behavior of night-flying migrants. Studies are especially useful if weather data are included for all nights, not only those associated with bird kills.
7. Analytical and statistical methods	• Are the data sufficiently robust to warrant statistical analysis? • Are the statistical approaches technically sound? • Do the results support the conclusion?
8. Inclusion of structural and landscape conditions	• Is information about the structural design of the tower available (e.g., height, guyed, and unguyed)? • Is information available pertaining to the towers lighting array? • Is information available regarding the physical setting of the landscape within which the tower is located?

TABLE 2-3

PRIMARY REFERENCE OR NEW DATA REVIEW SHEET

Comment # ___________________ Issue Type: __________________

(Article Number)

I. Citation or Source:	
Source Type (check one): **Peer-reviewed Paper ____** **Agency Report ____** **Conference Proceedings ____**	**Other (specify):**
II. Study Objectives (list)	
Do study objectives relate to scientific statement of conclusion being evaluated? Yes ____ No ____ Explain	
III. Species Studied (list)	
IV. Study Methods (briefly list)	
V. Duration of Study	
Duration (provide dates): **Single Year** ________________________________ **Multiple Years** ________________________________	**Seasons:** **Spring Migration ____** **Both ____** **Fall Migration ____** **Yearlong ____**

TABLE 2-3, CONTINUED

Primary Reference or New Data Review Sheet

VI. Carcass Search Methods (if applicable)

Search Conditions: Daily ____ Weekly ____ Only after overcast nights with a low ceiling or storm events ____

Other Periods (Describe):

Search Biases Evaluated, Including Observer Bias and Scavenger Activity? Yes ____ No ____

Search Area Described? Yes ____ No ____

Brief Description of Methods:

VII. Analytical and Statistical Methods

Are the data sufficiently robust to warrant statistical analysis? Yes ____ No ____

Statistical method(s) used: (list)

Are the statistical approaches technically sound? Yes ____ No ____

Do the results support the conclusion? Yes ____ No ____

Comments:

VIII. Number of Tower Sites: Proximity:

IX. Behavioral Observations at the Tower: Yes ______ No ______
Describe if applicable to statement or conclusion being evaluated.

X. Documentation of Weather Factors? Yes ______ No ______
Describe if applicable to statement or conclusion being evaluated.

TABLE 2-3, CONTINUED

Primary Reference or New Data Review Sheet

XI. Inclusion of Structural and Landscape Conditions? Yes ____ No ______ **Describe if applicable to statement or conclusion being evaluated.**
XII. Current State of Scientific Information (Only applicable if new data or study is provided.)
Is there any new scientific information that has been identified? Yes ______ No ___ **If yes explain and evaluate with separate review sheet if new data are provided.**
XIII. Need for and Scope of Additional Studies (Only applicable if new data or study is provided.)
Are additional studies identified? Yes ____ No ______ If yes explain and list studies.
XIV. Suggested Methods to Minimize Impacts (Only applicable if new data or study is provided.)
Are specific methods identified? Yes____ No ______ If yes explain and list specific mitigative methods.
Reviewer: **Date of Review:**
QA'ed by: **Date of QA:**

TABLE 2-4

PRIMARY STUDIES CITED BY NOI RESPONDENTS AND REVIEWED FOR THIS REPORT

USFWS ID-Peer Review	Cited in Analysis Summary	Author(s)	Title
Yes	No	Able, K.P. 1973.	The changing seasons. American Birds 27(1):19-23.
Yes	No	Aldrich, J.W., R.C. Banks, T.J. Cade, W.A.Calder, F.G. Cooch, S.T. Emlen, G.A. Greenwell, T.R. Howell, J.P. Hubbard, D.W. Johnston, R.F. Johnston, and L.R. Mewaldt. 1975.	Report of the American Ornithologists Union and ad hoc Committee on Scientific and Edcuational Use of Birds. Auk 92 (3, Supple):1-A-27A.
No, But Cited	No	Anderson, R., M. Morrison, K. Sinclair, D. Strickland, H. Davis, and W. Kendall. 1999.	Studying wind energy/bird interactions: a guidance document. Metrics and methods for determining or monitoring potential impacts on birds at existing and proposed wind energy sites. Avian Subcommittee, National Wind Coordinating Committee, Washington, D.C. 87 pp.
Yes	No	Aronoff, A. 1949.	The September migration tragedy. Linnaean News-Letter 3(1):2.
	No	Avery, M.L. and T. Clement. 1972.	Bird mortality at 4 towers in eastern North Dakota: Fall 1972. Prairie Naturalist. 4:87-95.
	Yes	Avery, M.L., P.F. Springer, and J.F. Cassel. 1975.	Progress report on bird losses at the Omega Tower, southeastern North Dakota. North Dakota Academy of Science 27(2):40-49.
Yes	Yes	Avery, M.L., P.F. Springer, and J.F. Cassel. 1976.	The effects of a tall tower on nocturnal bird migration – a portable ceilometer study. Auk 93(2):281-291.
Yes	Yes	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(2):291-299.
Yes	Yes	Avery, M.L., P.F. Springer, and J.F. Cassel. 1978.	The composition and seasonal variation of bird losses at a tall tower in southeastern North Dakota. American Birds 32(6):1141-1121.
	No	Baird, J. 1970.	Mortality of fall migrants at the Boylston television tower in 1970. The Chickadee 40:17-25.
No, But Cited	Yes	Ball, L.G., K. Zyskowski, and G. Escalona-Segura. 1995.	Recent bird mortality at a Topeka television tower. Kansas Ornithological Society Bulletin 46(4):33-36.
Yes	Yes	Banks, R.C. 1979.	Human related mortality of birds in the United States. U.S. Fish & Wildlife Service, National Fish and Wildlife Lab, Special Scientific Report – Wildlife No. 215:1-16. GPO 848-972.
	Yes	Boso, B. 1965.	Bird casualties at a southern Kansas TV tower. Transactions of the Kansas Academy of Science 68(1):131-136.
	Yes	Brewer, R. and J.A. Ellis. 1958.	An analysis of migrating birds killed at a television tower in east central Illinois. Auk 75(4):400-414.
	Yes	Caldwell, L.D. and G.J. Wallace. 1966.	Collections of migrating birds at Michigan television towers. Jack-Pine Warbler 44:117-123.
Yes	Yes	Caldwell, L.D. and N.L. Cuthbert. 1963.	Bird mortality at television towers near Cadillac, Michigan. The Jack-Pine Warbler 41(2):80-89.
	Yes	Carlton, R.G. (editor). 1999.	Avian interactions with utility and communication structures. Proceedings of a Workshop held in Charleston, South Carolina, December 2-3, 1999.

TABLE 2-4

PRIMARY STUDIES CITED BY NOI RESPONDENTS AND REVIEWED FOR THIS REPORT

USFWS ID-Peer Review	Cited in Analysis Summary	Author(s)	Title
	Yes	Carter, J.H. III and J.F. Parnell. 1976.	TV tower kills in eastern North Carolina. Chat 40:1-9.
	Yes	Carter, J.H. III and J.F. Parnell. 1978.	TV tower kills in eastern North Carolina: 1973 through 1977. Chat 42:67-70.
Yes	Yes	Cochran, W.W. and R.R. Graber. 1958.	Attraction of nocturnal migrants by lights on a television tower. The Wilson Bulletin 70:378-380. (Appears to be a duplicate of Cochran 1958.)
	Yes	Crawford, R.L. 1978.	Autumn bird casualties at a northern Florida TV Tower: 1973-1975. Wilson Bulletin 90(3):335-345.
	Yes	Crawford, R.L. 1981.	Bird casualties at a Leon County, Florida TV tower: a 25-year migration study. Bulletin of Tall Timbers Research Station 22:1-30.
	Yes	Crawford, R.L. 1981.	Bird kills at a lighted man-made structure: often on nights close to a full moon. Am. Birds 35:913-914.
Yes	Yes	Crawford, R.L. 1971	Predation on birds killed at TV tower. Oriole 36:33-35.
Yes	Yes	Crawford, R.L. and R.T. Engstrom. 2001.	Characteristics of avian mortality at a north Florida television tower: A 29-year study. J. Field Ornithol. 72(3):380-388.
	No	Curry & Kerlinger (web page)	What kills birds. Available at www.currykerlinger.com/birds.htm
	Yes	Elmore, J.B. Jr. and B. Palmer-Ball Jr. 1991.	Mortality of migrant birds at two central Kentucky TV towers. Kentucky Warbler 67:67-71.
	Yes	Evans, W.R. & A. Manville. 2000.	Avian mortality at communications towers. Transcripts of Proceedings of the Workshop on Avian Mortality at Communications Towers, August 11, 1999, Cornell University, Ithaca, N.Y.
	No	Evans, W.R. 1998.	Telecommunications towers affect avian community. Wave-Guide Information, Tower-Related Bird Kill Rates. http://www.wave-guide.org/archives/waveguide_3/birdkill.html
	Yes	Evans, W.R. 1998.	Two to four million birds a year: calculating avian mortality at communication towers. Bird Calls, American Bird Conservancy, March 1998:1pp.
No, But Cited	Yes	Gauthreaux, S.A., Jr. and C.G. Belser. 2000.	The behavioral reponses of migrating birds to different lighting systems on Tall Towers. 1 p. in W. R. Evans and A. M. Manville II (editors). Transcripts of the proceedings of the workshop on avian mortality at communication towers, August 11, 1999, Cornell University, Ithaca, NY, Published electronically at: http://migratorybirds.fws.gov/issues/towers/agenda.html
	No	Goodpasture, K.A. 1984.	Television tower casualties, Nashville, Tennessee 1976-1983. Migrant 55:53-57.
Yes	Yes	Herndon, L.R. 1973.	Bird kill on Holston Mountain. Migrant 44(1):1-4.
	No	Herron, J. 1997.	TV transmission tower kills in Lewis County, West Virginia. Redstart 64:114-117.

TABLE 2-4

PRIMARY STUDIES CITED BY NOI RESPONDENTS AND REVIEWED FOR THIS REPORT

USFWS ID-Peer Review	Cited in Analysis Summary	Author(s)	Title
No, But Cited	No	Johnson, G.D., W.P. Erickson, M.D. Strickland, M.F. Shepherd, D.A. Shepherd, and S.A. Sarappo. 2002.	Collision mortality of local and migrant birds at a large-scale wind power development on Buffalo Ridge, Minnesota. Wildlife Society Bulletin 30(3):879-887.
No, But Cited	Yes	Kemper, C.A. 1996.	A study of bird mortality at a central Wisconsin TV tower from 1957-1995. Passenger Pigeon 58:219-235.
	Yes	Kerlinger, P. 2000a.	Avian mortality at communication towers: a review of recent literature, research, and methodology. Prepared for the USFWS Office of Migratory Bird Management, 2000. Available at: http://migratorybirds.fws.gov/issues/towers/review/pdf
No, But Cited	Yes	Morris, S.R., A.R. Clark, L.H. Bhatti, and J.L. Glasgow. 2003.	Television tower mortality of migrant birds in western New York and Youngtown, Ohio. Northeastern Naturalist 10(1):67-76.
	No	National Wind Coordinating Committee (NWCC). 2001.	Avian collisions with wind turbines: a summary of existing studies and comparisons of avian collision mortality in the United States. Washington D.C.
	No	Nehring, J. (web page)	WSMV tower study summary 1960-1997. http://www.towerkill.com/statereports/TNR/TNdata1a.html
	Yes	Nehring, J. and S. Bivens. 1999.	A study of bird mortality at Nashville's WSMV television tower. Migrant 70:1-8.
	No	Ornithological Council. 1999.	Deadly Spires in the Night. Ornithological Council, 1(8), October, 1999.
No, But Cited	Yes	Podolsky, R, D.G. Ainley, G. Spencer, L. DeForest, and N. Nur. 1998.	Mortality of Newell's Shearwaters caused by collisions with urban structures on Kauai. Colonial Waterbirds 21(1):20-34.
	No	Savereno, A.J., L.A. Savereno, R. Boettcher, and S.M. Haig. 1996.	Avian behavior and mortality at power lines in coastal South Carolina. Wildlife Society Bulletin 24(4):636-648.
	Yes	Seets, J.W. and H.D. Bohlen. 1977.	Comparative mortality of birds at television towers in central Illinois. Wilson Bulletin 89(3):422-433.
No, But Cited	Yes	Shire, G.G., K. Brown, and G. Winegrad. 2000.	Communication towers: A deadly hazard to birds. American Bird Conservancy Special Report. 23 pp.
	Yes	Stoddard, H.L., Sr. 1962.	Bird casualties at a Leon County, Florida TV tower: 1955-1961. Bull. Tall Timbers Res. Sta. 1:94.
	Yes	Strnad, F. 1975.	More birds at KROC-TV tower, Ostrander Minnesota. Loon 47:16-21.
	Yes	Taylor, W.K. and B.H. Anderson. 1973.	Nocturnal migrants killed at a south central Florida TV tower, autumn 1969-1971. Wilson Bulletin 85(1):42-51.
Yes	Yes	Tordoff, H. B. and R.M. Mengel. 1956.	Studies of birds killed in nocturnal migration. University Kansas Museum Natural History Publication 10:1-44.

SECTION 3
BIRD COLLISIONS WITH TELECOMMUNICATIONS TOWERS

This section of the report presents the applicable information and data discussed in the Notice of Inquiry (NOI) comments and cited studies as they pertain to avian collisions with communication towers. Much of this compiled information that correlates with the comments received on the NOI was summarized from both peer- and non-peer reviewed reports, including the results of formal scientific studies as well as anecdotal information and observations. Sections 3.1 and 3.2 address one of the principal objectives of this study:

- *Review and evaluate the available, technically supportable information documenting the number of migratory bird collisions with telecommunications towers.*

3.1 GENERAL OVERVIEW

Recorded bird mortalities and associated monitoring studies at communication tower sites over the last five decades have come under increased scrutiny from regulatory agencies, the communication industry, avian specialists, environmental groups, and the public. However, as apparent from many of the referenced studies and incidental mortality reports for avian collisions with communication towers, little research has been completed on this issue in the last 20 years. Initial studies were conducted from the 1950s through the 1970s, with some studies continuing into the 1990s. On the night of January 22, 1998, an estimated 5,000 to 10,000 Lapland longspurs and other species were killed at three adjacent towers and a natural gas pumping facility in western Kansas. This single night, mass mortality event served as a catalyst to refocus the scrutiny of communication towers on avian mortality and subsequently to mobilize a number of actions in a variety of sectors, from federal to local and from private to industrial.

The first workshop to initiate the dialog regarding bird interactions with communication towers was held at Cornell University on August 11, 1999 (Evans and Manville 2000). Workshop speakers included a variety of prominent ornithological researchers, agency biologists, regulatory agency representatives, legal council, and communication tower industry personnel. Subsequently, there has been significant interest to further explore the magnitude of this problem and to develop potential solutions to minimize bird mortalities at communication tower structures. In support of this research and to facilitate communications among all the stakeholders, the *Communication Tower Working Group* (CTWG) was established in 1999. The U.S. Fish and Wildlife Service (USFWS) chairs the group, which is composed of a consortium of federal agencies, communication industry representatives, research scientists, conservation organizations, and interested private entities. A Research Subcommittee was appointed to identify research needs and objectives. Periodic workshops and meetings are held to discuss new information and ongoing studies.

In an effort to provide information to the communication tower industry on standardized approaches to minimize the potential for bird strikes at tower sites, the USFWS also developed voluntary guidelines for communication tower siting in October 2000. These guidelines are titled, *U.S. Fish and Wildlife Service Interim Guidelines for Recommendations on Communication Tower Siting, Construction, Operation, and Decommissioning.* Although there has been some debate from the communication tower industry with agencies in certain areas of the country regarding the term "voluntary", the intent of these guidelines was to provide directives and recommendations, based on the "best information available" at the time. These guidelines and the associated *Tower Site Evaluation Form* are available at
http://migratorybirds.fws.gov/issues/towers/comtow.html

The communication towers reporting the largest number of bird kills occur in portions of the heavily forested eastern third of the North American continent (Kemper 1964, Carter and Parnell 1978, Taylor and Anderson 1973, Stoddard 1962, Crawford and Engstrom 2001). In sheer number of migrating birds, detected mortality is substantially higher in the eastern U.S. than that observed in the western states (particularly the states of the interior west including Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming). Although tower kills do occur in the west, it appears that the western migrations are not as prone to nights of high-volume kills. No "mass kills" of birds have been reported west of Kansas to date. This phenomenon may be associated with several factors, one of which may be that overall populations of migratory birds in the western

U.S., especially those migratory species considered to be at the highest risk to tower collisions (e.g., warblers, thrushes, vireos, and finches), are smaller than those occurring in the eastern U.S. and that migration patterns differ between the eastern and western U.S. However, it also is evident that there is a geographical bias of the tower kill studies conducted to date. Of the 47 studies reviewed by Shire et al. (2000), only 14 (fewer than 30 %) were located west of the Mississippi River and none were located west of the Rocky Mountains. Consequently, a more balanced distribution of mortality studies throughout the U.S. is needed before conclusive statements can be made regarding regional differences in avian mortality from communication towers.

As discussed in Section 2.2, the following technical review of avian collisions with communication towers focuses on specific peer-reviewed studies and scientifically based approaches that examined a number of factors historically associated with bird collisions at communication tower sites. This review is not intended to be an exhaustive and all-encompassing literature search of bird kill studies and incidental mortality reports. Kerlinger (2000a) provides a comprehensive summary of studies completed through 2000. Similarly, Woodlot Alternatives (Woodlot) (2003), on behalf of the Cellular Telecommunications & Internet Association (CTIA) and others, presented a literature review of select studies and tower kill reports in response to the FCC's August 20, 2003 NOI request.

This technical review, prepared for the FCC, is structured to focus on the NOI comments received, the applicable studies referenced in those comments, and other ancillary studies that are associated with some of those issues discussed by Woodlot. The Woodlot report summarized a number of other anthropogenic mortality factors for birds associated with avian mortalities throughout the U.S. The report compared these estimated mortality levels and the relative significance of bird collisions with communication towers to the overall national bird populations. Although many of the following discussion topics summarized to address the NOI comments parallel the Woodlot information, the following discussions and analyses do not address the relative significance of bird mortalities associated with other human-induced causes (e.g., collisions with buildings, vehicles, power lines, wind turbines; effects of cat predation and hunting).

In response to the FCC's request to review the NOI comments and provide a "factual" summary on bird interactions with communication tower operation, the following discussions emphasize 1) the state-of-the-art knowledge regarding bird collisions with communication towers, 2) technically supportable information available regarding the number of birds reported to collide with these structures, and 3) the information available regarding the role that specific factors associated with communication towers may directly increase or decrease the incidence or risk of such collisions.

3.2 REPRESENTATIVE STUDIES AND INCIDENTAL MORTALITY REPORTS

Avian mortalities attributed to collisions with communication towers have been reported throughout North America since communication structures were first developed. Bird kills at tower sites have been documented in the U.S. from the late 1940's and continue to the present (Kerlinger 2000, Towerkill.com 2004).

Some of the more representative and high profile "bird kills" reported at communication towers over the last 50 years are shown in Table 3-1.

Over the last 50 years, a number of incidental mortality records, scientific studies, and anecdotal observations have been reported pertaining to bird kills at and near communication tower sites (Kerlinger 2000a). However, there are limitations in comparing these records due to the lack of continuity in study design (e.g., qualitative observations versus quantitative monitoring), data recording (e.g., anecdotal notes versus formal data records), and estimation biases (e.g., surveyor bias and scavenger removal rates). As previously noted, a number of confounding factors have limited the ability to determine the actual extent of avian mortalities and to make spatial and temporal comparisons of results. The following narrative discusses several of the more important factors.

TABLE 3-1

SIGNIFICANT BIRD MORTALITY EVENTS OVER LAST 50 YEARS

Location	Type of Tower	# of Species / Most Common Species Migratory or Non Migratory	Season, Dates & Duration	Description	Reference
Eastern and Southeastern U.S.	Broadcasting and television towers airport ceilometers, and tall buildings	• 61 species • 51 species • 68 species	Fall October 5-8, 1954	• October 5-6, documented 2,756 individual birds of 61 species at 5 northern locations. • October 6-7 recorded 4,478 birds of 51 species at 10 southern locations. • October 7-8 estimated 99,340 birds of 68 species at 11 of the southernmost locations	Johnston and Haines 1957
Topeka, Kansas	Television Tower, 950 feet	61 species / Nashville warbler, Common yellowthroat Migratory	Fall 11-day period, September – October 1954	Collected 1,090 birds of 61 species during cold fronts with rain, fog and low cloud ceiling	Tordoff and Mengel 1956
Chapel Hill, North Carolina	Television Tower, 78 feet	40 species	Fall September 28, 1956	Estimated 2,500 birds of over 40 species with low cloud ceiling	Trott 1957
WCIA Television Tower, Illinois	Television Tower, 983 feet	41 species / Warblers Migratory	Fall and spring 7 dates between September 1955 and May 1957	During reduced visibility and advancing cold fronts, recorded 486 individual birds of 51 species	Brewer and Ellis 1958

TABLE 3-1 (CONT'D)

SIGNIFICANT BIRD MORTALITY EVENTS OVER LAST 50 YEARS

Location	Type of Tower	# of Species / Most Common Species Migratory or Non Migratory	Season, Dates & Duration	Description	Reference
Springfield, Illinois	Television Tower, 998 feet	40 species Gray cheeked thrush Migratory	Fall September 16, 1959	Estimated 1,000 to 1,500 birds of over 40 species in heavy fog and low clouds	Parmalee and Parmalee 1959
Lewisville, Minnesota	Television Tower, 1,116 feet	47 species / Red eyed vireo Migratory	Fall September 20/21, 1963	Documented 924 birds of 47 species	Janssen 1963
Wisconsin and Minnesota	Television Tower (2), ?? feet		Season unknown - nights during migration, 1963	Recovered and identified 9,119 birds between the two sites	Kemper 1964
Michigan	Television Tower (7), 920 to 1,281 feet	92 species	Spring 1962-1964 and Fall 1959-1964	Recorded 6,505 birds of 92 species	Caldwell and Wallace 1966
Allegheny Plateau, New York	Communication Towers, ?? feet	NR	N/A	Estimate of over 10,000 passerines killed per year, based on monitoring of upstate New York communication towers and conservative extrapolations	Eaton 1967

TABLE 3-1 (CONT'D)

SIGNIFICANT BIRD MORTALITY EVENTS OVER LAST 50 YEARS

Location	Type of Tower	# of Species / Most Common Species Migratory or Non Migratory	Season, Dates & Duration	Description	Reference
WECT and WWAY Television Towers, North Carolina	Television Tower (2), 1,994 and 1,188 feet	• 88 species / Common Yellowthroat • 65 species / American Redstart Migratory	Fall migrations 1970, 1971, and 1972 Continued studies 1973-1977	• Recorded 3,070 birds, totaling 88 species for all surveys • Recorded more than 4,208 individuals of 65 species, including one night (September 4/5, 1974) in which 3,240 birds were killed.	Carter and Parnell 1978
WCYB, WJHL, and WKPT Television Towers, Tennessee	Television Tower (2), 125 and 85 feet	NR	Fall September 30, 1972	1,801 bird mortalities reported at two locations on top of Holston Mountain following a cold front with precipitation and low cloud ceiling	Herndon 1973
Omega Tower, North Dakota	Television Tower, 1,200 feet	NR	Spring and fall, 1971-1973	Studies estimated 4,298 birds and documented 5 red bats	Avery et al. 1975, 1977, and 1978
Illinois	Television Tower (7), 605 to 1,587 feet	NR	Fall Between September 2 and November 12, 1972	Collected 5,431 birds at 7 tower sites with 93.4% of the mortalities occurring on 3 nights in September and 1 night in October following cold fronts with reduced visibility and low cloud ceiling	Seets and Bohlen 1977
Orlando, Florida	Television Tower, – 1,484 feet	82 species / Common Yellowthroat Migratory	Fall monitoring 1969-1971	Documented 7,782 birds of 82 species	Taylor and Anderson 1973

TABLE 3-1 (CONT'D)

SIGNIFICANT BIRD MORTALITY EVENTS OVER LAST 50 YEARS

Location	Type of Tower	# of Species / Most Common Species Migratory or Non Migratory	Season, Dates & Duration	Description	Reference
Ostrander, Minnesota	Television Tower, 1,314 feet	• 84 species / NR • 28 species / NR	Sporadic monitoring from 1961 to 1974 Fall September 19, 1963	▪ collected 3,507 birds of 84 species • estimated minimum of 1,000 to 1,500 birds of 28 species	Feehan 1963 Strnad 1975
Elmira, New York	Television Tower, 843 feet	NR	• Fall September 20-24, 1977 • 1966-1977	▪ Collected 3,862 birds of 44 species, with 82% (3,175 kills) occurring on 2 nights. ▪ Total estimated mortality over 7,400 birds during the 11-year period.	Welles 1978 Howard 1977
Tall Timbers Research Station Florida	Television Tower, 669 feet, 1,010 feet, 295 feet	186 species / Red-eyed vireo Migratory	Spring and fall 1955 to 1983	Beginning in 1955, recorded 15,200 birds over 5.5-year period 44,007 individual birds of 186 species over 29-year period 1955 through 1983. Examined mortality numbers as tower height changed and examined predator/scavenger effects.	Stoddard 1962 Crawford and Engstrom 2001

TABLE 3-1 (CONT'D)
SIGNIFICANT BIRD MORTALITY EVENTS OVER LAST 50 YEARS

Location	Type of Tower	# of Species / Most Common Species Migratory or Non Migratory	Season, Dates & Duration	Description	Reference
Topeka, Kansas	Television Tower,– 1,440 feet	91 species / Gray catbird, sora, orange crowned warbler Migratory	Fall 1985 to 1994	Four mortality events preceded by cold fronts and low cloud ceilings totaling 2,808 birds of 91 species. ▪ September 25/26, 1985, recorded 919 birds of 54 species. ▪ September 30/October 1, 1986, recorded 635 birds of 49 species. ▪ October 11/12, 1986, recorded 834 birds of 64 species. ▪ October 8-9, 1994, recorded 420 birds of 45 species.	Ball et al. 1995
Kentucky	Television Towers (2), 1,000 and 1,739 feet,	NR	Fall and spring - 1983, 1986, 1990	1,806 (1983 and 1986) and 133 (1990) total bird mortalities, by tower respectively	Elmore and Palmer-Ball 1991
Eau Claire, Wisconsin	Television Tower, 1,000 feet	123 species / Red-eyed vireo, Tennessee warbler, ovenbird	1957 to 1995	Reporting 121,560 birds of 123 species over the 38-year period. One-night record kill occurred in 1963 where over 12,000 birds were collected and identified without adjusting for scavenger rates.	Kemper 1996 Manville 2000a
Nashville, Tennessee	Television Tower, 1,368 feet	112 species / Warblers and vireos	Fall September 1 to October 1, 1960 to 1997	Documenting 19,880 birds of 112 species, with the largest bird kills occurring on September 26, 1968 with 5,399 bird mortalities and on September 28, 1970 with 3,487 bird mortalities	Nehring 2000; Nehring and Bivens 1999

TABLE 3-1 (CONT'D)
SIGNIFICANT BIRD MORTALITY EVENTS OVER LAST 50 YEARS

Location	Type of Tower	# of Species / Most Common Species Migratory or Non Migratory	Season, Dates & Duration	Description	Reference
Western Kansas	Radio Towers (3),300 to 420 feet	Lapland longspurs	January 22, 1998	Between 5,000 and 10,000 Lapland longspurs killed at three towers and a natural gas pumping station on one foggy, snowy night. The largest bird kill in the Midwestern U.S. to date.	The Wichita Eagle 1998
New York and Ohio	Television towers (3), 961 to 1,084 feet	106 species – New York / Warblers and vireos 80 species – Ohio / Warblers and vireos	1970 to 1999	20,148 bird mortalities (106 species) recorded at the three New York towers; between 1974 and 1992, 4,310 mortalities (80 species) recorded at the one Ohio tower. Assuming these summaries extrapolated from A. R. Clark's surveys from 1967-2000, where he collected 20,514 birds of 110 species.	Morris et al. 2003

NR – Not Recorded

3.2.1 Study Duration and Survey Methods

Study design, study duration, and incidental mortality records have greatly varied over the last 50 years of communication tower reporting. This variance makes it difficult to compare scientifically based study results and more anecdotal mortality reports to adequately understand the extent of avian collisions with communication towers and whether the incremental and cumulative avian mortalities may be biologically meaningful to migratory species.

One of the primary issues identified to date and previously discussed during the August 11, 1999 *Workshop on Avian Mortality at Communication Towers* (Evans and Manville, 2000) is the lack of standardized methods and metrics for analyzing the extent of bird mortalities at communication towers. This topic is discussed in greater detail in Section 4.0.

In reviewing certain aspects of reported tower kills and associated monitoring studies, noting the absence of mortalities may be as important as noting the presence of large numbers of bird mortalities (i.e., "negative evidence may be as important, on occasion, as positive") (Stoddard 1962). In other words, it is just as important to record those towers of certain height, configuration, lighting regimen, and habitat that have not reported bird mortality. By limiting tower monitoring to only those towers associated with reported collision and bird mortalities may, in fact, prevent further characterization of collision factors and additional information that may be useful in minimizing future collision risk at certain tower sites.

3.2.2 Survey Biases

A few studies and researchers discuss the potential for biases in communication tower surveys. Potential survey biases include: 1) scavenger or predator removal (i.e., carcasses that are removed prior to surveys); 2) search efficiency (i.e., birds that may be missed during area searches); 3) habitat conditions (i.e., wetlands, water bodies and dense vegetation that cannot be searched); and 4) bird crippling (i.e., birds that may be crippled by tower collision but fall outside the search area). Any one of these biases could result in lower estimates of mortality at a tower site.

Predation or removal of bird carcasses by scavengers can significantly affect estimated mortality levels. In some areas of bird kills at communication tower sites, scavenger removal is rapid and aggressive (Kale et al. 1969; Kemper 1996; Crawford 1971; Crawford and Engstrom 2001; Stoddard 1962). Stoddard reported that nocturnal scavenger removal rates were high at his Florida study site, with carcasses often being consumed or removed within 0.5 hour of dawn (Kemper 1996). Carter and Parnell (1976 and 1978) reported notable scavenging of bird carcasses at two North Carolina towers, but no mortality adjustments were calculated. For one mass kill recorded on September 4-5, 1974, Carter and Parnell (1978) estimated that the number lost to predators and in dense vegetation and wetland areas could double the 3,200 birds collected from that one night.

Other representative data that examine predator or scavenger effects include the data summaries from the WCTV Television Tower, Florida, Tall Timbers Research Station, 29-year tower study. Crawford and Engstrom (2001) calculated the mean number of individuals killed was 2,248 (± 950) for years when scavenger controls were applied, and the mean number of mortalities was 642 (± 362) for years with no scavenger controls. Records also show that even with predator controls in effect, Stoddard was reporting an approximate 10% loss to scavengers (Crawford and Engstrom 2001).

Some studies have exhibited low scavenging rates. Avery et al. (1975 and 1978) monitored the scavenger removal rate of planted birds during both the spring and fall migratory periods in 1972 and 1973. Based on the low scavenging rates recorded, it was assumed that the daily carcass searches at the tower site kept the losses to scavengers and predators to a low level, and no mortality estimate adjustments were applied. However, based on the high scavenging rates recorded for some studies (Crawford 1971; Crawford and Engstrom 2001), predator control measures may be warranted for some areas (Crawford 1971), although not feasible for all studies. At a minimum, by estimating the scavenger removal rate of that site, the mortality numbers could be adjusted accordingly.

Although very few avian studies at communication tower sites incorporate scavenger removal studies, these estimates during both the spring and fall migration periods can aid in determining the overall scavenger rate for an area. This rate adjusts the mortality estimate accordingly, to provide a more representative number of bird kills. Without incorporating scavenger removal rates, relatively small kills (10 to 50 birds) could be masked by scavengers (Crawford and Engstrom 2001) and mortality numbers may be under-represented.

Surveyor bias relates to search efficiency, associated search images, and the potential for birds to be missed during tower surveys. Carter and Parnell (1978) provide a good example of the effects to mortality estimates from surveyor bias. The mass kill that occurred at a North Carolina tower (September 4-5, 1974) resulted in 3,200 birds retrieved, and estimated that thousands more were not found because of dense vegetation and loss to scavengers and predators. An area searched by two individuals was subsequently re-examined by a third surveyor. An additional 500 birds were discovered during this third attempt. As stated previously, without adjusting for search efficiency, the mortality estimates recorded at a particular tower site may be under-represented.

Other biases, such as habitat conditions and crippling effects, likely affect most tower studies to some degree and were indirectly mentioned in some reports. However, only general references were made to these effects (Carter and Parnell, 1978). Recommendations for addressing study biases are discussed further in Section 4.1.4.

3.2.3 Mass Mortalities vs. "Trickle Kills"

As might be expected, a significant amount of attention is drawn to records of mass bird kills at communication tower sites over the last 50 years. The following incidental reports of thousands of birds killed in one night are representative of these mass kills. The following list coincides with some of the mortality reports listed in Table 3-1 and are repeated here to better characterize the historical focus on single night, mass kills. These kills receive the greatest scrutiny from the media, public, and regulatory agencies; are often the focus of opposition to tower siting; and may have the greatest potential to result in regulatory action.

- 2,500 birds at a North Carolina tower on September 28, 1956 (Trott 1957).

- 1,000 to 1,500 birds at an Illinois tower on September 16, 1959 (Parmalee and Parmalee 1959).

- At a central Florida tower (Taylor and Anderson 1973):
    - 1,592 birds on September 29, 1970.
    - 859 birds on September 30, 1970.

- 1,801+ birds at four Tennessee towers at two locations on Holston Mountain on September 30, 1972 (Herndon 1973).

- At seven Illinois towers (Seets and Bohlen 1977):
    - 221, 735, 110, and 266 birds at four towers on September 2, 1972.
    - 391, 807, 992, 127, 634, and 206 birds at six towers on September 27, 1972.
    - 107 and 319 birds killed at two towers on September 29, 1972.

- At a New York tower (Welles 1978; Howard 1977):
    - 844 birds on September 22, 1974.
    - 1,817 birds on September 20, 1877.

- 3,240 birds at North Carolina tower on September 5, 1974 (Carter and Parnell 1978).

- At the Tall Timbers Research Station, Florida tower (Stoddard 1962 and Crawford 1978) (Note: a number of kills greater than 100 birds in a night were reported for this tower over the 29-year study. The following summaries include representative records over 400 birds in one night):
    - 4,000 to 7,000 birds on October 9, 1955.
    - 2,325 birds on October 5, 1957.
    - 971 birds on October 17, 1974.
    - 636 birds on September 14, 1975.
    - 486 birds on September 15, 1975.

- At a Kansas tower (Ball et al. 1995):
    - 919 birds on September 26, 1985.
    - 635 birds on October 1, 1986.
    - 834 birds on October 12, 1986.
    - 420 birds on October 9, 1994.

- 12,000 birds at a Wisconsin tower on 1 night in 1963 (Manville 2000a).

- At a Tennessee tower (Nehring 2000; Nehring and Bivens 1999):
    - 5,399 birds on September 26, 1968.
    - 3,487 birds on September 28, 1970.

- 5,000 to 10,000 birds at a Kansas tower facility on January 22, 1998 (The Wichita Eagle 1998).
- +1,576 and 133 bird mortalities at two Kentucky towers respectively (Elmore and Palmer-Ball 1991).

"Trickle kills" is a term used for the incremental mortality reports of low numbers of birds at tower sites, as compared to the mass kills that are more prominent in the literature and popular press. In the absence of routine surveillance of telecommunication towers, the extent of 'trickle kills' is poorly understood. Moreover, the potential cumulative effects of "trickle kills" remain an issue.

3.2.4 Declining Mortality

An observation that may have far-reaching repercussions for the communications industry is, that over the last five decades of monitoring bird populations, the number of bird mortalities at towers is reported to be decreasing while the number of towers is increasing. All long-term studies show a similar decline in total bird mortality (with other factors remaining equal, e.g., tower height).

Morris et al. (2003) compared mortality data from 1970 to 1999 for four separate towers (three in New York and one in Ohio), which were all approximately 1,000 feet in height. This comparison reported a "significant decrease" in the number of birds salvaged at all four towers occurred within the 30-year period, suggesting a corresponding reduction in the number of birds that collided with the towers during the same period. Morris et al. (2003) speculates on several possibilities to explain this reduction in bird mortality and include:

- Overall decrease in the migratory populations.
- Potential change in patterns of wind direction, cloud cover, and visibility.
- An increase in predator and scavenger removal of bird carcasses at tower sites.
- A change in the migration patterns.

- An increase in background light pollution (therefore a decrease in migrant attraction to tower lighting).
- An evolutionary reduction in bird attraction to tower lights.

However, when comparing the similar and parallel reduction in number of bird mortalities at the four tower sites, Morris et al. (2003) further suggest that the factors affecting changes in detected migrant mortality at communication towers are more likely large-scale factors, such as weather patterns and population size, rather than more site-specific factors, such as an increase in scavengers.

Nehring and Bivens (1999) reviewed a 38-year mortality study at a 1,364-foot television tower in Tennessee. They report a similar reduction in the number of mortality rates and species' diversity over time. Even after deducting the two mass kills recorded in 1968 and 1970, the long-term trend showed a significant reduction in the number of birds killed. They speculate on three potential causes for this decline, including:

- A change in the migration routes to avoid the expansion of Nashville, Tennessee.
- An increase in background light pollution, thereby reducing the attraction to the tower lights.
- An increase in scavenging rates, resulting in a decrease in birds recovered which is not indicative of a true measure of mortality.

Discussions on the reduction in bird mortality due to tower collisions over the last five decades have been speculative and have not been technically substantiated. Additional research on the hypotheses advanced is needed.

3.3 NOTICE OF INQUIRY COMMENT REVIEW AND SPECIFIC FACTORS AFFECTING BIRD COLLISIONS

The FCC's NOI (August 20, 2003) requested specific comments on a number of issues associated with avian collisions with communication towers including the current state of scientific information regarding the magnitude of these collisions and the effects of tower lighting, tower height, type of antenna structure, location of antenna structure, and other factors. In addition, information was solicited regarding the need for and scope of additional studies and suggested methods to minimize impacts. Within each of these categories, FCC posed a number of biologically based questions for comment.

In evaluating the information provided by respondents to the NOI, the FCC requested review of 12 specific comments and reply comments. These comments and the approach to their review have been previously discussed in Section 2.0 of this report (Table 2-1).

One of the principal objectives for this report includes a review and evaluation of the available, technically supportable information regarding the role that specific factors may increase or decrease the incidence of avian collisions with communication towers. The NOI comments and cited studies discuss a number of factors that may affect the incidence of avian collisions with telecommunications towers including:

- Migration patterns and seasonality
- Bird behavior
- Tower height and configuration
- Tower siting
- Tower lighting
- Weather

For each of these factors, the following subsections present a general discussion of the factor, e.g., bird behavior, followed by a discussion of the information provided in specific studies cited in the NOI comments. In addition, a discussion of the current research into the affect these factors may have on avian collisions is discussed where relevant.

For each of the associated topics and biologically based questions presented in the NOI, substantive comments on those topics were gleaned from each of the comments. Basic assumptions, conclusions, and opinions are further supported by the avian studies and incidental reporting. In the specific commenter response section, only those comments that contained a reference to that specific issue or topic are included; therefore, if a letter is not mentioned for a topic, the reader can assume the respondent did not address that issue in response to the NOI requests.

The numbers (e.g., 14, 15) refer to the paragraph numbers (where applicable) listed in the NOI. Some topics discussed (e.g., weather, bird behavior) were not specifically identified in the NOI; however, these subjects have been included and addressed since they are integrally involved in research of avian collisions with communication towers.

By way of background to the following discussion, a common theme that was observed in the NOI responses involved differing and/or the lack of definitions of terms. In particular, when a respondent debated the magnitude and importance of the mortality associated with tower strikes, the term “significance” was frequently used without defining the context of its use. For example, a number of respondents stated that mortality caused by telecommunication towers was biologically “insignificant” without qualifying the term. The term “biological significance” has been used to express a variety of meanings. Among others, it is used to reference individual, population and community level effects, species afforded special protection (e.g., endangered species or migratory species), or in reference to other regulatory legislation (e.g., the National Environmental Policy Act). Because of these different contexts and definitions of “biological significance,” caution must be taken in interpreting its meaning. A discussion of “Biological Significance” is presented in Section 3.5.

3.3.1 Current State of Scientific Information

The following discussion is associated with the request by FCC in its NOI to provide specific information regarding the quantity and quality of existing data documenting the mortality of migratory birds due to collisions with communication towers.

As defined by Department of Interior (See Federal Register, Friday, October 12 2001.50 CFR Part 10 General Provisions: Revised List of Migratory Birds: Proposed Rule) migratory birds include several hundred species of waterfowl, shorebirds, songbirds, raptors and other groups.

3.3.1.1 NOI Questions

- 14. *We seek comment on and analysis of existing scientific research and studies relating to the impact that communications towers may have on migratory birds.*
- *We ask that comments thoroughly discuss the methods that are used to quantify any information provided on this matter.*
- *We seek comment on the extent of migratory bird deaths that may be attributable to collisions with communications towers, the species and geographic locations involved, and what the raw numbers mean in terms of survival of species or in other relevant contexts.*
- *15. We also seek comment on the adequacy and reliability of scientific research on the impact of towers on migratory birds, including whether the parties that conducted the research are considered to be experts in the field and whether the research was conducted in a scientifically acceptable and rigorous manner.*
- *We seek comment on the extent to which research has considered these or other variables, and whether the research has considered the appropriate combination of variables in order to achieve reliable results.*
- *16. We also seek comment on whether the research included effective protocols to account for the actual numbers of birds killed at specific towers.*

3.3.1.2 General Responses and Summaries

Overall, there is general agreement that there is sufficient documented evidence of avian mortality by communication towers and that the construction and operation of tall structures will likely result in the risk of bird collisions and possible mortalities. This possibility is an unavoidable consequence of any elevated structure in the flight path of migrating birds. However, not all towers present the same collision hazard, and the same tower may result in markedly different mortality rates from night to night or season to season. The structure type, height, siting, lighting, season, species present, and weather conditions are thought to affect the potential risk for avian collisions and the magnitude of these effects. For the most part, comments of the NOI respondents do not disagree with this statement.

Although not all towers present the same collision risk, there is a consensus among the respondents that more information is needed to specifically identify the associated factors and the degree that each factor contributes to avian collision risks at communication tower sites.

Documented studies and anecdotal information were received referencing mortality to migratory birds. Both infrequent mass bird kills (e.g., scores to hundreds of birds) and smaller "trickle" kills were discussed by several respondents including industry (e.g., CITA et al.), government (USFWS), and environmental organizations (e.g., American Bird Conservancy, Forest Conservation Council, and Friends of the Earth). The American Bird Conservancy provides a species compilation through 2000 (Shire et al. 2000) of more than 230 bird species that have been documented at communication tower sites. Almost all of the reported mortality is associated with small songbirds although some gulls, waterfowl, shorebirds, and waders are occasionally recorded. Ninety-two percent of the mortalities are migratory species with the majority being nocturnal migrants.

NOI respondents did not explicitly address raw mortality numbers and species' survival rates. See Section 3.3.10 for additional discussions regarding avian mortality patterns. The term "significant" was used by many respondents, but each used the term differently. See Section 3.5 regarding "biological significance" and the difficulties in defining and applying this term.

No recent research was provided to account for the actual numbers of birds killed at communication towers (see Section 3.3.10). Past studies were referenced as an estimation of the amount of mortality at communication towers. Some, but not all, of these older studies attempted to account for scavenger removal rates and observer bias. Because of this inconsistency, cross-study comparisons are limited. Nor was any recent research provided on other variables.

Without a collective effort to record bird mortality it is difficult to predict the true magnitude of the problem. That birds are colliding with towers has been well-documented (See Section 3.2). USFWS (Manville 2001b), Evans (1998), and Woodlot (2003) have arrived at estimates of avian collisions with communication towers ranging from 2 to 5 million birds per year. Although the etiology of bird-tower mortality is a current research need, the empirical data and anecdotal reports on avian collisions with communication towers have contributed valuable information toward answering some of these questions and establishing a framework for developing standard methods and metrics necessary for comparing study results.

The lack of standardized methods for bird mortality surveys at tower sites suggests that avian mortality is likely underestimated for that particular sampling period or reported incident. Because of the lack of sufficient studies, it is not possible to draw conclusions on geographical mortality patterns. In addition, most mortality studies are from the eastern portion of the U.S., limiting our knowledge on other areas of the country.

Section 3.2 provides an overview of past, present, and proposed studies and incidental mortality reports at communication tower sites in the U.S. Section 4.1 discusses data gaps and lack of consistent methodology, with specific recommendations for future actions, based on the literature and best professional judgment. Additional dialog and planning is warranted, given the number of unknowns and inconsistencies among stakeholders.

3.3.1.3 Specific Respondent Comments

The following discussion provides a summary of the respondent's comments regarding the current level of scientific information pertaining to avian collisions with communication towers.

PCIA is a trade association representing the wireless telecommunications and broadcast infrastructure industry. PCIA members own or manage approximately 50,000 towers. PCIA conducted a survey of its members requesting information on bird collision mortality and its relationship to tower height, configuration, lighting, seasons, weather, and time of day. PCIA reported that it had received a 74% response rate from its membership. This response rate was based on responses from an unspecified number of representatives owning or managing 37,000 towers. Unfortunately, a compilation of the survey data was not provided.

The first question in the PCIA survey requested information on bird collisions. Survey Question 1 asked: "In your experience, is there evidence to suggest that birds – migratory or other – are colliding with the towers you oversee? For example, do the equipment compounds have signs of bird kills that could have been caused by such a collision?" According to the PCIA survey results, responding members overwhelmingly indicated that they do not observe or find evidence of bird collisions around towers. One respondent stated that evidence of bird collisions is found at 0.5% of tower sites it managed. Unfortunately, it is not clear how many tower sites these collective data represent or how these results were derived. PCIA also stated the survey respondents did not report any incidences of "significant" bird kills. There are no questions in their attached survey request on "significant" events, so presumably this was provided as supplemental information. Additionally PCIA does not define "significant bird kill" or "significant event." Although the survey is a good attempt at obtaining the industries knowledge on bird collisions, no new defensible evidence was provided on avian mortality or the role of specific factors affecting bird collisions. Absent the raw data, it is not possible to draw any defensible conclusions from the survey results, as reported in the PCIA comment letter.

CTIA and NAB stated that "reports claiming communications towers have been responsible for significant bird kills" are isolated and anecdotal. They also stated "no reliable scientific basis exists for accurately estimating the numbers of migratory birds killed by collisions with communications towers."

Woodlot (2003) reviewed existing literature for CTIA, PCIA, and NAB. Woodlot provided an overview of these studies and grouped this literature into non-peer reviewed and peer-reviewed literature. In reviewing the literature and extrapolating various area-specific studies, Woodlot acknowledged that comparisons between various mortality types should be made cautiously due to the limitations of this approach. Specifically, mortalities from windows and buildings, vehicle collisions, wind turbines, transmission lines, pesticides and oil pollution, cat predation, hunting, and communication towers were evaluated. An estimated range of 381 million to 2.3 billion birds dies each year from human-caused factors. Of these, collisions with communication towers represent approximately 0.05 percent (5 million birds) of the annual migratory bird population. It is uncertain what impact these sources of mortality are having on bird populations. Woodlot further commented that some experts believe the estimate of 4 to 5 million birds per year could be off by an order of magnitude. This statement was not clarified.

The USFWS presented a thorough history of bird collisions, while acknowledging that much is simply still not known about the impacts of communication towers on birds. Regarding estimates of avian mortality at communication towers, former USFWS' staff member, Dr. R. C. Banks estimated mortality at 1.25 million birds killed per year at tower sites (Banks 1979). The USFWS published an estimate of nationwide human-caused annual mortality, which Banks depicted as 196 million bird deaths caused by human activity. This estimate represented 1.9 percent of the projected bird population in North America in 1979. Evans (1998) reassessed tower mortality based on increased numbers of tall towers, estimating 2 to 4 million bird deaths per year. Manville (2001b), from a December 1999 evaluation, estimated annual mortality at 4 to 5 million birds, but indicated that mortality could range as high as 40 to 50 million (2001a), based on a December 2000 assessment. Note that these are simply estimates created by extrapolation and that the uncertainty associated with these estimates is high.

The National Association of Tower Erectors (NATE) has not undertaken scientific studies. However, it indicated "not one of their members has witnessed more than a few dead birds at one time." It is not clear how these conclusions were derived as neither study design nor supporting data were presented. No information was provided on the number or type of towers. Additionally, there are a number of biases associated with detecting bird carcasses including surveyor detection, scavenger removal, habitat, and crippling biases. Without the use of a validated search protocol, mortality information is largely anecdotal and provides limited value.

Cingular Wireless and SBC Communications provided additional mortality information from a Washington State Association of Broadcasters (WSAB) survey. According to Cingular Wireless and SBC Communications, the survey members stated, "Virtually all reported that they have never experienced significant number of bird kills at any tower site." They also indicated that Native American tribes report few if any bird deaths at towers on their lands. Although surveys of this kind can provide anecdotal information, the absence of a more formal and technically-based approach limits the usefulness of this information.

3.3.2 Migration Patterns and Seasonality

3.3.2.1 Current State of Knowledge – General

Neotropical migrants, particularly wood warblers (Parulidae), vireos (Vireonidae), and thrushes (Turdidae) appear to be the most susceptible to collisions with communication towers. Neotropical migrants migrate between North America and Central/South America and many of these species migrate at night (Kerlinger 1995). Distribution of species recorded at tower sites will vary by season (Kemper 1996). Although mortalities of diurnal bird species' have been recorded at tower sites, the majority of mortality records are composed of nocturnal migrants.

Prominent neotropical migration corridors include coastlines, mountain ridges and valleys (particularly those with a north-south orientation), and bodies of water connecting north-south land areas. Although the overall number of continent-wide birds migrating each spring and fall appears to be declining, specific population data are difficult to develop for mobile populations like birds (Temple 1998). Particularly troublesome is the collection of data for the number of birds migrating at night.

In addition, migration routes for a particular species often vary annually. Bird migration, even by the same species, does not typically occur in tight, linear patterns that traverse the same ground each year. Migration tends to occur across an expansive front and is quite complex (Evans 2000). Migrating birds exploit any number of weather-induced movements of air masses to aid their flight. These factors complicate the data compilation pertaining to avian collisions with communication structures.

Evans (2000) reported that acoustical data recorded in New York suggest that the risk of collisions for some species relative to tower siting may be the same over a large area (e.g.

within a 30-mile x 30-mile area), unless unique surface features or habitats are present. In other words, a species' risk of colliding with a communication tower would be similar within a geographical area unless unique terrain features such as coastlines, mountains, or valleys concentrate migratory movements along these features and increase the avian collision risk. Consequently, the siting of a tower in proximity to these landscape features would increase the probability of avian collisions.

The height at which birds fly is an important factor affecting collisions. Figure 3-1 depicts these altitudinal ranges by bird group and relative abundance. In migration, larger birds such as waterfowl and cranes generally fly at high altitudes. However, inclement weather and limited visibility generally force birds to fly lower, thereby correlating increased bird mortalities at communication tower sites with inclement weather, seasonal frontal movements, and reduced visibility.

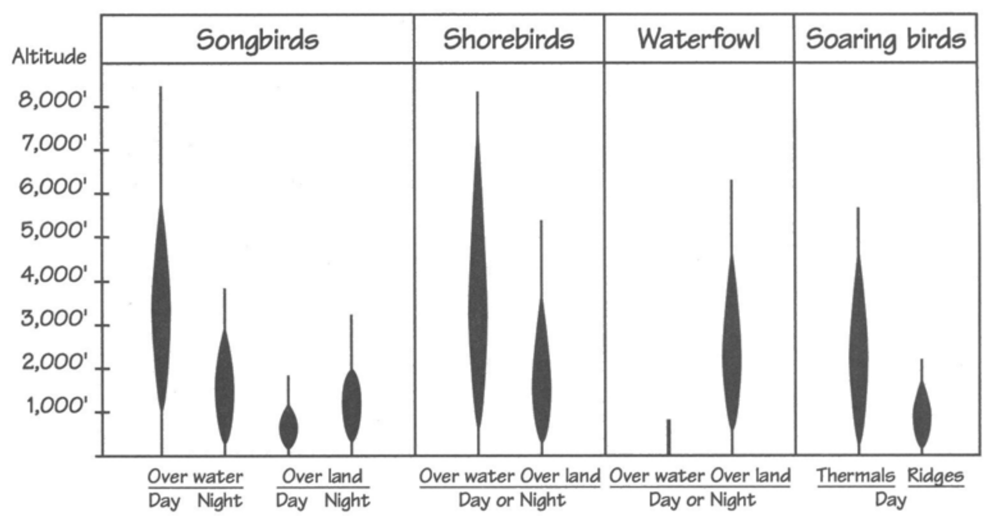

Figure 3-1 Relative Altitudes of Migrating Birds (Kerlinger 1995)

Other forms of monitoring bird migration include the use of various radar devices. Radar ornithology has been used to study bird migration since the 1960s, but it has more recently been used to monitor individual species' movements; track the use of birds' breeding, feeding, and roosting areas; measure species' abundance and movements; survey nocturnal burrow-nesting birds, record specific interaction and behavior of birds with overhead power lines, and determine relative impacts to birds from the operation of wind energy projects (Gauthreaux and Belser 2003). To date, one study completed in the 1980s used radar to monitor flight paths during migration near a 1,010-foot broadcasting tower (Larkin and Frase 1988). There is also a current study being conducted in Pennsylvania on three guyed, lighted communication towers ranging from 1,115 to 1,280 feet in height, using radar to monitor bird behavior and flight patterns in proximity to towers (see Section 3.4.4).

3.3.2.2 Discussion of Specific Studies

Biological Mechanisms

Bird migration is a complex phenomenon that is a combination of orientational cues, such as the position of the sun, moon, and stars; the Earth's geomagnetic field; polarized light; topographical features; and continental outlines (Cochran et al. 2004, Ogden 1996). Evidence suggests that despite the multiple navigational cues available for certain bird species, individuals are likely opportunistic in the choice and implementation of these mechanisms, depending on conditions or location (Ogden 1996). Recent evidence by Cochran et al. (2004) suggests that birds may daily calibrate their magnetic compass using twilight cues at sunset before nightly migration flights.

Seasonal Patterns

The seasonal pattern for increased bird mortalities at communication tower sites shows a pronounced spike during fall migration and another smaller spike during spring migration. Brewer and Ellis (1958) and Caldwell and Wallace (1966) both reported mortality numbers 10 times greater in the fall than in the spring. This increase during the fall period is presumably due to the greater number of young birds migrating in the fall and because advancing cold fronts that often are associated with increased avian mortalities, hasten migration in the fall and actually slow migration during the spring period. Additionally, these fall weather fronts typically include low visibility, winds and overcast conditions which all appear to increase bird collision risk with towers.

One valuable summary of bird mortalities during the spring and fall migration periods was provided for the Eau Claire, Wisconsin television tower study where the number of mortalities recorded by day of the month are compiled over the 38-year monitoring period for that latitude. During the spring migration, the greatest number of avian mortalities occurs in the month of May, with a peak averaging between May 22 and 25. During fall migration, the highest numbers of mortalities occur in September, with the highest peak averaging between September 15 and 20. Large kills also were recorded during late August and early October during this long-term study; however, mortality was significantly lower than that recorded in September over the 38-year period (Kemper 1996).

Tordoff and Mengel (1956) provides a summary of the fall migration timing of adult versus immature birds by species. . This summary shows that adult and immature birds of the same species migrate at different times, with the magnitude of the difference being species-specific. Therefore, migratory movements can be complex and varied, and one cannot assume that all age groups are moving at the same time across the same plane or front.

Although Brewer and Ellis (1958) only completed 7 surveys over a 3-year period (1955-1957), their survey results suggest that bird species that migrate earlier than other species exhibit a lower mortality rate than later-migrating species. They compared species composition of mortality at a 983-foot Illinois tower to reported mass bird kills at other tower sites. Brewer and Ellis (1958) indicated that they did not know why the timing of migration affected a species' susceptibility to tower collisions. However, Crawford (1978) speculates that early migrating birds may have lower levels of mortality because they simply avoid most of the later developing storm fronts.

Flight Patterns

Aggregation of birds in migration may confound mortality estimates and affect collision patterns. Aggregation of migrating birds may occur as either a line of individual birds following a feature (e.g., topography, water source) or possibly a random or evenly distributed clumping within the group. If birds are aggregated, mortality events may occur at some towers, but not others, thereby increasing the complexity of estimating the overall volume of birds migrating during any one period (Brewer and Ellis 1958) and affecting bird distribution near tower sites. Nocturnal migrants during the fall have been observed predominantly in tight flocks, whereas spring migrants appear to be more widely dispersed (Caldwell and Wallace 1966). However, Avery et al. (1975 and 1978) and Stoddard and Norris (1967) reported relatively large spring kills; the authors speculating that the spring mortalities were typically comprised of locally breeding bird species.

Species Composition

The distribution of bird carcasses on the ground near a tower site will generally depend on the individual's flight speed, height, and direction; the collision point; and wind velocity and direction. Brewer and Ellis (1958) further state that mapping carcass distribution may provide information on the relative roles of the tower versus the guy wires relative to bird mortality and possibly specifics on which species were migrating together or during the same time period.

Many researchers view avian mortality records at communication tower sites as important information pertaining to migrating birds, their distribution, and dispersal patterns. When comparing the mortality reports for the Tall Timbers Research Station tower located in northwest Florida (Crawford 1978) to those mortality records associated with a central peninsular Florida tower (Taylor and Anderson 1973), it became apparent that the two towers were "sampling" different migration patterns or systems (Crawford 1978). Other interesting migrational observations reported by Herndon (1973) included new state records of bird species' documented in Tennessee and the fact that on September 30, 1972, only 21 species (57%) of the state's 37 warbler species and no ovenbirds were recorded during the state's annual fall bird count, but that night

27 warbler species (73% of the state's warblers) and 303 ovenbirds (17% of the total kill of 1,801 avian mortalities) were reported in a mass mortality event on Holston Mountain. Therefore, these mortality accounts provided additional insight into local migration patterns that were not apparent from the annual population surveys.

Summary

A higher number of bird mortalities are recorded at communication tower sites during the spring and fall periods. The majority of these species encompass a variety of neotropical migrants, and a greater number of mortalities have been reported in the autumn. The higher fall numbers are likely due to an increased number of birds from breeding and the greater prevalence of advancing frontal systems. Difficulties in data collection and interpretation are problematic, although mortality reports have provided insight into migration patterns and species' distribution. A number of assumptions and conclusions are made, based on observations and study results; however, additional information pertaining to migratory movements, primarily of nocturnal neotropical migrants, is needed to draw additional conclusions and direct future research on this topic.

3.3.2.3 NOI Questions

The NOI did not specifically request comments on bird migration patterns and seasonality. However, these factors appear to correlate with avian collision risk at communication tower sites and a few comments on this topic were received.

3.3.2.4 General Responses and Summaries

Although there is still much unknown about how and why tower collisions occur, certain factors such as seasonal migration were mentioned by the NOI respondents. Large kills with lighted towers often are reported to be associated with songbird migration occurring in broad fronts during storm events. In the selected NOI comments and reply comments, no recent information on the effects of seasonal migration patterns on avian collisions was presented. Although respondents reference seasonal migration as a potential factor, and fall migrations may pose a greater risk than the spring migration, no specific studies or additional details were provided.

Section 3.3.2.1 discussed the relationship of bird migration in association with communication tower collisions. This summary focuses on how migration factors (e.g., seasonal patterns, bird behavior) correlate with reported tower kills and how mortality reports at tower sites aide in answering questions regarding species distribution and movement. The general consensus of respondents who discussed these issues was that additional information pertaining to migratory movements, primarily of nocturnal neotropical migrants, is needed before substantive conclusions can be derived regarding the association of seasonal migration patterns and tower collisions.

3.3.2.5 Specific Respondent Comments

Woodlot cited studies discussing the seasonality of avian mortalities recorded at communication towers stating that the majority of mortalities of neotropical migrants are reported in the spring and fall. Further, Woodlot cited data that although most mortality occurs during the fall migration the influence of varying weather conditions can affect the risk. A study was cited that indicated that cloudy nights with northerly winds appeared to result in a higher mortality rate than during other conditions.

The USFWS response referenced work by Crawford and Engstom (2001) documenting a 29-year study where 65% of detected mortality was in the fall and 20% in the spring.

3.3.3 Bird Behavior

3.3.3.1 Current State of Knowledge – General

Few in-depth behavioral studies on migratory bird behavior have been completed at communication tower sites. Avery et al. (1975) observed large flocks of blackbirds and smaller groups of sparrows, longspurs, shorebirds, ducks, and geese passing through a tower area with no difficulty. Other observations on lighted communication towers have shown a change in flight behavior and patterns as birds fly near above ground structures.

3.3.3.2 Discussion of Specific Studies

Avery et al. (1976) reported at the 1,200-foot North Dakota tower, nocturnal sightings of birds "fluttering and milling about" mainly into the wind with two observations of birds moving into a light southeasterly wind, taking them upwind slightly beyond the tower to the southeast, turning to be blown downwind to the northwest of the tower, stopping, and making way back upwind again. This pattern repeated itself, with the birds flying in a narrow elliptical path, issuing frequent flight calls, which Avery et al. (1976) stated, is generally characteristic of birds around a tower on overcast nights.

Taylor and Anderson (1973) reported unusual bird behavior during an incident on the night of September 28-29, 1970, when birds collided with the 1,484-foot tower at 11:00 p.m. following an extensive cold front. Collisions continued from 11:00 p.m. until dawn, with the greatest number of collisions occurred around 2:15 a.m. after heavy precipitation. Observers reported continuous "chirps and calls" from birds flying overhead, with individuals flying in rapid, erratic flights. Birds were seen to strike the lower part of the tower, two buildings, parked cars, and the ground. Almost 1,600 bird mortalities representing 37 species were recorded. The bird behavior and associated mortalities documented by Taylor and Anderson (1973) are some of the few direct observations of bird collisions at communication tower sites.

Larkin and Frase (1988) monitored nocturnal bird behavior and flights during migration near a 1,010-foot broadcasting tower using a portable tracking radar. This study reported that with a low cloud ceiling surrounding the tower, birds flew in nonlinear arcs and circles around the tower, but during clear conditions or a high ceiling, this behavior was not observed. According to Larkin and Frase, the slow circling speed recorded using this radar during low cloud cover was "remarkably precise" and inferred some sort of change in flight behavior relative to the tower location.

Gauthreaux and Belser (2000) also recorded flight behavior of nocturnal migrants in response to different tower lighting regimes. The study results showed a greater degree of nonlinear flight (i.e., pause-hover, curved, or circling) near towers with red lights than those with white lights or at a control site. These observations are discussed in greater detail for tower lighting in Section 3.3.6.2.

Cochran and Graber (1958) recorded bird behavior in response to lighting at a 984-foot tower in Illinois by monitoring bird vocalizations. This study was only completed on one night during the spring migration (May 29-30, 1957) and one night during fall migration (November 5, 1957). Through both acoustical monitoring and direct observations, Cochran and Graber (1958) were able to detect that the migrants were not evenly distributed. In the vicinity of the tower on nights with a low ceiling, migrants also appeared disoriented or confused, flying through the tower framework, circling, and passing through the tower again. However, on clear nights (unpublished manuscript), the auditory records show a number of migrants passing the tower with no apparent confusion or disorientation.

One interesting behavioral observation by Stoddard (1962) was the repeated presence of large numbers of exhausted and sleeping birds on the ground within 50 to 100 yards of the Florida tower following nights with low visibility and typically large numbers of mortalities and crippled birds. He assumed that the birds when circling the tower either fell to the ground exhausted or had been stunned by a strike. These birds were relatively unhurt, and remained on the ground until morning. These individuals would often fly off when approached upon waking the next morning. No sleeping birds were ever observed larger than "tanager-sized." Taylor and Anderson (1973) report a similar observation following nights with a large number of collisions, although the majority of the live birds recorded on the ground were injured.

Although records of bird behavior near communication towers are limited and few in-depth studies have been completed to date, a number of observations have been recorded by researchers that provide insight into attraction or avoidance of tower sites under varying environmental conditions. Different family or species migration patterns (e.g., flying altitudes, routes, social behavior) also may result in certain species being at a greater risk to collisions than others (Nehring and Bivens, 1999). As with other factors, several questions remain pertaining to bird behavior in the proximity to tower sites.

3.3.3.3 NOI Questions

The NOI did not specifically request comments on bird behavior near communication towers. However, a few comments on this topic were received.

3.3.3.4 General Responses and Summaries

Records of bird behavior near communication towers are limited. As stated above few in-depth studies have been completed to date. However, a number of observations have been recorded by researchers (Avery et al. 1976; Taylor and Anderson 1973; Larkin and Frase 1988; Gauthreaux and Belser 2000; Cochran and Graber 1958; Stoddard 1962; and Nehring and Bivens 1999), providing insight into birds' possible attraction or avoidance of tower sites under varying environmental conditions. As with other factors, questions remain pertaining to specific conditions that affect bird behavior in the proximity to tower sites. Little information was reported on the behavior of birds approaching towers during the day, specifically behavioral avoidance. The applicable studies provide information on bird behavior under lighted conditions but not under unlighted conditions.

3.3.3.5 Specific Respondent Comments

This topic was not specifically addressed by respondents except for the reference of a few studies that characterized bird behavior at lighted towers., e.g., the USFWS and Woodlot's reference to Avery (1976), and the USFWS reference to Gauthreaux and Belser (2000).

Woodlot discussed a few studies supporting the conclusion that seasonal differences in birds (assumed to be young versus adult) are reflected in mortality implying behavioral differences because of age.The American Bird Conservancy, Forest Conservation Council, and Friends of the Earth mentioned bird behavior relative to mortality effects from lighting and possibly attraction but no specific references to data were provided.

3.3.4 Tower Height and Configuration

3.3.4.1 Current State of Knowledge – General

Tower height appears to be a potential factor in the rate of bird collisions with towers, although there is considerable discussion regarding the importance of tower height to the risk of collision. Towers taller than 500 feet tend to be implicated in more of the mass kills reported for communication tower sites. However, there have been few mortality studies and monitoring programs for the "shorter towers" (500 ft and less). It may be premature, then, to assume that shorter towers present a lower collision risk and result in fewer bird mortalities. The following studies discuss these factors and how to define "tall" versus "short" towers, which can be interpreted differently.

3.3.4.2 Discussion of Specific Studies

Tower Height. One of the more long-term bird-monitoring projects on communication towers in the U.S. was conducted by a physician in Eau Claire, Wisconsin from 1957-1995. From 1949 to 1955, a 500-foot high television tower site was surveyed without any notable findings of bird mortalities. However, in 1957, a 1,000-foot-high tower was erected adjacent to the original tower, and on August 29, 1957, the first mass bird kill at this site was recorded (Kemper 1996). The 500-foot tower was ultimately removed in about 1960, but the 1,000-foot Eau Claire tower continued to be monitored with records of significant bird kills, reporting 121,560 birds of 123 species over a 38-year period (Kemper 1996).

A second long-term study that has provided valuable data on species' composition, bird behavior, predator/scavenger effects, and inferences to the effects to birds from tower height is the 29-year study at a northern Florida tower at the Tall Timbers Research Station (Stoddard 1962; Crawford and Engstrom 2001; Crawford 1971, 1978, and 1981). In October 1955, Stoddard (1962) initiated site surveys at a new 669-foot television tower. Almost daily, surveys were conducted at this site continuing from 1955 through 1983. In early 1960, the original 669-foot tower was replaced with a 1,010-foot tower. Subsequently in 1989, the tower was shortened to 295 feet. This long-term study of three tower heights at the same location provided a unique opportunity to compare avian kills with tower heights, while controlling for other variables (Crawford and Engstrom 2001). During the 29-year period, 44,007 birds of 186 species were collected and recorded for the three tower heights. Comparative mortality estimates were not provided for each tower height over time, however, Crawford and Engstrom's (2001) study summary showed that there was not a "significant difference" when comparing the mortality numbers attributed to the 669-foot tower and the 1,010-foot tower, even when controlling for weather conditions and cloud ceiling height. However, the data showed a "significant decrease" in mortality of nearly two orders of magnitude at a tower height of 295 feet. Based on these data, the authors further suggest that towers 300 feet and less pose little "significant threats" to migrating birds. However, this inference has yet to be proven and is currently being examined in an Arizona study, as discussed in Section 3.4.3.

Another example of tower height effects included a tower study in Indiana where minimal bird mortalities were reported for three television towers ranging from 350 to 450 feet high and that were oriented in a north-south direction. In July 1962, a 1,074-foot-high tower was erected nearby. After the taller tower was erected, Manuwal (1963) reported "significantly higher" bird mortalities for this site starting in the fall of 1962.

Although the critical threshold for tower height has not been definitively determined (Seets and Bohlen 1977; Crawford and Engstrom 2001), Kemper (1996) hypothesized this threshold to be approximately 400 feet.

Guy Wires vs. Self-supporting. Intuitively, one would assume that towers with an array of guyed wires would present a greater collision hazard or risk to migrating birds than self-supporting structures. . No specific studies comparing avian collisions with guyed towers to self-supporting structures were found as part of this review. Additionally, it would be difficult to differentiate causal factors between guyed structures and tower height, as tall towers require guy wires. Nevertheless, should the presence of guy wires represent an increased probability of bird strikes (i.e. larger collision potential), the development of a demonstration study and the collection of associated data would be valuable.

In summary, a number of studies and incidental mortality reports have been completed on the "taller" towers. However, existing data are not sufficient to draw direct conclusions between tower height and migratory bird collisions. The critical threshold for tower height has not been definitively determined relative to bird collision risks. Although some assumptions are made on tower height effects, additional information is warranted. Tower configuration, guyed versus self-supporting structures, appears to be more defined in that a greater number of mass kills of birds are associated with the taller, guyed structures. However, no specific studies comparing avian collisions between guyed and self-supporting structures are known to occur. Studies on shorter, self-supporting towers have been recently initiated, as discussed in Section 3.4.

3.3.4.3 NOI Questions

The following discussion is associated with the request by FCC in its NOI to provide specific information regarding the quantity and quality of existing data documenting the impact of tower height and tower configuration on migratory bird collisions with communication towers.

- *21. We seek comment on the role of tower height as a cause of collisions by migratory birds with communications towers.*
- *Are there reliable scientific studies that compare the impacts on migratory birds of towers of different heights, and do they control for other variables such as geographic location, proximity to bird movement corridors, and prevailing weather conditions?*
- *Do studies examine whether short towers have less impact on migratory birds than tall towers, and do they identify the heights of the towers that were studied?*
- *We also ask that comments address the relationship, if any, of tower height with other factors, such as lighting, and whether there are situations where tower height could be limited to deter collisions by birds with towers yet still allow the provision of reliable communications services.*
- *We seek comment on what impact, if any, different tower structures may have on migratory birds.*
- *Are there factors that may make a particular type of tower structure more or less of a risk to migratory birds?*

- *We also seek comment on whether particular tower designs or potential deterrent devices such as visual markers may deter migratory birds from towers.*

3.3.4.4 General Responses and Summaries

The respondents expressed opinions on the varying risks posed by different tower heights to migratory birds. However, no new research or data were provided in the NOI comments. There appears to be a consensus among the respondents that comparative studies of different tower heights are limited. However, a few studies discussed in Section 3.3.4.2 (Kemper 1996; Stoddard 1962; Manuwal 1963) infer that tower height likely influences migratory bird mortality under certain conditions. Although there also appears to be the consensus that other variables such as geographic location, proximity to bird movement corridors, and prevailing weather conditions are influential, the combined impact of these factors with tower height have not been specifically studied.

Additionally, no recent information or research was provided whether particular tower designs or potential deterrent devices, such as visual markers, might reduce the migratory bird collision risk with communication towers.

Existing data are not sufficient to draw direct conclusions between tower height and migratory bird collisions. As discussed above, the critical threshold for tower height has not been definitively determined relative to bird collision risks. Although some assumptions are made on tower height effects, additional information is needed. Tower configuration, guyed versus self-supporting structures, appears to be more defined in that a greater number of mass kills of birds are associated with the taller, guyed structures. However, no specific studies comparing avian collisions between guyed and self-supporting structures are known to occur. Studies on shorter, self-supporting towers have been recently initiated, as discussed below and in Section 3.4.

3.3.4.5 Specific Respondent Comments

No new research or data were provided in the individual comments.

CTIA, PCIA, and NAB generalized that because of the lack of studies, conclusions cannot be drawn on tower designs affecting mortality. Woodlot stated that few studies exist to draw conclusions on geographical, topographical, and elevation factors affecting mortality.

Woodlot further discussed that little information exists to draw conclusions on tower heights affecting mortality. However, they did report that when looking at towers with mass kills of 100 mortalities or more, the tallest towers appear to have the greatest impact. They cautioned that large biases may be involved with these data, and information on geographic and topographic locations may be important, missing components. Woodlot also commented that no observable trend could be presented on guy wires as a factor. This is because the literature had limited information on the presence of guy wires although it is likely that most tall towers reporting mortality were guyed.

NAB specifically stated that encouraging more towers of a shorter design is simply not feasible due to distance separation rules (FCC Parts 73.207 and 73.610), costs, and local jurisdictions. In addition, NAB speculated that installing a greater number of shorter towers (less than 200 feet tall) could actually contribute to increased mortality. No specific information was presented, however, to support this conclusion.

PCIA specifically referenced the Woodlot report in questioning USFWS' guidelines on lighting of towers <199 feet. As discussed in Section 3.3.1.3, PCIA conducted a survey of their members, which included information on bird collision mortality and its relationship to tower type along with other factors. PCIA indicated that two respondents stated certain tower types (monopoles or lattice) are more likely to be struck by birds. The respondents were split over whether birds are more likely to collide with guyed or self-supporting towers. No information is provided on the number of towers these data represent.

The American Bird Conservancy, Forest Conservation Council, and Friends of the Earth raised the issue of tower configuration but drew no conclusions. They cited one study in which bird mortality was observed at a 100-foot tower located on 2,600-foot ridge.

According to the USFWS, because so few studies have been conducted at both short and tall towers, it is premature to debate the impact and mortality caused by communication towers on birds until systematic research is conducted nationwide. There are no methodical studies analyzing the role of tower height and there is no established threshold effect reported in the literature. While short (<200 feet above ground level), unguyed, and unlit towers may be the least problematic, the USFWS further states that no systematic research has been conducted on impacts of short towers on birds. As discussed in Section 3.4.3, the U.S. Forest Service and WEST (2004) began a 3-year study April 2004 on six cell phone towers (less than 200 feet in height) on the Coconino and Prescott National Forests in Arizona to assess bird mortality for short towers in the western U.S.

Cingular Wireless and SBC Communications stated without documentation that the vast majority of cellular and PCS towers pose no danger to migratory birds because they are <200 feet in height, further stating available research fails to demonstrate significant risk. The authors indicated that there is no support for a 199-foot limit on tower height in the scientific literature and that based on the limited information available, it does not appear that migratory bird mortality would justify restrictions on towers < 400 feet tall. They also noted that the USFWS' guidelines recommending collocation of towers and tower height limitation to less than 200 feet may be unattainable in certain areas; stating that it is difficult to collocate multiple carriers while minimizing tower height. Finally, they stated that keeping towers less than 200 feet will likely require a greater number of towers, which is in opposition to USFWS' Guideline 10, which recommends minimizing the number of towers.

Cingular Wireless and SBC Communications reported tower height, rather than the type of antenna structure, seems to be implicated in migratory bird strikes, although no supporting information was provided. Additionally, it is unknown why 400 feet was selected as the tower height threshold by Cingular Wireless and SBC Communications in this discussion, unless it was in response to Kemper (1996) projecting a critical threshold of around 400 feet for tower height.

3.3.5 Tower Siting

3.3.5.1 Current State of Knowledge – General

Most researchers agree that tower siting can be key in minimizing the risk of future bird collisions with the tower and its ancillary facilities. Relative collision risk can be attributed to a number of variables, such as topography, land features, elevation, habitats, urban and suburban interface, degree of existing development, and climatic conditions (localized and regional). As discussed in Section 3.1, the USFWS has developed voluntary siting guidelines for communication towers. These guidelines incorporate siting variables with tower configuration options to provide direction, based on existing knowledge and developed theories regarding bird collisions with communication towers.

3.3.5.2 Discussion of Specific Studies

No studies specifically examining tower siting and associated variables or comparing tower site features were found as part of this review. Siting criteria are mentioned in tower studies in combination with other factors, such as tower lighting and height. Tower siting is important in some areas to reduce the collision risk to birds, although insufficient information is available to draw conclusions as to the specific importance of these factors.

3.3.5.3 NOI Questions

The following discussion is associated with the request by FCC in its NOI to provide specific information regarding the quantity and quality of existing data documenting the effect of communication tower siting on migratory bird collisions.

- *23. We seek comment on research or other data relating to any other matters within the scope of this inquiry.*
- *Do towers on ridges, mountains, or other high ground have a differential impact on migratory bird populations and, if so, are there scientifically rigorous studies that address such effects and their causes?*

- *We seek comment on the impact on migratory birds, if any, of locating towers in areas with a high incidence of fog, low clouds, or similar obscuration, in proximity to coastlines and major bird movement corridors, or either clustered near or dispersed from other towers. Comments on the role of any of these factors should consider the extent of any such impact during migration seasons.*
- *We also seek comment on any other factors that may influence the impact of communications towers on migratory birds.*
- *24. Consistent with that commitment, we specifically seek comments from the Tribes and other parties on whether any of the questions raised in this inquiry will significantly impact Tribal governments, their land, and resources.*

3.3.5.4 General Responses and Summaries

The effect of the siting of communication towers was not explicitly addressed by the respondents but was frequently referenced in the discussions of location towers in migration flyways and proximity to certain specific habitats. The respondents did not address differential mortality associated with tower siting, including topographical features, regional weather patterns, land ownership, or land use.

No specific studies on communication tower siting were cited by the respondents. As stated above, siting criteria are mentioned in tower studies in combination with other factors, such as tower lighting and height, which are addressed specifically for those study aspects. Tower siting is important in some areas to reduce the collision risk to birds, although insufficient information is available to draw conclusions as to the specific factors associated with siting towers.

3.3.5.5 Specific Respondent Comments

NAB stated that the USFWS' (2000) voluntary guidelines recommending against siting towers in areas that historically exhibit conditions with storm events or frontal systems, especially during spring and fall migrations, is unworkable because this suggested criteria could characterize a vast majority of territory. No specific information was provided.

The USFWS observed that because of their extensive use by avian populations, wetlands are some of the least desirable locations to site towers; however, they stated that information is still needed to support a minimum distance from wetlands to construct towers. The agency indicated that ongoing studies on Michigan State Police towers (see Section 3.4.1), as well as U.S. Coast Guard's (USCG) proposed "Rescue 21" project (see Section 3.4.6) next to the Great Lakes and along the U.S. coastline hopefully will provide the additional information needed to support guidance on where to site towers in, around, or near water or wetlands. They also acknowledged that impacts from communication towers situated on ridges, mountains, and other high ground are not well known. The USFWS stated that studies on cell towers in the National Forests in Arizona (see Section 3.4.3) also should begin to provide some useful data regarding this issue.

3.3.6 Tower Lighting

3.3.6.1 Current State of Knowledge – General

For aviation safety, tower lighting is required for towers exceeding 199 feet in height. Lighting specified by the FAA has traditionally included steady red lights, pulsating/flashing red lights, and/or white strobe lights. Historically, both lights and radio signals were implicated as potential factors for disorienting birds and thus contributing to the increased mortality rates reported for communication tower sites. However, the behavioral effects of radio signals on birds are poorly understood and are not usually identified as the major cause of tower kills. Limited studies suggest that bird behavior around communication towers is similar whether or not the tower is transmitting.

More compelling is the growing body of evidence that birds may be attracted to tower lights, and certain colors and flash patterns may have disorienting effects, especially during inclement weather conditions where the tower illumination bounces and refracts off a myriad of water droplets suspended in the air to create an aura of light and a greater illuminated space around the tower (Avery et al. 1976). Historically, birds have appeared to be "attracted" to artificial light sources from lighthouses and buildings (Ogden 1996). However, it is unclear whether birds are actually attracted to a light source and move toward it or whether the birds are "trapped" by the light during their nocturnal flights (Ogden 1996).

One prominent theory of the incidence of bird collisions with communication towers is that as birds enter this lighted area during foggy or inclement weather, they become disoriented, lose or change some of their nocturnal navigational cues, and are reluctant to leave the lighted sphere (Avery et al. 1976). As the birds begin to circle or flutter in the lighted space, individuals begin to strike guy wires, the tower, or each other often resulting in direct mortalities or crippling effects. Others fall to the ground exhausted. However, records of nocturnally migrating birds becoming confused by artificial lights also have been recorded during clear, calm nights (Ogden 1996).

Two aspects of tower lighting have been identified as possibly attracting birds and include color (white lights, ultraviolet, or specific wavelengths) and the light duration (strobes, flashing, or steady). Unfortunately, of the approximate 10,000 species of birds, we know the photo or visual pigments for only 11 of those species. Of those 11 species, only two are nocturnal migrants in the Western Hemisphere (Beason 2000). Although some studies and several anecdotal reports suggest that white strobe lights may be less attractive to birds, this has not been proven to date. To complicate policy implementation and local planning, white strobe lighting often is not favored by residents located within sight of the tower; therefore, this becomes an aesthetic issue as well.

3.3.6.2 Discussion of Specific Studies

One of the more dramatic examples of apparent light attraction by migrating birds was exhibited during the period of October 5-8, 1954, where 25 reported bird kills (over 100,000 total mortalities) occurred at airport ceilometers (devices used to measure the height of cloud cover), communication towers, and tall buildings from New York to the South Atlantic states following an advancing cold front (Johnston and Haines 1957). Of these 25 reports, an estimated 50,000 birds (53 species) were killed at one location in one night (October 7-8) at Warner Robins Air Force Base near Macon, Georgia. Birds were observed flying vertically down into the ceilometer beam, colliding with the ground. Of the other 24 incidents, 8 cases involved birds colliding with communication towers from 200 to 1,062 feet tall.

Avery et al. (1976) observed a 1,200-foot communication tower in North Dakota on overcast nights during the migratory periods. They found that the number of migrant birds observed directly at the tower was "significantly greater" than the number recorded 1,000 feet northeast of the tower at a control site. This study further suggests that migrants may not be attracted specifically to lit structures themselves on overcast nights simply because celestial navigational cues are not available, but rather because of the refraction of the light in the dense moisture droplets, which greatly increases the sphere of illumination around the tower. Birds that pass nearby the tower enter the illuminated area and are reluctant to leave. As they fly back toward the tower into the illuminated zone, it is more likely that individuals may strike the tower, guy wires, each other, resulting in mortalities or crippling effects.

As stated in Section 3.3.3.2, Gauthreaux and Belser (2000) recorded flight behavior of nocturnal migrants in proximity to different types of tower lighting during spring and fall migration in 1999 to better understand why birds appear to be attracted to lights and to determine the relative influences of different lighting regimes on migratory birds. During spring migration, they monitored migrant flight behavior, using an image intensifier, during nine evenings near a white strobe light FM broadcasting tower and over a control area. During the fall migration, Gauthreaux and Belser monitored migrant flight behavior on 14 evenings near a television tower with red lights, near a television tower with white strobe lights, and over a control area with no tower. They coded the flight behavior of the migrating birds into two categories: 1) linear flight (i.e., straight) and nonlinear flight (i.e., pause-hover, curved, or circling).

These unpublished results available in a report abstract compare the number of birds exhibiting nonlinear flight among sites and the total number of birds among sites:

- During the spring surveys, the number of birds exhibiting <u>nonlinear flight</u> near the tower with white strobe lights was significantly greater than at the control site, but the <u>number of birds</u> recorded at each site was not significantly different.

- During the fall surveys, the number of birds exhibiting nonlinear flight near the tower with red lighting was "significantly greater" than those flying near the tower with white strobe lighting. Similarly, the number of birds recorded in nonlinear flight near the tower with white strobes was "significantly greater" than the number of birds recorded flying over the control site.

- Parallel to the flight behavior observations, the number of birds recorded flying near the tower with the red lights was "significantly greater" than those recorded flying near the tower with the white strobes and over the control site. Interestingly, the number of birds detected flying near the tower with the white strobe lights did not "differ significantly" from the number observed over the control site.

Gauthreaux and Belser (2000) further suggest that the greater number of birds recorded for the tower with red lighting is likely the result of the "attraction" to constantly illuminated red lights on the tower and the proportion of the birds exhibiting nonlinear flight behavior (i.e., the individual birds pausing, hovering, or circling the tower) spending more time at the tower site than those in linear flight. Although these study results have not been published to date and the study has not been duplicated, the results provide evidence to suggest migrant attraction to red lights over the white strobes.

Another phenomenon reported at lighted towers relative to migrant bird behavior involves the species' individual flight calls. Migratory bird calls given while circling a lighted tower during low visibility and inclement weather have been acoustically recorded at tower sites (Evans 2000). Two representative studies temporarily extinguished the lights at two tower sites. Upon turning the lights off, the migrant calls then ceased and the birds left the circle of light (Avery et al. 1976; Cochran and Graber 1958). Cochran and Graber (1958) specifically reported that immediately after the tower lights were extinguished, the birds began to leave the tower vicinity, based on the diminishing volume of call notes and in less than 2 minutes all of the birds were out of hearing. After turning the tower lights back on, the first auditory calls from birds could be heard within 1 to 2 minutes, with the number of call notes increasing considerably thereafter.

Historically, observations have documented that birds appear to be ”attracted” to certain light sources under certain environmental conditions. However, no clear conclusions can be drawn, based on the existing literature, regarding the importance and effects of lighting color, duration, intensity, and type (e.g., incandescent, strobe, neon, or laser) and bird attraction. Additional research is needed on the types of lights in conjunction with other factors that increase or decrease the risk of bird collisions with communication towers.

3.3.6.3 NOI Questions

The following subsections are associated with the request by FCC in its NOI to provide specific information regarding the quantity and quality of existing data documenting the effect of communication tower lighting on migratory bird collisions.

- *18. We seek comment on whether and why lighted towers attract birds, and whether different lighting systems increase the potential for migratory bird collisions with communications towers.*
- *We seek information on whether studies document any difference in risk posed by lighting systems that use lights of different color or different rates of flash, pulse, or strobe (including red or white strobe).*
- *Comments also should address the effects of lighting color, duration, intensity, and type (e.g., incandescent, strobed, neon, or laser) on bird attraction, especially at night during inclement weather and during spring and fall migrations.*
- *In addition, we ask that respondents take into consideration, where appropriate, the impact of different tower lighting systems on human communities. Further, are particular lighting systems or colors more or less attractive to migratory birds based on differing tower heights?*
- *We also ask that respondents recommend specific lighting systems to minimize migratory bird collisions with towers, to the extent supported by scientific findings.*

3.3.6.4 General Responses and Summaries

Comments were received on the varied risks posed by different lighting systems. Credible studies were cited on avian attraction to lights. Hovering and circling behavior has been observed near tower lights. Radar studies have shown that birds will circle towers on overcast nights. It also has been documented that the frequency of call notes decreases when tower lights are turned off on nights with low cloud ceilings. It can be concluded from the respondents' comments that certain types of lights appear to attract birds more than other types of lights, but there still is debate. No firm conclusions could be drawn based on the existing literature regarding the importance and effects of lighting color, duration, intensity, and type (e.g., incandescent, strobe, neon, or laser) on bird attraction, although as discussed earlier in this section, inferences can be drawn on different lighting regimes. Additional research is needed on the types of lights in conjunction with other factors that increase or decrease the risk of bird collisions with communication towers.

3.3.6.5 Specific Respondent Comments

No recent research or data were provided by the respondents.

NAB stated that because the lighting effects of towers on avian attraction are not well known, it may be later determined that more species are attracted to the lighting configurations set forth in the USFWS' interim guidelines than are attracted to currently set lighting configurations. The USFWS guidelines recommend using only white (preferable) or red strobe lights with the minimum number, minimum intensity, and minimum number of flashes per minute (longest duration between flashes) allowable by the FAA. The use of solid red or pulsating red warning lights at night should be avoided. These guidelines are available at:

http://migratorybirds.fws.gov/issues/towers/comtow.html

Woodlot outlined scientific studies that infer that lights attract birds and that resulting mortality may be related to certain types of weather events. They further stated that insufficient published information exists on different lighting regimes to draw comparisons or clear conclusions.

PCIA referenced its member survey report (not provided) and the Woodlot report. Specifically, PCIA's member survey requested information on bird collision mortality and its relationship to lighting along with other factors. The reported 74% response rate is based upon receiving responses from an unspecified number of representatives owning or managing 37,000 towers. Only one survey response indicated a correlation between lighting and bird collisions. The number of survey respondents and the type of lighting were not provided. Also the number of towers represented in this single response is unknown. Interpreting the survey results is problematic without more information or a compilation of the survey data.

The American Bird Conservancy, Forest Conservation Council, and Friends of the Earth discussed the issue of lighting and bird mortality and drew conclusions based on cited studies that "lights on towers (especially solid red lights) disrupt neotropical migratory birds' celestial navigation system and perhaps the magnetic navigation system" resulting in disorientation and increasing the risk of collisions with the towers or their support structures.

The USFWS cited scientific literature that infers that bird collisions and consequent mortality may result from the combination of a lighting system in association with poor weather conditions. The USFWS further acknowledged that current lighting recommendations in their voluntary interim guidelines (USFWS 2000) are based on limited research. There is presently only a single study demonstrating a greater proportion of bird attraction to red flashing incandescent lights than to white strobes (Gauthreaux and Belser 2000). In this study, white strobe lights attracted birds as compared to unlit control sites that attracted none. Although there is strong evidence to support light as an attractant during inclement weather, there is still much speculation regarding light type, color, intensity, and duration. This is universally acknowledged as being a key research need. The impact of different lighting schemes on migratory birds is presently being investigated and preliminary results are expected after the 2005 fall migration season.

Cingular Wireless and SBC Communications iterated that an optimum balance must be sought between aircraft safety and avian mortality. In reference to this statement, however, the USFWS' comment letter clearly states they have no intention of requesting modifications that would negatively impact air safety. Cingular Wireless and SBC Communications also challenge the USFWS' voluntary guidelines that recommend white lights, citing an unpublished work by L.K. Raynor, et al. in which white-throated sparrows were shown to be attracted to white lights. These contradictory findings further support the need for additional information on avian vision because certain species may be more affected by certain spectral bands than others.

3.3.7 Weather

3.3.7.1 Current State of Knowledge – General

Stoddard (1962) states that furthering our knowledge of nocturnal bird migration is intricately connected with the study of weather factors and how they relate to migratory movements. The majority of tower studies and incidental mortality observations report the greater the frequency of inclement weather events at a tower site during bird migration the greater the likelihood of increased avian collisions and associated mortalities. Most researchers and tower operators agree that most bird mortalities have occurred during or after weather events, including precipitation, increased frontal system winds (particularly tail-winds), low cloud ceilings and visibility, and foggy conditions. However, the degree of association between climatic factors and bird kills is not completely known or understood.

3.3.7.2 Discussion of Specific Studies

The correlation between bird kills and advancing cold fronts with lower cloud ceilings, increased winds, and lower visibility appears to be strong, particularly during autumn (Avery et al. 1977; Brewer and Ellis (1958); Eaton 1967; Kemper 1996; Mollhoff 1983; Nicholson 1984; Norwoods 1960). Some of the larger bird kills recorded at tower sites have occurred as the birds move into weather frontal systems from an area that was clear upon leaving that night or as weather systems overtake birds already migrating, forcing the birds to lower altitudes (Kemper 1996; Stoddard 1962; Welles 1978). Tail winds also are a factor for increasing the avian collision risk with communication towers (Kemper 1996), even on clear nights (Stoddard 1962).

An example of how changing weather patterns may affect the rate of bird collisions with communication towers includes an observation by Kemper (1996). During an overcast night at the Wisconsin tower site, birds were recorded falling steadily at a rate of two to three birds per minute at a lighted structure. When the overcast conditions broke and the sky became clear, the collisions ceased (Kemper 1996).

Both Kemper (1996) and Stoddard (1962) state that it is typically clear weather when migrants begin their nightly movement. As weather fronts move in or visibility decreases with reduced cloud ceilings or increased precipitation or fog, migrating birds are forced down in altitude, increasing the collision risk with tall man-made structures. Stoddard (1962) observed that families, such as warblers, vireos, and thrushes do not migrate on nights with heavy precipitation in the early evening hours, particularly during fall migration. However, finches (Fringillidae) were found to initiate migration despite early evening precipitation. Therefore, on nights where clear, dry conditions existed early in the evening followed by later storm events, warblers, vireos, and thrushes typically comprised approximately 75% of the mortalities recorded at the Tall Timbers Research Station tower site. However, on those nights when rainfall occurred early in the evening, mortality was dominated by finches and waterbird species (Stoddard, 1962).

Vocalizations by nocturnal migrants near towers have provided researchers additional information on the duration of a species' presence, flight behavior, composition, and relative bird density (Kale et al. 1969). Surveyors using acoustic monitoring have observed that rapid weather changes from overcast to clear conditions have resulted in the cessation of bird collisions (Kemper 1996; Avery et al. 1976). This phenomenon parallels the behavior reported in Section 3.3.6 where migratory birds calls given while circling a lighted tower during low visibility and inclement weather cease and the birds leave the circle of light once the lights have been temporarily extinguished at the tower site (Avery et al. 1976; Cochran and Graber 1958).

The North Dakota tower study by Avery et al. (1976) examined nocturnal bird behavior and movements. Weather patterns appeared to influence the number and distribution of birds around the tower's lights. On overcast nights, "significantly greater" numbers of birds were documented at the tower than during clear nights, and many individual birds appeared to be disoriented during these inclement weather periods. This study also suggested that some birds may actively avoid towers on clear nights (Avery et al. 1976). However, another study completed by Avery et al. (1977) recorded incidents of bird mortalities during migration, particularly in the spring, when skies were clear. Although bird losses during the fall period were associated with overcast skies and advancing cold fronts, 58% of the mortalities recorded during the spring occurred on non-overcast skies typically with southeasterly (i.e., favorable) winds. Another interesting note recorded during these North Dakota studies was related to the location of the bird mortalities. The birds killed during fall migration were generally found close to the tower as birds continued to circle the tower and area of illumination. However, the spring mortalities were documented farther from the tower than those on overcast nights, as the birds were assumed to be colliding with the outlying guy wires and transmitting cables. The differences in mortality between overcast and clear nights within certain distances from the tower base were determined to be "statistically significant", indicating that the distance of bird losses from the tower was influenced by the cloud cover (Avery et al. 1976).

Crawford (1981) compared recorded bird mortalities at a Florida tower site to the moon phases. Verheijen (1981) initially hypothesized that bright moonlight mitigated the disorienting effects on birds from the artificial lights located on communication tower structures. Crawford (1981) tested this hypothesis, using a "fraction illuminated" lunar value compared with mortality records. Crawford found that although there was some evidence that the moon phase may indirectly influence the number of bird mortalities at tower sites, since the volume of migrating birds appeared to be less during a full moon, there did not appear to be a direct association between the moon phase, tower lights, and bird orientation during migration. Crawford (1981) further states that weather at tower sites and the magnitude of migrating birds during a certain period are more significant factors for determining tower kills.

Based on these studies and incidental mortality reports comparing the number of bird kills to environmental conditions, most of the moderate to large bird kills at tower sites have occurred during or following a storm event or frontal system, particularly during the migration periods. Many of these studies suggest a direct correlation between bird collision risk and weather events. However, the extent or degree of this association and how other factors may influence mortality rates are essentially unknown. Additional information is needed on weather patterns relative to bird movement and other conditions that may contribute to increasing or decreasing risk of bird collisions.

3.3.7.3 NOI Questions

The NOI did not specifically request comments on the effects of weather conditions on bird mortalities with communication towers. However, based on a review of the literature, there appears to be a correlation between certain weather conditions and avian collisions , and a few comments on this topic were received.

3.3.7.4 General Responses and Summaries

There is general consensus that most collision events, particularly during the fall period, occur in tandem with a weather system or inclement weather, including overcast, foggy, or low cloud ceiling conditions. Respondents also recognized that weather conditions resulting in poor visibility for birds increase collision risk. These conditions are especially important with increasing mortality around lighted towers.

As discussed previously in this section, there is general consensus that most of the moderate to large bird kills at tower sites have occurred during or following a storm event or frontal system, particularly during the migration periods. Many of the studies cited suggest a correlation or an association between bird collision risk and weather events. However, the extent or degree of this association is unknown, and additional information is needed on the weather conditions that may contribute to increasing or decreasing risk of bird collisions.

3.3.7.5 Specific Respondent Comments

As discussed in Section 3.3.5.5, NAB commented that the USFWS (2000) voluntary guidelines recommending against siting towers in areas that historically exhibit conditions noted for severe storm events or frontal systems, especially during spring and fall migrations, is unworkable because this suggested criterion characterizes a vast majority of territory.

Woodlot cited studies stating that although sampling designs have varied, weather conditions have been shown to influence mortality rates. PCIA's member survey included information on bird collision mortality and its relationship to weather. PCIA stated the survey results indicate that isolated collision incidents usually occurred after inclement weather. However, no information was provided on either the number of respondents or the number of towers these data represent.

USFWS documented that weather factors are involved with some mortality events especially those associated with lighted towers.

NATE acknowledged they have not undertaken any scientific studies relative to birds and communication towers, but they asserted a great deal of reports from their members suggest that only in the most severe wind conditions have they ever found significant numbers of dead birds at or near the bases of telecommunications towers. It is not clear how these conclusions were derived or the extent of these storm events. No study designs or statistical review were presented.

3.3.8 Need For and Scope of Additional Studies

3.3.8.1 NOI Questions

- *25. In the event that parties believe that existing research is insufficient to permit the Commission to address fully the issue of migratory bird collisions with towers, we seek comment on what additional study or studies may be needed.*

- *We also seek comment on what types of procedures should be used to monitor birds that may be killed at communications towers during these studies.*
- *In addition, we request comment on whether studies can be structured specifically to research potential methods of reducing the potential for migratory bird collisions with towers.*
- *We seek comment on the factors that would impact the length of any study, including the number of towers that would be the subject of the research, and the particular testing procedures that would be used.*
- *We also seek comment on whether pilot studies followed by one or more larger studies are necessary, or whether one or more smaller studies could yield sufficient information, on which the Commission could base future actions respecting migratory bird issues.*
- *27. We also seek comment on the appropriate party or parties to design and conduct a study.*
- *We also seek comment on any ongoing or planned studies with which the Commission might coordinate in order to achieve synergies and avoid duplication of effort.*
- *28. Comments should address both the estimated cost of any studies and potential sources of funding.*
- *29. We seek comment on whether existing studies or research address the use of particular methods to minimize any impact of communications towers on migratory birds.*
- *31. We request comment on the scientific basis for these guidelines (i.e., USFWS Tower Siting Guidelines), the general use of the guidelines and the use of each of the specific guidelines, and any other potential measures to minimize impacts on migratory birds within the scope of our current rules.*
- *Further, does current scientific evidence support a finding that particular towers do not significantly pose a threat to migratory birds?*

3.3.8.2 General Responses and Summaries

NOI respondents who commented on the adequacy of the existing research generally agreed that for many specific issues (e.g., tower lighting, tower configuration, tower siting) the existing research is insufficient or inadequate. Based on the respondents' comments, more information is needed to determine the importance of different factors on bird mortality before specific mitigative measures can be identified. Several respondents (see Sections 3.3.4.5 and 3.3.5.5) questioned the application of the USFWS' 2000 *Interim Guideline for Recommendations on Communication Tower Siting, Construction, Operations and Decommissioning* based on the limitations of the existing studies.

Section 4.1, *Going Forward and Data Needs,* discusses the identified data gaps relative to bird collision with communication towers and suggests recommended approaches to begin to answer some of these outstanding questions. These recommendations are based on previous study results, incidental mortality reporting at tower sites, researchers' input, and industry feedback

No new studies or recommended study designs were identified by the respondents. There was general agreement among the respondents for standardized mortality survey methods including adjusting for scavenger removal rates and observer bias.

3.3.8.3 Specific Respondent Comments

CITA, PCIA, and NAB provided comments that recognize scavenging as factors affecting mortality results. Woodlot discussed that duration, sampling frequency, and survey efforts vary between studies and, therefore, limit conclusions, except possibly, for the influence of inclement weather on fall migrants.

The USFWS provided comments on the need for standardized mortality sampling protocols including estimating and adjusting for scavenger removal rates and searcher bias. They referenced a recent recommended protocol for wind turbines (Anderson et al. 1999) that could be followed for mortality monitoring. The USFWS further suggested additional studies that are warranted, including a 3-year, 250-tower comparative study and monitoring program. For individual tower mortality monitoring, they recommended monitoring throughout the fall and spring migration periods. The USFSW acknowledged that a nationwide study is likely not feasible. The agency recommended utilizing information for several referenced pilot studies in Michigan, Arizona, and the Midwest to be used to provide information to FCC on future actions. The USFWS suggests that agency involvement in such research is important.

Regarding communication tower research programs, cost for such research, and appropriate parties who should carry out the needed research, only the USFWS provided comments on the estimated cost for conducting research. The estimated cost for a nationwide 3-year study of 250 towers was $15 to 20 million. They recommended that FCC participate in this funding effort.

3.3.9 Mitigation Approaches

3.3.9.1 NOI Questions

- *29. We seek comment on whether existing studies or research address the use of particular methods to minimize any impact of communications towers on migratory birds.*

3.3.9.2 General Responses and Summaries

FCC sought comment on these issues but few specific comments were provided by the respondents. Based on the reviews of the NOI comments and available literature, not enough is known to recommend different types of mitigation for mortality. Studies are presently ongoing that may suggest possible mitigation strategies. A review of the transmission line and wind turbine literature on bird mortality and mitigation could provide possible directions for mitigation research in addition to the Communication Tower Working Group's recommendations, specifically the Research Subcommittee. Section 4.2 contains an overview of the devices and approaches that are presently being used on overhead wires specific to the electric utility industry. Applying these types of devices to guy wires on communication towers would need to be examined further. Specifically, the majority of these devices have not been specifically designed to address nocturnal migrant bird collisions.

As stated in the Section 4.2 discussion, wire marking is not a perfect solution for the power line industry, nor would it be expected to completely resolve avian collision issues at communication tower sites. Presently, it is unknown whether this approach would result in: 1) operational problems for the broadcasting company, 2) public opposition from an aesthetics perspective, and 3) a decrease in bird collisions and associated mortalities. Ongoing communications among the FCC, communication industry, avian researchers, the public, and other interested stakeholders are necessary to identify appropriate future options and approaches to test.

3.3.9.3 Specific Respondent Comments

The American Bird Conservancy, Forest Conservation Council, and the Friends of the Earth provided recommendations for minimizing avian collisions at communication tower sites, which coincide with the USFWS' tower siting guidelines (USFWS 2000). These options included: 1) collocate facilities to minimize the number of new towers in new areas; 2) construct towers <199 feet to avoid using guy wires and the FAA lighting requirement; 3) use white (preferably) or red strobe lights, avoiding the use of solid red or pulsating (beacon) red lights; 4) use downshielded security lighting; 5) install daytime visual markers on guy wires in areas with raptors or waterfowl or with other diurnal movement routes for birds; 6) implement proper tower siting; and 7) develop appropriate survey methods. However, no specific details were provided on how these specific recommendations were developed.

3.3.10 Mortality Patterns

3.3.10.1 NOI Questions

- *We seek comment on the extent of migratory bird deaths that may be attributable to collisions with communications towers, the species and geographic locations involved, and what the raw numbers mean in terms of survival of species or in other relevant contexts.*

A discussion of the impact of communication towers on the mortality of migrating birds has been provided previously in Sections 3.2.3 and 3.2.4. The reader is referred to these sections for a more thorough review.

3.3.10.2 General Responses and Summaries

To a certain degree, the respondents addressed some mortality patterns, including the type of species more frequently affected; the seasonality of the mortality, and the magnitude of the mortality. Additional research on bird species most affected by tower collisions and why they are more susceptible is needed. Information on other factors, such as seasonality and magnitude, also would be valuable and could be incorporated into the appropriate study design.

3.3.10.3 Specific Respondent Comments

CTIA concluded causes of mortality are unknown. Woodlot stated that given the limitation of studies, the magnitude of mortality estimates are probably underestimated; declines in mortality over time at a site have been documented but the reasons are unknown. Mass mortality does occur but is an infrequent event. Woodlot further states mass mortalities can result in a substantial impact on the total number of birds killed in a subpopulation.

In their mortality summary, the American Bird Conservancy, Forest Conservation Council, and the Friends of the Earth characterize these mortalities as "sizeable kills," "regularly" occurring, and occurring in "North America."

3.3.11 New Information

3.3.11.1 NOI Questions

The FCC sought new information available on avian interactions with communication towers.

- *We also seek comment on any ongoing or planned studies with which the Commission might coordinate in order to achieve synergies and avoid duplication of effort.*

3.3.11.2 General Responses and Summaries

No new or original scientific research on the impact of towers on migratory birds was provided by the respondents. Overall, the respondents cited literature based on scientific articles by experts in ornithology. Many of the published studies that were cited can be considered to be scientifically acceptable, having gone through a peer review process before publishing. The issue of scientifically acceptable research is more applicable to the interpretation of the results beyond the objectives of the specific studies. The controversy regarding scientifically acceptable and rigorous methodologies relates to developing new conclusions from the previous research (e.g., issues of tower height and mortality).

3.3.11.3 Specific Respondent Comments

CITA, PCIA, and NAB provided no new information on bird collisions and communication towers. They did provide an updated extensive literature review in the Woodlot Report. PCIA referred to a member survey, requesting mortality information, but no details were given on the survey in order to evaluate it, as outlined and discussed in Section 3.3.1.3.

3.4 CURRENT RESEARCH EFFORTS

3.4.1 Michigan State Police Tower Study

A pilot study was conducted September 2003 on three guyed and three unguyed 479-foot towers owned and operated by the Michigan State Police. A total of 22 bird carcasses were recovered during the 20-day survey, all under the three-guyed towers. Adjusting for surveyor detection bias, an estimated 51 bird mortalities were estimated at the three towers during this 20-day period. A subsequent 2-year (4-season) study began spring of 2004 on 24 towers. Research hypotheses include predictions that guyed towers are riskier than unguyed, blinking lights are more attractive to birds than red strobes, and red strobes are more attractive than white strobes (Communication Tower Working Group Meeting, February 11, 2004, Gehring 2004).

3.4.2 Clear Channel of Northern Colorado Tower Study

One communication tower study was recently completed in the western U.S. This study encompassed a 2-year monitoring project to record bird collisions with the Slab Canyon

KQLF broadcasting tower owned and operated by Clear Channel Communications of Northern Colorado. Construction of a 500-foot, lighted, and guyed tower was completed by July 2002, and monitoring efforts began immediately. Because of public opposition to white strobe lights at night, the tower uses white strobe lights during the day and red blinking, incandescent lights at night. The study paralleled the methods used by Avery et al. (1977), recording the incidence of bird mortalities at the tower site and at a reference site along the eastern flank of the Front Range of Colorado. Tower surveys were conducted once per week throughout the year during the 2-year period, with additional surveys completed following storm events during the migration periods. Three remote-control cameras also were periodically used to monitor the remote and rugged site, particularly following storm fronts during migration. The emphasis on using the remotely controlled cameras was to determine whether moderate to significant mortalities may have occurred overnight at the site (i.e., multiple or mass kills). Scavenger removal rates were calculated and surveyor bias was estimated to compensate for birds lost to predators or not observed during the surveys, respectively. Weather patterns are currently being analyzed for the 2-year period. Study results should be available by the end of 2004 (EDM and CSU 2004).

3.4.3 Coconino and Prescott National Forest Tower Study

Another western study is a 3-year monitoring program in Arizona on the Coconino and Prescott National Forests, which was initiated in April 2004. This study will monitor bird mortalities associated with six communication towers located along I-17 south of Flagstaff. All six towers are less than 199 feet above ground level (AGL), unlit, and self-supporting (WEST 2004). American Tower Corporation owns five of the towers and DW Tower owns the sixth.

3.4.4 Philadelphia Tower Study

J. Johnson of Swarthmore College initiated a 3-season radar study of migratory bird behavior near three guyed, lighted communication towers 1,115 to 1,280 feet in height. Using a mobile marine, high-resolution radar scanner, surveyors monitored bird movement up to 1,476 feet in altitude, focusing on inclement weather events. Acoustical monitoring also was conducted to record flight calls. During the 2003 spring period (N=14 nights) and fall period (N=7 nights), a "curvature index" was developed, concluding that not all birds flew in linear, straight lines. Preliminary conclusions suggest that the birds exhibited non-linear flight patterns around tower sites. This will be tested for two more seasons (Communication Tower Working Group Meeting, February 11, 2004).

3.4.5 Mobile Lighting Study

Old Bird Inc. is initiating a ground-based, mobile lighting study to test and compare bird attraction to red incandescent, red strobe, and white strobe lighting. Truck-mounted, portable lights will be illuminated in areas with inclement weather or frontal systems to record bird behavior relative to the different lighting regimes (i.e., color and flash rate). The study will be testing the hypothesis that red wavelengths of light appear to disrupt birds' navigational systems, particularly their magnetic systems used during migration. Acoustical monitoring equipment also will be used to record flight calls and to document the relative degree of bird "congestion" (Communication Tower Working Group Meeting, February 11, 2004).

3.4.6 U.S. Coast Guard "Rescue 21" Study

In support of upgrading and reconfiguring existing communication structures, the U.S. Coast Guard (USCG) and the USFWS have entered into a Memorandum of Understanding (MOU) to examine 20 towers relative to lighting, tower height, guy wires, location, weather, possible collision deterrents and how they relate to birds. This 3-year study is part of the USCG's "Rescue 21" ship-to-shore emergency communication system. The project's start date is currently unknown (Communication Tower Working Group Meeting, February 11, 2004).

3.5 BIOLOGICAL SIGNIFICANCE

3.5.1 Introduction

One common theme that was observed in the NOI replies involves the differing uses of the term "significance." "Significance" can be used in two ways. "Significance" can refer to statistical significance, which involves the probability of obtaining certain results given that a null hypothesis is true. "Significance" also can refer to a biological or ecological value attributed to an individual species or population of biological significance. The following discussion refers to the latter.

Biological significance reflects a combination of both the magnitude of the biological effect and the importance of the biological effect. The magnitude of an effect may be considered high when a large number, percentage or proportion of a population is affected and low when the converse is true. Importance is a judgment based on ecological principles and/or societal values ascribed to a given effect. For example, effects that cause an increase in the normal mortality rate or reduce the normal birth rate for a species resulting in a decline in the local, regional or range-wide populations would be considered biologically important based on principles of population biology. Any effects to a species that society has designated as rare (e.g., threatened or endangered species) also would be considered important.

3.5.2 Summary of Respondents' Comments

A review of the respondents' replies showed that when a respondent discussed the communication tower mortality, the term "significance" was frequently used without defining the context of its use. Both "statistical significance" and "biological significance" were referred to. For example CITA, PCIA, and NAB generalized from statements by USFWS in a summary article on migratory bird mortality (USFWS, 2002. *Migratory Bird Mortality: Many Human Caused Threats Affect Our Bird Populations.* http://birds.fws.gov/mortality-fact-sheet.pdf) and the Woodlot report that since 1) other activities cause greater mortality (e.g., collision with utility structures, automobile strikes, habitat loss, cat predation, etc); 2) the numbers of individuals killed relative to total population numbers are small; and 3) because the information available with which to judge the "significance" of impacts to bird populations is lacking, it is not possible to conclude that collisions with towers have a "biologically significant" adverse effect on migratory bird populations.

The NAB stated that the comparatively small numbers of birds killed in communication tower collisions is not having a material effect in altering migratory bird populations. In addition, CTIA stated that there has been no evidence that communication towers are having a significant effect on migratory bird populations. CTIA and NAB supported these conclusions by comparing communication tower mortality estimates summarized by Woodlot (2003) with other forms of avian mortality such as window collisions, vehicle collisions, transmission lines, pesticides and oil pollution, and domestic cat predation. They stated that avian mortality from all human-related factors is estimated to be approximately 950 million birds annually, out of an estimated 10 to 20 billion migratory bird population. They concluded that compared with other forms of mortality, communication tower collisions are not significant.

Cingular Wireless and SBC Communications also stated the number of birds estimated to die as the result of tower collisions is relatively small. The Woodlot report stated that communication towers are estimated to cause 0.42% of human-caused mortality (approximately, 4 million bird deaths), which represents about 0.05% of the total migratory bird population. No discussion of significance is provided.

PCIA concluded that without documentation (assumed to refer to mortality studies) that a “statistically significant impact" of bird mortality cannot be determined and because of the lack of critical scientific studies, the role that communication towers play in migratory bird mortality cannot be judged.

The USFWS discussed national and regional mortality estimates and concluded that “this level of mortality” (i.e., mortality caused by collisions with communications towers) represents a significant and unacceptable impact on avian populations, particularly warblers (Parulidae), thrushes (Turdidae), and vireos (Vireonidae), which, based on mortality studies, appear to be the most vulnerable. The USFWS used the example of the three-tower, single-night event on January 22, 1998, in western Kansas where 5,000 to 10,000 Lapland longspurs were estimated to have been killed. The USFWS concluded that if tower kills create a biological breeding threshold below which avian species stop breeding then species extinction is possible. In support of this argument, the USFWS stated that a Federally endangered female Kirtland's warbler was retrieved at a 700-foot tower in South Carolina in the fall of 2003. A 2003 survey estimated the total population of singing male Kirtland's warblers at only 1,202 birds. The implication is that any mortality above the natural levels could be considered biologically significant.

The American Bird Conservancy, Forest Conservation Council, and Friends of the Earth do not make specific reference to biological significance but state that communication towers do kill migratory birds and endangered species, implying some importance to this effect. They also cite Shire et al. (2000). This compilation reviewed 149 documents on avian tower kills. An important point discussed in this review and summary is that of 230 species recorded killed in these studies, 52 species are in decline or require special management attention. These 52 species were either on the USFWS' *Nongame Birds of Management Concern List* or the *Partners in Flight Watch List*. Two federally endangered species, the red cockaded woodpecker and Kirtland's warbler, have been found at tower sites.

3.5.3 Other Relevant Information

In November 2003, the National Wind Coordinating Committee (NWCC) held a meeting to discuss "biological significance" as it applies to wind turbine projects (*How is Biological Significance Determined When Assessing Possible Impacts of Onshore Wind Power Facilities?).*` Speakers were invited to discuss the term biological significance and its use. The following is a selected list of conclusions of the meeting regarding biological significance that should be applied to communication tower mortality.

Definition of Biological Significance

- A biologically significant effect is an effect that could result in an influence on population viability.

Characteristics of the Term Biological Significance

- Who defines biological significance is important. Biological significance should not be framed by the concerns for a single bird or by a local population.

- Defining biological significance for a population may require examination of the region and habitat for a specific species.

- Biological significance is most useful at a site-specific and regional scale.

- Biological significance needs to consider the following questions: Significant to what? Within what geographic area? Over what time frame?

Accepting Uncertainty in the Definition

- The definition of biological significance needs to include a statement about accepting uncertainty in characterizing biological significance.

- Precise population estimates are not required to assess whether an impact is significant.

Application or Use of Biological Significance

- Biological significance should be used as a tool for assessing significant impacts at a site in permitting processes.

- Use defined criteria for biological significance to evaluate potential sites as to the likelihood of resulting in major impact as compared with other sites (i.e., comparison of areas where important populations of birds migrate, are used as flyways, or are close to threatened species and suitable habitat versus other areas).

A USFWS presentation at the same meeting provided information on the regulatory interpretation to the term biological significance. (A. Manville. 2003. *The MBTA, BGEPA, ESA, NEPA and Migratory Birds – Legal and Ecological Implications in Dealing with Biological Significance*. Available from:

http://www.nationalwind.org/events/wildlife/20031117/presentations/Manville.pdf)

Dr. Manville stated that Division of Migratory Bird Management does not have an accepted definition of "biological significance." The Migratory Bird Treaty Act (MBTA) does not address biological significance and in the Endangered Species Act (ESA), biological significance is only addressed in terms of definitions specific to species status (i.e., their rareness as threatened and endangered species).

Manville indicated that the National Environmental Policy Act (NEPA) addresses "biological significance" but only where a Federal nexus (i.e., Federal action requiring NEPA review) applies. Specifically, significance under NEPA requires consideration of the "context" (i.e., importance) and "intensity"(i.e., magnitude) of the action. The context of an action may include societal (human, national) context as it relates to the affected region, the affected interests, and the locality. Intensity refers to severity of impact.

3.5.4 Conclusions

Biological significance is an important concept that needs to be defined in any discussion regarding the significance of communication tower mortality. As previously noted, biologically significant mortality is any mortality that is of sufficient magnitude and importance that it causes the viability of a particular population or species to be affected. It also needs to be defined in the context of a particular species or population of a species to which it is being applied. Precise population estimates are not needed to assess whether an impact is significant. Because of the variability of a species and site conditions some uncertainty needs to be accepted in determining significance.

In estimating and characterizing the impact of communication towers on avian populations, our knowledge of biological factors critical to the development of predictive impacts is simply not adequately developed to draw specific conclusions on the effects to migratory bird populations as a whole and possibly to specific species. It is established that communication towers cause mortality to migratory bird populations. In some instances this mortality can be very large (i.e., hundred to thousands of birds) in mass mortality events.

The issue with migratory birds is complex both in terms of what species are being referred to as well as their status. The challenge in developing more confident estimates of population change resulting from telecommunication mortality is that it is fundamentally difficult to demonstrate for many species of migrant birds that any 'particular' kind of stress causes a reduction in migratory bird population size. The observed decline in migratory birds as a group and individual species is a cumulative response to various factors. It is recognized that bird populations are perpetually in flux for numerous reasons, so determining a baseline population size, then detecting a trend, and then determining if a trend is a significant deviation from an existing baseline or is simply an expected fluctuation around a stable equilibrium is problematic in many cases. However, some bird populations are well studied such as the Kirtland's warbler and red cockaded woodpecker, and sufficient information is available to determine the contribution of one stress or another on the population's viability. In these instances an analysis of biological significance is possible.

SECTION 4
DATA NEEDS AND MITIGATION METHODS

4.1 GOING FORWARD AND DATA NEEDS

The following discussion focuses on specific areas or approaches that may aid in answering some of the outstanding questions pertaining to bird collision risks with communication towers.

4.1.1 Standardized Methods and Metrics

When examining the studies and incidental reporting of bird mortalities within the last 50 years, it is apparent that few data have been collected with a standard, systematic process. One of the more important aspects for planning future studies on bird interactions with communication towers is to develop a system of standardized methods and metrics for finding and reporting bird mortalities. These standards would allow comparisons among studies in order to develop consistent conclusions and identify possible mitigation approaches. Kerlinger (2000b) outlines the necessary components of developing standard methods and metrics, as done in the windpower industry for determining avian collisions with wind turbine units. He emphasizes that these need to be established in order to begin measurements and applicable comparisons.

The Communication Tower Working Group's Research Subcommittee has developed an *Integrated Nationwide Research Proposal - "Causes and Solutions to Bird Strikes at Communication Towers,"* dated April 14, 2000. This resource and associated dialog would provide a basis for standardizing applicable study methods.

Meyers (2000) and Kerlinger (2000b) both discuss the value of establishing well designed, scientifically based methods that standardize the studies to answer some of the unknowns. However, in the interim, Myers (2000) also argues that biologists and regulatory agencies need information in the near term, in order to make decisions and determine an applicable course of action (i.e., "adaptive management").

4.1.2 Species-specific Susceptibility to Tower Collisions

Nocturnal migrants, such as warblers, vireos, thrushes, and sparrows appear to be more susceptible to tower collisions than other species. Diurnal species most affected appear to be fast-flying species, such as waterfowl, other waterbirds, and raptors. Differences among various taxa of nocturnal migrants in response to tall, lighted structures warrant further research (Avery et al. 1976). Applicable data may provide information regarding family or bird group behavior that may identify measures by which losses of certain species could be reduced. Brewer and Ellis (1958) state that there is a need for direct, quantitative studies on aggregation of migrants and apparent attraction to towers. Understanding those species most susceptible to tower collisions is also critical in the selection of mitigating measures. For example, marking guy wires with bird flight diverters may be of limited value for nocturnal migrants.

4.1.3 Site Monitoring Approaches

4.1.3.1 Radar

In an effort to standardize future study methodologies to monitor bird interactions with communication towers, it would be advantageous to establish baseline information on bird densities, movements, altitudes, and behaviors during migration in proximity to tower sites. The use of radar ornithology was briefly discussed relative to the work of Gauthreaux and Belser (2003) and Larkin and Frase (1988). Unpublished study results by Gauthreaux and Belser using "image intensifiers" provide insight into bird behavior at tower sites under various specific conditions. Where feasible, use of radar to determine relative numbers and species of birds proximate to a specific tower site would help to establish this information, particularly relative to the numbers of bird mortalities that could be associated with these migration patterns. Gauthreaux and Belser (2003) provides detailed background information on radar availability and applicability. Specifically, the nationwide network of 151 WSR-88D radars in the contiguous U.S. provide an option to monitor bird migration across the country, although individual tower locations may dictate the feasibility of this approach.

4.1.3.2 Acoustics

Evans (2000) outlines possible acoustical monitoring options, including the use of remote sensors that can transmit information to an offsite, data processing station. This type of system would allow a researcher to obtain data for a large number of towers in regions and flyways noted for avian collisions with towers. This information would be used, among other things, to automatically monitor the frequency of bird concentrations near a tower site, to estimate the numbers of birds, and to test alternative lighting regimes on towers and associated bird responses. In addition, this approach could also provide valuable ancillary information, such as the timing of specific tower surveillance and carcass retrieval, etc.

4.1.3.3 Strike Indicators

A consortium of interested stakeholders is currently involved in the development and testing of the "Bird Strike Indicator" (BSI) as a tool to remotely monitor bird collisions with overhead wires. These entities include:

- Electric Power Line Research Institute
- Western Area Power Administration
- Bonneville Power Administration
- California Energy Commission
- Southern California Edison
- Avian Power Line Interaction Committee
- U.S. Fish and Wildlife Service - Audubon National Wildlife Refuge
- NorthWestern Energy
- Ottertail Power Company

The BSI (Figure 4-1) consists of biaxial accelerometer to monitor line strikes and a wireless radio for communicating with a base station. The BSI sensor includes analog filters to remove very low frequency signals and any 60 Hz noise that might be present. Once a strike is detected, the sensor automatically initiates communication with the base station and reports the date, time, and severity of the impact as peak accelerations encountered in the two axes perpendicular to the line or guy wire. Exceeding the threshold of any of the two perpendicular axes will result in a strike to be detected. After communicating the strike parameters, the sensor transmits the vibration data for each of the two perpendicular axes to be stored in the base station for retrieval or further processing. The monitoring parameters of the BSI can be remotely modified to change the trigger threshold, sampling rate, and number of data points.

Figure 4-1 Bird Strike Indicator

The base station currently consists of a desktop or laptop computer running the graphical user interface (GUI). In the near future, the base station will consist of a datalogger that can run the developed GUI and solar power supply for application at remote sites where it won't be feasible to use a computer. The GUI collects all the strike data from the BSI sensors and logs them on the base station, as well as displays the signal for quick viewing. The base station GUI monitors the health of all the sensors at least once daily and logs their status. The GUI also can change the monitoring parameters on an individual BSI or all the BSI units simultaneously. A variety of communication options will be available to communicate with the base station for remote access and downloading of the gathered strike data.

This project is a 4-year study to develop, apply, and test the BSI sensor for a series of overhead power lines on the Audubon National Wildlife Refuge in North Dakota. The two primary goals of testing the BSI are to: 1) develop automated monitors to gather information on avian collisions that is difficult or impossible to obtain through direct human observations and 2) evaluate the efficacy of mitigating devices, such as markers and bird diverters designed to reduce avian collisions and associated mortalities with overhead lines or guy wires.

The development of prototype BSI sensor is complete and has successfully undergone laboratory testing at EDM International in Colorado. Field testing of the BSI is presently scheduled to start in spring of 2005. As stated in Section 4.5, EPRI is presently working with the USCG to deploy a BSI on a USCG tower for testing.

Following the development of the BSI, research on developing a “Bird Activity Monitor” (BAM) will be initiated. The BAM would be an intelligent image-based sensing and recording tool to assist with the detailed study of bird interactions with various types of structures. This type of tool would not only identify species that collide with overhead lines or guy wires, it also would record bird behavior as individuals approach the wires and the relative degree of crippling effects (i.e., the number of individuals that may be injured by line collision, but fly off site).

4.1.3.4 Tower Site Studies

At a minimum, it is recommended that access to tower sites be allowed to encourage ongoing dialog between avian researchers and the communication tower industry. This type of agreement would be case-specific and voluntary.

4.1.4 Study Biases

As stated, there is no standard, accepted research protocol for studying communication tower collisions. Dead and injured bird searches can result in an underestimation of mortality if biases are not taken into account. Studies should incorporate the following four main biases:

- Scavenger/Predator Removal Bias
- Crippling Bias
- Searcher Efficiency Bias
- Habitat Bias

Scavenging or predator biases occur when animals remove dead birds before a search. These rates will vary from site to site and by season. In addition rates will vary by species of bird, with smaller birds disappearing more frequently and quickly than larger birds.

A crippling bias occurs when injured birds fall outside the study area and are not detected. Rates vary by bird species and are difficult to obtain. They are calculated as the percentage of birds that collide with a feature and then continue to fly out of the search zone. This bias is least likely to be incorporated into a study because of the effort required to actually observe collisions.

The searcher efficiency bias is based on the ability of a surveyor to detect dead birds. The ability to detect birds is based upon factors such as terrain, vegetation, species of bird, coloration of bird, and the searcher's skill and experience. This bias can be measured by randomly or systematically planting dead birds throughout a study area and measuring the relative detection rate of the searcher.

A habitat bias occurs when there is some part of a study area that simply cannot be searched (e.g., wetland, open water body, dense vegetation). This bias estimate can be very problematic. Habitat biases are restricted to areas of unsearchable habitat interspersed within searchable habitat. This type of bias can sometimes be avoided by designing a study in an area that is completely searchable.

In independent tower studies, determining the bias rates is less critical than in comparative studies. For example, if a single tower is being monitored and the scavenger/predation bias is not determined, the results will represent minimum mortality figures. In comparative studies it is important to understand what the bias rates may be, because their absence will confound any comparisons of mortality to determine if a difference exists between the subject tower and a suitable reference..

4.1.5 Research on Avian Vision

Beason (2000) outlines the current knowledge regarding avian vision and how a bird's perception may be directly associated with collision risks at communication towers. Specific data in this area is lacking, particularly as it pertains to nocturnal neotropical migrants. Future research involving bird vision could greatly enhance the knowledge of how and why birds appear to be attracted to certain lighting regimes.

To implement this approach, the creation of a comprehensive summary of current knowledge on avian vision would be the first step. This literature search and report could guide future research needs. The development of an appropriate study design would build on studies that have been completed to date, incorporating discussions and recommendations from associated avian research scientists. At a minimum, any future research on avian vision should provide information on those species that are most affected by communication tower collisions..

4.1.6 Other Concepts, Approaches, and Recommendations

Larkin (2000) presents a number of ideas in the 1999 Communication Tower workshop for further studies including:

- Wash out the birds' retinas, using a series of flash bulbs on the towers to determine whether a bird without its dark-adapted vision still circles the tower.
- Compare mortality rates at towers in urban locations surrounded by city lighting with more rural towers that have minimal to no light pollution.
- Install mirrors below the lights, so they only shine upwards.
- Paint the guy wires with fluorescent paint and illuminate them.
- Use "coherent radar" to monitor bird movements near the tower structure.
- Implement acoustical monitoring to localize bird calls around the tower.
- Compare the amount of water and fat in a bird carcass as compared to mist netted individuals during the same period to test for physiological stress.
- Experiment with both flashing and red steady lights, alternating and measuring bird behavior.
- Use Doppler radar to record bird strikes on a tower.

4.1.7 Oversight and Research Organization

Finally, a number of discussions have been held (e.g., August 11, 1999 Workshop on Avian Mortality at Communication Towers; February 11, 2004 Communication Tower Working Group Meeting) regarding the value of structuring an oversight research organization for the communication tower industry. Examples of parallel national organizations for other industries include: the Electric Power Research Institute (EPRI), the Avian Power Line Interaction Committee (APLIC), and the National Wind

Coordinating Committee's (NWCC) Avian Subcommittee. The intent would be to establish an organization that could tier off of the efforts and communications to date (e.g., Communication Tower Working Group, RESOLVE) to direct research design, investigate funding options, manage information distribution, encourage communications, and aid in problem and dispute resolution.

4.2 CURRENT STATE-OF-THE-ART MITIGATION METHODS AND APPROACHES

Most avian researchers agree that there are no unambiguous answers on how to avoid avian collisions and mortalities at communication tower sites. It also is commonly agreed that a combination of approaches will likely be required to minimize the collision hazard, particularly for high-risk structures.

No products have been tested specifically on communication tower guy wires to mitigate bird collisions. As discussed in Section 4.1.3, EPRI is presently working with the USCG to deploy a Bird Strike Indicator (BSI) on a USCG communication tower.

Although none of the following devices have been tested on communication towers and their associated guy wires, these devices have had varying levels of success on power lines. Because the success of different devices may be area- and condition- specific, potential applications need to be tested accordingly.

4.2.1 Wire Marking

One of the most effective ways to reduce avian mortality is to mark wires to make them more visible (Beaulaurier 1981). However, from an engineering point of view, wire marking is not always a good solution. Devices that physically enlarge the wire commonly act as wind-catching objects and may increase the risk of wire breaks due to line tension, vibration, and stress loads. The physical attachment of devices also may be problematic, depending on the structure type.

Wire marking has not proved to be the perfect solution for bird collisions and there is no broad agreement among biologists on the success of line marking. However, the effectiveness of some marking methods that target specific bird species and have been implemented for overhead power lines in the electric utility industry is well documented. Wire marking may increase guy wire visibility thereby reducing the collision risk for some birds.

Although several products are available to mark overhead power lines, there have been few rigorous experimental designs to test their effectiveness on electric lines and no studies have been completed to date on communication tower guy wires. Also, very few studies comparing products have been completed. Following is a discussion of the various products available to mark wires and their advantages and disadvantages.

TABLE 4-1

BIRD COLLISION DEVICES AND MANUFACTURERS

Manufacturer	Device	Description	Web Site
Kaddas	Flapper	Swinging Plate	http://www.kaddas.com
BirdMARK	Bird Flight Diverter	Swinging Plate	http://www.pr-tech.com/products/birds/birdsigns.htm
MidSUN	Collision Guard	Swinging Mat	http://www.midsungroup.com
Mission Engineering	Bird Collision Diverter	Swinging Plate	http://www.mission-eng.co.za
Dulmison	Bird Flight Diverter - BFD	Coiled Solid PVC Wire Marker	http://catalog.tycoelectronics.com
Preformed Line Company	Bird Flight Diverter - BFD	Coiled Solid PVC Wire Marker	http://www.preformed.com
Dulmison	Swan Flight Diverter - SFD	Coiled Solid PVC Wire Marker	http://catalog.tycoelectronics.com
Dulmison	Spiral Vibration Dampers - SVD	Vibration Dampers	http://catalog.tycoelectronics.com

4.2.1.1 Flapper

The Flapper (Figure 4-2) was designed in South Africa in partnership with Preformed Line Products, ESKOM, and the Endangered Wildlife Trust (EWT). The Flapper is distributed by Kaddas and is designed to securely grip wires up to a diameter of 0.75 inch with a locking plastic jaw. The Flapper can be installed and removed from the ground. Figure 4-3 shows installation on overhead power lines. The Flapper has been ultraviolet (UV) stabilized; and is available in red, white, and black. Black and white flappers provide maximum contrast.

Figure 4-2 White Flapper

The Flapper is used in Africa and is effective at reducing collisions with overhead power lines. However, ESKOM has experienced problems with the device shifting in some the earlier versions (van Rooyen 2000). The EWT recommends two modified ways of attaching the flapper to mitigate this problem:

Figure 4-3 Flapper Installation

- Attach the flapper disk (not the clip) to a helical holder (basically a metal wire pigtail), which is then wound around the conductor or guy wire. ESKOM has 2 years of experience of his method on small wires 0.9 inch diameter with no shifting.
- Attach a spiral onto the

conductor and then attach the flapper by its hook to the spiral. This has the advantage of making the line even more visible as the device is now bigger. ESKOM has not experienced spirals shifting since implementing these measures.

The newest Flapper version is attached by a clamp arrangement activated by a (nonmetallic) screw eye, which can be installed using a shotgun stick. According to the distributor, this unit when properly applied, will not shift and move on the wire. The manufacturer also recommends using silicone adhesive on the clamp.

There are two versions of the Flapper, one is attached with a ratcheted clamp, and the other is installed with a breakaway composite screw using a hotline stick. The Flapper is available with a luminescent paint that will glow in low light situations. The color of devices plays an important role in reducing collisions (Kreithen 1996).

The advantage of the Flapper is the movement of the swinging plate helps make a line more visible than simply increasing the line profile. The effectiveness of the Flapper has been scientifically tested in South Africa, and preliminary data show that the Flapper is effective in reducing bustard and crane collisions (van Rooyen 2000; Anderson 2001). However, Flapper applications to communication towers would primarily target diurnal birds and would not likely reduce the collision risk for nocturnal migrants. Other operational issues to consider include possible vandalism, since marking devices resembling targets might create problems. The potential for devices slipping on hard to access tower guy wires also is of concern and would need to be tested.

4.2.1.2 BirdMARK Bird Flight Diverter

The BirdMARK (Figure 4-4) is distributed by P&R Industries and is designed to securely grip wires up to a diameter of 2.5 inches with a strong spring-loaded clamping jaw. The clamping jaw also is used with several other P&R products designed specifically for overhead lines. The BirdMARK is presently being used in England and Ireland on power lines.

The BirdMARK can be installed and removed from the ground. The manufacturer claims the BirdMARK will stay in position even in a Force 8 gale. The swinging roundel is available in either orange or red-and-white.

Figure 4-4 BirdMARK Bird Flight Diverter

As discussed for the Flapper, the advantage of the BirdMARK is the movement of the swinging plate makes a wire more visible than simply increasing the line profile. However, vandalism can be a problem. Unfortunately, no studies on the effectiveness of the BirdMARK were found in the scientific literature although it would appear the device should be similarly effective as the Flapper.

Recently this product line has been expanded to include the FireFly, which may be more applicable to reducing nocturnal collisions with communication tower guy wires. The FireFly uses the same clamp as the BirdMARK but the circular plate has been replaced with a rectangular plate. The rectangular plate includes a reflective and fluorescent reflective plate for low light and nighttime conditions (Figure 4-5 and Figure 4-6).

Figure 4-5 FireFly During the Day

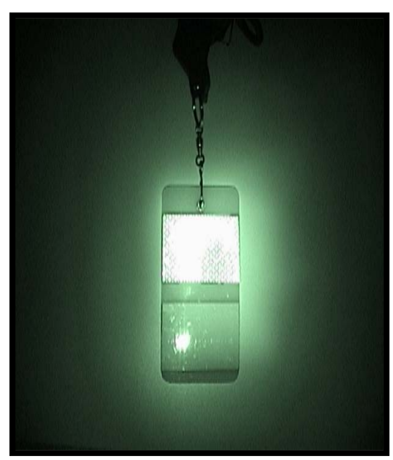

Figure 4-6 FireFly at Night

The FireFly's clamp has been designed to be installed on communication tower guy wires; however, this product has not been tested.

Mission Engineering and MIDSUN Company also have recently introduced their own versions of swinging devices to prevent collisions (Figure 4-7). However, no data are currently available on their effectiveness.

Figure 4-7 Mission Engineering (left) and MIDSUN (right) Bird Diverters

4.2.1.3 Bird Flight Diverter

The Bird Flight Diverter (BFD) was developed in Europe during the 1970's (Figure 4-8). The BFD is made from a high-impact, standard gray PVC and is UV stabilized.

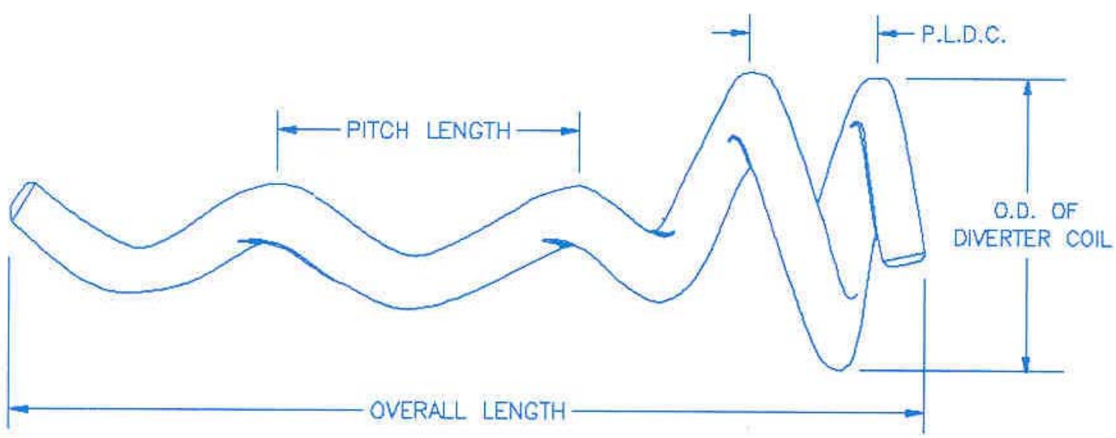

Figure 4-8 Bird Flight Diverter Manufactured by Dulmison. Made from High-impact PVC and is UV Stabilized.

The Dulmison BFD is available in a variety of colors and different sizes to accommodate wires ranging from 0.175 to 1.212 inches (Figure 4-9).

The BFD has been effective when tested on transmission overhead static wires in Europe, where typical spacing ranges from 16 to 33 feet. In North America, the BFD also has shown to be effective in reducing waterfowl collisions with overhead static wires (Crowder 2000). The BFD is believed to be effective because its profile increases line visibility. As with "active devices" such as the Flapper, these more "passive" devices have not been tested on communication tower guy wires; however, it is assumed that they would increase the profile and, therefore, the visibility of the guy wires during daytime conditions.

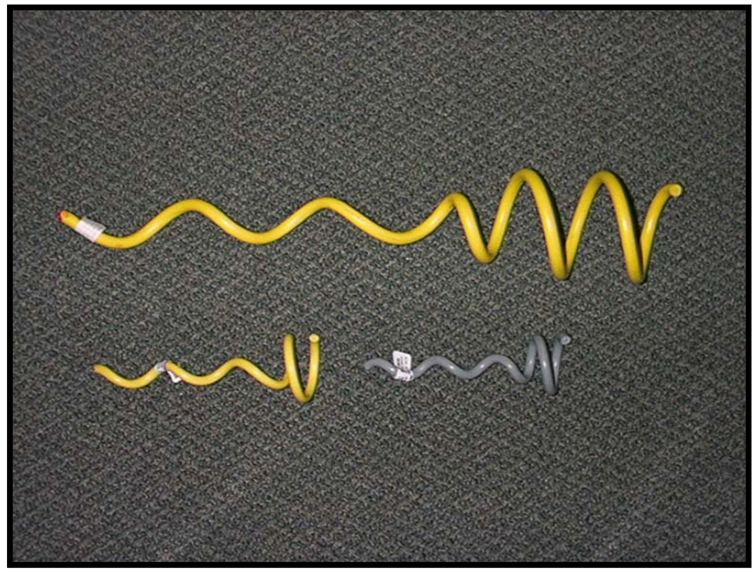

Figure 4-9 Bird Flight Diverters for Small and Larger Wires

Regarding long-term use, BFD colors may fade after long periods of exposure but should not become brittle or lose their elastic properties. ESKOM has used the Preformed Line Products, BFD in South Africa for years with no reports of mechanical failure (van Rooyen 2000) although some red PVC devices have faded.

4.2.1.4 Swan Flight Diverter

The Swan Flight Diverter (SFD) is similar to the BFD but includes four 7-inch spirals (Figure 4-10). The SFD also is made from a high-impact, standard gray PVC and is UV stabilized. The Dulmison SFD is available in a variety of colors and sizes to accommodate wires ranging from 0.175 to 1.212 inches.

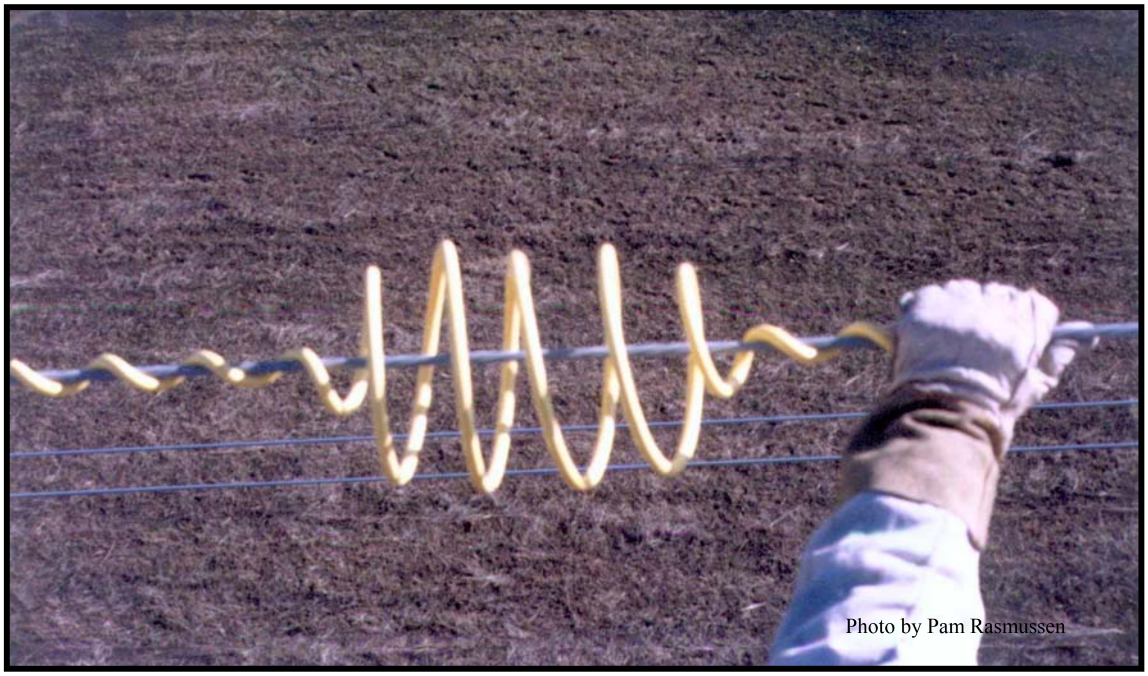

Figure 4-10 Swan Flight Diverters Being Placed on a Static Wire

As with the BFD, the SFD has been shown to be effective when installed on transmission overhead static wires in North America, but has not been tested on tower guy wires. In the early 1990's Northern States Power Company addressed a problem where endangered trumpeter swans were colliding with a power line during the winter months in a small bay on the St. Croix River in Hudson, Wisconsin. Yellow SFDs were installed to increase the smaller-diameter shield wires' visibility in low light conditions. The SFDs were installed May of 1996, using a 50-foot spacing staggered on each parallel shield wire, resulting in an appearance of a 25-foot spacing. To date no additional collisions or deaths have been documented (Rasmussen 2001).

In Indiana, the SFD also has recently shown to be effective in reducing waterfowl collisions with static wires on overhead transmission lines (Crowder 2000). The spacing of the SFDs in Crowder's 1998-2000 study was 20 feet apart. Figure 4-11 provides a representative view of SFD spacing on transmission line static wires. Whether this type of spacing would aid in increasing communication guy wire visibility remains to be tested.

As discussed for BFDs, the SFD colors may fade after long periods of UV exposure but should not become brittle or lose their elastic properties.

Figure 4-11 Swan Flight Diverters Installed at a 20-foot Interval in Indiana

4.2.1.5 Spiral Vibration Damper

Spiral Vibration Dampers (SVDs) are manufactured from solid PVC into a helix (Figure 4-12). The original purpose of the damper was to reduce high-frequency aeolian vibration on power lines. The SVD is designed to provide the action/reaction motion to oppose the natural vibration of cable by gripping a line tight at one end; loosely on the opposite end. The vibration is often inducted by low velocity winds of 3 to 8 mph.

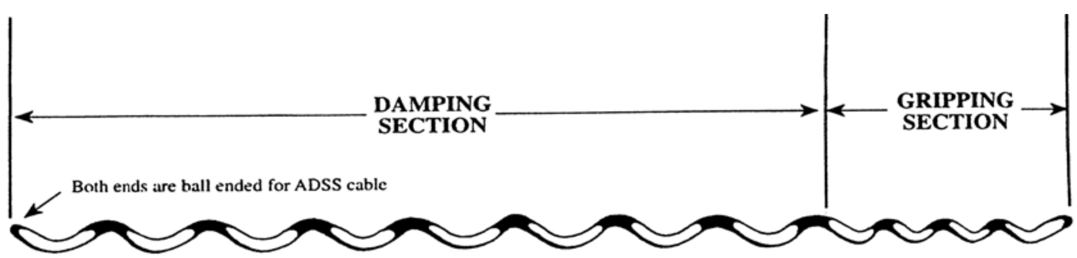

Figure 4-12 Spiral Vibration Damper

The Dulmison SVD is made from a high-impact, standard UV-stabilized PVC. The SVD also is available in a variety of colors, and there are different sizes available to accommodate a wire ranging from 0.175 to .76 inch.

SVDs have been used in the San Luis Valley in Colorado to mitigate crane collisions on overhead power lines. As an example, coverage of the overhead wires was 27.5 percent per span, reducing collisions by 61 percent. As discussed for BFDs and SFDs, the SVD has not been tested on guy wires, and the SVD colors also may fade after long periods of UV exposure but should not become brittle or lose their elastic properties. Tri-State Generation and Transmission Association has used the Dulmison and Preformed spiral vibration dampers since 1985 without any failures (Dille 2001). The dampers are easy to install; however, after several years they do become brittle and will break if they need to be removed.

SECTION 5
CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

The siting and construction of communication towers is becoming an increasingly important issue in North America. It is difficult to predict with any significant level of certainty, the relative incidence of bird collisions anticipated for a proposed communication tower site without pre-construction site analyses and pre- and post-construction monitoring programs. With increased public and agency awareness and scrutiny of this growing problem, a better established and more rigorous review process may be developed in the future. This process would incorporate a greater degree of site-specific analyses, short- or long-term field studies, increased regulatory review, and additional public participation in the permitting process.

Although most of the causes and possible solutions for increased avian mortalities associated with communication structures remain speculative, a few conclusions have been advanced with some degree of confidence within the scientific community studying this problem. Among them include:

- The largest bird kills tend to occur on nights with low visibility conditions, especially fog, low cloud ceiling, or other overcast conditions.
- All other things being equal, taller towers with lights tend to represent more of a hazard to birds than shorter, unlit towers.
- Towers with guy wires are at higher risk than self-supporting towers.
- Two collision mechanisms appear to be a factor in bird collision: 1) blind collision and 2) illuminated sphere of influence.
- Certain avian families or species tend to be more affected than others, among them vireos, warblers, and thrushes.
- The seasonal pattern exhibits a pronounced collision spike during fall migration and another smaller spike during spring migration. However, bird collisions with towers can occur any time of the year under any weather condition.

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- There are no studies to date that demonstrate an unambiguous relationship between avian collisions with communication towers and population decline of migratory bird species.

- Although biologically significant tower kills have not been demonstrated in the literature, the potential does exist, especially for threatened and endangered species.

- More research is warranted in order to identify specific causes and possible solutions to this problem.

5.2 RECOMMENDATIONS

It is clear that birds collide with communication towers. However, to understand why those collisions occur, additional research is needed. This subsection proposes further actions necessary to reduce the substantial uncertainty associated with the magnitude of bird collisions and causative factors, and provides direction for future studies.

The communication industry is not unique in addressing avian issues. Avian interactions occur with a variety of man-made infrastructure. These interactions include electric distribution power line electrocutions, transmission power line bird collisions, and wind turbine bird and bat collisions. These industries and associated interest groups have responded by developing guidance documents to aid in understanding the problem and providing standardized approaches to studying the problem. These documents also provide state-of-the-art knowledge on how to better define and mitigate problems. Examples of existing guidelines include the following:

- *Studying Wind Energy/Bird Interactions - A Guidance Document (NWCC 1999)*

- *Mitigating Bird Collisions With Power Lines: The State of the Art in 1994 (APLIC 1994)*

- *Suggested Practices for Raptor Protection on Power Lines: the Stare of the Art in 1996 (APLIC 1996)*

Much of the information contained in these documents would be directly applicable to the telecommunication industry with applicable, representative changes.

It would be to the FCC's advantage to develop a parallel guidance document for the telecommunication industry.

The following short- and long-term recommendations shown in Table 5-1 provide a basis for developing this type of guidance document. Many of these recommendations are inter-related and inter-dependent and reflect concerns and questions identified from the NOI responses, industry input, and ongoing dialog with the Communication Tower Working Group. Because many of these suggested recommendations also are complex and potentially controversial, the applicable approaches would need to be delineated in detail, in accordance with regulatory requirements and methods that are scientifically valid. Development of this type of document also would show a proactive stance by the FCC and initiate valuable working relationships integral to answering some of these outstanding questions and identifying future actions. In addition, the short-term recommendations are listed according to suggested priorities in Table 5-2.

TABLE 5-1 RECOMMENDATION MATRIX BY TOPIC

Recommendation Topic and Discussion	Recommendation	Priority	
		Short Term (6 to 12 months)	**Long Term (1 to 3 years)**
Research Oversight			
1. There is great value in structuring an oversight research organization for the communication tower industry. Examples of parallel national organizations for other industries include the: Electric Power Research Institute (EPRI), Avian Power Line Interaction Committee (APLIC), and National Wind Coordinating Committee's (NWCC) Avian Subcommittee. The intent would be to establish an organization that could tier off of the efforts and communications to date (e.g., Communication Tower Working Group, RESOLVE) to direct research design, investigate funding options, manage information distribution, encourage communications, and aid in problem and dispute resolution. This organization also could provide a clearinghouse for data review. A critical component of this would be to create a way to assist with funding of needed science. This could be accomplished by partnering with other groups already funding communication tower research, such as EPRI.	1. Continue participation in the Communication Tower Working Group and monitor and provide comments, where appropriate, on proposed research projects. Specifically, support the existing Research Subcommittee of the Communication Tower Working Group that would focus on developing mitigation measures and other information important in understanding the factors contributing to bird collisions.	X	

TABLE 5-1 RECOMMENDATION MATRIX (cont'd)

Recommendation Topic and Discussion	Recommendation	Priority	
		Short Term (6 to 12 months)	**Long Term (1 to 3 years)**
2. There are a number of ongoing studies including: o Michigan State Police Tower Study o Clear Channel of Northern Colorado Tower Study o Coconino and Prescott National Forest Tower Study o Philadelphia Tower Study o Mobile Lighting Study o U.S. Coast Guard "Rescue 21" Study The results should become available over the next 12 to 36 months.	2. Review the results of these studies as they become available and incorporate relevant results and conclusions into their review of FCC tower applications and, where appropriate, provide comments on these applications.		X
Standardized Methods and Metrics			
1. When examining the studies and incidental reporting of bird mortalities within the last 50 years, it is apparent that few data have been collected with a standard or systematic way that allows for comparison with other studies or to be able to draw conclusions. One of the more important aspects for planning future studies on bird interactions with communication towers is to develop a system of standardized methods and metrics for finding and reporting bird mortalities. Kerlinger (2000b) outlines some of the necessary components of developing standard methods and metrics including developing a metric such as the number of birds killed per tower per unit of time and	1. Initiate dialog with applicable research entities and telecommunication industry to identify the most appropriate approach and mechanism to develop standardized methods and metrics for data collection and monitoring. These standardized approaches could tier from existing references for avian collision studies and would closely inter-relate with other short- and long-term recommendations. 2. From these communication and coordination efforts, produce a	X	X

TABLE 5-1 RECOMMENDATION MATRIX (cont'd)

Recommendation Topic and Discussion	Recommendation	Priority	
		Short Term (6 to 12 months)	Long Term (1 to 3 years)
species-specific fatality rates. In addition identify independent variables that are standardized such as the lighting, the guy wires, tower height, location (*e.g.,* geography and topography). In addition, the Communication Tower Working Group's Research Subcommittee's Integrated Nationwide Research Proposal - "Causes and Solutions to Bird Strikes at Communication Towers," may provide information and a basis for standardizing applicable study methods.	comprehensive guidance document with input from applicable research entities and telecommunication industry. Producing this type of guidance and direction for both the telecommunication industry and associated research groups would be critical to standardizing the research approaches and facilitating problem resolution relative to avian collisions at tower sites.		
Study Biases			
1. Estimating dead and injured birds can result in an underestimation of mortality if biases are not taken into account. Studies should incorporate the following four main biases: • Scavenger/Predator Removal Bias • Crippling Bias • Searcher Efficiency Bias • Habitat Bias	1. In developing a guidance on standard methods (See Standardized Methods and Metrics Recommendation), provide recommendations accounting for the four study biases or develop a statement for the need of standardizing monitoring methods to account for these biases	**X**	

TABLE 5-1 RECOMMENDATION MATRIX (cont'd)

Recommendation Topic and Discussion	Recommendation	Priority	
		Short Term (6 to 12 months)	**Long Term (1 to 3 years)**
Tower Lighting			
1. Nocturnal migrating birds are thought to be attracted to artificial light sources on communication towers. The mechanisms for this attraction are not well understood. In addition, no firm conclusions can be drawn, based on the existing literature, regarding the importance of different lighting colors, durations, intensities, and types (e.g., incandescent, strobe, neon, or laser) on bird attraction in conjunction with other factors (e.g., certain weather conditions that increase or decrease the risk of bird collisions with lighted communication towers). A number of research investigations on lighting and communication towers are in progress.	1. Continued research in these areas should be supported or encouraged (See Avian Vision Recommendation). The results of these and other investigations need to be evaluated to better define the relationship of lighting and communication towers and incorporated into any recommendations for tower lighting.	**X**	
Data Gaps and Research Needs			
1. Present studies do not establish the degree of impact that mortality at towers is having on migratory and resident bird populations. It is documented that avian mortality does occur at communication towers; however, the extent this mortality is having on bird populations is unknown. Although there have been numerous studies on tower collisions, very few comparative studies have been completed.	1. Provide guidance on the need for both comparative studies and studies investigating the factors contributing to mortality (See Standardized Methods and Metrics Recommendation below).	**X**	

TABLE 5-1 RECOMMENDATION MATRIX (cont'd)

Recommendation Topic and Discussion	Recommendation	Priority	
		Short Term (6 to 12 months)	Long Term (1 to 3 years)
Species Differences and Susceptibility to Tower Collisions.			
1. Nocturnal migrants, such as warblers, vireos, thrushes, and sparrows appear to be more susceptible to tower collisions than other species. Diurnal species most affected appear to be fast-flying species, such as waterfowl and other waterbirds. Differences among various taxa of nocturnal migrants in response to tall, lighted structures warrant further research.	1. Provide guidance on compiling data as part of the standard methods to provide insight into family or bird group behavior differences that may identify why some species are more susceptible to collisions and how losses of certain species could be reduced. This can only occur after additional research is conducted in this area.	**X**	
Monitoring Migration Patterns			
1. In an effort to standardize future study methodologies to monitor bird interactions with communication towers, it would be advantageous to establish baseline information on bird densities, movements, altitudes, and behaviors during migration in proximity to tower sites. If bird mortality corrected for study biases is monitored at a site at the same time as bird abundance is monitored then the relationship between mortality and abundance can be established and risk factors can be developed.	1. Encourage the development of this information as a part of the standardization of methods (See Standards and Metrics Recommendation).	**X**	

TABLE 5-1 RECOMMENDATION MATRIX (cont'd)

Recommendation Topic and Discussion	Recommendation	Priority	
		Short Term (6 to 12 months)	**Long Term (1 to 3 years)**
Avian Vision and Avoidance Behavior.			
1. Knowledge about avian vision is lacking, particularly as it pertains to nocturnal neotropical migrants. To what degree do night flying migrants avoid tower and guyed wires? What is the avoidance behavior of diurnal species? What conditions enhance or diminish a bird's ability to avoid collisions? Future application of such research to try to answer some of these questions involving bird vision and behavior would greatly enhance the knowledge to develop mitigation measures. A high research priority is to determine why birds appear to be attracted to certain lighting regimes.	1. Since FAA is the lead agency in lighting issues, FCC should encourage research on avian vision.	**X**	
	2. Avian vision research should initially be laboratory-controlled studies and then field applications, tiering off of the work completed to date by Beason (2000). These would be long-term studies first using representative model species followed by confirmatory field studies. Some limited research on avian vision has been conducted regarding bird collisions with wind turbines but research is not applicable to lighting.		**X**
	3. Recommend that during tower monitoring studies information be collected not only on mortality but also abundance and any behavioral avoidance exhibited by birds attempting to avoid collisions.	**X**	

TABLE 5-1 RECOMMENDATION MATRIX (cont'd)

Recommendation Topic and Discussion	Recommendation	Priority	
		Short Term (6 to 12 months)	Long Term (1 to 3 years)
Mitigation Measures			
1. No products have been tested specifically on communication tower guy wires to mitigate bird collisions. Although several products are available to mark overhead power lines, there have been very few rigorous experimental designs to test their effectiveness on electric lines and no studies have been completed to date on communication tower guy wire. Also, very few studies comparing products have been completed. Although no marking devices has been tested on communication towers and their associated guy wires, they have had varying levels of effect on power lines. It is likely that different devices may work for certain areas under certain conditions, but applications need to be tested, accordingly.	1. Encourage research on potential measures that mitigate avian mortality at communication towers, especially mass mortality events.	**X**	
	2. Conduct a review of the applicability of mitigation measures proposed for transmission lines and wind turbines as they may pertain to the telecommunication towers.	**X**	
Biological Scoping.			
1. Pre-permitting review and compliance under NEPA has been a controversial topic in the past by opponents of communication tower siting. Compliance with the Migratory Bird Treaty Act, the Endangered Species	1. Develop a more specific set of FCC National Environmental Policy Act (NEPA) biological scoping issues for the Environmental Checklist Assessment.	**X**	

TABLE 5-1 RECOMMENDATION MATRIX (cont'd)

Recommendation Topic and Discussion	Recommendation	Priority	
		Short Term (6 to 12 months)	Long Term (1 to 3 years)
Act, and the Bald and Golden Eagle Protection Act are part of the NEPA review. Establishing applicable biological scoping issues for avian collisions with telecommunication towers would be in compliance with these bird protection Acts and simultaneously narrow the issues to focus of environmental assessment aiding the FCC in making applicable NEPA decisions.	These scoping issues should reflect the factors that are known to be associated with avian mortality (See Chapter 3) to the extent that information is known at this time. The checklist should be expanded to reflect these issues. If an environmental assessment is warranted based on the checklist guidance for the applicant in standard methods (See Standard Methods and Metrics Recommendation), it should be referenced.		
U.S. Fish and Wildlife Service Interim Guidelines for Recommendations on Tower Siting, Construction, Operation, and Decommissioning.			
1. Some of the NOI responses indicated that some of the specific guideline recommendations might be in conflict with each other. For example they cite, limiting tower height <200 feet may be unattainable in certain areas. They state difficulty of collocating multiple carriers while minimizing tower height. They also state that keeping towers <200 feet will likely require a greater number of towers, which is in opposition to the USFWS guideline recommending minimizing the number of towers.	1. Provide a vital role in readdressing the voluntary guidelines to eliminate some of the confusion regarding their voluntary implementation by providing comment on those components where more research is needed before definitive recommendations are proposed.	X	

TABLE 5-1 RECOMMENDATION MATRIX (cont'd)

Recommendation Topic and Discussion	Recommendation	Priority	
		Short Term (6 to 12 months)	Long Term (1 to 3 years)
Tower Siting			
1. The siting and construction of communication towers is becoming a more prominent issue in North America. It is difficult to predict with a high level of certainty the relative incidence of bird collisions anticipated for a proposed communication tower site without pre-construction site analyses and pre- and post-construction monitoring. With increased public and agency awareness and scrutiny of this growing problem, a more established review process may be needed in the future. The USFWS has developed a Potential Impact Index (PII) as a tool to evaluate the ecological value of potential wind turbine locations. The PII is a standardized, quantifiable tool using landscape-scale information for wind turbine siting to minimize ecological impacts, including bird and bat collisions. Similar parameters and criteria could be used with some modifications for communication towers and geographical location. Other parallel processes also could be developed depending on their applicability.	1. Develop appropriate criteria or ecological parameters to be used in communication tower siting. Similar approaches to that used for wind turbines should be examined for potential applicability and adaptation for communication tower sites.		X
	2. Modify the PII process or develop a similar process for analyzing project siting for telecommunication towers.		X

Table 5-2 SHORT-TERM RECOMMENDATIONS BY PRIORITY

Priority	Recommendation
1	**Research Oversight** - Continue participation in the Communication Tower Working Group (CTWG) and monitor and provide comments where appropriate on proposed research projects. Specifically FCC should support the existing Research Subcommittee of the CWTG that would focus on developing information important in understanding the factors contributing to bird collisions. This should be done in conjunction with Priority 5.
2	**Standardized Methods and Metrics** - Initiate dialog to identify the most appropriate approach and mechanism to develop standardized methods and metrics for data collection and monitoring. Produce a comprehensive guidance document with input from applicable research entities and telecommunication industry.
3	**Study Biases –** Develop a statement for the need of standardizing monitoring methods to account for the four primary study biases.
4	**Tower Lighting** - Support and encourage continued research on tower lighting and how it relates to avian vision.
5	**Data Gaps and Research Needs -** Provide guidance on the need for both comparative studies and studies investigating the factors contributing to mortality. This guidance should be based on information developed in Priority Recommendations 2 and 3 and also reflect Priority 4.
6	**Species Differences and Susceptibility to Tower Collisions -** Provide guidance on compiling data as part of the standard methods to provide insight into family or bird group behavior differences that may identify why some species are more susceptible to collisions and how losses of certain species could be reduced.
7	**Monitoring Migration Patterns** – Support the development of standardized methods to monitor migration patterns pertaining to birds at greatest risk of tower collision.
8	**Avian Vision -** Compile existing information on avian vision and encourage additional research.
9	**Avoidance Behavior -** Recommend that during tower monitoring studies information be collected not only on mortality but also abundance and any behavioral avoidance exhibited by birds attempting to avoid collisions.
10	**Mitigation Measures -** Research measures to mitigate mass mortality events.
11	**Biological Scoping** – Develop a specific set of FCC National Environmental Policy Act (NEPA) biological scoping issues and revise the environmental assessment checklist.
12	**U.S. Fish and Wildlife Service Interim Guidelines** - Readdress the voluntary guidelines to eliminate confusion regarding some of the specific recommendations based on this technical review.

SECTION 6
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APPENDIX A

REFERENCE REVIEW SHEETS

Primary Reference or New Data Review Sheet

I. Citation or Source:

Avery, M.L., P.F. Springer, and J.F. Cassel. 1975. Progress report on bird losses at the Omega Tower, southeastern North Dakota. North Dakota Academy of Science 27(2):40-49.

Source Type (check one): Study

Peer-reviewed Paper √ **Other (specify):**
Agency Report ____
Conference Proceedings ____

II. Study Objectives (list)

Record bird mortality numbers, species, and extent.

III. Species

Total: 633 birds; 5 red bats (*Lasiurus borealis*).
409 found in sampling areas were extrapolated to an estimated total of 3,062 birds killed.
Mortalities fairly consistent b/w spring and fall periods.

IV. Study Methods (briefly list)

Sampling plan b/c of habitat.
Previous tower mortality studies; most dead birds found w/in 62 m of tower.

V. Duration of Study 2 seasons

Duration (provide dates):	**Seasons:**
Single Year fall 1971/spring and fall 1972	**Spring Migration ____** **Both** √
Multiple Years ____________________	**Fall Migration ____** **Yearlong ____**

Primary Reference or New Data Review Sheet (cont'd)

VI. Carcass Search Methods (if applicable)

Search Conditions: Daily ____ Weekly ____ Only after overcast nights with a low ceiling or storm events ____

Other Periods (Describe): Survey several times/week fall 1971. Daily @ dawn spring and fall 1972.

Search Biases Evaluated, Including Observer Bias and Scavenger Activity? Yes √ No ____ Scavenger Activity

Search Area Described? Yes √ No ____

Mostly marshy area with some grassland upland.
Scavenger removal study (1 night only)
Daily carcass retrieval was thought to keep scavenger numbers low.

VII. Analytical and Statistical Methods

Statistical method(s) used: (list)

N/A

Comments:

VIII. Number of Tower Sites: 1 **Proximity:**

U.S. Coast guard Omega Navigational Station – James River Valley; 3 km W. LaMoure, ND.
5 red, non-flashing, obstruction lights
4 red, flashing 700-W beacons
366–meter tower; guyed; 16 evenly spaced transmitting cables from top of antennae to a perimeter road 732 meters from tower.

IX. Behavioral Observations at the Tower: Yes √ No ____
Describe if applicable to statement or conclusion being evaluated.

Spring and fall 1972: using portable ceilometer.

X. Documentation of Weather Factors? Yes √ No ____
Describe if applicable to statement or conclusion being evaluated.

General

Primary Reference or New Data Review Sheet (cont'd)

XI. Inclusion of Structural and Landscape Conditions? Yes √ No ____ **Describe if applicable to statement or conclusion being evaluated.**
Marshy
XII. Brief Description of Results
Relatively large spring kills (as compared to fall). May suggest that in spring, migrants seek appropriate feeding and resting areas more so than in fall. Stoddard and Norris (1967) also state that breeding birds had higher mortality numbers than those species breeding farther north.
XIII. Need for and Scope of Additional Studies (Only applicable if new data or study is provided.)
Are additional studies identified? Yes √ No ____ If yes explain and list studies.
Recommended additional research on light attraction.
XIV. Suggested Methods to Minimize Impacts (Only applicable if new data or study is provided.)
Are specific methods identified? Yes____ No √ If yes explain and list specific mitigative methods.

Primary Reference or New Data Review Sheet

I. Citation or Source:

Cochran, W.W. and R.R. Graber. 1958. Attraction of nocturnal migrants by lights on a television tower. The Wilson Bulletin 70:378-380. (Appears to be a duplicate of Cochran 1958.)

Source Type (check one): Study

Peer-reviewed Paper √
Agency Report ____
Conference Proceedings ____

Other (specify):

II. Study Objectives (list)

Record bird behavior in response to tower lighting.
Monitor bird vocalizations.
Note direction of flight, elevation, and any mortalities.

III. Species

May 1957: acoustical monitoring: veery, dickcissel, indigo bunting, warbler species. Heard birds hit guy wires or tower, but no carcasses found next morning.
Nov 1957: carcass data (all in proximity to tower)
5 mortalities: 3 fox sparrows, 1 golden-crowned kinglet, 1 woodcock
3 crippled: 2 "slate-colored" juncos, 1 golden-crowned kinglet
Birds observed fluttering around outdoor lights of transmitter building: 5 slate-colored juncos, 1 myrtle warbler, 1 swamp sparrow.

IV. Study Methods (briefly list)

Direct observation.
Auditory monitoring; number of birds calling w/ in specific time frame.
Modified tower lighting (on/off).
Collected mortalities and crippled birds.

V. Duration of Study 1 night each survey (two total)

Duration (provide dates):

Single Year 1957
Multiple Years ______________________________

May 29-30, 1957 (2000 –0515 hours)
Nov 5, 1957 (0330-0545 hours)

Seasons:

Spring Migration √ **Both** ____

Fall Migration √ **Yearlong** ____

Primary Reference or New Data Review Sheet (cont'd)

VI. Carcass Search Methods (if applicable)

Search Conditions: Daily ____ Weekly ____ Only after overcast nights with a low ceiling or storm events ____

Other Periods (Describe): see Section V.

Search Biases Evaluated, Including Observer Bias and Scavenger Activity? Yes ____ No √ (see below)

Search Area Described? Yes ____ No √

Heard birds hit guy wires or tower, but no carcasses found next morning. Either scavenger removal or surveyor detection likely prevented carcass retrieval?

VII. Analytical and Statistical Methods

Statistical method(s) used: (list)

N/A

Comments:

VIII. Number of Tower Sites: 1 **Proximity:**

984-foot television tower; 10 miles W. Champaign, Illinois. Guyed. Red lights.

IX. Behavioral Observations at the Tower: Yes √ No ______
Describe if applicable to statement or conclusion being evaluated.

May 1957: Apparent increased number of birds occurring near tower than away, based on calls (acoustical monitoring).
Also observed visually, using light height and guy attachments as measurements.
Migrants not evenly distributed; waves from South. Birds exhibited confused behavior in the vicinity of the tower. Flew through tower framework, circled edge of lit area and passed through again: most @ 400 and 900 feet elevation, but few above tower and others as low as 150 ft. Calls = 9-26/minute; seen = 5-51/minute. Same confused behavior w/ or w/out spotlight. TV tower not transmitting; therefore, assumed confusion due entirely to lights.
Nov 1957 : Turning off tower lights definitely modified presence of migrants @ tower.

X. Documentation of Weather Factors? Yes √ No ______
Describe if applicable to statement or conclusion being evaluated.

Overcast; light mist. Light surface wind from E-SE (May 1957).
Overcast; no precipitation. (Nov 1957)

Primary Reference or New Data Review Sheet (cont'd)

XI. Inclusion of Structural and Landscape Conditions? Yes ____ No √
Describe if applicable to statement or conclusion being evaluated.

XII. Brief Description of Results

Observations suggested confusion of nocturnal migrants by tower lights occurring only on nights w/ low ceiling and migrants forced to fly at or below 1000 to 3000 feet. On clear nights auditory records show numbers of migrants pass w/ no apparent confusion.

Author states: Estimates of bird numbers and densities during migration cannot be calculated based on sample of bird mortalities at towers sites for two reasons.

1) Migrants are attracted to tower lights.
2) Only very small % of birds @ towers are killed (i.e., much greater number not killed).

XIII. Need for and Scope of Additional Studies (Only applicable if new data or study is provided.)

Are additional studies identified? Yes ____ No √ If yes explain and list studies.

XIV. Suggested Methods to Minimize Impacts (Only applicable if new data or study is provided.)

Are specific methods identified? Yes____ No √ If yes explain and list specific mitigative methods.

Primary Reference or New Data Review Sheet

I. Citation or Source:

Carter, J.H. III and J.F. Parnell. 1978. TV tower kills in eastern North Carolina: 1973 through 1977. Chat 42:67-70.

Source Type (check one): Study

Peer-reviewed Paper ____
Agency Report ____
Conference Proceedings ____

Other (specify): Popular Press

II. Study Objectives (list)

Continuing study on two TV towers in SE North Carolina for avian collisions and mortality.

III. Species

WECT = 4,208 birds; 65 species.
WECT = mass mortalities: 1 Oct 1973 (660 +); 5 Sep 1974 (3, 240); 28 Oct 1975 (306 +).
Because of dense vegetation and predators, believed total mortality numbers could be double those found.

IV. Study Methods (briefly list)

Irregular surveys; majority @ WECT tower.
Sporadic surveys; as compared to 1971 and 72 studies.

V. Duration of Study 4 years

Duration (provide dates):

Single Year ________________________________
Multiple Years 1973-1977

Sep/Oct each year

Seasons:

Spring Migration ____ **Both ____**

Fall Migration √ **Yearlong ____**

Primary Reference or New Data Review Sheet (cont'd)

VI. Carcass Search Methods (if applicable)

Search Conditions: Daily ____ Weekly ____ Only after overcast nights with a low ceiling or storm events ____

Other Periods (Describe): See Sections IV and V.

Search Biases Evaluated, Including Observer Bias and Scavenger Activity? Yes ____ No √

Search Area Described? Yes ____ No √

Scavenging noted, but no calculations or estimates of removal rates.

VII. Analytical and Statistical Methods

Statistical method(s) used: (list)

N/A

Comments:

VIII. Number of Tower Sites: 2 **Proximity:** See Carter and Parnell 1976

WECT TV: see Carter and Parnell, 1976 (1,994 ft = 42 miles from coast).
WWAY TV: see Carter and Parnell, 1976 (1,188 ft = 10 miles from coast)
Guyed; red flashing and steady lights.

IX. Behavioral Observations at the Tower: Yes ______ No √
Describe if applicable to statement or conclusion being evaluated.

X. Documentation of Weather Factors? Yes √ No ______
Describe if applicable to statement or conclusion being evaluated.

Little information. Early Sep 1974 kills (3240+) were associated with strong cold front as Hurricane Carmen approached.
Other bird mortality events believed to be associated w/ cold fronts.

Primary Reference or New Data Review Sheet (cont'd)

XI. Inclusion of Structural and Landscape Conditions? Yes ____ No √ **Describe if applicable to statement or conclusion being evaluated.**
XII. Brief Description of Results
Detailed species lists. See Section III.
XIII. Need for and Scope of Additional Studies (Only applicable if new data or study is provided.)
Are additional studies identified? Yes ____ No √ If yes explain and list studies.
XIV. Suggested Methods to Minimize Impacts (Only applicable if new data or study is provided.)
Are specific methods identified? Yes____ No √ If yes explain and list specific mitigative methods.

Primary Reference or New Data Review Sheet

I. Citation or Source:

Carter, J.H. III and J.F. Parnell. 1976. TV tower kills in eastern North Carolina. Chat 40:1-9.

Source Type (check one): Study

Peer-reviewed Paper ____
Agency Report ____
Conference Proceedings ____

Other (specify): Popular Press

II. Study Objectives (list)

Recorded mortalities following inclement weather two fall migration periods.

III. Species

3,070 bird mortalities; 84 species (both towers)
Several large kills 1971 = 2,683 total mortalities (83 species)
Fall of 1972 = 387 total mortalities (45 species)
WECT; 30 Oct 1970 = 1,000 birds

IV. Study Methods (briefly list)

Surveyed after cold fronts and overcast nights.
Problems w/ scavenger removal and difficulty in searching dense vegetation; therefore, mortality numbers conservative.

V. Duration of Study 2 years

Duration (provide dates):

Single Year ________________________________
Multiple Years 1971-72

23 sep = 1971 (mid-Nov)
early Aug = 1972 (mid-Nov)

Seasons:

Spring Migration ____

Fall Migration √

Both ____

Yearlong ____

Primary Reference or New Data Review Sheet (cont'd)

VI. Carcass Search Methods (if applicable)

Search Conditions: Daily ____ Weekly ____ Only after overcast nights with a low ceiling or storm events ____

Other Periods (Describe): See Section V.

Search Biases Evaluated, Including Observer Bias and Scavenger Activity? Yes ____ No √

Search Area Described? Yes ____ No √

Problems of loss to predators noted, but no calculations of removal rates.

VII. Analytical and Statistical Methods

Statistical method(s) used: (list)

N/A

Comments:

VIII. Number of Tower Sites: 2 Proximity: ≈ 30 miles

WECT (tallest in eastern U.S. at the time): 1,994 feet; guyed; red steady and flashing. Bladen Co, North Carolina, 5 miles SE of White Lake, ~ 42 miles from east coast.
WWAY: 1,188 feet: guyed; (Brunswick Co, North Carolina, 10 miles from east coast.

IX. Behavioral Observations at the Tower: Yes ______ No √
Describe if applicable to statement or conclusion being evaluated.

X. Documentation of Weather Factors? Yes √ No ______
Describe if applicable to statement or conclusion being evaluated.

Focused on frontal systems and overcast conditions for surveys.
Fall of 1971 = large kills @ WECT w/ low ceilings and N. winds.
3-4 and 4-5 Oct 1971 @ WWAY, not overcast but 3 days after Hurricane Ginger = 1,000 bird mortalities.
Same day = 111 birds @ WCET.
Weather conditions "favorable for large kills" prevalent during fall of 1971 (several large kills reported), but infrequent the fall of 1972.

Primary Reference or New Data Review Sheet (cont'd)

XI. Inclusion of Structural and Landscape Conditions? Yes ____ No √ **Describe if applicable to statement or conclusion being evaluated.**
XII. Brief Description of Results
WECT completed Jan 1969; employees report large number of bird kills fall of 1969. WWAY completed Oct 1964; no previous data. Large kills often @ WECT Sep/Oct under certain weather conditions. Large kills @ WWAY less frequent. Used mortality data to document unusual or rare occurrences (e.g., coastal species migrating 42 miles inland).
XIII. Need for and Scope of Additional Studies (Only applicable if new data or study is provided.)
Are additional studies identified? Yes ____ No √ If yes explain and list studies.
XIV. Suggested Methods to Minimize Impacts (Only applicable if new data or study is provided.)
Are specific methods identified? Yes____ No √ If yes explain and list specific mitigative methods.

Primary Reference or New Data Review Sheet

I. Citation or Source:

Caldwell, L.D. and N.L. Cuthbert. 1963. Bird mortality at television towers near Cadillac, Michigan. The Jack-Pine Warbler 41(2):80-89.

Source Type (check one): Study

Peer-reviewed Paper √
Agency Report ____
Conference Proceedings ____

Other (specify):

II. Study Objectives (list)

Record kills @ Cadillac tower.
Using similarity index, compare w/ other mortality studies in fall w/ 7 other areas east of Rocky Mts.
Compare two towers' spring mortality numbers w/in 35 miles.

III. Species

See detailed report tables.
Cadillac Tower:
- Total 812 birds fall 1961 (8 visits) (42 species)
- Total 74 birds spring 1962 (15 visits) (27 species)
- 602 birds on 26 Sep 1961
- 94 birds on 28 Sep 1961
- Fewer numbers in spring.

Harietta Tower:
- Total 125 birds spring 1962 (15 visits) (36 species)

IV. Study Methods (briefly list)

Compared MI site to seven other studies (5 or 6 other sites).

V. Duration of Study

Duration (provide dates):

Single Year ________________________________
Multiple Years 1961, 1962

Only Cadillac Tower:
26 Sep 1961; 1 Oct 1961
28 Sep 1961; 2 Oct 1961
30 Sep 1961; 5 Oct 1961
9 Oct 1961
16 Oct 1961

Both Cadillac and Harietta Towers:
22, 23, 25, 29 Apr 1962
6, 9, 10, 11, 12, 19, 25 May 1962
4, 5, 10, 11 Jun 1962

Seasons:

Spring Migration √
Fall Migration √
Both √
Yearlong ____

VI. Carcass Search Methods (if applicable)

Search Conditions: Daily ____ Weekly ____ Only after overcast nights with a low ceiling or storm events ____

Other Periods (Describe): See Section V.

Search Biases Evaluated, Including Observer Bias and Scavenger Activity? Yes ____ No √

Search Area Described? Yes ____ No √

VII. Analytical and Statistical Methods

Statistical method(s) used: (list)

N/A

Comments:

VIII. Number of Tower Sites: 2 **Proximity:** Harietta Tower 35 miles NW of Cadillac tower

WWTV: 1, 295-foot Cadillac, Michigan tower.
WPBN: 1,130-foot Harietta tower.

IX. Behavioral Observations at the Tower: Yes ______ No √
Describe if applicable to statement or conclusion being evaluated.

X. Documentation of Weather Factors? Yes √ No ______
Describe if applicable to statement or conclusion being evaluated.

Often fog/rain/low ceiling during fall/winter.
26 Sep 1961 – several days of cold, rainy weather preceded survey.

XI. Inclusion of Structural and Landscape Conditions? Yes ____ No √
Describe if applicable to statement or conclusion being evaluated.

XII. Brief Description of Results

Detailed mortality comparisons between the two towers by species. Summaries recorded in Section III.

XIII. Need for and Scope of Additional Studies (Only applicable if new data or study is provided.)

Are additional studies identified? Yes ____ No √ If yes explain and list studies.

XIV. Suggested Methods to Minimize Impacts (Only applicable if new data or study is provided.)

Are specific methods identified? Yes____ No √ If yes explain and list specific mitigative methods.

Primary Reference or New Data Review Sheet

I. Citation or Source:

Brewer, R. and J.A. Ellis. 1958. An analysis of migrating birds killed at a television tower in east central Illinois. Auk 75(4):400-414.

Source Type (check one): Study of 7 incidental kill reports

Peer-reviewed Paper √
Agency Report ____
Conference Proceedings ____

Other (specify):

II. Study Objectives (list)

Recorded species and numbers of bird mortalities following mass kill events.

III. Species

486 birds; 51 species (80 neotropical migrants).

IV. Study Methods (briefly list)

7 surveys over 3-year period after major kills.
Tower visited w/in 24 hrs of 3 kills and 60 hours after fourth kill. (Unknown when surveyed after other 3 surveys?)

V. Duration of Study Select Dates from 1955-1957

Duration (provide dates):

Single Year ________________________________
Multiple Years 1955-1957

23-24 Sep 1955	1-2 Oct 1956
6-7 Oct 1955	15-16 May 1957
6-7 May 1956	19-20 May 1957
	21-22 May 1957

Seasons:

Spring Migration ____
Fall Migration ____
Both √
Yearlong ____

VI. Carcass Search Methods (if applicable)

Search Conditions: Daily ____ Weekly ____ Only after overcast nights with a low ceiling or storm events ____

Other Periods (Describe): See Section V.

Search Biases Evaluated, Including Observer Bias and Scavenger Activity? Yes ____ No √

Search Area Described? Yes √ No ____

Corn and soybean fields surround tower. Sangamon River forested flooodplain is 2.5 miles to the west.
Estimate only 85% birds found; rest overlooked or scavenged.

VII. Analytical and Statistical Methods N/A

Statistical method(s) used: (list)

Index values to total volume of migration based on number of birds killed at TV towers subject to several sources of error. Values only useful if no aggregation of birds in migration or attraction to tower.

Comments:

VIII. Number of Tower Sites: 1 **Proximity:**

WCIA = 983-foot TV tower; 1 mi west. Seymour, Illinois. Guyed.
Red flashing and steady/incandescent lights 8 feet from ground illuminate transmitter building (white sides).

IX. Behavioral Observations at the Tower: Yes √ No ______
Describe if applicable to statement or conclusion being evaluated.

Many hit guy wires; some died by colliding w/ ground after stun or injury when hitting guy wires. Some survived collisions but were killed when colliding w/ brightly lit sides of transmitter building.

X. Documentation of Weather Factors? Yes √ No ______
Describe if applicable to statement or conclusion being evaluated.

Mortalities occurred w/ 80-100% cloud cover; ceiling 400-1,600 ft; fog or haze.
Both spring and fall mortalities associated w/ cold fronts w/in previous 12 hours. Wind variable; temperatures 43^o-66^o F.

XI. Inclusion of Structural and Landscape Conditions? Yes ____ No √
Describe if applicable to statement or conclusion being evaluated.

XII. Brief Description of Results

Reported mortality rates 10 times greater in fall than in spring. Taxonomic pattern was same as for other studies. Parulidae (wood warblers) = 17 species; 70% of total individuals. Species composition reflected migration periods by species. Comparison of species w/ other kills reports. Believes aggregation of birds during migration occurs. Adult birds had higher number of mortalities than juveniles in fall; spring = 100% complete skull ossification. Sex differences recorded. Bird location and distribution pattern recorded.

Suggests that species that migrate earlier than other species show lower mortality rates. Unsure why timing of migration (for later species) may affect susceptibility to tower collisions. Bird distribution discussed; bimodal distribution. Some distribution patterns suggesting collision w/ guy wires and not tower.

If birds aggregate, then some towers will kill none, few, or thousands.

XIII. Need for and Scope of Additional Studies (Only applicable if new data or study is provided.)

Are additional studies identified? Yes √ No ______ If yes explain and list studies.

Need for direct, quantitative studies on aggregation of migrants and attraction to towers.

XIV. Suggested Methods to Minimize Impacts (Only applicable if new data or study is provided.)

Are specific methods identified? Yes____ No √ If yes explain and list specific mitigative methods.

Primary Reference or New Data Review Sheet

I. Citation or Source:

Boso, B. 1965. Bird casualties at a southern Kansas TV tower. Transactions of the Kansas Academy of Science 68(1):131-136.

Source Type (check one): Incidental Reports – but multiple surveys.

Peer-reviewed Paper √
Agency Report ____
Conference Proceedings ____

Other (specify):

II. Study Objectives (list)

Record species and number of bird mortalities or crippling effects.

III. Species

125 birds; 49 species (> 70 neotropical migrants) = 1963-64 surveys.
85 birds; 23 species (3 nights 27-29 September 1961) = 576-foot tower.

IV. Study Methods (briefly list)

Site surveys/carcass retrieval/bird identification.

V. Duration of Study 1 year

Duration (provide dates):

Single Year 1963-64
Multiple Years ______________________________
12 fall trips = 21 Sep – 30 Oct 1963 (1,200-foot tower)
14 spring trips = 15 Mar – 23 May, 1964 (1,200-foot tower)
3 nights = 27 – 29 Sep, 1961 (567-foot tower)

Seasons:

Spring Migration ____ **Both** √

Fall Migration ____ **Yearlong** ____

VI. Carcass Search Methods (if applicable)

Search Conditions: Daily ____ Weekly ____ Only after overcast nights with a low ceiling or storm events ____

Other Periods (Describe): See Section V

Search Biases Evaluated, Including Observer Bias and Scavenger Activity? Yes ____ No √

Search Area Described? Yes √ No ____

KOAM 1,200-foot television tower; Cherokee Co. Kansas. (13 miles south of. Pittsburg, Kansas).
Agricultural field. 25 acres; 11 acres mowed; 14 acres cropland.
Midway b/w Mississippi and Central Flyways.
Scavengers noted; no scavenger removal rate calculated in fall. No predators or evidence observed spring (?)

VII. Analytical and Statistical Methods

Statistical method(s) used: (list)

N/A

Comments:

VIII. Number of Tower Sites: 2 **Proximity:**

1963 = 576-foot tower; guyed; 4 sets lights
1962 = 1,200-foot tower (100 yards west of original tower); guyed; 8 sets lights
Steady and flashing red lights.

IX. Behavioral Observations at the Tower: Yes ______ No √
Describe if applicable to statement or conclusion being evaluated.

X. Documentation of Weather Factors? Yes √ No ______
Describe if applicable to statement or conclusion being evaluated. Days of pickup only.

Stated that visibility/wind direction had little to do w/ kills in the fall season.
Clear weather during all spring carcass collections. [Note: only recorded day of pickup, not weather preceding survey date.]

Primary Reference or New Data Review Sheet (cont'd)

XI. Inclusion of Structural and Landscape Conditions? Yes ____ No √
Describe if applicable to statement or conclusion being evaluated.

XII. Brief Description of Results

Detailed carcass retrieval quadrant surrounding tower by season:
Fall = 49% SW quarter
Spring = 62% N half
Suggest/infers that towers that are not on or adjacent to primary main traveled migration routes may not present as great a collision risk to birds as for other towers located in other regions.

XIII. Need for and Scope of Additional Studies (Only applicable if new data or study is provided.)

Are additional studies identified? Yes ____ No √ If yes explain and list studies.

XIV. Suggested Methods to Minimize Impacts (Only applicable if new data or study is provided.)

Are specific methods identified? Yes____ No √ If yes explain and list specific mitigative methods.

Primary Reference or New Data Review Sheet

I. Citation or Source:

Banks, R.C. 1979. Human related mortality of birds in the United States. U.S. Fish & Wildlife Service, National Fish and Wildlife Lab, Special Scientific Report – Wildlife No. 215:1-16. GPO 848-972.

Source Type (check one): Mortality Summary

Peer-reviewed Paper √
Agency Report ____
Conference Proceedings ____

Other (specify):

II. Objectives (list)

Summarize avian mortalities from different sources. Banks indicates that mass mortalities are of little value in establishing an estimate of avian kills under "normal conditions." Estimates 2,500 bird kills/tower/year. No mass mortalities in or west of Rocky Mountains. If only half of towers presents hazards, 1979 estimates 1,250,000 birds killed annually in U.S.

III. Species

Addressed mortality factors by family or groups.

IV. Study Methods (briefly list)

N/A

V. Duration of Study N/A

Duration (provide dates):

Single Year ________________________________
Multiple Years ________________________________

Seasons:

Spring Migration ____ **Both** ____

Fall Migration ____ **Yearlong** ____

Primary Reference or New Data Review Sheet (cont'd)

VI. Carcass Search Methods (if applicable) N/A

Search Conditions: Daily ____ Weekly ____ Only after overcast nights with a low ceiling or storm events ____

Other Periods (Describe):

Search Biases Evaluated, Including Observer Bias and Scavenger Activity? Yes ____ No √

Search Area Described? Yes ____ No √

VII. Analytical and Statistical Methods N/A

Statistical method(s) used: (list)

N/A

Comments:

VIII. Number of Tower Sites: N/A **Proximity:**

IX. Behavioral Observations at the Tower: Yes ______ No √
Describe if applicable to statement or conclusion being evaluated.

X. Documentation of Weather Factors? Yes ______ No √
Describe if applicable to statement or conclusion being evaluated.

XI. Inclusion of Structural and Landscape Conditions? Yes ____ No √ **Describe if applicable to statement or conclusion being evaluated.**
XII. Brief Description of Results
Discusses overall bird mortality reports at communication towers to date. Most reports were of mass mortalities, which is of limited value in establishing annual mortality rates under "normal conditions." Estimates if only 50% of towers at that time presented an avian collision risk, an estimated 2.500 birds per tower could be affected, totaling an estimated 1,250,000 birds per year in the U.S. Vireonidae, Parulidae, and Fringillidae are the most frequently affected bird families.
XIII. Need for and Scope of Additional Studies (Only applicable if new data or study is provided.)
Are additional studies identified? Yes ____ No √ If yes explain and list studies.
XIV. Suggested Methods to Minimize Impacts (Only applicable if new data or study is provided.)
Are specific methods identified? Yes____ No √ If yes explain and list specific mitigative methods.

Primary Reference or New Data Review Sheet

I. Citation or Source:

Ball, L.G., K. Zyskowski, and G. Escalona-Segura. 1995. Recent bird mortality at a Topeka television tower. Kansas Ornithological Society Bulletin 46(4):33-36.

Source Type (check one): Incident report

Peer-reviewed Paper √
Agency Report ____
Conference Proceedings ____

Other (specify):

II. Study Objectives (list)

Monitoring number of bird kills and species recorded.

III. Species

Detailed species list: 2,808 bird mortalities; 91 species. Gray catbird and sora most common in Sep 1985. Orange-crowned warbler most common for October dates. A number of larger, water birds, wrens, kinglets, thrushes, vireos, warblers, sparrows, orioles, and other passerines recorded.

IV. Study Methods (briefly list)

Focus was to document otherwise rare occurrences of birds in area.

V. Duration of Study 4 events

Duration (provide dates):

Single Year ______________________________
Multiple Years 25-26 Sep 1985, 30 Sep – 1 Oct 1986, 11-12 Oct 1986, 8-9 Oct 1994.

Seasons:

Spring Migration ____ **Both** ____

Fall Migration √ **Yearlong** ____

Primary Reference or New Data Review Sheet (cont'd)

VI. Carcass Search Methods (if applicable)

Search Conditions: Daily ____ Weekly ____ Only after overcast nights with a low ceiling or storm events ____

Other Periods (Describe): Based on events (four total).

Search Biases Evaluated, Including Observer Bias and Scavenger Activity? Yes ____ No √

Search Area Described? Yes ____ No √

VII. Analytical and Statistical Methods N/A

Statistical method(s) used: (list)

Comments:

VIII. Number of Tower Sites: 1 **Proximity:**

KTKA tower 4 km west of Topeka, Kansas.
439 m tall. Guyed. Incandescent (red?) lights.

IX. Behavioral Observations at the Tower: Yes ______ No √
Describe if applicable to statement or conclusion being evaluated.

X. Documentation of Weather Factors? Yes √ No ______
Describe if applicable to statement or conclusion being evaluated.

Low cloud ceiling following major decrease in wind speed and preceding temperatures falling. Only precipitation occurred 11-12 Oct 1986, which coincided w/ rain and light snow.

XI. Inclusion of Structural and Landscape Conditions? Yes ____ No √ **Describe if applicable to statement or conclusion being evaluated.**
XII. Brief Description of Results
No scientific data, but good information on potential effects to rare, threatened, or endangered species. Detailed species list.
XIII. Need for and Scope of Additional Studies (Only applicable if new data or study is provided.)
Are additional studies identified? Yes ____ No √ If yes explain and list studies.
XIV. Suggested Methods to Minimize Impacts (Only applicable if new data or study is provided.)
Are specific methods identified? Yes____ No √ If yes explain and list specific mitigative methods.

Primary Reference or New Data Review Sheet

I. Citation or Source:

Avery, M.L., P.F. Springer, and J.F. Cassel. 1978. The composition and seasonal variation of bird losses at a tall tower in southeastern North Dakota. American Birds 32(6):1141-1121.

Source Type (check one): Study

Peer-reviewed Paper √
Agency Report ____
Conference Proceedings ____

Other (specify):

II. Study Objectives (list)

Determine extent and seasonal variation of bird mortality.

III. Species

937 (partial sample) (1,075 mean annual)
102 species of birds; 46% neotropical migrants; predominantly vireos and warblers.
4, 298 estimated for 5 seasons 1971-73.

IV. Study Methods (briefly list)

Surveyed at dawn almost daily. Strata w/in 151 ft surveyed 100%.
Randomized sampling effort for 3 other concentric strata (302, 600, and 2,400 ft).
Total 8 sampling plots for each concentric circle (40.7 ft ea. side ea. plot).
Used nets on sampling plots.

V. Duration of Study: 3 years - nightly

Duration (provide dates):

Single Year ________________________________
Multiple Years 1971-1973 (3 yrs)
Except for 7 days: daily @ dawn
30 Mar – 4 Jun (1972) 2 Apr – 2 Jun (1973)
8 Aug – 15 Nov (1972) 12 Aug – 3 Nov (1973)
(surveyed other adjacent days)

Seasons:

Spring Migration ____ **Both** √

Fall Migration ____ **Yearlong** ____

Primary Reference or New Data Review Sheet (cont'd)

VI. Carcass Search Methods (if applicable)

Search Conditions: Daily √ Weekly ____ Only after overcast nights with a low ceiling or storm events ____

Other Periods (Describe):

Search Biases Evaluated, Including Observer Bias and Scavenger Activity? Yes √ No ____ Scavenger Study

Search Area Described? Yes √ No ____

Scavenger Study: planted 296 birds at various points over 4 seasons
Results: Range 2.4% carcass removal in spring 1972 (7.3% nightly); 17.6% carcass removal in spring 1973. Removal averaged 7.4% overall.

Marshy/grassland search area.

VII. Analytical and Statistical Methods

Statistical method(s) used: (list)

Predominantly descriptive study. Chi-square tests used to determine if kill rates of particular species or families varied w/ season.

Comments:

VIII. Number of Tower Sites: 1 **Proximity:**

U.S. Coast guard Omega Navigational Station – James River Valley; 3 km W. LaMoure, ND.
5 red, non-flashing, obstruction lights
4 red, flashing 700-W beacons
366–meter tower; guyed; 16 evenly spaced transmitting cables from top of antennae to a perimeter road 732 from tower.

IX. Behavioral Observations at the Tower: Yes ______ No √
Describe if applicable to statement or conclusion being evaluated.

X. Documentation of Weather Factors? Yes ______ No √
Describe if applicable to statement or conclusion being evaluated.

Primary Reference or New Data Review Sheet (cont'd)

XI. Inclusion of Structural and Landscape Conditions? Yes ____ No √ **Describe if applicable to statement or conclusion being evaluated.**
XII. Brief Description of Results
Consistent sampling effort; measured scavenger removal estimated @ 7.3% nightly (7.4% overall). 54% kills occurred in fall migration (Sep-Nov) = Stratum D (183-732 m from tower) suggest that most mortality caused by guy wires/transmitting cables farther from towers. 44% warblers and 11% vireos over half of mortalities recorded primarily in fall. Fall mortalities typically not local breeders. Wrens, icterids, and fringillids predominantly spring kills. Spring mortalities commonly local breeding birds, inferring that local breeders more affected than migrants heading north. Hypothesize local breeders more selective in spring as compared to fall as to where perch after nights migration. Birds breed in habitats similar to Omega station are more prone to collisions. Also, diurnal collisions w/ local breeders may occur, particularly during inclement weather or poor visibility. Seasonal variation in species composition.
XIII. Need for and Scope of Additional Studies (Only applicable if new data or study is provided.)
Are additional studies identified? Yes ____ No √ If yes explain and list studies.
XIV. Suggested Methods to Minimize Impacts (Only applicable if new data or study is provided.)
Are specific methods identified? Yes____ No √ If yes explain and list specific mitigative methods.

Primary Reference or New Data Review Sheet

I. Citation or Source:

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(2):291-299.

Source Type (check one): Study

Peer-reviewed Paper √
Agency Report ____
Conference Proceedings ____

Other (specify):

II. Study Objectives (list)

Record weather influences on bird mortalities.

III. Species

~ 1, 064 birds collected.

IV. Study Methods (briefly list)

4 concentric strata (strata A = 100%; other strata lower percentage cover).

V. Duration of Study: 4 migrational seasons

Duration (provide dates):

Single Year ________________________________
Multiple Years 1972-1973 (2 yrs)
30 Mar – 4 Jun (1972) 2 Apr – 2 Jun (1973)
8 Aug – 15 Nov (1972) 12 Aug – 3 Nov (1973)
nightly searches @ daybreak (except 7 days)

Seasons:

Spring Migration ____ **Both** √
Fall Migration ____ **Yearlong** ____

VI. Carcass Search Methods (if applicable)

Search Conditions: Daily √ Weekly ____ Only after overcast nights with a low ceiling or storm events ____

Other Periods (Describe):

Search Biases Evaluated, Including Observer Bias and Scavenger Activity? Yes ____ No √

Search Area Described? Yes √ No ____

VII. Analytical and Statistical Methods

Statistical method(s) used: (list)

- Chi-square-goodness-of-fit test – w/in ea family; losses in entire peak periods were same proportion to number of nights in those categories.
- G-test – determine independence b/w cloud cover and distance of kill and b/w cloud cover and season.

Comments:

VIII. Number of Tower Sites: 1 **Proximity:**

U.S. Coast guard Omega Navigational Station – James River Valley; 3 km W. LaMoure, ND.
5 red, non-flashing, obstruction lights
4 red, flashing 700-W beacons
366–meter tower; guyed; 16 evenly spaced transmitting cables from top of antennae to a perimeter road 732 from tower.
Omega tower unique because of 16 transmitting cables - increase collision risk, particularly farther from base on clear nights.

IX. Behavioral Observations at the Tower: Yes √ No ____
Describe if applicable to statement or conclusion being evaluated.

Similar to Cochran and Graber 1958 and Avery et al., 1976.
Mortality information suggests behavioral differences that depict where families or group-level birds may be affected.

X. Documentation of Weather Factors? Yes √ No ____
Describe if applicable to statement or conclusion being evaluated.

Hourly weather reports from FAA Flight Service Station @ Jamestown (72 km N-NW of LaMoure).
Precipitation; wind speed and direction recorded.
On overcast nights – losses concentrated near the tower (and lights) in strata A and B; non-overcast nights – more evenly distributed.
Spring and fall – difference in mortality b/w overcast and non-overcast was statistically significant. Infers distance of losses from tower was influenced by cloud cover.

XI. Inclusion of Structural and Landscape Conditions? Yes √ No ____
Describe if applicable to statement or conclusion being evaluated.

Marshy/grassland.

XII. Brief Description of Results

Consistent sampling effort, major fall kills followed cold fronts.
Table 1: 5 largest single-night losses in 1972-73; 4 of 5 nights overcast. Fall losses on overcast nights occurred w/in 12 hours of cold fronts, which is consistent w/ other studies (as listed). Spring kills more evenly distributed; no direct association w/ frontal movements; majority of kills occurred w/ favorable (SE) winds.
Ceilometer observations – majority of spring migration occurred w/ SE winds.
The percent of fall mortalities were higher than the percent recorded in the spring migration w/in 92 m of the tower; beyond 92 m this is reversed except in 1972. In summary, larger spring losses consistently occurred at greater distances from the tower than in the fall.
16 transmitting cables increase the collision risk. During clear (non-overcast) nights, birds avoided towers, but higher collisions recorded farther from tower.

Mortality data infer/suggest difference in bird strikes (number, location, weather conditions) relates to family or bird group.

XIII. Need for and Scope of Additional Studies (Only applicable if new data or study is provided.)

Are additional studies identified? Yes √ No ____ If yes explain and list studies.

Differences among various taxa of nocturnal migrants in responses to tall, lighted structures warrants further research. Conceivably, data may provide methods where losses to same species at towers could be reduced.

XIV. Suggested Methods to Minimize Impacts (Only applicable if new data or study is provided.)

Are specific methods identified? Yes____ No √ If yes explain and list specific mitigative methods.

Primary Reference or New Data Review Sheet

I. Citation or Source:

Avery, M.L., P.F. Springer, and J.F. Cassel. 1976. The effects of a tall tower on nocturnal bird migration – a portable ceilometer study. Auk 93(2):281-291.

Source Type (check one): Study

Peer-reviewed Paper √
Agency Report ____
Conference Proceedings ____

Other (specify):

II. Study Objectives (list)

Record bird behavior at and away from tower.
Examine bird distribution @ towers.
Monitor numbers of birds at and away from tower.
Record bird behavior near tower lighting.
Monitor movements.

III. Species

Three species frequently recorded at the tower: sora, common yellowthroat, and savannah sparrow.

IV. Study Methods (briefly list)

Nighttime observations of migrants using portable ceilometer technique.
Monitored/recorded weather conditions.
Used binoculars and spotting scope.

V. Duration of Study 4 nights/week

Duration (provide dates):

Single Year ________________________________
Multiple Years 1972, 1973

18 April – 1 June (1972)	2 Apr – 31 May (1973)
19 Aug – 26 Oct (1972)	16 Aug – 27 Oct (1973)

Seasons:

Spring Migration ____ **Both** √

Fall Migration ____ **Yearlong** ____

Primary Reference or New Data Review Sheet (cont'd)

VI. Carcass Search Methods (if applicable)

Search Conditions: Daily ____ Weekly ____ Only after overcast nights with a low ceiling or storm events ____

Other Periods (Describe): 4 nights/week (see V.)

Search Biases Evaluated, Including Observer Bias and Scavenger Activity? Yes ____ No √

Search Area Described? Yes √ No ____

VII. Analytical and Statistical Methods

Statistical method(s) used: (list)

N/A

Comments:

VIII. Number of Tower Sites: 1 **Proximity:** N/A

U.S. Coast guard Omega Navigational Station – James River Valley; 3 km W. LaMoure, ND.
5 red, non-flashing, obstruction lights
4 red, flashing 700-W beacons
366–meter tower; guyed; 16 evenly spaced transmitting cables from top of antennae to a perimeter road 732 from tower.

IX. Behavioral Observations at the Tower: Yes √ No ____
Describe if applicable to statement or conclusion being evaluated.

"Fluttered/milled about" oriented mainly into wind (did <u>not</u> orient toward tower lights). Flight pattern: several wingbeats – brief pause – (whether transmitting or not). Foggy @ dawn 26 Aug 1973; 35 m near red tower lights – flew upwind, frequently pausing/fluttering ~20 m SE of tower – turn slightly – blown downwind ~ 50 m NW of tower – stopped and began slow flight upwind again. Counterclockwise – narrow elliptical path.

X. Documentation of Weather Factors? Yes √ No ____
Describe if applicable to statement or conclusion being evaluated.

Data grouped by season (spring or fall).
Within each seasonal group, sightings divided into overcast or nonovercast (clear or partly cloudy) classes.
Classes subdivided by location (at tower or 305 m to NE of tower).

Primary Reference or New Data Review Sheet (cont'd)

XI. Inclusion of Structural and Landscape Conditions? Yes ____ No √ **Describe if applicable to statement or conclusion being evaluated.**
XII. Brief Description of Results
Overcast nights each season - number of migrants observed @ tower significantly greater than number observed 305 m to NE of tower. Clear nights – reverse was true. Partly cloudy nights – not significant in fall. Directional movements under various conditions; multiple seasons recorded. Overcast nights w/ clearing showed number birds sharply decreasing @ tower. Number of birds decreased/increased when lights turned off/on 22-23 Aug 1973. Inference: congregation of nocturnal migrants – orientation using celestial cues. More likely: reluctant to leave area of illumination when passing tower, particularly during inclement weather. Migrants may actively avoid tower on clear nights.
XIII. Need for and Scope of Additional Studies (Only applicable if new data or study is provided.)
Are additional studies identified? Yes ____ No √ If yes explain and list studies.
XIV. Suggested Methods to Minimize Impacts (Only applicable if new data or study is provided.)
Are specific methods identified? Yes____ No √ If yes explain and list specific mitigative methods.

Primary Reference or New Data Review Sheet

I. Citation or Source:

Crawford, R.L. and R.T. Engstrom. 2001. Characteristics of avian mortality at a north Florida television tower: A 29-year study. J. Field Ornithol. 72(3):380-388.

Source Type (check one): Study

Peer-reviewed Paper √
Agency Report ____
Conference Proceedings ____

Other (specify):

II. Study Objectives (list)

Determine extent of avian mortality over long study period.

1) Summarize 29 years of data.
2) Examine effects of tower height on avian mortality.
3) Evaluate effects of scavengers on number of mortalities detected.

III. Species

44,007 bird kills of 186 species over 29-year period.
> 94% were neotropical migrants; red-eyed vireo #1 mortality recorded.
After tower shortened, only 32 bird mortalities recorded Oct 1999 (27 visits); 14 recorded Oct 2000 (18 visits)
Of 41 families; Parulidae and Vireonidae = 64%; primarily neotropical migrants/nocturnal migrants.
99% of mortality concentrated in only 15 of the 43 total families recorded at site.

IV. Study Methods (briefly list)

Attempted daily surveys at dawn.
Descriptive study; information not quantified.

V. Duration of Study: 29 years

Duration (provide dates):

Single Year ________________________________
Multiple Years 1955-1967-1983 (29 years)
Main part of study concluded 1985.
284-ft tower also checked in Oct 1999 and 2000 for comparison w/ taller tower for same period.

Seasons:

Spring Migration ____ **Both** √

Fall Migration ____ **Yearlong** ____

Primary Reference or New Data Review Sheet (cont'd)

VI. Carcass Search Methods (if applicable)

Search Conditions: Daily √ Weekly ____ Only after overcast nights with a low ceiling or storm events ____

Other Periods (Describe):

Search Biases Evaluated, Including Observer Bias and Scavenger Activity? Yes √ No ____

Search Area Described? Yes √ No ____

20-acre mowed area under tower and guy wires.

Aggressive scavenger removal using live trapping and poisons from 1955-1967 (13 years) and again 1974-1976 (3 years). Determined strong scavenger effect; reduced predator control resulted in 71% reduction in birds found.

VII. Analytical and Statistical Methods Largely descriptive

Statistical method(s) used: (list)

Used ANOVA to determine if kill rates changed when tower height increased from 669 to 1,010 feet. No effect reported.

Comments:

VIII. Number of Tower Sites: 1 **Proximity:**

WCTV tower northern Leon co, FL (Tall Timbers Research Station reporting)
1955-1960 = 669 feet
1960 = new tower replaced 1,010 feet
1989 = tower shortened to 295 feet

IX. Behavioral Observations at the Tower: Yes ______ No √
Describe if applicable to statement or conclusion being evaluated.

X. Documentation of Weather Factors? Yes ______ No ______
Describe if applicable to statement or conclusion being evaluated.

Crawford and Engstrom controlled for weather and scavenger conditions.

Primary Reference or New Data Review Sheet (cont'd)

XI. Inclusion of Structural and Landscape Conditions? Yes ____ No √ **Describe if applicable to statement or conclusion being evaluated.**
XII. Brief Description of Results
Examines relationship of tower height (3 towers at same site) to bird kills. Authors state that towers less than 295 feet may not present serious risk for bird collisions. Scavenger control recommended. Mean mortality numbers = 1,517/year overall. With scavenger control the mean = 2,248 mortalities/year; without scavenger control the mean = 642.
XIII. Need for and Scope of Additional Studies (Only applicable if new data or study is provided.)
Are additional studies identified? Yes ____ No √ If yes explain and list studies.
XIV. Suggested Methods to Minimize Impacts (Only applicable if new data or study is provided.)
Are specific methods identified? Yes____ No √ If yes explain and list specific mitigative methods.

Primary Reference or New Data Review Sheet

I. Citation or Source:

Crawford, R.L. 1971. Predation on birds killed at TV tower. Oriole 36:33-35.

Source Type (check one): Study

Peer-reviewed Paper √
Agency Report ____
Conference Proceedings ____

Other (specify):

II. Study Objectives (list)

Descriptive summary of predation issues on bird mortalities at tower sites.

III. Species

N/A

IV. Study Methods (briefly list)

Tall Timber Bulletin Number 1 (1962) and Number 8 (1967) have detailed methodology for period 1955-1966.
Planted birds on tower site for 5 nights to monitor/calculate scavenging rates.

V. Duration of Study

Duration (provide dates):	Seasons:	
Single Year 5 nights 21-27 Oct 1971	**Spring Migration** ____	**Both** ____
Multiple Years ______________________	**Fall Migration** √	**Yearlong** ____

Primary Reference or New Data Review Sheet (cont'd)

VI. Carcass Search Methods (if applicable)

Search Conditions: Daily ____ Weekly ____ Only after overcast nights with a low ceiling or storm events √

Other Periods (Describe):

Search Biases Evaluated, Including Observer Bias and Scavenger Activity? Yes √ No ____ Scavenger Removal

Search Area Described? Yes ____ No √

1955-1966/ 1971 5 nights = scavenger removal monitored.

VII. Analytical and Statistical Methods

Statistical method(s) used: (list)

N/A

Comments:

VIII. Number of Tower Sites: 1 **Proximity:**

WCTV tower northern Leon co, FL (Tall Timbers Research Station reporting)
1955-1960 = 669 feet
1960 = new tower replaced 1,010 feet

IX. Behavioral Observations at the Tower: Yes ______ No √
Describe if applicable to statement or conclusion being evaluated.

X. Documentation of Weather Factors? Yes ______ No √
Describe if applicable to statement or conclusion being evaluated.

Primary Reference or New Data Review Sheet (cont'd)

XI. Inclusion of Structural and Landscape Conditions? Yes ____ No √
Describe if applicable to statement or conclusion being evaluated.

XII. Brief Description of Results

Predation was high. Total predation rates (day and night) were 93% (147 of 157 birds). Great horned owls were the primary nocturnal scavengers, with common and fish crows scavenging diurnally.

XIII. Need for and Scope of Additional Studies (Only applicable if new data or study is provided.)

Are additional studies identified? Yes √ No ____ If yes explain and list studies.

Tower studies should account for predation and scavenger removal rates. Recommended strict predator control, early morning surveys, and whether drastic predator control measures are worth the data.

XIV. Suggested Methods to Minimize Impacts (Only applicable if new data or study is provided.)

Are specific methods identified? Yes____ No √ If yes explain and list specific mitigative methods.

Primary Reference or New Data Review Sheet

I. Citation or Source:

Crawford, R.L. 1978. Autumn bird casualties at a northern Florida TV Tower: 1973-1975. Wilson Bulletin 90(3):335-345.

Source Type (check one): Study

Peer-reviewed Paper √
Agency Report ____
Conference Proceedings ____

Other (specify):

II. Study Objectives (list)

Record age and sex data for 3, 223 birds killed during fall periods (Aug-Nov) of 1973-1975.

III. Species

3,864 bird mortalities reported; 109 species
Mass Mortalities:
17 Oct 1973 = (133); 5 Sep 1974 (134); 23 Sep 1974 (220); 17 Oct 1974 (971); 14 Sep 1975 (636); 15 Sep 1975 (486)
Aug-Nov only:
1973 = 261 birds; 57 species
1974 = 1,832 birds, 87 species (w/ predator control)
1975 = 1,771 birds; 90 species (w/ predator control)

IV. Study Methods (briefly list)

Almost daily searches. Reinstituted rigorous predator control in 1974-75, which explains increased carcass retrieval rates. Analyzed sex and age ratios.

V. Duration of Study 3 years

Duration (provide dates):

Single Year ________________________________
Multiple Years 1973-1975

Seasons:

Spring Migration ____ **Both** ____

Fall Migration (Aug – Nov) √ **Yearlong** ____

Primary Reference or New Data Review Sheet (cont'd)

VI. Carcass Search Methods (if applicable)

Search Conditions: Daily √ Weekly ____ Only after overcast nights with a low ceiling or storm events ____

Other Periods (Describe):

Search Biases Evaluated, Including Observer Bias and Scavenger Activity? Yes √ No ____

Search Area Described? Yes ____ No √

Scavenger/predator removal program in place.

VII. Analytical and Statistical Methods

Statistical method(s) used: (list)

Variance test for homogeneity of the binomial distribution.

Comments:

VIII. Number of Tower Sites: 1-2 Proximity:

WCTV – Leon Co. Florida
1,008-foot, guyed TV tower (see Crawford and Engstrom 2001).
Steady and flashing red lights.
WCTV tower was focus, but these tower results compared to central peninsular tower (WDBO) by Taylor and Anderson, 1973.

IX. Behavioral Observations at the Tower: Yes ______ No √
Describe if applicable to statement or conclusion being evaluated.

X. Documentation of Weather Factors? Yes √ No ______
Describe if applicable to statement or conclusion being evaluated.

Most mortalities occurred following cold fronts.

Primary Reference or New Data Review Sheet (cont'd)

XI. Inclusion of Structural and Landscape Conditions? Yes ____ No √ **Describe if applicable to statement or conclusion being evaluated.**
XII. Brief Description of Results
Compared different types of species' migration. Authors state that differences in migration movement periods result in differences in mortality events (e.g., displaced female ruby-crowned kinglets). Larger number of adults (earlier migrants) than immature birds recorded (Taylor and Anderson, 1973). The two tower comparisons and sampling delineated different migration systems. Strong inference to mass mortalities associated w/ cold fronts. Suggests those species that migrate early are less likely to be impacted by cold fronts and hence collisions. Also see Nolan and Mumford 1965.
XIII. Need for and Scope of Additional Studies (Only applicable if new data or study is provided.)
Are additional studies identified? Yes ____ No √ If yes explain and list studies.
XIV. Suggested Methods to Minimize Impacts (Only applicable if new data or study is provided.)
Are specific methods identified? Yes____ No √ If yes explain and list specific mitigative methods.

Primary Reference or New Data Review Sheet

I. Citation or Source:

Stoddard, H.L., Sr. 1962. Bird casualties at a Leon County, Florida TV tower: 1955-1961. Bull. Tall Timbers Res. Sta. 1:94.

Source Type (check one): Study.

Peer-reviewed Paper √
Agency Report ____
Conference Proceedings ____

Other (specify):

II. Study Objectives (list)

Initiate a long-term study of bird collisions w/ towers.
Record species and number of birds killed.
Document extent of scavenger removal of carcasses.

III. Species

15, 251 total birds; 149 species
See page 3 of report for listings of mass mortality kills.
Few to several species of bats recorded.

IV. Study Methods (briefly list)

Almost daily surveys.

V. Duration of Study 7 years

Duration (provide dates):

Single Year ______________________________
Multiple Years 1955-1961

Seasons:

Spring Migration ____ **Both** √

Fall Migration ____ **Yearlong** ____

Primary Reference or New Data Review Sheet (cont'd)

VI. Carcass Search Methods (if applicable)

Search Conditions: Daily √ Weekly ____ Only after overcast nights with a low ceiling or storm events ____

Other Periods (Describe):

Search Biases Evaluated, Including Observer Bias and Scavenger Activity? Yes √ No ____

Search Area Described? Yes ____ No √

Except for <12 mornings in June, practically 0 dead birds found during that period.
Proactive scavengers removal program.
See Crawford and Engstrom, 2001 for details.

VII. Analytical and Statistical Methods

Statistical method(s) used: (list)

N/A

Comments:

VIII. Number of Tower Sites: 1 **Proximity:**

See Crawford and Engstrom, 2001 for details.
673 feet then rebuilt Apr 15, 1960 to 1,008 feet.
Steady/flashing red lights; guyed.

IX. Behavioral Observations at the Tower: Yes √ No ______
Describe if applicable to statement or conclusion being evaluated.

Other papers detail, but not this paper.

X. Documentation of Weather Factors? Yes √ No ______
Describe if applicable to statement or conclusion being evaluated.

General factors only.

Primary Reference or New Data Review Sheet (cont'd)

XI. Inclusion of Structural and Landscape Conditions? Yes ____ No √
Describe if applicable to statement or conclusion being evaluated.

XII. Brief Description of Results

*Early rain in p.m. grounds vireos, warblers, and thrushes (but not finches). With early rain in the early p.m., more finch mortalities reported; dry in early p.m. results in greater number of vireo, warbler, and thrush mortalities (which typically comprise > 75% of total mortalities).
*Winds reported to contribute to collisions, even on clear nights. Reported large number of migratory birds on clear nights at higher altitudes and 0 mortalities at the tower.
*Diagrams of carcass locations relative to tower, guy wires, and wind direction.
*Detailed predator scavenger information.

Mass Mortalities:

4 Apr 1956 (190)	27 Sep 1957 (111)
5 Apr 1956 (135)	30 Sep 1957 (146)
26 Apr 1956 (201)	1 Oct 1957 (222)
2 Apr 1957 (130)	2 Oct 1957 (126)
4 Apr 1958 (228)	5 Oct 1957 (2,325) (63 species)
6 Apr 1959 (102)	9 Oct 1955 (4,000-7,000)
9 Apr 1958 (220)	

*Author interested as much in the total absence of dead birds of any morning as the presence of large numbers; i.e., negative evidence can be as important, on occasion, as positive.
*Reported large numbers of exhausted and sleeping birds on ground w/in 50-100 yards of tower. No birds seen larger than tanager-sized, except for mortally wounded ones. Author believed this phenomenon was related to clouds engulfing tower lights.

XIII. Need for and Scope of Additional Studies (Only applicable if new data or study is provided.)

Are additional studies identified? Yes ____ No √ If yes explain and list studies.

XIV. Suggested Methods to Minimize Impacts (Only applicable if new data or study is provided.)

Are specific methods identified? Yes____ No √ If yes explain and list specific mitigative methods.

Primary Reference or New Data Review Sheet

I. Citation or Source:

Shire, G.G., K. Brown, and G. Winegrad. 2000. Communication towers: A deadly hazard to birds. American Bird Conservancy Special Report. 23 pp.

Source Type (check one): Summary

Peer-reviewed Paper ____
Agency Report ____
Conference Proceedings ____

Other (specify): Summary Report

II. Study Objectives (list)

N/A

Do study objectives relate to scientific statement of conclusion being evaluated? Yes ____ No ____ Explain

N/A

III. Species Studied (list)

N/A

IV. Study Methods (briefly list)

N/A

V. Duration of Study N/A

Duration (provide dates):

Single Year ______________________________
Multiple Years ______________________________

Seasons:

Spring Migration ____ **Both ____**

Fall Migration ____ **Yearlong ____**

Primary Reference or New Data Review Sheet (cont'd)

VI. Carcass Search Methods (if applicable) N/A

Search Conditions: Daily ____ Weekly ____ Only after overcast nights with a low ceiling or storm events ____

Other Periods (Describe):

Search Biases Evaluated, Including Observer Bias and Scavenger Activity? Yes ____ No ____

Search Area Described? Yes ____ No ____

N/A

VII. Analytical and Statistical Methods N/A

Statistical method(s) used: (list)

Comments:

VIII. Number of Tower Sites: N/A **Proximity:**

IX. Behavioral Observations at the Tower: Yes ______ No ______
Describe if applicable to statement or conclusion being evaluated.

N/A

X. Documentation of Weather Factors? Yes ______ No ______
Describe if applicable to statement or conclusion being evaluated.

N/A

XI. Inclusion of Structural and Landscape Conditions? Yes ____ No ______
Describe if applicable to statement or conclusion being evaluated.

N/A

XII. Brief Description of Results

Point that of 230 species killed @ towers, 52 are in decline or need special management attention. One Federally endangered species has been found, the red-cockaded woodpecker. Other species are on the extremely high priority PIF watch list or FWS "Species of Mgmt Concern" list.

XIII. Need for and Scope of Additional Studies (Only applicable if new data or study is provided.)

Are additional studies identified? Yes √ No ______ If yes explain and list studies.

Need further studies to better define:
1) Why warblers and sparrows most affected.
2) Applicable research mitigation measures.
3) The exact cause of bird mortalities.
4) Lighting differences.

XIV. Suggested Methods to Minimize Impacts (Only applicable if new data or study is provided.)

Are specific methods identified? Yes√ No ______ If yes explain and list specific mitigative methods.

Not studied yet, but shows promise:
1) Changes in lighting protocol.
2) Infra-red use.
3) Bird diverters.
4) Visual markers/audible devices.
5) See list Page 19 of report.

Primary Reference or New Data Review Sheet

I. Citation or Source:

Seets, J.W. and H.D. Bohlen. 1977. Comparative mortality of birds at television towers in central Illinois. Wilson Bulletin 89(3):422-433.

Source Type (check one): Study

Peer-reviewed Paper √
Agency Report ____
Conference Proceedings ____

Other (specify):

II. Study Objectives (list)

1) Obtain research specimens for preservation.
2) Obtain comparative data on migration patterns across the state.

III. Species

See Page 3; 5,138 total birds.

IV. Study Methods (briefly list)

Checked towers on all mornings followed nights w/ reduced visibility from fog, precipitation, or low cloud ceilings.

V. Duration of Study 1 year

Duration (provide dates):

Single Year 1972
Multiple Years ______________________________
13 dates b/w 2 Sep and 12 Nov 1972, following cloudy weather.

Seasons:

Spring Migration ____ **Both** ____
Fall Migration √ **Yearlong** ____

VI. Carcass Search Methods (if applicable)

Search Conditions: Daily ____ Weekly ____ Only after overcast nights with a low ceiling or storm events √

Other Periods (Describe): 13 visits following overcast conditions.

Search Biases Evaluated, Including Observer Bias and Scavenger Activity? Yes ____ No √

Search Area Described? Yes ____ No √

Scavengers noted, but no calculations or scavenger removal rates developed.

VII. Analytical and Statistical Methods

Statistical method(s) used: (list)

Chi-square indicated species composition differed significantly b/w eastern and western Illinois.

Comments:

VIII. Number of Tower Sites: 7 **Proximity:** Across state of Illinois.

7 towers all guyed:
1,587
1,458
1,063
1,047
981
1,338
605
Lighting not reported.

IX. Behavioral Observations at the Tower: Yes ______ No √
Describe if applicable to statement or conclusion being evaluated.

X. Documentation of Weather Factors? Yes √ No ______
Describe if applicable to statement or conclusion being evaluated.

Surveys completed mornings following precipitation or low visibility.
Obtained weather station data.
All but 4 of kills occurred w/ low ceiling and visibility.
4 nights when 93% of kills occurred ceiling was 550 meters or less.
Often cold fronts w/ northerly winds.
All kills occurred w/in 32 hours of weather events (usually w/in 6 hours).

Primary Reference or New Data Review Sheet (cont'd)

XI. Inclusion of Structural and Landscape Conditions? Yes ____ No √
Describe if applicable to statement or conclusion being evaluated.

XII. Brief Description of Results

No consistent relationship b/w tower height, terrain, or location and the number of bird kills. Kills neither consistently high or low @ tower sites. Authors believe number of kills directly related to weather and number birds flying (i.e., present).

Timing may be important because the time that birds are killed may have bearing on the species affected.

When comparing radar data from 1968 for different locations, a number of migrants are consistently uniform. Assumed if weather conditions were the same then number of kills should be similar b/w towers, but some were very different. Cannot explain without more detailed weather data.

	Kills	Species	Mass Mortalities:
(1)	328	43	2 Sep 1972 (221); 29 Sep 1972 (107)
(2)	1,680	61	2 Sep 1972 (735); 27 Sep 1972 (391); 29 Sep 1972 (319)
(3)	969	55	2 Sep 1972 (110); 27 Sep 1972 (807)
(4)	1,176	57	27 Sep 1972 (992); 31 Oct 1972 (184)
(5)	130	22	27 Sep 1972 (127)
(6)	942	63	2 Sep 1972 (266); 27 Sep 1972 (634)
(7)	206	27	27 Sep 1972 (206)

* 59.8% total killed 27 Sep 1972

XIII. Need for and Scope of Additional Studies (Only applicable if new data or study is provided.)

Are additional studies identified? Yes ____ No √ If yes explain and list studies.

XIV. Suggested Methods to Minimize Impacts (Only applicable if new data or study is provided.)

Are specific methods identified? Yes____ No √ If yes explain and list specific mitigative methods.

Primary Reference or New Data Review Sheet

I. Citation or Source:

Podolsky, R, D.G. Ainley, G. Spencer, L. DeForest, and N. Nur. 1998. Mortality of Newell's Shearwaters caused by collisions with urban structures on Kauai. Colonial Waterbirds 21(1):20-34.

Source Type (check one): Study.

Peer-reviewed Paper √
Agency Report ____
Conference Proceedings ____

Other (specify):

II. Study Objectives (list)

To document mortality rates of Newell's shearwaters from collisions w/ urban structures, primarily overhead power lines.

III. Species Studied (list)

Newell's shearwaters.

IV. Study Methods

Ran transects for shearwater collision crippling or mortalities w/ power lines.
Recorded: 1) location, 2) nearby wires and lights, 3) general background light intensity, 4) traffic, and 5) behavior or mortality.
1993 = 1,043 km of power lines and roads surveyed.
1994 = 732 km and 648 km

V. Duration of Study fall fledging period

Duration (provide dates):	Seasons:	
Single Year ________________________________	**Spring Migration** ____	**Both** ____
Multiple Years 1993 and 1994 June – July 1993 = 4-6 days/week when commuting 4-27 Oct 1993 5-7 Oct 1994 27 Oct-12 Nov 1994	**Fall Migration** √	**Yearlong** ____

VI. Carcass Search Methods (if applicable) Driving and pedestrian surveys.

Search Conditions: Daily ____ Weekly ____ Only after overcast nights with a low ceiling or storm events ____

Other Periods (Describe): See methods.

Search Biases Evaluated, Including Observer Bias and Scavenger Activity? Yes √ No ____

Search Area Described? Yes ____ No √

Scavenger removal study: 1994 = 23 carcasses, monitored daily; Possibly underestimated shearwater mortality rates by 17% due to scavenger removal.

VII. Analytical and Statistical Methods

Statistical method(s) used: (list)

Mann-Whitney U-Tests.
Single-variable logistic regression analysis.

Comments:

VIII. Number of Tower Sites: N/A **Proximity:**

IX. Behavioral Observations at the Tower: Yes ______ No √
Describe if applicable to statement or conclusion being evaluated.

X. Documentation of Weather Factors? Yes ______ No √
Describe if applicable to statement or conclusion being evaluated.

XI. Inclusion of Structural and Landscape Conditions? Yes ____ No √ **Describe if applicable to statement or conclusion being evaluated.**
XII. Brief Description of Results
References possible attraction of birds to lights and overall issues associated with rare and sensitive species. Discusses potential repercussions if threatened and endangered species are affected by collisions, which could apply to communication towers.
XIII. Need for and Scope of Additional Studies (Only applicable if new data or study is provided.)
Are additional studies identified? Yes ____ No √ If yes explain and list studies.
XIV. Suggested Methods to Minimize Impacts (Only applicable if new data or study is provided.)
Are specific methods identified? Yes____ No √ If yes explain and list specific mitigative methods.

Primary Reference or New Data Review Sheet

I. Citation or Source:

Nehring, J. and S. Bivens. 1999. A study of bird mortality at Nashville's WSMV television tower. Migrant 70:1-8.

Source Type (check one): Study

Peer-reviewed Paper √
Agency Report ____
Conference Proceedings ____

Other (specify):

II. Study Objectives (list)

Determine extent of bird mort during fall.
Document long-term trends.

III. Species

19,880 total birds; 112 species; >90% neotropical migrants.
Two large kills:
    5,399 birds on 26 Sep 1968
    3,487 birds on 28 Sep 1970
Of 19,880 birds, only 128 birds (0.64%) not neotropical migrants.
Parulidae and Vireonidae most prominent groups recorded.

IV. Study Methods (briefly list)

Daily surveys 1 Sep – 31 Oct for 38 years.

V. Duration of Study 38 years

Duration (provide dates):

Single Year ________________________________
Multiple Years 1960-1997
Focused on fall migration b/c several years of spring searches were "unproductive."

Seasons:

Spring Migration ____ **Both** ____

Fall Migration √ **Yearlong** ____

VI. Carcass Search Methods (if applicable)

Search Conditions: Daily √ **Weekly ____ Only after overcast nights with a low ceiling or storm events ____**

Other Periods (Describe): 1 Sep – 31 Oct for 38 years.

Search Biases Evaluated, Including Observer Bias and Scavenger Activity? Yes ____ No √

Search Area Described? Yes ____ No √

Scavengers noted, but no calculations or scavenger removal rates developed.

VII. Analytical and Statistical Methods

Statistical method(s) used: (list) N/A

N/A; descriptive only.

Comments:

VIII. Number of Tower Sites: 1 **Proximity:**

WSMV – 1,364 feet.
Red steady and flashing lights; guyed.
3 mi SW Nashville, TN.

IX. Behavioral Observations at the Tower: Yes ______ No √
Describe if applicable to statement or conclusion being evaluated.

X. Documentation of Weather Factors? Yes ______ No √
Describe if applicable to statement or conclusion being evaluated.

XI. Inclusion of Structural and Landscape Conditions? Yes ____ No √
Describe if applicable to statement or conclusion being evaluated.

XII. Brief Description of Results

Results published through the years by Laskey and Goodpasture.
Mortality rates declined over time. Even deducting two mass kills in 1968 and 1970, the trend over time shows reduction in bird mortalities. Different families' or species' approach to migration (flying altitudes, routes, social behavior) may put certain species @ greater risk.
Authors speculate three possible causal factors for declining mortality numbers although communication towers are increasing:

1) An increase in carcass removal by scavengers..
2) An increase in background lights.
3) A change in migration routes due to an expansion of the Nashville urban area.

Authors state: "These structures specifically sample migrating birds because they do not represent a hazard to resident species". In other words, they state that few resident species are found and the majority of the birds killed are migrants.

XIII. Need for and Scope of Additional Studies (Only applicable if new data or study is provided.)

Are additional studies identified? Yes √ No ______ If yes explain and list studies.

Need consistent and standardized data collection from most hazardous objects, towers >300 meters (1,000 feet).

XIV. Suggested Methods to Minimize Impacts (Only applicable if new data or study is provided.)

Are specific methods identified? Yes____ No √ If yes explain and list specific mitigative methods.

Primary Reference or New Data Review Sheet

I. Citation or Source:

Morris, S.R., A.R. Clark, L.H. Bhatti, and J.L. Glasgow. 2003. Television tower mortality of migrant birds in western New York and Youngtown, Ohio. Northeastern Naturalist 10(1):67-76.

Source Type (check one): Study

Peer-reviewed Paper √
Agency Report ____
Conference Proceedings ____

Other (specify):

II. Study Objectives (list)

Compare mortality rates among 4 towers.

III. Species

20,148 birds; 106 species; 1970-1999 (New York towers = 3); annual mean = 672.
4,310 birds; 80 species; 1974-1992 (Ohio tower = 1); annual mean = 227.
NY WRGZ = 8,011 birds.
NY WKBW = 11,092 birds.
NY WIBV = 1,043 birds.
OH WFMY = 4,310 birds.

IV. Study Methods (briefly list)

Following overcast nights (8-67 annual visits). 100% survey 164 to 197 feet from tower.

V. Duration of Study NY = 30 yrs; OH = 18 yrs

Duration (provide dates):

Single Year ______________________________
Multiple Years NY = 1970-1999, OH = 1974-1992
NY: 11 annual visits (4-33 nights).
OH: 1974 fall survey daily; other periods only after kills or overcast
NY: 1971 = daily 29 Aug – 1 Nov

Seasons:

Spring Migration ____ **Both** ____

Fall Migration √ **Yearlong** ____

Primary Reference or New Data Review Sheet (cont'd)

VI. Carcass Search Methods (if applicable)

Search Conditions: Daily ____ Weekly ____ Only after overcast nights with a low ceiling or storm events ____

Other Periods (Describe): See Section V.

Search Biases Evaluated, Including Observer Bias and Scavenger Activity? Yes ____ No √

Search Area Described? Yes ____ No √

Scavengers noted, but no calculations or estimates developed for scavenger removal rates.

VII. Analytical and Statistical Methods

Statistical method(s) used: (list)

Largely descriptive. Linear regression to determine whether number of kills declined during course of study.

Comments:

VIII. Number of Tower Sites: 4 **Proximity:** 3 in NY (S. Erie Co.); 1 in OH

961 feet, 1,076 feet, 1,059 feet, 1,084 feet; all towers guyed w/ red lights (beacon).

IX. Behavioral Observations at the Tower: Yes ______ No √
Describe if applicable to statement or conclusion being evaluated.

X. Documentation of Weather Factors? Yes ______ No √
Describe if applicable to statement or conclusion being evaluated.

Only surveyed following overcast conditions.

XI. Inclusion of Structural and Landscape Conditions? **Yes ____** **No √**
Describe if applicable to statement or conclusion being evaluated.

XII. Brief Description of Results

Collision rates often determined by factors, such as cloud cover, cold fronts, and tailwinds. Reduction in foggy/overcast nights also may contribute, but no data to support other than number of survey days (following overcast nights) were reduced through time.

Mort. Rates decrease through time @ all 4 towers.
Suggested reasoning:

1) Overall decrease in migratory bird populations.
2) Potential change in patterns of wind direction and cloud cover.
3) An increase in predation/scavenger removal.
4) Change in migration patterns.
5) Increase in light pollution.
6) Evolutionary reduction in bird attraction to tower lights.

Authors state that study results suggest that factors affecting changes in migrant mortalities are more likely large-scale factors, such as weather patterns and population size (rather than local factors such as increase in predators and scavengers).

XIII. Need for and Scope of Additional Studies (Only applicable if new data or study is provided.)

Are additional studies identified? Yes √ No ______ If yes explain and list studies.

Recommend additional studies on communication towers.

XIV. Suggested Methods to Minimize Impacts (Only applicable if new data or study is provided.)

Are specific methods identified? Yes____ No √ If yes explain and list specific mitigative methods.

Primary Reference or New Data Review Sheet

I. Citation or Source:

Manuwal, D. D. 1963. TV transmitter kills in South Bend, Indiana, Fall 1962. Indiana Audubon Quarterly 41(3):49-53.

Source Type (check one): Incidental Report

Peer-reviewed Paper ____
Agency Report ____
Conference Proceedings ____

Other (specify): Popular Press

II. Study Objectives (list)

Document species and number of bird kills.

III. Species

Numbers given by date; no total by tower or period.
WSBT: few kills prior to 1962 tower reconstruction; mostly warblers (mostly fall kills).

WSJV: increased kills; warblers and Swainson's thrushes (mostly fall kills).

IV. Study Methods (briefly list)

Retrieved carcasses, identified species, and recorded bird numbers by date.

V. Duration of Study Fall 1961 and 1962

Duration (provide dates):

Single Year ______________________________
Multiple Years 1961 and 1962

Seasons:

Spring Migration ____ **Both ____**

Fall Migration √ **Yearlong ____**

Primary Reference or New Data Review Sheet (cont'd)

VI. Carcass Search Methods (if applicable)

Search Conditions: Daily ____ Weekly ____ Only after overcast nights with a low ceiling or storm events ____

Other Periods (Describe): not detailed

Search Biases Evaluated, Including Observer Bias and Scavenger Activity? Yes ____ No √

Search Area Described? Yes ____ No √

VII. Analytical and Statistical Methods

Statistical method(s) used: (list)

N/A

Comments:

VIII. Number of Tower Sites: 2 **Proximity:**

WSJV tower: 650 feet = higher number of kills than 350- to 450-foot towers.
WSBT tower: prior to July 1962 = 3 towers 350- to 450-foot along N-S line; July 1962 - 1,074-foot tower constructed. (Unknown if tower replaced or added.)

IX. Behavioral Observations at the Tower: Yes ______ No √
Describe if applicable to statement or conclusion being evaluated.

X. Documentation of Weather Factors? Yes √ No ______
Describe if applicable to statement or conclusion being evaluated.

Some weather conditions reported for 29 Sep 1962, indicating NW winds (tailwinds), precipitation.

XI. Inclusion of Structural and Landscape Conditions? Yes ____ No √
Describe if applicable to statement or conclusion being evaluated.

XII. Brief Description of Results

With NW tailwinds, most carcasses found ≈ 120 yards SE of tower base.
Tower comparisons b/w 1961 and 1962 not clear. However, tower comparison b/w WSJV and WSBT fall of 1962 stated to be significant.
Fall 1962:
WSJV (650-foot) = 23 birds, 4 Sep–25 Nov (≈ 18 species)
WSBT (1,074-foot) = 259 birds, 28 Aug–22 Nov (unknown number of species)

XIII. Need for and Scope of Additional Studies (Only applicable if new data or study is provided.)

Are additional studies identified? Yes ____ No √ If yes explain and list studies.

XIV. Suggested Methods to Minimize Impacts (Only applicable if new data or study is provided.)

Are specific methods identified? Yes____ No √ If yes explain and list specific mitigative methods.

Primary Reference or New Data Review Sheet

I. Citation or Source:

Larkin, R.P. and B.A. Frase. 1988. Circular paths of birds flying near a broadcasting tower in cloud. Journal of Comparative Psychology 102:90-93.

Source Type (check one):

Peer-reviewed Paper √
Agency Report ____
Conference Proceedings ____

Other (specify):

II. Study Objectives (list)

Record bird behavior in proximity to towers relative to flight patterns.

III. Species

Migrating.

IV. Study Methods (briefly list)

Using portable tracking radar 838 m S of tower; recording flight paths (tracks) @ 1-sec intervals to 1-meter resolution.

V. Duration of Study 1 night - 1983

Duration (provide dates):

Single Year 9-10 Sep 1983
Multiple Years ______________________________

Seasons:

Spring Migration ____ **Both** ____

Fall Migration √ **Yearlong** ____

Primary Reference or New Data Review Sheet (cont'd)

VI. Carcass Search Methods (if applicable) N/A

Search Conditions: Daily ____ Weekly ____ Only after overcast nights with a low ceiling or storm events ____

Other Periods (Describe):

Search Biases Evaluated, Including Observer Bias and Scavenger Activity? Yes ____ No √

Search Area Described? Yes ____ No √

VII. Analytical and Statistical Methods N/A

Statistical method(s) used: (list)

N/A

Comments:

VIII. Number of Tower Sites: 1 **Proximity:**

308-meter tower = Michigan.
Guyed; red blinking lights.
Radio transmitting ceases @ 12:30 am (00:30 hours)

IX. Behavioral Observations at the Tower: Yes √ No ______
Describe if applicable to statement or conclusion being evaluated.

Flight paths examined

X. Documentation of Weather Factors? Yes √ No ______
Describe if applicable to statement or conclusion being evaluated.

Overcast; scattered precipitation

Primary Reference or New Data Review Sheet (cont'd)

XI. Inclusion of Structural and Landscape Conditions? Yes ____ No √
Describe if applicable to statement or conclusion being evaluated.

XII. Brief Description of Results

Behavior was "remarkably precise." 10 occasions on 9 Sep, birds flying w/in the clouds circled the tower @ distances of 108 to 279 meters. 5 birds exhibited possible reactions not partial circles. Circling of towers only occurred in region of low clouds @ altitudes below the tower. Could not record behavior/flight patterns near tower due to radar limitations.

Nonlinear flight patterns in proximity to towers during migration (i.e., possible avoidance or attraction).

XIII. Need for and Scope of Additional Studies (Only applicable if new data or study is provided.)

Are additional studies identified? Yes √ No ______ If yes explain and list studies.

Suggests experimental approaches to answering same mortality questions and behavioral patterns of migrating birds.

XIV. Suggested Methods to Minimize Impacts (Only applicable if new data or study is provided.)

Are specific methods identified? Yes____ No √ If yes explain and list specific mitigative methods.

Primary Reference or New Data Review Sheet

I. Citation or Source:

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

Source Type (check one): Study

Peer-reviewed Paper ____
Agency Report ____
Conference Proceedings ____

Other (specify): Popular Press

II. Study Objectives (list)

Document bird mortalities, species, and numbers.

III. Species

121,560 birds through 1994; 123 species.
Species list of most prevalent species documented.

IV. Study Methods (briefly list)

Carcass retrieval/ bird identification. Searches varies (see Section V).

V. Duration of Study 38 years

Duration (provide dates):

Single Year ________________________________
Multiple Years 1957-1995
Prior to 1960 = only mass kills surveyed.
After 1960 = almost daily basis.

Seasons:

Spring Migration ____ **Both ____**

Fall Migration ____ **Yearlong √**

Primary Reference or New Data Review Sheet (cont'd)

VI. Carcass Search Methods (if applicable)

Search Conditions: Daily ____ Weekly ____ Only after overcast nights with a low ceiling or storm events ____

Other Periods (Describe): See Section V.

Search Biases Evaluated, Including Observer Bias and Scavenger Activity? Yes ____ No √

Search Area Described? Yes √ No ______

No scavengers mentioned.

VII. Analytical and Statistical Methods

Statistical method(s) used: (list)

N/A

Comments:

VIII. Number of Tower Sites: 2-3 **Proximity:** Unknown

West/central Wisconsin
Guyed.
1949-1957 = 500-foot
1957 = 1,000-foot alongside 500-foot
1960 = 500-foot tower removed and 2,000-foot tower erected ~40 miles away.

IX. Behavioral Observations at the Tower: Yes ______ No √
Describe if applicable to statement or conclusion being evaluated.

X. Documentation of Weather Factors? Yes ______ No √
Describe if applicable to statement or conclusion being evaluated.

XI. Inclusion of Structural and Landscape Conditions? Yes ____ No √
Describe if applicable to statement or conclusion being evaluated.

XII. Brief Description of Results

Used mortality data to draw population inferences on rare species; species' migration dates, length of migration, etc.
Figures 1 and 2 provide detailed information pertaining to mortalities recorded during migration months.
Table 4 summarizes species that appear to be in decline as they pertain to tower mortalities.

Author lists factors that all contribute to mortality events (i.e., mass kills).

1) Time of year (mid-Aug to mid-Oct and mid-May).
2) Tail winds.
3) Clear weather where and when birds take off that night.
4) Intercepted by weather fronts.
5) If precipitation occurs early in the evening; birds will not take off for nocturnal flights.
6) Towers 400 feet or greater.
7) Ground easily observable for surveyors to find carcasses and determine extent of mortality.
8) The taller the tower the more dispersed the carcasses.

XIII. Need for and Scope of Additional Studies (Only applicable if new data or study is provided.)

Are additional studies identified? Yes √ No ______ If yes explain and list studies.

Recommends experiment w/ mitigation methods.

XIV. Suggested Methods to Minimize Impacts (Only applicable if new data or study is provided.)

Are specific methods identified? Yes √ No ______ If yes explain and list specific mitigative methods.

1. Tower dismantling.
2. No towers over 300 feet.
3. Illuminate towers w/ floodlights.
4. Use moving lights or strobe lights.
5. Fluorescent tape on guy wires to increase wire visibility.
6. Turn off lights @ critical times (problems with FAA regulations).

Primary Reference or New Data Review Sheet

I. Citation or Source:

Johnston, D. W. and T. P. Haines. 1957. Analysis of mass bird mortality in October 1954. Auk 74:447-458.

Source Type (check one): Incidental Report.

Peer-reviewed Paper √
Agency Report ____
Conference Proceedings ____

Other (specify):

II. Study Objectives (list)

N/A

III. Species

Summary of kills reported @ broadcasting/TV towers, airport ceilometers, and tall buildings w/ advancing cold fronts.

IV. Study Methods (briefly list)

N/A

V. Duration of Study 4 days

Duration (provide dates):

Single Year 1954
Multiple Years ______________________________
5-8 Oct 1954; 25 reported kills (25 locations) from NY to S. Atlantic states.

Seasons:

Spring Migration ____ **Both** ____

Fall Migration √ **Yearlong** ____

Primary Reference or New Data Review Sheet (cont'd)

VI. Carcass Search Methods (if applicable)

Search Conditions: Daily ____ Weekly ____ Only after overcast nights with a low ceiling or storm events √

Other Periods (Describe): 4 days

Search Biases Evaluated, Including Observer Bias and Scavenger Activity? Yes ____ No √

Search Area Described? Yes ____ No √

No details provided.

VII. Analytical and Statistical Methods

Statistical method(s) used: (list)

N/A

Comments:

VIII. Number of Tower Sites: 8 **Proximity:**

IX. Behavioral Observations at the Tower: Yes √ No ______
Describe if applicable to statement or conclusion being evaluated.

Within ceilometers (ceiling @ 800 ft), birds fluttering w/in the beam; others on level flight through beam.

X. Documentation of Weather Factors? Yes √ No ______
Describe if applicable to statement or conclusion being evaluated.

Cold front N to S. Precise role of each climatic condition not determined.

XI. Inclusion of Structural and Landscape Conditions? **Yes ____** **No √**
Describe if applicable to statement or conclusion being evaluated.

XII. Brief Description of Results

Total estimated mortalities = 106,804 5-8 Oct @ 25 locations.
5-6 Oct = 2,756 birds/ 61 species @ 5 northern locals.
6-7 Oct = 4, 478 birds/ 51 species @ 10 southern locals.
7-8 Oct = 99,340 birds/68 species @ 11 southernmost locals.
High number of kills reported @ ceilometers (15 incidents).
8 incidents @ communication towers (200-1,060 feet)
Higher number of kills in southern states as compared to northern states.
At Warner Robins AFB, birds flying straight down into ceilometer beam "bouncing off" concrete runway (estimated 50,000 birds killed; 2,552 examined).

Authors present strong argument for light attraction. However, suggested reduced attraction to lights @ communication towers or else a higher number of bird mortalities at the tower sites would have occurred.
Extensive species list = inferring behavior commonalities among species.

XIII. Need for and Scope of Additional Studies (Only applicable if new data or study is provided.)

Are additional studies identified? Yes ____ **No √** **If yes explain and list studies.**

XIV. Suggested Methods to Minimize Impacts (Only applicable if new data or study is provided.)

Are specific methods identified? Yes____ **No √** **If yes explain and list specific mitigative methods.**

Primary Reference or New Data Review Sheet

I. Citation or Source:

Herndon, L.R. 1973. Bird kill on Holston Mountain. Migrant 44(1):1-4.

Source Type (check one): Incidental Report.

Peer-reviewed Paper √
Agency Report ____
Conference Proceedings ____

Other (specify):

II. Study Objectives (list)

Reported 1 night kill @ 4 towers and 2 buildings.

III. Species

WCXB-TV = 402 birds on 1 Oct; 180 on 2 Oct 1972.
Radar Station = 349 bird kills 1 Oct; 850 on 2 Oct 1972.
Total = 1,801 birds, 44 species.
Most all birds found SE of tower (NW wind).
27 of 37 warbler species documented in bird mortalities (73% of state species).

IV. Study Methods (briefly list)

Variety of collection, identification, and reporting techniques.

V. Duration of Study 1 night

Duration (provide dates):

Single Year 30 Sep 1972
Multiple Years ________________________________

(Carcasses retrieved on 1 Oct w/ some additional retrieval on 2 Oct.)

Seasons:

Spring Migration ____ **Both** ____

Fall Migration √ **Yearlong** ____

Primary Reference or New Data Review Sheet (cont'd)

VI. Carcass Search Methods (if applicable)

Search Conditions: Daily ____ Weekly ____ Only after overcast nights with a low ceiling or storm events ____

Other Periods (Describe): See Section V.

Search Biases Evaluated, Including Observer Bias and Scavenger Activity? Yes ____ No √

Search Area Described? Yes ____ No √

VII. Analytical and Statistical Methods

Statistical method(s) used: (list)

N/A

Comments:

VIII. Number of Tower Sites: 2+ **Proximity:**

WCYB-TV = 2 towers; 1 building. One tower = 125 feet (tallest of two towers); guyed.
Elizabethton, TN Floodlights.
On mountain (2) ≈ 85 feet tall; ? guy wires
Domed building = weather radar: WJHL-TV, WKPT-TV (? ht ?)

IX. Behavioral Observations at the Tower: Yes √ No ______
Describe if applicable to statement or conclusion being evaluated.

Same birds hitting building windows, floodlights, and dome on weather radar building.

X. Documentation of Weather Factors? Yes √ No ______
Describe if applicable to statement or conclusion being evaluated.

Airport:
20:00 hours = cloud ceiling = 4,000 feet; NW winds 5 mph, visibility = 15 miles.
22:00 hours = ceiling risen to 5,000 feet.
23:00 hours = clear w/ NW wind @ 8 mph.
Holston Mt = 4,300 feet; fogged in during this period.

Primary Reference or New Data Review Sheet (cont'd)

XI. Inclusion of Structural and Landscape Conditions? Yes ____ No √
Describe if applicable to statement or conclusion being evaluated.

XII. Brief Description of Results

Some mortalities at 22:00 w/ lighted windows of building and floodlights along NE corner of building; 0 mortalities @ NW corner.

30 Sep 1972, annual fall bird counts = poor representation of species (e.g., warblers, ovenbird). Only 21 warbler species (57%) of state's 37 warbler species and 0 ovenbirds seen during the day during the annual bird count. However, that night 27 warbler species (73%) of state's warblers and 303 (17% of kill) ovenbirds were reported bird mortalities at the tower. Additional insight into local migration patterns that were not apparent from annual population surveys.

XIII. Need for and Scope of Additional Studies (Only applicable if new data or study is provided.)

Are additional studies identified? Yes ____ No √ If yes explain and list studies.

XIV. Suggested Methods to Minimize Impacts (Only applicable if new data or study is provided.)

Are specific methods identified? Yes____ No √ If yes explain and list specific mitigative methods.

Primary Reference or New Data Review Sheet

I. Citation or Source:

Gauthreaux, S.A., Jr. and C.G. Belser. 2000. The behavioral responses of migrating birds to different lighting systems on tall towers. Avian mortality at communication towers. Transcripts of Proceedings of the Workshop on Avian Mortality at Communication Towers, August 11, 1999, Cornell University, Ithaca, NY. http://migratorybirds.fws.gov/issues/towers/agenda/html

Source Type (check one): Study.

Peer-reviewed Paper ____
Agency Report ____
Conference Proceedings √

Other (specify):

II. Study Objectives (list)

Determine influences of both red and white lights on the flight and orientation behavior of nocturnally migrating birds.

III. Species

Not listed in abstract.

IV. Study Methods (briefly list)

Compared the number and behavior of nocturnal migrants near strobe-lit radio tower against control site during spring migration. Compared the number and behavior of nocturnal migrants near red-lit TV tower, white strobe-lit TV tower and control site during fall migration.

V. Duration of Study

Duration (provide dates):

Single Year 9 evenings = spring, 14 evenings = fall
Multiple Years ______________________________

Seasons:

Spring Migration √ **Both ____**

Fall Migration √ **Yearlong ____**

Primary Reference or New Data Review Sheet (cont'd)

VI. Carcass Search Methods (if applicable)

Search Conditions: Daily ____ Weekly ____ Only after overcast nights with a low ceiling or storm events ____

Other Periods (Describe): See Section V.

Search Biases Evaluated, Including Observer Bias and Scavenger Activity? Yes ____ No √

Search Area Described? Yes ____ No √

Abstract contained little methodology information.

VII. Analytical and Statistical Methods

Statistical method(s) used: (list)

Unknown.

Comments:

VIII. Number of Tower Sites: 3 ? **Proximity:** Unknown

IX. Behavioral Observations at the Tower: Yes √ No ______
Describe if applicable to statement or conclusion being evaluated.

Number of birds at each site were not significantly different; but proportion of curved, circling, or hovering behavior was significantly higher at red-lit tower than strobe-lit tower and control. Also higher at strobe-lit towers when compared to control site both spring and fall.

X. Documentation of Weather Factors? Yes ______ No ______ Unknown ?
Describe if applicable to statement or conclusion being evaluated.

Primary Reference or New Data Review Sheet (cont'd)

XI. Inclusion of Structural and Landscape Conditions? Yes ____ No ______ Unknown.
Describe if applicable to statement or conclusion being evaluated.

XII. Brief Description of Results

Using an image intensifier, coded flight behavior:

1) linear flight (straight)
2) nonlinear flight (pause-hover, curved, or circling)

Spring = number of birds were not significantly different, but numbers showing nonlinear flight at strobe-lit tower were significantly higher than at control site.
Fall = number of birds were not significantly different b/w white strobe and control site; numbers significantly higher at red light than white strobe or control site; numbers w/ nonlinear flight were significantly higher at red than white strobe towers. White strobe was significantly higher than at control site.

Birds in linear flight were at the tower only briefly and leave area.
Birds w/ curved, circling, or hovering behavior showed increased time at the tower w/ an increase in bird concentrations. Hazards w/ colliding w/ other birds in addition to tower and guy wires.

XIII. Need for and Scope of Additional Studies (Only applicable if new data or study is provided.)

Are additional studies identified? Yes ____ No ______ If yes explain and list studies. .

Unknown.

XIV. Suggested Methods to Minimize Impacts (Only applicable if new data or study is provided.)

Are specific methods identified? Yes____ No ______ If yes explain and list specific mitigative methods.

Unknown.

Primary Reference or New Data Review Sheet

I. Citation or Source:

Elmore, J.B. Jr. and B. Palmer-Ball Jr. 1991. Mortality of migrant birds at two central Kentucky TV towers. Kentucky Warbler 67:67-71.

Source Type (check one): Incidental report.

Peer-reviewed Paper √
Agency Report ____
Conference Proceedings ____

Other (specify):

II. Study Objectives (list)

Sporadically recorded species and number of bird mortalities.

III. Species Studied (list)

72 species.
Mass kills:
WGRB = 8 May 1983 (55 birds/16 species), 14 May 1983 (62 birds/16 species), 11 Oct 1986 (113 birds/35 species), 17 Oct 1990 (1,576+ birds/59 species).
WAVE = 20 Oct 1990 (133 birds/36 species).

IV. Study Methods (briefly list)

Infrequent surveys.

V. Duration of Study WGRB = 8 years WAVE = ?

Duration (provide dates):

Single Year ________________________________
Multiple Years Sporadic
WGRB = 1983-1990
WAVE = ?

Seasons:

Spring Migration ____ **Both** √

Fall Migration ____ **Yearlong** ____

Primary Reference or New Data Review Sheet (cont'd)

VI. Carcass Search Methods (if applicable)

Search Conditions: Daily ____ Weekly ____ Only after overcast nights with a low ceiling or storm events ____

Other Periods (Describe): Sporadic

Search Biases Evaluated, Including Observer Bias and Scavenger Activity? Yes ____ No √

Search Area Described? Yes ____ No √

Brief Description of Area/Tower:

Predator and scavenger activity noted, but not calculated or estimated.

VII. Analytical and Statistical Methods

Statistical method(s) used: (list)

N/A

Comments:

VIII. Number of Tower Sites: 2 **Proximity:** Unknown

1)WGRB – Aclair Co, Kentucky. 1,000 feet; guyed. Lighting?
2)WAVE – Oldham Co, Kentucky. 1,739 feet; guyed.

IX. Behavioral Observations at the Tower: Yes ______ No √
Describe if applicable to statement or conclusion being evaluated.

X. Documentation of Weather Factors? Yes √ No ______
Describe if applicable to statement or conclusion being evaluated.

Many surveys followed inclement weather.

Primary Reference or New Data Review Sheet (cont'd)

XI. Inclusion of Structural and Landscape Conditions? **Yes ____** **No √**
Describe if applicable to statement or conclusion being evaluated.

XII. Brief Description of Results

Detailed species lists and discussion on families affected. Also, see Section III.

XIII. Need for and Scope of Additional Studies (Only applicable if new data or study is provided.)

Are additional studies identified? Yes √ No ______ If yes explain and list studies.

Authors state that further studies on avian collision factors are needed.

XIV. Suggested Methods to Minimize Impacts (Only applicable if new data or study is provided.)

Are specific methods identified? Yes____ No √ If yes explain and list specific mitigative methods.

Primary Reference or New Data Review Sheet

I. Citation or Source:

Crawford, R.L. 1981. Bird casualties at a Leon County, Florida TV tower: a 25-year migration study. Bulletin of Tall Timbers Research Station 22:1-30.

Source Type (check one): Study

Peer-reviewed Paper √
Agency Report ____
Conference Proceedings ____

Other (specify):

II. Study Objectives (list)

Summarized 25 years of studies on avian collisions with communication towers at the Tall Timbers Research Station.

III. Species Studied (list)

Total 42,384 bird mortalities recorded; 189 species.

IV. Study Methods (briefly list)

Daily searches; extensive use of carcasses for scientific research.

V. Duration of Study 25 years

Duration (provide dates):	Seasons:
Single Year ______________________________	**Spring Migration** ____ **Both** ____
Multiple Years 1955-1980	**Fall Migration** ____ **Yearlong** √

Primary Reference or New Data Review Sheet (cont'd)

VI. Carcass Search Methods (if applicable)

Search Conditions: Daily √ Weekly ____ Only after overcast nights with a low ceiling or storm events ____

Other Periods (Describe):

Search Biases Evaluated, Including Observer Bias and Scavenger Activity? Yes √ No ____ Scavenger

Search Area Described? Yes ____ No √

Predator Scavenger removal program implemented. See Crawford and Engstrom, 2001.

VII. Analytical and Statistical Methods

Statistical method(s) used: (list)

N/A

Comments:

VIII. Number of Tower Sites: 1 **Proximity:**

See Crawford and Engstrom, 2001).

IX. Behavioral Observations at the Tower: Yes ______ No √
Describe if applicable to statement or conclusion being evaluated.

X. Documentation of Weather Factors? Yes ______ No √
Describe if applicable to statement or conclusion being evaluated.

Not reported as part of this study summary, but some weather conditions were recorded over the 25-year history.

XI. Inclusion of Structural and Landscape Conditions? Yes √ No ____ **Describe if applicable to statement or conclusion being evaluated.**
35 acres mowed; 4000-acre Lake Iamonia ~1 mile S of tower (waterfowl and water bird accounts).
XII. Brief Description of Results
See Section III and general reference to 25 years of studies.
XIII. Need for and Scope of Additional Studies (Only applicable if new data or study is provided.)
Are additional studies identified? Yes √ No ____ If yes explain and list studies.
Ongoing studies at Tall Timbers Research Station although predator control will not occur.
XIV. Suggested Methods to Minimize Impacts (Only applicable if new data or study is provided.)
Are specific methods identified? Yes____ No √ If yes explain and list specific mitigative methods.

Primary Reference or New Data Review Sheet

I. Citation or Source:

Crawford, R.L. 1981. Bird kills at a lighted man-made structure: often on nights close to a full moon. Am. Birds 35:913-914.

Source Type (check one): Study

Peer-reviewed Paper √
Agency Report ____
Conference Proceedings ____

Other (specify):

II. Study Objectives (list)

Compared mortality data to moon phase.

III. Species Studied (list)

3,223 birds; 57 species.
Mass mortalities see Crawford 1978 summary.

IV. Study Methods (briefly list)

Searches almost daily.
Plotted moon fraction illumination to number of birds killed.

V. Duration of Study 3 years

Duration (provide dates):

Single Year ________________________________
Multiple Years 1973-1975

Seasons:

Spring Migration ____ **Both** ____

Fall Migration ____ **Yearlong** √

Primary Reference or New Data Review Sheet (cont'd)

VI. Carcass Search Methods (if applicable)

Search Conditions: Daily √ **Weekly** ____ **Only after overcast nights with a low ceiling or storm events** ____

Other Periods (Describe):

Search Biases Evaluated, Including Observer Bias and Scavenger Activity? Yes √ **No** ____ Scavenger

Search Area Described? Yes ____ **No** √

Predator Scavenger removal program implemented. See Crawford and Engstrom, 2001.

VII. Analytical and Statistical Methods

Statistical method(s) used: (list)

Regression; Chi-squared tests.

Comments:

VIII. Number of Tower Sites: 1 **Proximity:**

1,008-foot tower (see Crawford and Engstrom, 2001).

IX. Behavioral Observations at the Tower: Yes ______ **No** √
Describe if applicable to statement or conclusion being evaluated.

X. Documentation of Weather Factors? Yes ______ **No** √
Describe if applicable to statement or conclusion being evaluated.

Yes = study; no = summary.

Primary Reference or New Data Review Sheet (cont'd)

XI. Inclusion of Structural and Landscape Conditions? Yes ____ No √ **Describe if applicable to statement or conclusion being evaluated.**
XII. Brief Description of Results
States that moon phase is not related to avian kills. Weather patterns and migration numbers appear to be more relevant.
XIII. Need for and Scope of Additional Studies (Only applicable if new data or study is provided.)
Are additional studies identified? Yes ____ No √ If yes explain and list studies.
XIV. Suggested Methods to Minimize Impacts (Only applicable if new data or study is provided.)
Are specific methods identified? Yes____ No √ If yes explain and list specific mitigative methods.

Primary Reference or New Data Review Sheet

I. Citation or Source:

Taylor, W.K. and B.H. Anderson. 1973. Nocturnal migrants killed at a south central Florida TV tower, autumn 1969-1971. Wilson Bulletin 85(1):42-51.

Source Type (check one): Study.

Peer-reviewed Paper √
Agency Report ____
Conference Proceedings ____

Other (specify):

II. Study Objectives (list)

To record number of birds and species killed @ tower site.

III. Species

7,782 birds; 82 species
Mass Mortalities:
29 Sep 1970 (1,592) (37 species)
30 Sep 1970 (859) (31 species)

IV. Study Methods (briefly list)

Early a.m. searches; with large kills = night into morning.

V. Duration of Study 3 years

Duration (provide dates):	**Seasons:**	
Single Year ________________________________	**Spring Migration** ____	**Both** ____
Multiple Years 1969-1971	**Fall Migration** √	**Yearlong** ____

Primary Reference or New Data Review Sheet (cont'd)

VI. Carcass Search Methods (if applicable)

Search Conditions: Daily ____ Weekly ____ Only after overcast nights with a low ceiling or storm events ____

Other Periods (Describe): See Section V.

Search Biases Evaluated, Including Observer Bias and Scavenger Activity? Yes ____ No √

Search Area Described? Yes √ No ____

Survey area limited to 1 acre.

VII. Analytical and Statistical Methods

Statistical method(s) used: (list)

N/A

Comments:

VIII. Number of Tower Sites: 1 **Proximity:**

WDBO in central Florida.
1,484 feet; guyed; red steady and flashing.

IX. Behavioral Observations at the Tower: Yes √ No ______
Describe if applicable to statement or conclusion being evaluated.

On 10-11 Sep 1969, collisions began @ 23:00 hours and continued until dawn. Chirps and calls were continuous. Rapid, erratic flights, many birds hit buildings, cars, ground, and lower part of tower.
At day break: live birds crouched in open areas; many injured and/or exhausted.

X. Documentation of Weather Factors? Yes √ No ______
Describe if applicable to statement or conclusion being evaluated.

Local weather station @ Herndon Airport used.
Large kills associated w/ cold fronts and inclement weather.
A few mortalities recorded on clear nights.

Primary Reference or New Data Review Sheet (cont'd)

XI. Inclusion of Structural and Landscape Conditions? Yes ____ No √ **Describe if applicable to statement or conclusion being evaluated.**
XII. Brief Description of Results
Detailed species lists.
XIII. Need for and Scope of Additional Studies (Only applicable if new data or study is provided.)
Are additional studies identified? Yes ____ No √ If yes explain and list studies.
XIV. Suggested Methods to Minimize Impacts (Only applicable if new data or study is provided.)
Are specific methods identified? Yes____ No √ If yes explain and list specific mitigative methods.

Primary Reference or New Data Review Sheet

I. Citation or Source:

Tordoff, H. B. and R.M. Mengel. 1956. Studies of birds killed in nocturnal migration. University Kansas Museum Natural History Publication 10:1-44.

Source Type (check one):

Peer-reviewed Paper √
Agency Report ____
Conference Proceedings ____

Other (specify):

II. Study Objectives (list)

Analysis of migratory birds killed fall of 1954 @ TV tower.
Some aspects of migration also recorded.

III. Species

1,090 birds; 61 species.

IV. Study Methods (briefly list)

Not detailed.

V. Duration of Study 1 season

Duration (provide dates):	**Seasons:**	
Single Year 1954	**Spring Migration** ____	**Both** ____
Multiple Years ________________	**Fall Migration** √	**Yearlong** ____

VI. Carcass Search Methods (if applicable)

Search Conditions: Daily ____ Weekly ____ Only after overcast nights with a low ceiling or storm events √

Other Periods (Describe):

Search Biases Evaluated, Including Observer Bias and Scavenger Activity? Yes √ No ____

Search Area Described? Yes ____ No √

Predator removal noted.

VII. Analytical and Statistical Methods

Statistical method(s) used: (list)

Used for sex/age comparisons.

Comments:

VIII. Number of Tower Sites: 1 **Proximity:**

WIBW – TV tower 1 mile west of Topeka, Kansas.
950-foot;guyed; red steady and flashing.

IX. Behavioral Observations at the Tower: Yes ______ No √
Describe if applicable to statement or conclusion being evaluated.

X. Documentation of Weather Factors? Yes √ No ______
Describe if applicable to statement or conclusion being evaluated.

All major kills = cloudy/foggy nights w/ frontal systems; however, some kills occurred on fairly clear nights.
Cloud ceiling typically as low as 800 to 1,000 feet.

Primary Reference or New Data Review Sheet (cont'd)

XI. Inclusion of Structural and Landscape Conditions? Yes ____ No √
Describe if applicable to statement or conclusion being evaluated.

XII. Brief Description of Results

Mortality reports provided data on birds' origination (e.g., most birds came from Central Flyway, nothing west of Great Plains). Computed numbers of migrants flying over, assuming uniform distribution, 1-mile-wide and 500-foot-high (450 to 950 feet). Compared to 950-foot tower to 500-foot radio tower ~ 24 mile east. Towers had same weather reported, but distinctly different mortality numbers. An increased number of mortalities at 950-foot tower, whereas 500-foot numbers were lower. Given this difference and location of birds near base of tower, the authors infer that most of the birds were flying >450 feet above the ground. Detailed species list.

XIII. Need for and Scope of Additional Studies (Only applicable if new data or study is provided.)

Are additional studies identified? Yes √ No ______ If yes explain and list studies.

Need additional studies on bird flight patterns > 450 feet above ground.

XIV. Suggested Methods to Minimize Impacts (Only applicable if new data or study is provided.)

Are specific methods identified? Yes____ No √ If yes explain and list specific mitigative methods.