# Cities are Killing Birds, How to Save Our Winged Friends & Lower Your OpEx

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DS 201: Unit 14 Research Design Final Report

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## OVERVIEW

Nearly one billion birds die from building collisions in the US every year, and according to the US Fish & Wildlife Service most of these fatalities are due to light pollution and windows[(1)]. Birds do not see glass as a barrier, and therefore do not avoid it. They collide with glass when they see natural reflections, and are attracted to interior lights as well. It is imperative that we preserve the bird population – birds are vital to our ecosystem, eating insects that would otherwise destroy our vegetation, as well helping to keep rodent populations in check in major cities.

In this study, we will explain how certain conservation techniques, such as being conscious about light pollution and environmentally-friendly light fixtures, can lead to a reduction in bird fatalities. Prioritizing bird conservation efforts also provides tangible cost savings for buildings. According to the US Energy Information Administration, lighting is the second largest proponent of a commercial building's energy costs, behind HVAC (Heating, Ventilation, and Air Conditioning). For example, New York City has approximately 540 million square feet of rentable office space as of 2022, which implies up to $1 billion in total energy costs annually[(2)]. We believe light reduction in the evenings alone could save up to 10% in energy costs, which would result in $100 million in total cost savings for New York City commercial real estate building managers. The broader impact is significantly higher when including residential building managers, as well as expanding the calculation across all US cities. Through our conscious conservation efforts to minimize bird fatalities the anticipated impact is clear: we will save the lives of millions of birds, while also saving millions of dollars in building expenses.

Our intended audience for this research design consists of building managers that operate mid- to high-rise buildings in major US cities, bird conservation groups, such as the American Bird Conservancy, and city government officials. We are targeting building managers given their responsibility in managing the operating expenses associated with energy usage, as well as bird conservation groups that can work with government officials to encourage laws that help reduce bird collisions.

Our goal is to measure the causal relationship between conscious conservation efforts and the number of bird fatalities in American cities, while doing so in an ethical manner. Considering one of the most significant causes of bird crashings is due to light pollution, this is the condition we will control for in our experimental study. Our study will take place over one year, covering both the spring and fall bird migration seasons. While we do expect bird fatalities to occur over the course of our study, we do not anticipate the level of fatalities will go beyond any historical pattern, given we are treating to reduce fatalities. We do not intend to cause more fatalities

through our experimental design. We believe this is a proper ethical framework given the ultimate goal of this study is to support long-term change with bird conservation efforts.

**RESEARCH QUESTION**

Will reduction of light pollution in US Metropolitan Statistical Areas decrease building collision bird fatalities?

- Collect data from before and after 'Lights Out' programs go into effect
- US Metropolitan Statistical Areas, or MSAs (387 across the United States)
- How do the various MSAs differ?
- Which MSA's dimming seems to be most/least effective? Why?
    - How will dimming be defined?
- Seasonal variations, weather, migration patterns?

Definitions:

- Weather patterns: Temperature and environmental condition changes in weather throughout the calendar year
- Migration: The relocation of birds due to these weather patterns
- Bird fatalities: The number of bird deaths due to building collisions
- Light pollution: Human-made alteration of outdoor light levels from those occurring naturally
- US Metropolitan Statistical Areas (MSA): A group of geographic entities with a central urbanized area of at least 50,000 people, and adjacent counties, cities, or towns that have economic ties with the primary area[3].

**STUDY DESIGN**

Considering bird collisions are most prevalent during their two migration periods, spring and fall, our study will span an entire calendar year and encompass both migrations. Observing both migrations will provide sufficient evidence to help answer our research question.

Our sampling frame for this study will be United States Metropolitan Statistical Areas, or MSAs. As an example, New York City's MSA consists of the five boroughs of New York, Jersey City, and Newark. Our sampling methodology will include all 387 officially recognized MSAs.

Considering MSAs have a significant number of differing characteristics, such as building density, zoning laws, geographic locations, and climates, we will utilize stratified random sampling for our experimental treatment and control groups. This will ensure our groups have proportional representation of MSAs that vary in makeup. We will work with a highly recognized consultant group with connections to city government officials in order to ensure cooperation with our treatment conditions throughout our study.

**Control**: For MSAs in the control group, cities and buildings will function per their normal operation and routine. We will not apply any of our conservation efforts to MSAs in the control group.

**Treatment**: In order to test the efficacy of our conservation efforts, more than one treatment group will be necessary. Through several treatment groups, we will determine if there is any particular effort, or combination of efforts, that reduce bird fatalities the most.

- Baseline treatment – according to DarkSky, the simplest solution to reduce light pollution and protect wildlife is to utilize warm-colored LED light bulbs. MSAs in this sample group will be directed to convert to warm-colored LED light bulbs, both outdoor street lighting as well as interior building lights[4].
- Enhanced treatment – those in the enhanced treatment group will convert light bulbs just as the Baseline group, but will take a number of additional steps to reduce light pollution further:
    - Interior lighting in empty office buildings will be completely turned off during evening hours
    - Shields will be added to outdoor lighting fixtures to minimize glare
    - Dimmers, motion sensors, and timers will be installed where necessary to avoid lights when not in use

To measure the effectiveness of our conditions, we will measure bird fatality at the MSA level. Measuring at the MSA level rather than singular city level will provide us with greater observational stability – if instead we compared bird fatalities at the city level, for example Manhattan versus Brooklyn, treatment of one city could influence the other given the close proximity. Additionally, we will measure bird fatality on a weekly basis during each migration season. This will allow us to collect time series data and understand potential fluctuations or patterns over time.

**DATA**

To date, there is no officially published data source that tracks bird collisions and fatalities. Therefore, we will use previous literature and crowd-sourced resources to assist in executing our study design. When conducting our experiment, we will collect new data about bird collisions within our treatment and control groups.

Previous crowd-sourced data includes resources such as the Global Bird Collision Mapper and dBird as data collection methods for bird collisions[5,6]. Research also highlights areas with high exposure of lights to birds during migration seasons [7]. Data from these sources will help ensure our samples have a wide representation of MSAs that birds travel through.

To collect data of bird collisions throughout the treatment we will need the following:

- Type of Treatment (Baseline / Enhanced)
- Date & Time
- MSA & location specifics

- MSA characteristics including building density, zoning laws, geographic locations, and climates

Furthermore, weather data will help us understand confounding factors throughout seasonal variations. Migration pattern data of birds across North America will also help us understand when to best conduct the experiment.

- Weather data from the National Weather Service[8]
- Bird Migration Data from birdcast.info[9]

By combining these datasets over peak migration seasons and actively collecting collision data post treatment, we should be able to identify if changing light patterns on buildings will have an effect on bird collision.

**SAMPLE**

The goal of our sampling is to ensure we include numerous MSAs with diverse characteristics and lighting conditions to represent the broader population of American cities. We will attempt to minimize biases, account for confounding factors, and have valid comparisons between the treatment and control groups.

- The inclusion criteria for the treatment locations will be all 387 MSAs listed in the US.
- The exclusion criteria are locations that are not identified as MSAs.

To split our treatment and control groups, we will use stratified random sampling to ensure that we have representative coverage of MSAs that are within high and low volume bird traffic areas, along with diverse MSA characteristics. We will gather data of all bird collisions in these MSAs.

**HYPOTHESIS**

**Null**: If US Metropolitan Statistical Areas decrease their light pollution output over the course of one calendar year, then a consequential reduction in bird fatalities attributed to building collisions is not anticipated.

**Alternative**: If US Metropolitan Statistical Areas decrease their light pollution output over the course of one calendar year, then a consequential reduction in bird fatalities attributed to building collisions is anticipated.

**VARIABLES / INTERVENTION**

To test the effect of treatment on reducing bird collision in MSAs, here are the following operationalized variables we need to measure and analyze:

For the treatment condition:

- Light pollution output on an MSA level via satellite imagery
- Geo-mapping of MSA points to identify treatment areas
- Office building data to ensure treatment

The outcome variables we are measuring include:

- Bird collision rates will be found by counting the number of bird collisions per MSA
- Location and time of the bird collision spotted
- Species of birds to identify if certain species or population densities are more affected by our interventions

Confounding variables:

- Environmental factors such as weather throughout the months as it might impact bird migration patterns
- MSA characteristics, such as building density, zoning laws, geographic locations, and climates to ensure fair sampling

## STATISTICAL METHODS

We will use conventional statistical methods to compare bird fatality rates in MSAs that have been treated versus controlled. As indicated in the Study Design, observations will be collected on a weekly basis over the course of both the spring and fall migration seasons. To answer our research question, we will collect the number of bird fatalities in each MSA, and then employ a t-test to compare how our treatment and control conditions affected the underlying samples. T-tests are designed to compare the means of different groups – in our case utilizing a t-test will allow us to understand if our treatment conditions had an effect on the treatment group when comparing it to the control group.

It will be important to consider the differing characteristics of MSAs, such as urban sprawl, zoning laws, geographic locations, and climates, when performing our statistical analysis. These characteristics may influence bird fatality rates, and are important to take into account when comparing our groups during a t-test. Lastly, we realize that city government bodies and building managers will be a factor as these are the actors responsible for following our treatment conditions. We recognize that we will not be able to obtain complete compliance from all the MSAs in the treatment group, and that this may affect our final results. This is something we hope to address stronger in the future, during a second iteration of this experimental study.

## POTENTIAL RISKS

Below are the potential risks of our research design:

**Stakeholders expectations:** Our intended audience contains three different groups of people with very different outcomes for our study:

- **Buy-in from building managers:** Persuading building managers at scale within the treatment group of cities to apply bird conservation techniques, which include converting light fixtures and installing light timers. It is possible we could receive pushback from these individuals given the additional expense.
- **City officials and lobbyists:** If our research design does not provide a compelling call to action, it may be difficult to encourage laws or protocols to prevent bird fatalities.
- **Bird conservationists:** We may not receive support from bird advocacy groups if our experiment is not conducted ethically. If we take measures that can possibly cause birds harm, we run the risk of alienating the bird conservationist community.

**Weather:** Weather is a leading cause of bird fatalities given that rain, low visibility, and other climate factors make it difficult for birds to travel. Our results could be skewed if we endure abnormal weather patterns throughout our study.

**Migration patterns:** Our research design is based on the assumption that migration patterns will remain the same throughout our experiment. However, climate change continues to impact our environment and this in turn has an impact on all animals. If bird migration patterns change during our experiment, then the data collected could be invalid or corrupt.

**Data issues:** There is not a central reliable data source that has tracked bird collisions and deaths historically. While we may encounter incomplete or a lack of robust data, we do not expect to encounter any data security issues that could arise from bird collision tracking. We have identified several organizations, researchers, and conservation groups that have attempted to gather this data; however, each group has not tracked this data at scale holistically across the US. Therefore, we do run into the risk of having incomplete or unstable data to base our findings and determine our conclusions.

## DELIVERABLES

For our experimental design, we are aiming to observe both the spring and fall bird migration seasons in a single year. Therefore, our study will span the course of twelve months.

**January - February**

- Data collection, and perform our sampling strategy to create our control and treatment groups
- Set expectations with our recognized consultancy group who will get us in contact with city government officials
- Organize meetings with city government officials as well as building managers. Ensure they understand their responsibilities and expectations. This will require time, coordination, and expenses to retrofit the many buildings in anticipation of applying our bird conservation techniques
- Finalize application of treatment conditions for MSAs in both the baseline and enhancement treatment groups

**March - November**

- Migration seasons: conduct weekly observations and collect bird fatality data
- Continue coordination with city governments and building managers, as different needs or questions may arise
- Prepare weekly updates throughout the migration seasons to engage these stakeholders. These updates will mention any significant changes in the data, and highlight any weather challenges that may be impacting our results.

**November - December**

- Organize and analyze our results
- Prepare deliverable: a written report with tables of relevant data, helpful visualizations, and digestible commentary. This report will highlight changes in the data and any challenges that may be impacting our results.
- Present our findings by mid-December to our intended audience. Mid-december deadline is important:

- Presenting to city officials and building managers before the new year will assist in legislation and budget planning.
- Articulating our results to the bird conservation community to ensure maximum advocacy and journalistic reporting ahead of the next migration period.

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## STATEMENTS OF CONTRIBUTION

**Paul Choi**: My contribution to this final report was researching and writing the Overview, Potential Risks, and Deliverables section. I helped coordinate our check-in meeting with Professor Conor and began the slides. My experience working with my group was very positive given each person contributed equally to the final report, presentation, and video recording. If I had to do this over again, I'd spend more time researching other ways to add to our experimental design given the uniqueness of the project focused on bird preservation.

**Nicholas Lin**: My contribution to this project was doing the research and the writeup for the Data, Sample, and Variable sections. Overall, the group did a great job of working together and helping each other refine our respective sections. If I had to do this again, I would spend more time looking through the comments about the challenges during the project pitching to ensure we covered more areas of concern.

**Sameer Karim**: My contribution included thoroughly researching the question, sub-questions, and hypothesis. These sections ensured that our research project had a reachable, yet challenging goal. Using various research design methods, we were able to compile a cohesive proposal. Peer feedback improved each part of our design, showing the strength of our diverse group. I would improve our draft by comparing it to more past, proven research designs. As some of these projects used elements to improve the presentability, such as easy-to-read visuals and tables. This would help us in communicating our proposal effectively.

**Yoni Nackash**: My primary contribution to this project was the Study Design and Statistical methods sections. I feel our team worked very well and efficiently together – we were able to combine our assigned work into one cohesive narrative, and provide clear and concise feedback to each other on how to make each section stronger. In the future, it might be beneficial to discuss each section in a little bit more detail as a group before separating and focusing on our own sections. This will ensure each member has the same general understanding and direction of the project in mind.

## REFERENCES


[1] US Fish & Wildlife Conservation: Threats to Birds: Collisions-Buildings & Glass
[2] https://www.statista.com/statistics/605882/size-of-office-area-manhattan-by-submarket/
[3] https://www.census.gov/programs-surveys/metro-micro/about.html
[4] https://darksky.org/resources/what-is-light-pollution/light-pollution-solutions/
[2] NPR: Big Cities, Bright Lights And Up To 1 Billion Bird Collisions
[5] https://www.birdmapper.org/
[6] https://dbird.org/
[7] https://www-jstor-org.libproxy.berkeley.edu/stable/26674998?sid=primo&seq=5
[8] https://www.weather.gov/
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