

**Avian Collision Study Plan for the Michigan Public Safety  
Communications System (MPSCS): Assessing the Role of Lighting,  
Height, and Guy Wires in Avian Mortality Associated with Wireless  
Communications and Broadcast Towers**

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Revised and Pilot Study Added August 2003

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**This project is underwritten by the State of Michigan  
Department of State Police, and  
Department of Information Technology**

## Introduction

This is a proposal for a study of avian collisions at communications towers, underwritten by the State of Michigan, Departments of State Police and Information Technology. It was originally designed and approved in December of 2002 by Paul Kerlinger, Ph.D. of Curry and Kerlinger, as representative of the State of Michigan, and Albert Manville, Ph.D. of the United States Fish and Wildlife Service, Division of Migratory Bird Management, and Chair, Communication Tower Working Group. The proposal was then reviewed by two professional biologists who were recruited and recommended by The Ornithological Council, a private organization that maintains a database of qualified ornithologists willing to provide scientific review of avian research projects.

In the summer of 2003, management and implementation of the study was turned over to principal researcher Joelle Gehring, Ph.D. (pending), with Central Michigan University. Thereafter, Paul Kerlinger and Albert Manville became additional reviewers of the study proposal. At the suggestion of the two anonymous reviewers, the study plan was revised. The first step in that revision was a decision to perform a pilot study to be conducted in autumn 2003. The pilot study is more fully described in Attachment A attached hereto, and incorporated into this Avian Collision Study Plan. The pilot study will focus on determining optimal sample sizes and other aspects of design as suggested by the reviewers. The main study will then be further revised taking into account the findings of the pilot study and reviewer input. Implementation of the main study is scheduled to begin in spring 2004.

## Background

For more than 50 years, fatalities of night migrating birds, primarily songbirds, have been documented at communications towers in the United States. Research into these tower kills has often been anecdotal, with studies of varying intensity and different designs being used over the years. Little in the way of standardization or control has occurred, with a few notable exceptions, with respect to search methods, research design, duration of study, observer efficiency, or even the reporting of tower height or lighting. Thus, it is difficult to compare the studies and make definitive statements about how to reduce risk. However, some things have been gleaned from the more than 150 studies that have been conducted at communications towers since the late 1940s. Scientists now believe that there are many factors that determine the degree of risk (numbers of fatalities) to night migrating birds at communications towers. These factors include lighting, the presence of guy wires, tower height, geographic location of towers in relation to migration concentration/corridor areas, topography (ridges, coastlines, etc.), habitat (wetlands vs. upland, grassland vs. forest), and possibly some others.

Probably the most important factors in determining the degree of risk at communications towers are lighting (towers with lights are riskier than towers without lights and towers with some lighting types are riskier than other lighting types), height of the tower (tall towers are hypothesized to be riskier than short towers), and guy wires (towers with guy wires are hypothesized to be riskier than unguyed towers). However, it is difficult to separate the relative importance of these factors because the study of these factors is complex and logistically

difficult. Thus, to tease apart the roles of these factors, a study must be designed such that the most important factors or variables can be tested under controlled or managed situations.

### Proposal and Scope of Work

The following proposal and scope of work will be the first attempt to determine the relative importance of what are generally believed to be the three key factors (independent variables) involved in avian collisions with communications towers. These factors include lighting, the presence of guy wires, and height. The study will be conducted primarily using a portion of 179 towers that comprise the MPSCS (Table 1). These towers range in height from less than 100 feet to 485 feet, with a majority (151 or 84.4%) between 350- 485 feet Above Ground Level (AGL). In addition to the MPSCS towers, 3 towers in excess of 800 feet will be included to better test the role of tower height. The inclusion of these tall towers will facilitate a comparison of towers less than 500 feet in height with towers greater than 800 feet AGL. A secondary hypothesis that towers closer to lakeshores (coastlines) are riskier than towers farther inland, will also be tested by including 8 towers within 5 miles of the shore of the Great Lakes. In addition, 2 towers from the Upper Peninsula (9003 and another to be determined) will be included to compare fatalities in the Upper Peninsula with the Lower Peninsula. The inclusion of these towers were added as a means of specifically answering questions posed by National Wildlife Federation and others about towers in the Upper Peninsula and near lakeshores. Mortality studies/monitoring will be conducted at all towers examined in this study and monitoring will be done simultaneously at all towers studied.

#### Summary of hypotheses to be tested.

- $H_0$  – No difference between red strobes, white strobes, and blinking red incandescent lights
  - $H_1$  – Red incandescents are riskier than red strobes are riskier than white strobes
- $H_0$  – No difference between guyed and unguyed towers
  - $H_2$  – Guyed towers are riskier than unguyed towers
- $H_0$  – No difference between towers of different heights
  - $H_3$  – Taller towers are riskier than shorter towers
- $H_0$  – No difference between towers near shorelines and towers farther away
  - $H_4$  – Towers closer to lake shores are riskier than inland towers

(The alternative hypotheses are derived primarily from current belief among biologists on the Communication Tower Working Group and correspond closely to the U.S. Fish and Wildlife Service [USFWS] guidelines.)

Quantitative Determinations. In addition to determining the relative importance of the three factors, an effort will be made to determine fatality rates at each of the towers studied. Such rates will help in estimating overall fatalities from towers like those tested over larger geographic and political areas. Such determinations may be used for estimating and evaluating cumulative effects of tower collisions on avian populations.

Significance of the Study. The significance of determining the relative roles of lighting, height, and guy wires should be obvious. Future tower construction and permitting should hopefully result in the reduction of fatalities. In addition, some towers may be retrofitted to reduce fatalities and a prioritization of towers that need retrofitting can also be determined. The results of this study will also facilitate the identification of the most problematic towers.

Table 1. Summary of tower height and guy wire status for Michigan Public Safety Communications System. E-1 lighting includes a medium intensity top flashing red strobe at night with sets of steady-on red side lights. E-2 lighting includes a medium intensity top flashing red strobe at night with a second set of red strobes at ½ way up the tower and 2 sets of 3 steady-on red lights (at ¼ and ¾ heights).

| Tower Height | Number of Towers | Guy Wires | Number Lit - Type   |
|--------------|------------------|-----------|---------------------|
| 30-199 feet  | 9                | 1 guyed   | 1 – E-1             |
| 200-299 feet | 12               | 4 guyed   | 12 – E-1            |
| 300-399 feet | 14               | 7 guyed   | 7 – E-1, 7 – E2     |
| 400-499 feet | 141              | 108 guyed | 141 – E-2           |
| Totals*      | 176              | 120 guyed | 20 – E-1, 148 – E-2 |

\*Totals do not add up to the 179 towers in the system because several towers are on buildings and cannot be considered for study.

Design/Methodology. The research methodology to be used is a modified matched-pairs/repeated measures design. The dependent variable in this research will be the number of carcasses found. Each morning of observation will represent a single sample. Towers are considered replicates. Towers will be matched in a manner that permits statistical evaluation of the independent variables of interest. The independent variables include:

- Height of Tower – 2 categories (350-499 feet vs. >800 feet)
- Guy Wires – presence vs. absence
- Lighting – red incandescent vs. red strobe vs. white strobe
- Location in relation to lakeshore (within 1-5 miles vs. >5 miles)

Table 2. Summary of tower height, guy wires, and lighting to be used for evaluating the role of the three independent variables.

| Tower Height Class | Guy Wires Red Strobes   | Unguyed Red Strobes | Guy Wires White Strobes* | Guy Wires Red Incandescents* | No Guy Wires Red Incandescents* |
|--------------------|---|---------------------|--------------------------|------------------------------|---------------------------------|
| 350-485'           | 3   | 3                   | 3                        | 3                            | 3                               |
| 350-485'           | 2 guyed, red strobe lit towers from the Upper Peninsula   |                     |                          |                              |                                 |
| >800'              | 3 Towers with Guy Wires and Red Incandescent Blinking Lights (traditionally associated with large-scale mortality) – non-MPSCS towers |                     |                          |                              |                                 |

\*Acquiring Federal Aviation Administration (FAA) permission to change lighting from red strobes at night to white strobes and red incandescents is the responsibility of the USFWS.

A total of 17 MPSCS towers from Table 1 plus 3 non-MPSCS towers will be included in this study (see Table 2). Ideally, the two of the three towers in excess of 800 feet (Table 2) should be those studied by Caldwell and Cuthbert in 1963 and Caldwell and Wallace in 1966. These towers are 1,295 and 1,130 feet AGL in height, respectively. A third tower will be chosen. The rationale for including the two towers studied previously is they are known to present a high risk to night migrating birds and comparisons can be made between the numbers killed in the 1960s and in the proposed study. Permission to study these towers must be obtained prior to study initiation. The original data sets would also be requested from the researchers. Inclusion of these tall towers would provide an estimate of the relative risk of the MPSCS and other towers with the same characteristics as the MPSCS towers.

All towers will be searched on the same mornings to insure that nightly and seasonal variation in migration intensity is controlled. Migration intensity varies dramatically from night to night in a particular geographic area. By having all towers searched on the same mornings, it is likely that the day-to-day variation in migration (based on weather and seasonality) will be reduced or controlled for.

To insure that migration intensity is controlled (relatively similar), all towers in the study, with two exceptions (#9003 and another to be determined), will be in the Lower Peninsula. Eight of the fifteen 350-485' towers in the first row of Table 2 will be within 5 miles (all greater than 1 mile because no towers are closer to the lake shores) of the shores of Lake Huron and Lake Michigan.

Fatality searches will begin 30 minutes before sunrise and last for approximately one hour – until the complete search area has been assessed, thereby commencing before diurnal scavengers like crows, gulls, and ravens have a chance to remove carcasses.

Towers will be searched out to a distance/radius that is equal to the height of the tower and the complete area within this circle will be searched. Thus, the search area for taller towers will necessarily be larger. Search patterns will be concentric circles starting at 10 m from the tower base. Each concentric circle will be at 10 m intervals, to be marked with stakes along a transect out from the tower. Therefore, the search area will include the area out 5 m either side (the midway point between concentric circles) from the searcher. This will facilitate the searching of the entire area under the tower. On every fourth survey, a transect 15 m wide will be searched out to a distance of 1.5 times the height of the tower. The direction of that transect will be selected randomly. These transects are being included to determine whether collisions result in carcasses being found at distances greater than the height of the tower from the tower base. Previous researchers have found that most fatalities land within the range of the guy wires.

Data to be recorded will include: species, number of individuals, tower number, date, distance bird carcass found from the tower, distance from guy wires bird carcass found (to nearest point on the ground beneath wires) if present, condition of carcass (fresh, or more than 3 days old, scavenged, parts consumed, carcass intact, broken leg[s], signs of blunt trauma, broken neck, broken wing[s], etc.).

All tower search areas will be “cleaned” prior to fatality searches. This “cleaning” is to remove any existing carcasses.

All dead birds will be bagged, given an acquisition number, tower number, date, technician name, and retained at a location to be determined.

Both USFWS migratory bird and Michigan Department of Natural Resources permits will be required (for main permit and for designates/sub-permittees).

Observer Efficiency and Carcass Removal. Two factors are known to influence whether or not carcasses are found at communications towers after fatalities have occurred. These factors influence the numbers of fatalities reported and, therefore, the dependent variable in these studies. To attempt to account for this variability, scavenging and observer efficiency rate studies will be part of the present study. Marked, tagged carcasses of nonmigratory birds will be used in these studies. Once scavenging and efficiency rates are determined, they can be used to determine the actual number of fatalities that likely occurred based on these rates and the numbers of carcasses found by searchers. The protocol for observer efficiency and carcass removal studies will be based on previously used, scientifically peer-reviewed methods.

Constraints and Caveats. It should be remembered that this project is not intended to resolve all issues regarding the communications tower-bird collision issue. Although the MPSCS includes 179 towers that are available for study, the tallest is slightly less than 500 feet and lighting is already established, although some short-term changes (retrofitting with red blinking

incandescent lights and white strobes) should be possible with cooperation from the FAA with the assistance from USFWS.

The major constraint in this study is that the towers involved are largely limited to those in the MPSCS, although the present study design includes 3 taller towers if such towers can be located and necessary cooperation obtained. It would be of value to include these taller towers, but this may be difficult because access to towers owned by others may involve logistical complications such as additional permits and access agreements, and owners of tall towers may be reluctant to participate in a study that may show their towers may have a greater impact. However, if three >800 foot AGL towers can be located, the USFWS and the Federal Communications Commission will work with the tower owner(s) to garner their cooperation. The MPSCS towers also do not include any red incandescent blinking nor white strobe lights, the color and type of incandescent lighting that is now the dominant lighting on towers in the United States and the color and type associated with a large proportion of fatalities at communications towers. To resolve this issue six MPSCS will be retrofitted with red incandescent blinking lights and three MPSCS with white strobe lighting, if permitted by the FAA. FAA approval for lighting changes are the responsibility of the USFWS. This study will not include lighting changes without approval from the FAA. Efforts will be made to seek such approval well before the study is to commence to permit sufficient time to retrofit towers.

Weather during the 78 nights (Table 3) previous to the morning carcass searches should include ample nights with the type of inclement weather that has been demonstrated to cause large-scale or catastrophic mortality events. A total of 24 nights (6 per season) of such weather will be targeted for inclusion. These weather situations include low or complete cloud cover (total obscuration), light rain, fog or snow flurries that occur at least between 2000 and 0200 hours on the night previous to the morning on which fatality searches occur.

Table 3. Seasonal timing and number of carcass surveys during spring and autumn 2003 and 2004. Spring carcass surveys would be conducted in May and autumn surveys would be conducted between September 5 and October 20. The seasonal distribution of nights to be surveyed within a given migration season will be determined after consultation with an expert on seasonal timing of migration in Michigan and with a weather expert.

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Spring 2004 Sample Size. 17 mornings of searches at each tower  
Autumn 2004 Sample Size. 22 mornings of searches at each tower

Spring 2005 Sample Size. 17 mornings of searches at each tower  
Autumn 2005 Sample Size. 22 mornings of searches at each tower

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Total 78 searches during two years (4 migration seasons)

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Logistics. To conduct this project a total of about 20 technicians will be needed, as well as a technician/supervisor. Each of the technicians should reside within a 15-30 minute drive of one of the subject tower sites. Each will be assigned 1 tower to search for the season. Random assignment of towers to technicians is not possible here because of the distance among towers selected for this study. Each tower technician will be required to put in  $\pm 3$  hours (depending on driving time) on 34 days of spring migration and 44 days of fall migration.

Principal Investigator. The drafters agreed that a principal investigator would be recruited and enlisted in the project. An ideal candidate was described as a recent Ph.D. or M.S. graduate of a recognized graduate program with management skills and field research experience. Joelle Gehring, a graduate student at Purdue University was selected as the Principal Investigator in the late spring of 2003. She has completed her dissertation and coursework and is scheduled to defend her dissertation in September of 2003. She will be responsible for the design and implementation of the study, including recruiting the tower technicians, training those technicians, collecting and curating the data from the technicians, keeping track of weather conditions, etc. as well as analyzing the data and writing reports. Gehring has been granted adjunct faculty status at Central Michigan University Biology Department and resides near Midland, Michigan.

Acknowledgements. Ellen Paul, Executive Director of the Ornithological Council, suggested an outside review of this proposal and subsequent revisions, as a means of providing scientific validity and integrity. Ms. Paul recommended two reviewers who have reviewed this proposal and suggested changes. One result of this review has been the development of the pilot study summarized in Exhibit A at the end of this proposal. Following completion of the pilot study, these reviewers, together with reviewers Paul Kerlinger and Albert Manville, will review the final study plan as further provided in the Pilot Study Plan, attached hereto as Attachment A.



**Table 3. Estimated Budget for Conducting Tower Fatality Research – 2 years (total)**

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|  |             |
|--|-------------|
| Select Towers and Prepare Sites (choose, screen, flag, visit,<br>find field tech)  | \$ 8,000    |
| Field Technicians<br>22 technicians<br>3 hours per day (1-2 hours searching, 0.5-1.0 hour in transit, etc.)<br>78 mornings of searches<br><u>\$20 per hour</u> | \$102,960   |
| Technician Supervisor  | \$25,000    |
| Travel and other Expenses Costs for Technicians and Researchers  | \$24,000    |
| Data Analysis and Report (Presentation at Meetings)  | \$19,000    |
| Cost of lighting, and modifying and installing white strobe and blinking red<br>incandescent lighting  | \$~20,000   |
| <hr/>  |             |
| Total  | \$ 198,960* |

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\* The total includes the cost of retrofitting 6 MPSCS towers with red incandescent blinking lights and 3 towers with white strobe lights. Contribution of such lighting will also be sought from lighting companies. Installation of lighting will be accomplished by the MPSCS.

This budget is a rough estimate based on assumptions that may or may not be realistic. A more definitive budget will be prepared following evaluation of the design/methodology proposed in this document and recruitment of the Field Supervisor.

Attachment A.

**Pilot Study for the Avian Collision Study Plan: Quantifying Avian Mortality  
Associated with the Michigan Public Safety Communications System  
(MPSCS)**

**Joelle Gehring  
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In response to the suggestions of the two anonymous peer reviewers from the Ornithological Council, the Avian Collision Study described in that certain plan originally dated December 23, 2002<sup>1</sup> will be augmented to include a pilot study to begin September 15, 2003. The addition of this pilot study will push back the start date of the main study by approximately 8 months, and increase the projected cost of the entire study, including the pilot, by an estimated \$20 to 30,000.

The principal researcher and reviewers believe that the implementation of this pilot study is necessary to address questions raised by the reviewers about the sample size for the main study and the statistical validity of the results that might be gained therefrom. The pilot study will provide preliminary data on the numbers of birds colliding with towers and allow the main study to estimate data variance, determine statistical power of the proposed analyses, explore methods of economically increasing the main study's sample size of towers sampled. The pilot study will also provide an opportunity to field-test research methods planned for use in the spring 2004 field season.

The researchers and reviewers recognize, however, that the duration of this pilot study will not encompass the complete migration period of night-migrating songbirds. It is possible we may not sample the migration of some songbird species or some portions of a species population.

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<sup>1</sup> The full name of December 23, 2002 plan was "Avian Collision Study Plan for the Michigan Public Safety Communications System (MPSCS): Assessing the Role of Lighting, Height, and Guy Wires in Avian Mortality Associated with Wireless Communications and Broadcast Towers." The researchers identified on that proposal were Paul Kerlinger, Ph.D., in collaboration with Albert Manville, Ph.D. Herein, the September 11, 2003 Avian Collision Study of which this pilot is now a part, directed by principal investigator Joelle Gehring, Ph.D. (pending), with reviewers Paul Kerlinger, Ph. D., Albert Manville, Ph. D is referred to as "the main study." The main study and pilot study together is referred to as the "combined study."

According to regional bird migration biologists, Dr. Mic Hamas, Dr. Robert Smith, Dr. Larry Caldwell, and Mr. Chris Schumacher, fall songbird migration takes place between August 1<sup>st</sup> and November 1<sup>st</sup>, with the peak of migration typically occurring in middle to late September.

Although the complete 2-year study design will consider studying longer periods of the migration seasons, considering the recommendations of the Ornithological Council reviewers, the pilot project is designed for a 20 day period during peak fall migration in Michigan for a number of bird species. The timing of the pilot study also seeks to maximize the utility of available funding and personnel..

In general, the principal investigator and the reviewers believe that the addition of the pilot study will provide the tools and information necessary to address the questions raised by the reviewers and change the sample size or other design criteria of the main study, as may appear necessary, with more confidence, and for the minimum necessary cost.

The following text is an outline of what is being proposed for the pilot study.

- A sub-sample of 6 communications towers, three guyed and three unguyed, will be methodically searched during the fall bird migration period with the assistance of trained volunteers. Carcass searches will be conducted on 20 mornings during the fall migration season at each tower selected, with an effort to include a variety of weather conditions. To minimize potential bias, volunteer technicians will each sample the same tower throughout the study period. These samples will provide estimates of data variance, and the statistical validity of our analyses. A power analysis will assist in making a more accurate estimate of the required sample size of communications towers needed to draw meaningful conclusions from this research. The subsample of towers will be representative of the guy wire patterns proposed for study in the original study plan: the 6 towers will be between 350 and 475 feet in height, and will all exhibit the identical standard lighting scheme for the towers in the MPSCS (see table 1 in the main study). Although lighting will be a component of the main study, the potentially different effects on birds from various lights or lighting schemes will not be addressed in the pilot study.
- These preliminary data will also allow the principal investigator to calculate the number of search days needed at towers in the main study as well as the required frequency of search days (e.g., every day or once a week, etc.). Both of these variables will provide

valuable information that could assist in increasing the sample size of communications towers in the study by altering the search methodology, but without increasing the number of technicians.

- It is expected that bird carcasses will be removed from tower locations by scavengers (e.g. coyotes, owls, corvids, cats, etc.). Scavenging rates at towers will be estimated using pre-placed bird carcasses (e.g., domestic chicks). In a similar manner, we will test the trained volunteer observers' efficiency in finding pre-placed bird carcasses. We will also explore other methods of determining the presence of mammalian scavengers in search areas, such as recording tracks at scent stations by employing a 4-foot diameter circle of bare sand with a mild scent placed in the center. We will include measures of scavenging rates and observer bias rates in the final study plan as well.
- The pilot study will also be investigating the utility of NEXRAD weather radar as a method of quantifying the numbers of birds migrating over the towers on the nights previous to searches. Although typically used for weather prediction, this Doppler radar technology has recently been used to quantify large-scale bird movements. It is hoped that this will provide a quantitative measure of the migration rates at each tower and therefore provide a relative estimate of the numbers of birds killed at each site.
- Preliminary data will be statistically analyzed to identify significant differences in the number of bird collisions among guyed and unguyed towers and allow further refinement of statistical analyses and data collection procedures. A biometrician will be consulted for assistance with this process.

The effects from adding the pilot study to the main study are estimated to include the following:

1. The start of the main study will be delayed by an estimated 7-8 months, to the spring of 2004.
2. The estimated time for completion of the combined study will be extended beyond that planned for the main study by approximately 7-8 months, ending in the fall of 2005.
3. With the addition of the pilot study, the cost of the combined study, if the main study is completed through four migration

seasons as originally planned, will be increase by an estimated \$20,000 to \$30,000.

The principal investigator, reviewers, and others involved with the development of this study understand that the State of Michigan's cash contribution to the combined study is fixed at no more than \$200,000, its other non-cash contributions are strictly limited to those outlined in the Avian Collision Study Plan. The financing to cover the additional costs that will be needed to complete the combined study as planned and budgeted will need to be secured from some source other than the State of Michigan. If such additional funding is not obtained, and the study design is executed as planned, the main study may have to be terminated after the spring migration season of 2005, or when the \$200,000 funding runs out.

#### Additional Funding

It is the desire and intention of the principal investigator and the reviewers' principals that additional funding be obtained to cover the costs of this pilot study, and any other components that may be determined to be desirable additions to the main study, such as a NEXRAD radar component or other possible components, in addition to the \$200,000 committed by the State of Michigan. For this purpose, the principal investigator will approach and seek funds from all reasonably accessible potential funding sources, including the National Fish and Wildlife Foundation and the National Science Foundation, among other similar organizations or interested individuals. Ellen Paul of the Ornithological Council has committed to assist this effort. The Federal Communications Commission ("FCC"), the USFWS and the State of Michigan Departments of State Police and Information Technology, have each committed to use their best efforts to cooperate with, facilitate, and provide such assistance to this effort as these agencies are able to provide under applicable law.

#### Reviewers and Use of the Pilot Study to Develop the Main Study

The reviewers for both the pilot study and the main study will be as follows: (1) Al Manville, Ph.D., of the USFWS, Division of Migratory Bird Management, and Chair, Communication Tower Working Group, and Steve Lewis, of the Division of Migratory Bird Management, as representatives of the USFWS; (2) Paul Kerlinger, Ph.D., of Curry and Kerlinger, and Mary Levine, Contract Administrator for the State of Michigan, as representatives of the State of

Michigan; and (3) the two reviewers identified by The Ornithological Council who have been participating as reviewers on this project. The State of Michigan, USFWS and Ornithological Council may each replace their own representative reviewer(s) upon notice and providing contact information to the other two entities.

After the conclusion of the pilot study, the principal investigator will compile the results and prepare a brief written analysis and report (the "pilot report"). The pilot report will be distributed to the reviewers by December 1, 2003. The reviewers may see any underlying data from the pilot study as they request. Reviewers will submit comments to the principal investigator, with copies to the other reviewers, by January 9, 2004. Reply comments will be submitted by January 23, 2004. The reviewers will treat the contents of the pilot report and any supporting data confidentially to the extent allowed by the Freedom of Information Act (FOIA) and Federal Privacy Act. The reviewers may share the pilot report and any supporting data with other employees of or counsel to the USFWS, the FCC or the State of Michigan.

The principal investigator may share the pilot report, other subsequent reports, and any supporting data, with other qualified scientists, and consult with such persons, as well as with the reviewers, as she deems appropriate. The principal investigator may consult with the reviewers and other consultants, individually or in groups, to discuss the pilot report or its supporting data, the pilot study itself, or any aspect of the main study, and she may convene meetings or conference calls for this purpose as she may deem convenient and expedient. The reviewers may consult with each other, with persons with whom the principal investigator is consulting as they desire, and with the principal investigator on request. The principal investigator will keep the reviewers informed of all major decisions and developments regarding the study.

The principal investigator will use the results of the pilot study to alter or amend as may be prudent and reasonable, and finalize the design of the main study, taking into account the goals of the study as set forth above, the comments and suggestions of the reviewers and consultants, and the costs, budget and reasonably certain and committed funds available for each of the four seasons of the planned study. The principal investigator will circulate a revised main study plan to the reviewers no later than February 25, 2004. Reviewers may submit comments on the revised main study up until March 10, 2004.

The spring 2004 element of the main study will start on or before April 20, 2004.

Subsequent Seasons of the Main Study

The principal investigator will prepare a similar report after the conclusion of each of the three seasonal elements of the main study, in spring and fall of 2004, and in spring of 2005. The reviewers will thereafter be given a reasonable opportunity to see the results of the previous study, comment thereon, consult with each other and with the principal investigator, and make suggestions for revisions of the remaining seasonal elements of the main study, on such reasonable schedule as the principal investigator will establish.

Authority of the Principal Investigator

In case of a dispute or disagreement among the reviewers or consultants on any aspect of the pilot study, or any element of the main study, the principal investigator has full authority to make all final determinations, to side with one opinion against one or several others, to combine some elements of different opinions, or to reject all proffered opinions and develop others, as she deems fit, in the interest of developing the most scientifically fair, reasonable, valid and proper study seeking to achieve the goals outlined in the Study Plan above.

Release of the Main Study

Upon conclusion of the main study in the spring of 2005, the principal investigator will prepare the final study. The principal investigator will distribute a proposed draft of the final study to the reviewers, giving them a specified time and reasonable opportunity to comment thereon. After receiving the comments of the reviewers, the principal investigator will release the final study to the reviewers, the FCC, the State of Michigan and the USFWS, any of whom may release or distribute the final study as they see fit, with appropriate acknowledgement of the roles of the principal investigator, underwriter and the original drafters and reviewers Manville and Kerlinger.

**Time Line for the Combined Study (through the beginning of the main study)**

|                                       |                             |
|---------------------------------------|-----------------------------|
| 1. Start of Pilot Study               | September 15, 2003          |
| 2. Pilot Study Report due             | December 1, 2003            |
| 3. Comments due on Pilot Study        | January 9, 2004             |
| 4. Reply comments due on Pilot Study  | January 23, 2004            |
| 5. Circulation of revised Main Study  | February 25, 2004           |
| 6. Comments due on Revised Main Study | March 10, 2004              |
| 7. Main Study begins                  | On or before April 20, 2004 |