1-1-2002

Summary Report on the Bird Friendly Building Program: Effect of Light Reduction on Collision of Migratory Birds.

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Effect of Light Reduction on Collision of Migratory Birds.

Special Report for the Fatal Light Awareness Program (FLAP)

by

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January, 2002

Fatal Light Awareness Program

FLAP

The following organizations and companies have supported the work of the Fatal Light Awareness Program, which led to the publication of this report:

Helen McCrea Peacock Foundation

Toronto Atmospheric Fund

The Ontario Trillium Foundation
La Fondation Trillium de l'Ontario

British Airways

TD Friends of the Environment Foundation

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Executive Summary

Most migratory songbirds are nocturnal migrants, which makes them vulnerable to collision with lighted structures they encounter along their flight path during migration. The Fatal Light Awareness Program (FLAP) was formed by a group of concerned citizens to rescue and relocate disoriented birds trapped in the city centre, and to record the number and species of birds killed due to collision. Following the initiation of the Bird Friendly Building (BFB) Program by FLAP and World Wildlife Fund Canada in 1997, light emissions at 16 buildings in the downtown core of Toronto were also monitored during migration seasons. This report summarizes data on birds and light emissions collected from 1997 to spring 2001. This data provides evidence that:

- the number of fatal bird collisions increases with increasing light emissions
- the number of birds entrapped by particular buildings rises with increasing light emissions
- the BFB has been successful in reducing light emissions
- weather is the most important factor influencing collision risk
- nights of heavy cloud cover and/or nights with precipitation are the conditions most likely to result in high numbers of collisions.

A survey of building managers involved in the BFB program revealed that tenant education programs about bird collisions had increased awareness of the problem. Managers found that most tenants were willing to participate in the BFB, which they saw as a "green" initiative that had a positive environmental impact. Many buildings had installed or re-programmed automated light systems that reduced the number of night-time hours that lights were left on. Several buildings that had limited success in reducing light levels between 1997 and fall 2001 have recently installed automated timer systems that should dramatically improve their light emission reductions in the future. In general, the BFB represents a win-win situation for property managers because reducing the period of time that lights are on not only reduces bird mortality but also results in substantial cost savings due to reduced energy consumption. An estimated $3.2 million could be saved if all of the 16 monitored buildings employed the night-time light emission reductions already in place at several of the BFB sites. Such a reduction in power consumption would result in an estimated reduction of 38,400 tons of CO_2-emissions from fossil-fuel burning energy sources. The BFB therefore contributes locally to a reduction in bird mortality, and globally to a reduction in carbon dioxide emissions, thus reducing the production of greenhouse gases that lead to global climate change.

Introduction:

In recent years, scientists have raised the alarm that many birds species are undergoing population declines, and attributed these declines to factors such as habitat loss, house cats, environmental toxins, oil spills, electrocution, and disease (e.g. Erickson et al., 2001). Any additional sources of mortality, which may add to these threats, are therefore cause for concern. Most migratory songbirds are nocturnal migrants, which makes them vulnerable to collision with lighted structures they encounter along their flight path, particularly when inclement weather forces birds to migrate at low elevations. In addition to mortality directly caused by collision, the apparent entrapment of birds at artificial light sources results in exhaustion, disorientation, and increased risk of incurring secondary injuries. The problem of collisions of nocturnally migrating birds with Toronto's tall buildings has been recognized for three decades, and concern for this issue spawned the creation of the Fatal Light Awareness Program (FLAP) in 1993. FLAP and World Wildlife Fund Canada produced a comprehensive report on this issue (Evans Ogden, 1996), and for a detailed background on the subject of building collisions, bird migration behaviour, light entrapment, and the history of the problem in Toronto, the reader is referred to this report, entitled "*Collision Course: The Hazards of Lighted Structures and Windows to Migrating Birds*."

The recommendations of this earlier report were used to launch FLAP's *Bird Friendly Building* (BFB) Program in 1997, with the goal of the program to reduce light emissions, and ultimately reduce the mortality of birds due to nocturnal collisions with lit buildings. This program initially involved establishing contact with building managers in Toronto's downtown core, and educating building managers and tenants about the issue. Subsequently, formal agreements were made between FLAP and building managers. When managers agreed to take steps to reduce light emissions, FLAP formally designated such structures as "Bird Friendly Buildings." To determine the effectiveness of the BFB program in reducing light emissions during migration seasons, FLAP has monitored light emissions from 16 core area buildings since 1997. Concurrent with light emission monitoring, FLAP has continued its tireless efforts throughout spring and fall migration seasons to collect dead birds, care for injured birds, and re-locate uninjured birds to natural areas outside of the city centre, while recording data on all birds collected or captured. The purpose of this report is to summarize the progress of the BFB program thus far, to interpret trends in the bird collision data with reference to light emissions and weather, and to make recommendations to ensure and enhance the continued success of this program.

Specifically, this report will summarize an analysis of:

(1) Data on the relationship between light emissions and the likelihood of bird collisions over all years, and looking specifically at spring 2001;
(2) Data on changes in quantity of light emissions since BFB's inception;
(3) Data on the relationship between weather and the likelihood of bird collisions;
(4) Data on which species are particularly at risk of collision;
(5) A survey of responses by building managers to questions about how light emissions were reduced, (or why they were not), what effects the BFB program had on its tenants, and where data was available, how much energy and/or money was saved as a result of reduced light emissions;
(6) Additional benefits of the program such as cost savings and CO_2 emission reductions.

The continued operation of the *Bird Friendly Building Program* will also be discussed in relation to expected and current trends, such as building retrofit incentives, lighting laws, building security issues, West Nile Virus, and the Canadian Endangered Species Act.

Methods

I. Bird collision data

During migration seasons, FLAP volunteers patrol Toronto's downtown core anywhere between midnight and 9:30 am to capture live birds and collect the dead ones. Volunteers capture live birds using nylon nets, placing them immediately in paper bags to minimize stress and provide a safe means for transport. All birds are identified by species if possible (a small number of birds are recorded as species unknown, but included in total numbers). The location of each bird with respect to the nearest building is also recorded. Uninjured birds are relocated to more suitable habitat outside the city, and released. Two to three volunteers collect and rescue birds on any given night. The same route is used on each night to ensure that all affected birds are retrieved before dawn, in order to minimize scavenging and hunting of birds by predators (gulls, etc), and to minimize disturbance and stress to birds caused by the early morning arrival of office workers. While the total number of nights of volunteer activity varies between seasons and between years, the search effort on each individual night is assumed to be constant (i.e. fewer volunteers search for a longer time period, or many volunteers search for a shorter time period, with either scenario resulting in the maximum possible number of birds retrieved). This assumption allows us to directly compare seasonal and annual values for average number of birds killed and found alive per night. Data from the fall and spring of 1997-2000, and from spring 2001 were used in the analyses. The distributions of average numbers of birds killed and average numbers of birds found alive per night were not normally distributed[1], and were log transformed for standard univariate and stepwise multivariate linear regression analyses. Data from the five nights in spring 2001 when both light emission and bird numbers were recorded was converted to presence/absence data (0 = no birds, 1 = at least 1 bird found) for use in logistic regression analyses. Statistical analyses were performed using the Statistical Analysis System (SAS Institute, Inc., 2000).

Light emission data

Light emission levels during migration seasons were recorded for 16 buildings in the downtown core of Toronto beginning in 1997. The managers of each of the buildings had previously joined FLAP's *BFB* program. Light emission was quantified by taking digital photographs of buildings at night. Eight to ten times per migration season (with dates randomly selected), a digital photograph was taken of one side of each building. The same building side was photographed on all subsequent dates. In the first years of light emission data collection, all four sides of each building were photographed. All sides were determined to have equal percentage light emissions, so in subsequent years only one side of each building was photographed, and assumed to represent all sides of the structure. Photographs were taken between 4:30 and 5:45 am. From the photographs, a count was made of the total number of lighted windows visible. The percentage of windows lit was calculated as the number of lit

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[1] A normal distribution is a statistical term that refers to a frequency distribution of data points around the mean (average), which resembles a bell-shaped curve. Many statistical tests require that data be normally distributed, and log transformation is used in this case to transform the data into a distribution that is more normal than the raw data.

windows divided by the total number of visible windows. A seasonal average for each building was then calculated. Because buildings varied greatly in size (see Figure 1), light percentage values were corrected for the size of the building by multiplying the proportion of light emitted by the number of floors of the building, giving a "light index" value. For example, a building 10 stories high with 10% of windows lit emits significantly less overall light than a building 100 stories high with 10% of windows lit (i.e. 10 x 10% is equivalent to 1 floor of windows lit, while 100 x 10% is equivalent to 10 floors of windows lit). This light index was therefore used to represent total light emission in analyses of the effect of light on bird collisions. Data from spring and fall of 1997-2000, and from the spring of 2001 were used in light emission analyses. For analyses combining all years or multiple seasons, average light index values were computed. For analyses of 2001 data, light emission raw data was used from all dates on which it was quantified concurrently with bird numbers: March 22, April 6, 9, 12, 16 and 30. A logistic regression was used to determine whether buildings with higher light output had a greater likelihood of killing or entrapping birds.

The operating hypothesis underlying FLAP's work has been that light emissions are the main cause of bird collisions. However this hypothesis has not hitherto been scientifically tested. One alternative hypothesis would be that the number of collisions is simply a function of the height of the building, with taller buildings providing a greater surface area for collision, regardless of the amount of light emitted. This alternative hypothesis was therefore tested by examining the relationship between the number of floors of each building versus the number of birds killed or found alive at each building.

Weather data

Weather data on daily minimum and maximum temperatures, daily precipitation, hourly cloud amounts, wind speed, and wind direction for the spring and fall migration periods were obtained from Environment Canada. Cloud data was obtained at Vancouver airport, wind data was obtained from a weather monitoring station on Toronto Island, and temperature and precipitation data were obtained from a weather station located near the University of Toronto. All stations are presumed to closely reflect the weather conditions that migrating birds would have experienced in the vicinity of Toronto's downtown core. To perform statistical analyses that included both light emission data and weather data, seasonal weather indices were calculated. To standardize the period of time over which weather was considered to influence migration, spring migration was considered to be March 1 to June 30, and fall migration from August 1 to November 30. This closely paralleled the period of time that FLAP volunteers monitored birds and light emission in each year (mid-March to early June in spring, and mid-August to early November in fall). The seasonal weather indices calculated represented the summation of weather effects over the entire spring or fall season. Seasonal indices for rainfall, precipitation, cloud amounts, and wind speed were calculated as the sum of the daily averages for each parameter over the entire season. Warmth-sum values represent the sum of minimum and maximum average daily temperatures over the entire season. This parameter is considered an ecologically relevant measure of ambient temperature, and has been used in previous studies on the effects of weather on birds (e.g. Perrins & McCleery, 1989).

Building Manager Survey

Phone interviews were conducted with building managers. Each manager was asked to comment on:

(1) how building management accomplished reductions in light emissions,
(2) if unsuccessful in reducing light emission levels, the explanation for this,
(3) the effect that participation in the BFB program had had (positive or negative),
(4) the energy and cost saving if light emissions were reduced,
(5) any recommendations for improving the BFB program in future.

Interviews were completed with 15 of the 16 buildings for which light levels have been monitored. The representative from the Merrill Lynch tower did not respond to repeated attempts at contact for an interview.

Results:

Influence of light emissions on bird collisions

Before examining the effect of light emission on collision rates, we examined building height (Figure 1) as an alternative explanation for the number of birds killed or found alive over the entire period from 1997-2001. Building height, measured in terms of the number of floors, was indeed correlated with the number of birds killed and found alive, explaining nearly 5% of the variance in numbers of birds killed ($r^2 = 0.049$, $F = 7.36$, = $p = 0.0075$), and explaining over 6% of the variance in the number of birds found alive ($r^2 = 0.064$, $F = 9.62$, $p = 0.0023$)[2]. However, when building height and light emission (referred to hereafter as light index) were both taken into account simultaneously (using a stepwise multiple regression analysis), the influence of building height was no longer significant, and light emission was the most significant factor in explaining the number of bird collisions (birds killed: $r^2 = 0.075$, $F = 11.36$, $p = 0.0010$; birds found alive: $r^2 = 0.080$, $F = 12.21$, $p = 0.0006$).

As illustrated in Figures 1 and 2 examining data for the spring of 2001, the tallest buildings are not necessarily those emitting the most light. For example, Canada Trust is the fourth tallest building, yet it had the 5th lowest index for light emissions in spring 2001. Conversely, the Sun Life of Canada Tower is the second shortest building, but had the 6th highest light emission index in spring 2001. Figures 3 to 7 illustrate the proportion of bird deaths occurring at each monitored building during each year in which complete data was available for both migration seasons (1997-2000).

The effect of light emissions on the numbers of birds killed and found alive was investigated in all fall data, all spring data, and in fall and spring combined for all years. In spring, both the number of birds killed and the number of birds found alive were significantly correlated with light emissions (Figure 8 & 9). As the light index increased, the number of birds

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[2] In regression analyses, which look at the relationship between one or more independent variables (predictors) and a dependent variable, r^2 refers to the amount of variance in the dependent variable explained by one or more of the predictors. The percentage of the variance that the predictor variable explains is equal to $r^2 \times 100$. Variance is a measure of the amount of variability, and indicates how much the scores deviate from the average (or mean) values. The p value is the statistical value that indicates the significance of the finding. If $p \leq 0.05$, the slope of the relationship between the variables is considered statistically significant, meaning that it can be considered different from zero (i.e. there is a relationship between the variables). F values are a standard statistical value reported for regression analysis (Miles and Shevlin, 2001). Values for p in a stepwise multiple regression are considered significant if $p \leq 0.15$.

killed or found alive showed a corresponding increase. In fall, the number of birds found alive was significantly correlated with building light indices (Fig. 11), showing the same relationship as in spring data, but this trend was not significant for the number of birds killed (Fig. 10). However, combining spring and fall data for all years, we see a significant positive correlation between light emissions and the number of birds killed or found alive (Figures 12 & 13).

2001 data

The results from the logistic regression indicate that over the five dates in spring 2001 on which light emissions and bird kills were recorded concurrently, bird deaths were significantly more likely to occur at buildings with higher light emissions (Figure 20) (Wald statistic = 4.93, p = 0.026 level, model predicted 61.5% of the responses correctly). Similarly, there was a greater likelihood of finding birds alive at buildings emitting greater amounts of light (Figure 21) (Wald statistic = 5.97, p = 0.015, model predicts 68% of the responses correctly).

Changes in light levels since the inception of the BFB program

An important question for FLAP is whether the BFB Program has successfully reduced overall light emissions since the program's inception. Figures 14 and 15 show the annual light indices for the years 1997 through 2000 for fall, and for the years 1997 through 2001 for spring. These figures show that there has been a marginally significant reduction in light emissions from buildings in fall from 1997 through 2000 ($r^2 = 0.060$, $F = 3.92$, $p = 0.052$). However there has been no statistically significant reduction in light emissions from buildings in spring during the 5 years since 1997 ($r^2 = 0.017$, $F = 1.36$, $p = 0.25$). Nevertheless, combining spring and fall for all years (Figure 16), there has indeed been a statistically significant reduction in light emission at the 16 buildings monitored ($r^2 = 0.037$, $F = 5.37$, $p = 0.022$). Error bars on graph represent standard deviations from the average light emission.

Influence of weather

Weather factors have been reported in a number of studies to have a profound influence on the number of bird collisions during migration (e.g. Verheijen, 1981; Aldrich et. al., 1966). The relationship between seasonal weather patterns and the number of bird collisions was examined, while also taking light emission into account as an additional factor in the analysis. Using a multiple regression to examine the relative importance of temperature, rainfall, wind, cloud cover, and light index, total cloud cover was found to be the most important variable predicting the number of bird deaths, followed by total rainfall (Figures 17 and 18). Total cloud cover alone explained 43% of the variance in bird mortality, rainfall alone explained 21% of the variance, and cloud and rainfall together explained 64% of the variance in bird deaths. Light index was not a significant factor in predicting bird mortality when these two weather variables were taken into account. Examining the number of birds found alive versus weather factors, wind was the most important factor. Wind explained 44% of the variance in numbers of birds found alive.

Species-specific risk of collision

Trends are quite consistent between years in terms of which species represent the greatest proportion of total kills. In the years 1997-2000, combining both migration seasons, White throated sparrows (*Zonotrichia albicollis*) and Ovenbirds (*Seiurus aurocapillus*) consistently represented the top two species as proportions of the total birds killed. Common Yellowthroats

(*Geothlypis trichas*), Brown Creepers (*Certhia americana*), and Hermit Thrushes (*Catharus guttatus*) were also reported each year as amongst the top ten kills for species. As reported previously (Evans Ogden, 1996), banding data from Toronto Island suggests that these numbers do not simply reflect a greater preponderance of these species flying through the area, but apparently result from a species-specific propensity for collision. Why do some species appear to be more vulnerable than others to collision? At the present time, insufficient research has been done on species differences in reaction to artificial light during migration, and it is too early to speculate as to why these species-specific trends are seen. This is clearly a much-needed area of research for future studies. Nevertheless, the fact that some species are at greater risk of collision should be taken into account when making risk assessments for particular species in the listing process for endangered species.

Building manager survey

Building managers responded to questions about how light emissions were reduced, (or why they were not), what effects the BFB program had on its tenants, and when data was made available, how much energy and/or money was saved as a result of reduced light emissions. The following summarizes the input from the 15 building managers that responded.

Light reduction strategies and other bird-friendly measures

Managers cited a variety of mechanisms by which light emissions had been reduced. A key initiative in most buildings (at least 12 of 15) is a tenant-awareness program encouraging selective use of lights, and involves a mail-drop of memorandums to tenants twice each year, and/or posting of reminders in the building lobbies just before each migration season. At least two buildings (BW & CT) also send email reminders to tenants to tell them when migration seasons have begun. One manager (RB) commented that light reduction information had been written into the tenant manual. Bay Wellington Tower had issued its security staff with bird identification books and gave staff instructions on how to deal with dead or injured birds. If buildings did not send out specific information on light reduction during migration, tenants were reminded of bird friendly building practices in the building management's quarterly newsletter (RA).

At least 10 of the buildings had computer-controlled systems in place which automatically switched off lights at pre-programmed times. Four of the towers (CP, TD, RT, MT) that did not have a coordinated switch-off of lights during the period of data reported here (1997-spring 2001) have a new computer-automated light switch system that went into operation on November 19, 2001. In buildings where lights are switched off by a timer, tenants working after regular business hours must contact building management or security in order to switch on lights in specific areas of the building. At least three of the buildings had instructed tenants (ATT, SLC) to close window blinds when working after dark, or had instructed cleaners (CC) to switch off lights when cleaning work was completed. Two buildings (ATT, SLC) had implemented a staggered switch-on of lights in the morning. Instead of switching on lights for the entire building simultaneously, lights were switched on floor by floor, resulting in a gradual rather than instant light-up of the building.

Several buildings were particularly progressive in pursuing unique methods of reducing light emissions and bird collisions. Motion-sensitive lighting is being used at Simcoe Place after 5p.m. Measures to reduce day-time window strikes by birds have been introduced at Metro Hall, where adhesive material (originally designed for applying stripes on vehicles) has been applied to windows (externally) in patterns that visually break up the large windows (8m / 25ft tall) on the lower floors into smaller parts. The shopping centre in Simcoe Place has installed speakers on the building roof that broadcast six different bird distress calls. This technique is presumed to give birds an early warning of an obstruction close by, and allows them to avoid collision. While this technique is an excellent idea in theory, it should be noted that this system has not been experimentally tested for this specific use, and testing is recommended before widespread deployment of similar systems on other buildings. Testing is particularly important in light of the fact that some species of birds respond to distress calls by flying towards the source of the call, rather than away from it (Haase, 1998).

Challenges

Several towers have experienced difficulty in reducing light emissions. The Toronto Dominion Tower is the most notable of these cases, and in the fall of 2000 light emissions at this tower exceeded all of FLAP's previous records for this building, reaching 60% of windows lit, the highest percentage emissions of any building monitored since 1997. The TD management explained that while tenant education has been put into place, the reasons for these high levels of light emissions were a lack of technology with which to control the lights, and that large numbers of tenants in this building work after hours. The promising news for this building, as well as the Canadian Pacific tower, the Royal Trust Tower, and Maritime Life tower, is that the lighting system in these four buildings has recently been upgraded, and automated lighting using the new technology went into operation on November 19, 2001. This new system will switch lights off at 9p.m., compared with the previous switch-off time of midnight. Amongst the 16 monitored, all four of these buildings have had relatively high light emissions, and thus this new system should have a dramatic positive impact in reducing light emission indices for these buildings.

The Sun Life Tower, where a sudden jump in light emissions was seen in the spring of 2001 compared with previous years (up to 38% from the previous year's 19%), explained that this building had had a change in property management in the summer of 2001, and prior to that the building was without property management for a period of time. The memos that had previously informed tenants about migration periods and light reduction were not sent out during this period. The new management suspects that lack of management and then lack of reminders during this period of transition probably explains the anomalous result for the spring of 2001.

Effects of the program on managers, staff, and tenants

The majority (14/15) of managers responded that the BFB had had only positive or neutral effects on building management, staff, and tenants, and only one building (RA), responded that the program "took some getting used to," and initially was met with some reluctance. In general, managers commented that tenants were becoming increasingly aware of environmental issues, and were thus enthusiastic and receptive about participating in the BFB program as a positive "green" initiative. From the perspective of building managers, reduced light emission as a result of the BFB was cited by many as being "a win-win situation", since reduction in light emission resulted in reduced power consumption and ultimately decreased operating costs.

Energy, cost and CO_2 reductions

Building managers were asked to comment on whether energy and cost savings had resulted from participation in the BFB program, and were asked to provide specific details on these savings. Many of the building managers had not kept a record of cost savings, did not have access to this data, or were reluctant or not permitted to divulge this information, considered to be confidential tenant information. However, three buildings (MH, RB, SLT) were able to provide specific details, and an additional four made general comments about savings.

Seven of the 15 building managers interviewed believed that light reduction measures taken as part of the BFB had resulted in significant energy and cost savings (BW, CT, FC, SP, MH, RB, SLT). Four buildings (CP, TD, RT, MT) have only recently (November 2001) installed and implemented an automated lighting system, and expect to see significant energy and cost savings in the future, but have not had the system in place long enough to quantify these savings as yet. The manager at two of the buildings (ATT, SLC) believed that some savings may have been realized, but did not feel that these were substantial. Commerce Court West outlined that their automated lighting system had been in place since before they joined the BFB program, and thus there would be no difference between energy consumption before and after they joined the program. Only one tower, the Richmond-Adelaide Centre, represented an anomaly in terms of cost savings. The manager here believed that changes in lighting procedures had actually increased power consumption and consequent energy costs. He explained that this was due to the full automation of the switch-off times for lights. Whereas prior to the BFB, the cleaners would manually switch off lights after 6pm, the present automated system now turns lights off at a later time. Clearly this is a building where changes in the automatic switch-off system, implementing an earlier switch-off time, are needed.

At Metro Hall, the savings resulting from reduced lighting was estimated at $200,000 per year. The exact power saving was not known as a result of wide fluctuations in electricity rates over time. Royal Bank Plaza was unable to divulge specific savings due to tenant confidentiality concerns, but management there commented that savings had been very significant, since one of its highest bills is for light and heat. Management stated that the cost to run one single fluorescent light for 24 hours over one year is $25.

Sun Life Tower provided the greatest insight into specific energy and cost savings. Management cited that lighting consumed 23 kilowatts per floor, and between the two buildings, there were 50 floors in total. This building switches lights off between 11p.m. and 6a.m. all year long. This amounts to 7 hours off in each 24-hour period. At an estimated cost of 8 cents per kilowatt-hour, this equates to an annual savings of:

23kw/floor x 50 floors x 7 hours/day x 8cents/kw-hour x 365days/year = $235, 060

Commercial lighting represents 10% of the energy use in the City of Toronto (Toronto Atmospheric Fund, 2001). A significant proportion of that energy (<25%) is generated by power stations that burn fossil fuels, a process that releases carbon dioxide into the atmosphere. Approximately 20% of Ontario's greenhouse gas emissions are produced by these stations (other sources include vehicle emissions, landfill sites, etc.). In addition to reducing bird mortality, an additional benefit of the BFB program is the decreased electricity consumption that results from turning off lights at night. This reduces demand for fossil-generated power, which in turn reduces the resulting CO_2 emissions. Using the example of BCE Place, which is comprised of the Canada Trust Tower (51 stories) and Bay Wellington Tower (47 stories), electricity use at night costs two million dollars per year. A reduction of just 5% would result in \$100,000 in savings. At \$0.05 per kilowatt-hour this savings would be equivalent to 2 million kilowatt hours or 1,200 tons of CO_2.[3]. Using the same cost and energy ratios, Metro Hall's \$200,000 annual savings would equate to 4 million kilowatt hours or 2,400 tons of CO_2. Similarly, Sun Life Tower's savings of 2, 938,250 kilowatts during night-time lights out amounts to a reduction in CO_2 emissions of 1763 tons.

Metro Hall and the Sun Life of Canada Tower are amongst the 4 shortest structures of the 16 monitored (Figure 1). If we make the conservative assumption that Metro Hall represents the average value of total savings that could potentially be realized by all 16 towers if the same strategies were employed, we can make a crude estimation that an annual savings of 16 x \$200,000 = \$3,200,000 would be realized, which equates to a reduction in CO_2 emissions of approximately 38,400 tons. Since several of the towers are more than double the height of Metro Hall, 3.2 million is likely to be a substantial underestimation of the true cost savings and CO_2 emissions reduction that could be realized. Nevertheless, this estimation serves to underline the significant role that the BFB program can play in terms of helping to reduce Toronto's contribution to greenhouse gas emissions.

Suggestions by managers for improvements in the BFB

Managers were asked to comment about the operation of the BFB program, and give suggestions for anything that could be improved in the future. The vast majority of managers were pleased with the manner in which FLAP operates the BFB, in particular the job that Michael Mesure, FLAP executive director, does of keeping them informed. Managers (BW, CT) felt that the charts and graphs provided by FLAP on light emissions in current and previous years were valuable to their tenant education campaigns gave management a sense of how successful their strategies were. They requested that FLAP provide more feedback information during the migration season itself, rather than after the fact, so that management could be more proactive about reducing light emissions during the time it matters most. One manager expressed concern that the photographing of only one side of a building was not a very scientific method for quantifying light emissions, since it could be misleading if the side photographed was not representative of light emission from the other 3 sides.

Another comment (SP) was that the issue of bird collisions had received recognition downtown, but it was felt that FLAP needed to expand the BFB to other areas of Metropolitan Toronto where there are tall office towers. This manager also commented that they would like to have some sort of "report card" or assessment to let them know how their building was doing, and would like to have feedback from FLAP more often.

The Royal Bank Plaza is currently working on initiating a campaign, the "Adopt a Bird Program," that will extend the work of the BFB program. Similar to symbolic adoption programs used by other charities, this program will allow individuals or organizations to make contributions to FLAP that will support continued and perhaps expanded operation of the BFB program.

Another comment was that management (CC) would like more emailed communication from FLAP, suggesting that this was more effective (and less costly) than mailing materials, and email communication at the beginning of every migration season would be helpful. Flyers that FLAP can provide for tenants also make the job of property managers easier. Management (CC) also commented that Michael Mesure's Power Point presentation to tenants was very effective,

[3] Calculation performed by Kai Millyard, consultant to Ontario Energy Board, for the Toronto Atmospheric Fund.

important, and powerful. This type of direct communication between FLAP and tenants was felt to be far more effective than communications on the issue disseminated to tenants via property management.

One additional suggestion given (by buildings that had excellent records of low light emissions) was that there should be some mechanism in place so that buildings not fulfilling their commitment to reduce light emissions could have their BFB status revoked. It was felt that the BFB status should continue to be earned over time, and not be a permanent designation, but rather something that could be taken away if it was no longer deserved.

Discussion

The data from 1997 to spring 2001 provide evidence that:

- The number of fatal bird collisions increases with increasing light emissions, and is not simply a function of the relative size of the building
- The number of birds entrapped by lights emanating from particular buildings increases with increasing light emissions
- The BFB has been successful in reducing light emissions
- Weather is the most important factor predisposing birds to collision
- Nights of high cloud cover and/or nights with precipitation are the conditions most likely to result in high numbers of collisions, since birds descend to lower flight altitudes during such conditions, increasing their vulnerability to collision will tall buildings.

FLAP's data suggest that the more light a building is emitting, the higher the number of collisions occurring. While light emissions have not been detectably reduced in spring, the overall trend since 1997 has been for a reduction in overall building light emissions at the 16 towers monitored. Since data suggest a relationship between light emissions and the numbers of birds killed, this reduction in light emissions since 1997 is likely to have reduced the numbers of birds killed in comparison to the numbers that would have been killed if no light reduction measures had been in place. It is important to recognize that it is problematic to directly attribute changes in absolute numbers of birds killed between years to changes in light emissions because of the multitude of other factors at play. Many external factors can result in different volumes of bird traffic passing through Toronto. For instance, successful breeding seasons result in inflation of the total population size migrating in fall because of the large number of juveniles. Weather during migration can affect the altitude at which birds pass through in both seasons, and thus determine how frequently birds are prone to collision. Over-winter survival of birds on their non-breeding grounds affects the overall volume of birds passing through in spring. Therefore a comparison between buildings within the same season, (so that such external factors are controlled for), such as the data from spring 2001 (Figures 20 & 21), provides the best evidence that light reduction really does have a positive impact on bird survival by reducing the numbers of birds entrapped by and killed by lighted towers. This data provides scientific evidence for FLAP's mission: when buildings reduce their light outputs, fewer birds are entrapped in the area and fewer birds are killed.

The data are also consistent with other studies in confirming the important role of weather as a collision risk factor, with increased cloud cover and rainfall resulting in larger numbers of bird deaths. Low cloud and rain are known to cause migrating birds to descend to lower flight elevations, below the cloud ceiling (e.g. Erickson, 2001). When their flight path during these conditions takes them over cities, light emanating from buildings or other structures increases their risk of collision (Larkin & Frase, 1988). Since weather conditions can often be forecast several days in advance, this allows FLAP to make predictions about when the risk of collision will be highest. This predictive capability provides the opportunity to warn BFB participants of nights when light reduction is crucially important. FLAP should pay particular attention to nights of heavy cloud and heavy precipitation that follow relatively clear, precipitation-free days. Under these conditions many birds will begin migration but encounter inclement weather when already aloft, sending them down to lower flight elevations where they become vulnerable to collision.

Building Managers Survey

Building managers were generally pleased with the BFB program and their interactions with FLAP. One manager commented that he had seen FLAP evolve over the years from a relatively small-scale group of volunteers to a highly organized organization that now was able to "speak the same language" as building managers. The main goal of FLAP to reduce light emissions presents a win-win situation for office managers because saving birds represents only one of several benefits, including substantial cost savings due to energy reduction.

Summary

Many birds species, including a number of Canada's migratory songbirds, are experiencing population declines. Unlike many of the more complex and seemingly intractable threats to bird populations, such as mortality due to house cats, pesticide use, oil spills, electrocution, and disease, nocturnal collision with buildings is a threat that is largely preventable with the flick of a switch. The BFB program has made measurable progress towards minimizing night-time bird collisions in Toronto by reducing nocturnal light emissions. An added benefit of the BFB program has been a reduction in carbon dioxide emissions due to reduced electricity consumption. As the human population climbs and resource demands grow, the cumulative impacts of all mortality factors on birds continue to increase. By working to minimize bird deaths and reverse avian mortality trends, continuation and expansion of the bird friendly building program into the future remains an important contribution to bird conservation.

Related Issues:

Daytime building collisions

While working to minimize nocturnal collisions has been FLAP's main focus, day-time collisions with windows are also an important concern. Nocturnal migrants that are not killed outright by collision with lighted windows become vulnerable to window collisions and opportunistic predators if they are still entrapped in the urban environment the following day. Dr. Daniel Klem Jr., a professor at Muhlenberg College in Pennsylvania, has researched the issue of bird window collisions since the 1970s, documenting window kills for 225 North American species and 556 species worldwide. Klem estimates that 100 million to 1 billion birds are killed annually by day-time window collisions at low-level structures in the US alone (e.g. Klem Jr., 1991; 1990). Striking a window at high speed, birds die of brain haemorrhaging from the powerful impact. His experiments demonstrate that fit and weak birds are equally at risk. Window strikes occur under all weather conditions, during all seasons, at buildings of all heights, and with windows facing any direction. Klem's research has determined that the visual system of birds is simply not capable of perceiving glass as a physical obstacle. Thus wherever birds and glass coexist, birds are in danger. Day-time window kills have been monitored by FLAP at Consilium Place, which consists of three buildings almost entirely faced with mirrored glass. Tenants and building security staff assist FLAP with rescue efforts and in reporting the incidence of bird injuries and mortalities at these buildings. During migration seasons in the years 2000 and 2001, at least 1265 bird mortalities were recorded here.

Minimizing window kills is conceptually simple: window exteriors need to be made less reflective and more visible to birds. Metro Hall has already taken steps to make their ground level windows more visible to birds by installing adhesive material in patterns to the exterior of windows, and by hanging birds of prey decals inside the windows. Consilium Place has installed netting in specific areas near windows to reduce bird collisions with the glass. Other buildings could be encouraged to follow their lead, and developing strategies for minimizing day-time window collisions is a possible additional goal for the future of the BFB.

Building retrofit incentives

On a broader scale, the BFB program is making a national and global contribution to the environment by reducing carbon dioxide emissions, thus contributing to efforts to minimize global climate change. Recognizing that the goals of both organizations are compatible, FLAP has partnered with the Toronto Atmospheric Fund (TAF), a funding organization that is seeking to help Toronto meet its goal of reducing greenhouse gas emissions by 20 per cent by the year 2005. TAF was one of the early sponsors of the BFB program. The TAF is one of several initiatives that provide financial incentives for buildings to undergo energy-efficiency upgrades. TAF is one of many partners in the Better Buildings Partnership, along with founding partners the City of Toronto, Enbridge Consumers Gas, Toronto Hydro and various Energy Management Firms (EMFs). EMFs provide up-front financing for energy-efficiency retrofits, with re-payment made later from the energy and water savings realized. The federal government also provides incentives for such upgrades through the Energy Innovators Initiative (EII), a program of the Office of Energy Efficiency (OEE). EII's Pilot Retrofit Incentive is designed to stimulate the development, implementation and replication of new energy retrofit projects within existing buildings. EII will contribute up to 25 percent of the eligible costs of a pilot project (to a maximum of $250,000) if the qualified organization replicates the energy-efficient measures in at least 25 percent of their remaining facilities (See http://oee.nrcan.gc.ca/eii/english/incentives.cfm?PrintView=N&Text=Y). Making building management aware of the availability of such initiatives can bolster the success of the BFB.

Transport Canada laws on obstruction lighting for aviation safety

While night-time light emissions from windows could potentially be eliminated entirely, Transport Canada requires that any structure greater than 150m be marked or lighted at night. Transport Canada standards for obstruction lighting state that such lighting can be a red, steady-burning light, or a white, flashing or strobed light. While the reduction in window lighting obviously remains a priority for FLAP, an obvious next step in the process is to lobby for use of flashing lights instead of steady-burning lights, since available evidence suggests that this is the better option of the two in terms of minimizing the risks to migrating birds (Evans Ogden, 1996). Some evidence suggests that white lights are also preferable to red lights, since the latter may interfere with birds' navigational ability (Kerlinger, 2000).

Building Security Issues

Recent terrorist acts have highlighted the importance of enhanced security at public buildings throughout North America. While lighting may have been important in the past for facilitating detection of security breaches at night, newer technologies such as motion-sensitive alarm systems eliminate the need for buildings to be lit in order to detect suspicious activities or intruders. Thus it seems unlikely that the increased concern for security need have a significant impact on FLAP's activities.

West Nile Virus

West Nile Virus (WNV), a virus reported since the 1930s to cause disease in humans in Africa, West Asia, and the Middle East, was first reported in North America in 1999. WNV is transmitted to humans through mosquito bites. Mosquitoes become infected when they feed on infected birds that have high levels of WNV in their blood. Infected mosquitoes can then transmit WNV when they feed on humans or other animals. In 1999 and 2000, 83 human cases of West Nile illness were reported in the New York City metropolitan area. There were 9 fatalities amongst those infected. The first Canadian incidence of West Nile Virus was confirmed in August 2001 from a bird in Windsor, Ontario, and presence of WNV was subsequently confirmed in Toronto and other areas of southern Ontario.

To date, a total of 6 blue jays and 34 crows in various areas of the City of Toronto have been confirmed with the virus. As yet there have been no documented human cases of WNV in Canada. While the virus has been found in at least 70 species of birds, crows and jays are particularly susceptible, and are being used as sentinel species to monitor the spread of the virus in Canada. Other species are often carriers for the disease but may show no outward signs of infection. There is no evidence that handling live or dead WNV-infected birds can infect a person. Nevertheless, one potential concern is contact with feces. In experimental studies, live virus particles were detected in the feces of acutely affected birds. The amount of virus shed and the survival time of live virus in the excreted feces are unknown at this time. Therefore, caution in handling birds, such as wearing surgical gloves, is advised, and Hepa-filtered surgical masks should be worn to avoid inhalation of fecal aerosols, especially if birds are examined at face-level. Paper bags used to hold birds should be used only once, and each individual bird should be placed in a separate bag to avoid potential bird-to-bird transmission of WNV via infected feces. Paper holding bags used by FLAP should be considered a biohazard and should be discarded appropriately after use. Any reusable cloth bags or holding cages should be thoroughly cleaned and disinfected between uses. These practices are advisable not just for WNV, but to guard against various bacterial diseases that can be transmitted to humans by birds.

West Nile Virus is closely monitored in Canada by the Canadian Cooperative Wildlife Health Centre (http://wildlife.usask.ca/english/frameWestNile.htm), and in the US by the Center for Disease Control (http://www.cdc.gov/ncidod/dvbid/westnile/q&a.htm), and by the Center for Integration of Natural Disaster Information (http://cindi.usgs.gov/hazard/event/west_nile/west_nile.html). The Toronto Department of Public Health also has up to date information on WNV in the Toronto Region (http://www.city.toronto.on.ca/health/west_nile_index.htm).

Species at Risk Act

Canada is in the process of enacting endangered species legislation, which would include special protection for several species of migratory birds. Migratory birds are already protected under the Migratory Birds Act of 1994, a joint US-Canada agreement. This act was created largely to regulate the hunting of game species, but also serves to regulate the scientific study of birds, and prohibits the possession of or intentional killing of birds by individuals without a permit. The act makes no specific reference to the legality of bird mortality caused by building collisions, and indeed there are no Canadian laws that pertain to the collective responsibility of companies or organizations to prevent harm or death to migratory birds as a result of structural hazards. Endangered species legislation should provide protective measures for species at risk. The implications of the forthcoming Species At Risk Act in terms of holding individuals or companies responsible for birds killed by collision at their buildings is as yet unclear. It remains to be seen whether airspace for migrating birds will be considered "habitat" under this legislation, however this seems unlikely. While Canadian endangered species legislation may provide opportunities to strengthen the impact of the BFB program, the majority of species impacted by collision with Toronto buildings are not considered species at risk, and thus voluntary compliance with FLAP's BFB measures seems a more promising approach than pursuing compliance via legal means.

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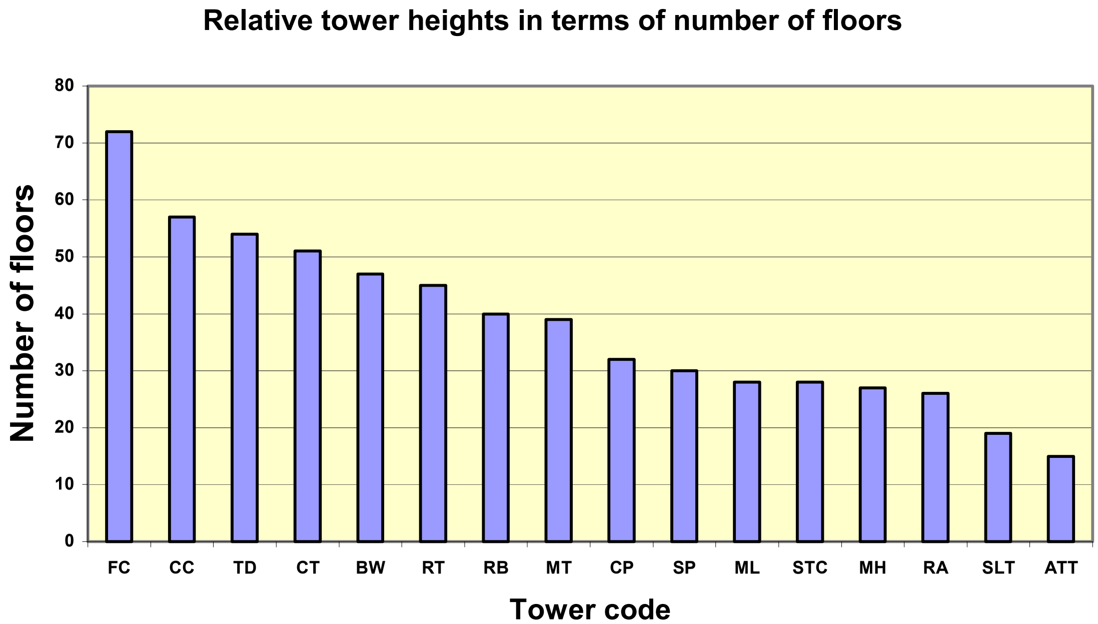
Results:
Figure 1.



Tower	*Tower name*
FC	1 First Canadian Place
CC	Commerce Court West
TD	Toronto-Dominion Tower
CT	Canada Trust Tower
BW	Bay-Wellington Tower
RT	Royal Trust Tower
RB	Royal Bank Plaza
MT	Maritime Life Tower
CP	Canadian Pacific Tower
SP	Simcoe Place
ML	Merrill-Lynch Tower
SLC	Sun Life of Canada Tower
MH	Metro Hall
RA	Richmond-Adelaide Centre
SLT	Sun Life Financial Trust
ATT	AT&T Tower

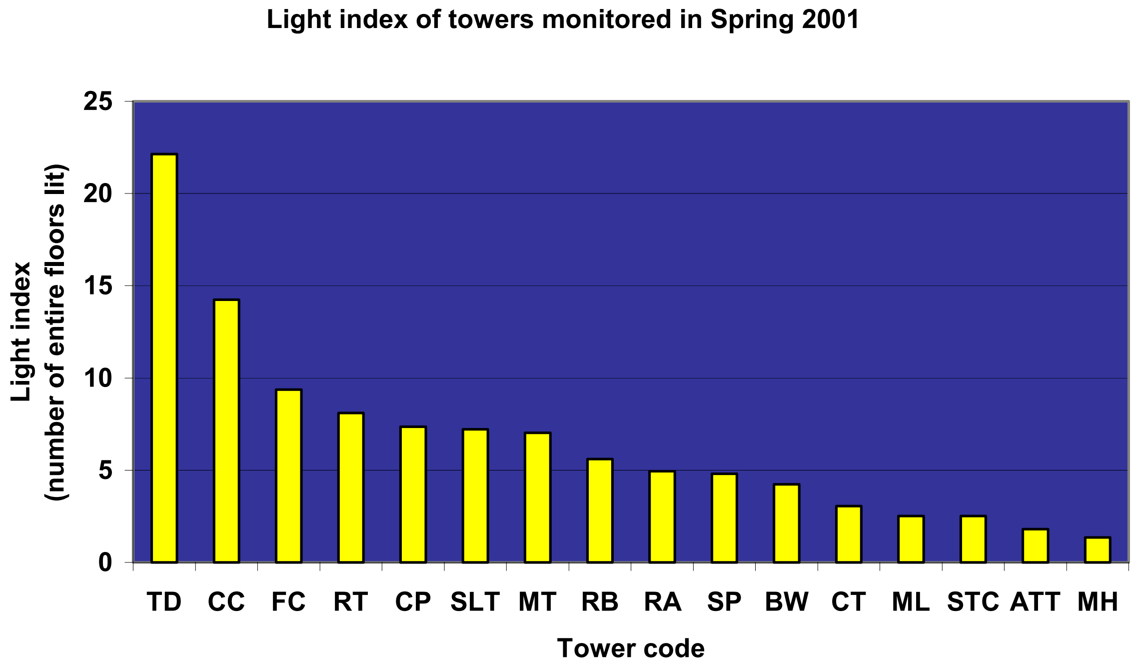
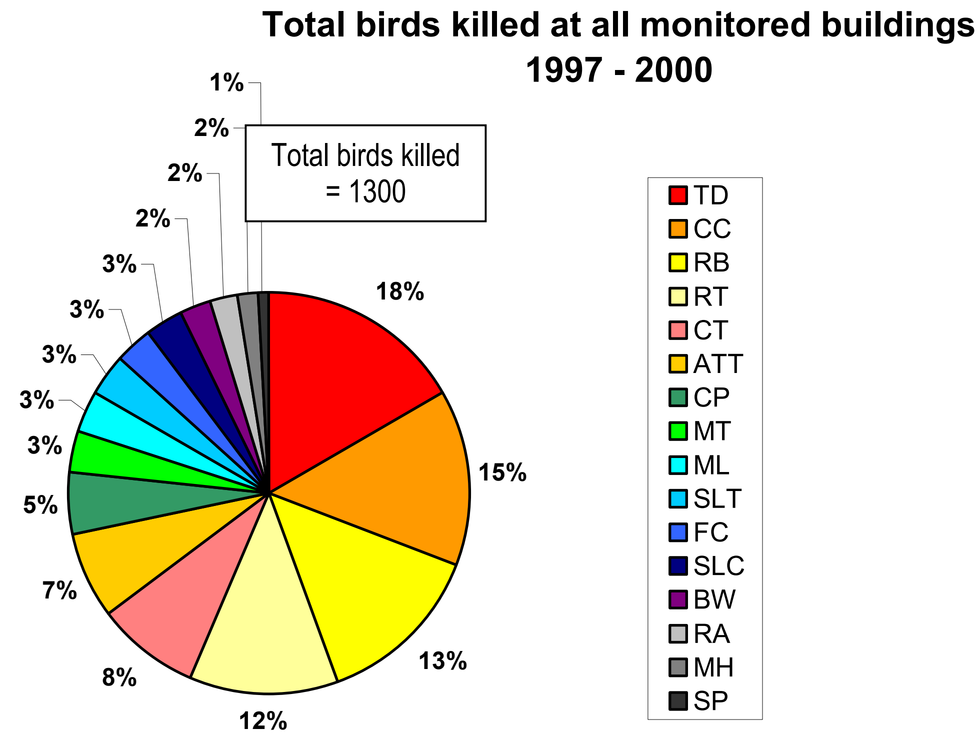


Figure 2.

Tower	*Tower name*
TD	Toronto-Dominion Tower 1
CC	Commerce Court West
FC	First Canadian Place
RT	Royal Trust Tower
CP	Canadian Pacific Tower
SLT	Sun Life Financial Trust
MT	Maritime Life Tower
RB	Royal Bank Plaza
RA	Richmond-Adelaide Centre
SP	Simcoe Place
BW	Bay-Wellington Tower
CT	Canada Trust Tower
ML	Merrill-Lynch Tower
SLC	Sun Life of Canada Tower
ATT	AT&T Tower
MH	Metro Hall

Figure 3.



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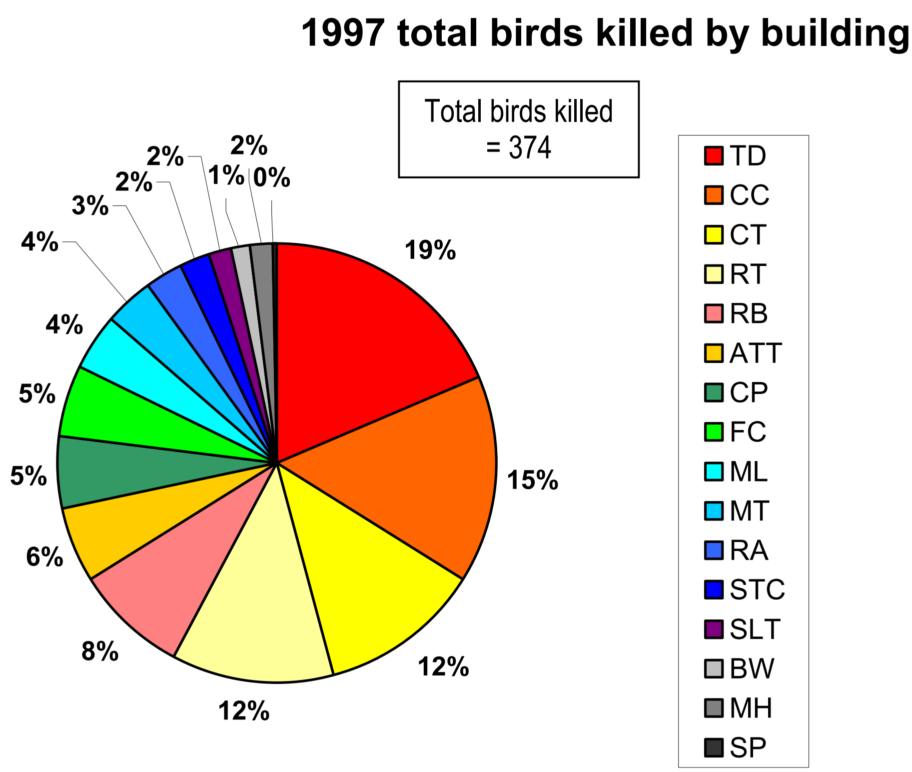

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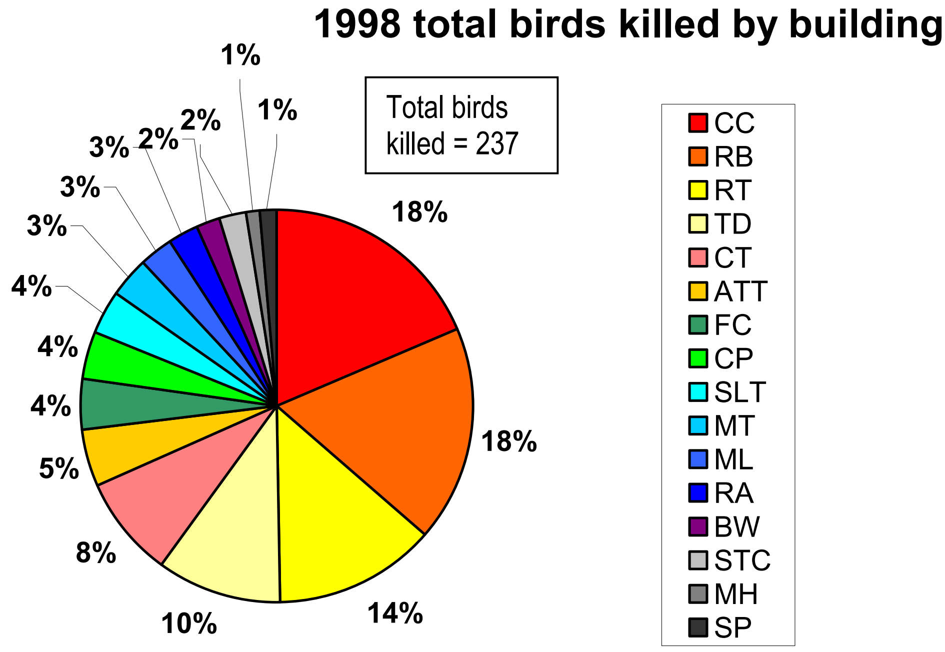

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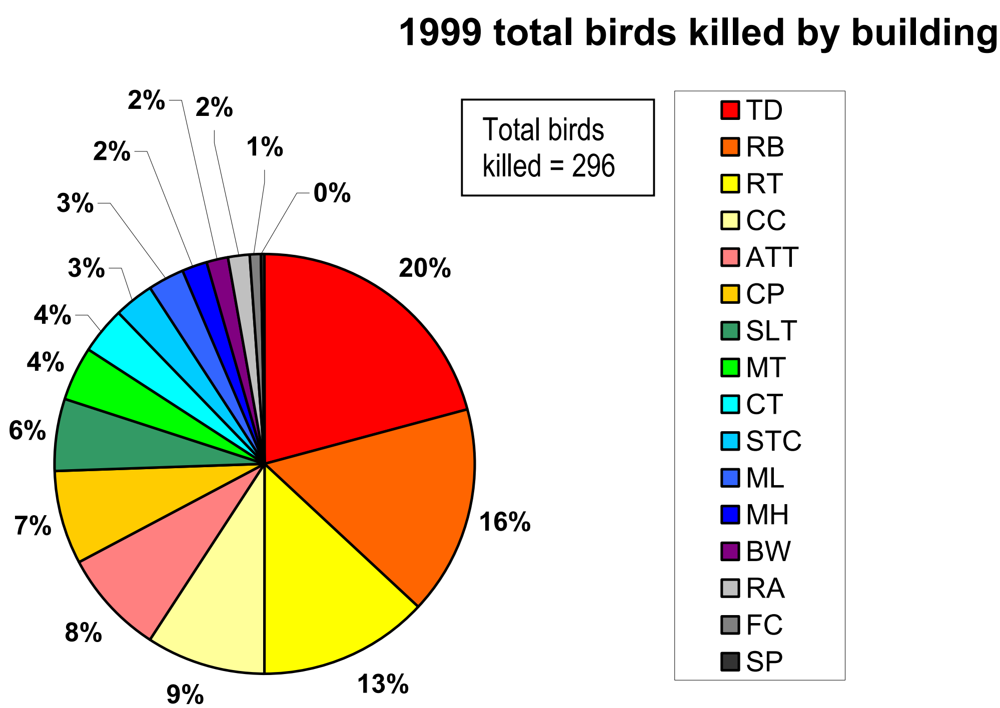

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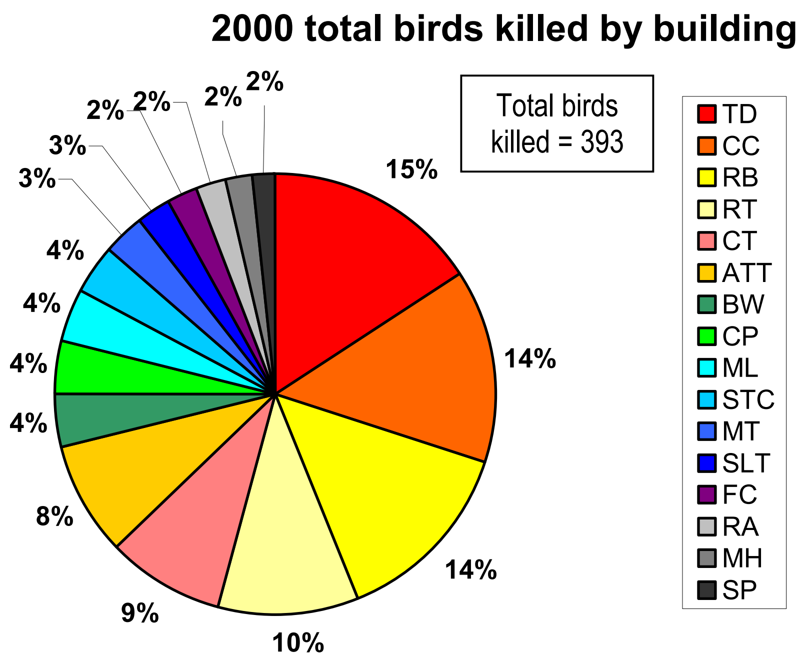
2000 total birds killed by building
Total birds killed = 393
15%
14%
14%
10%
9%
8%
4%
4%
4%
4%
3%
3%
2%
2%
2%
2%
TD
CC
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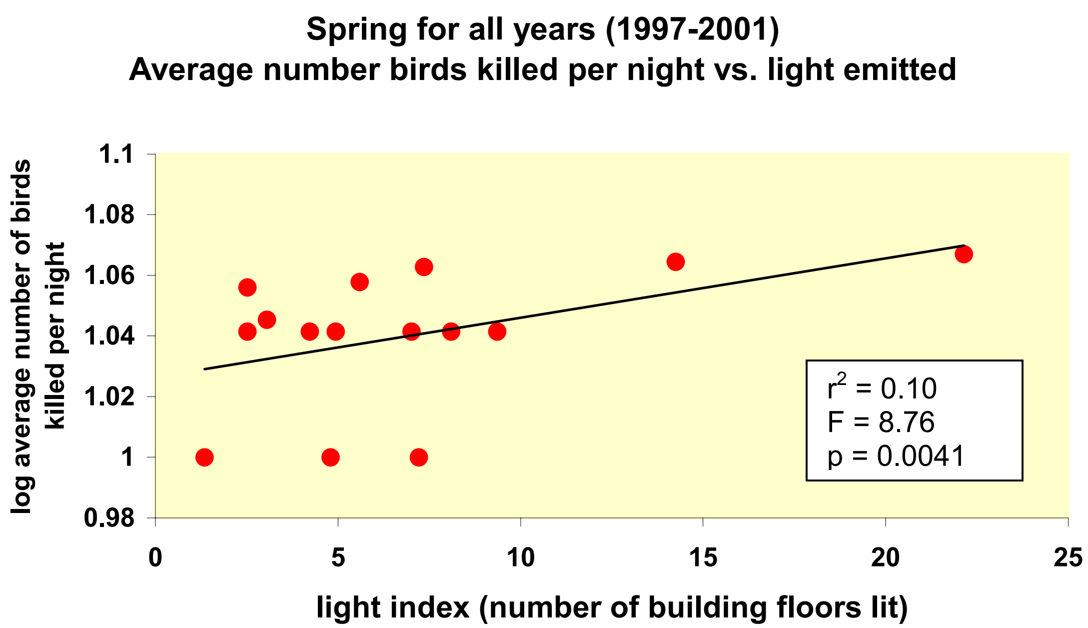
MH
SP

Figure 8.



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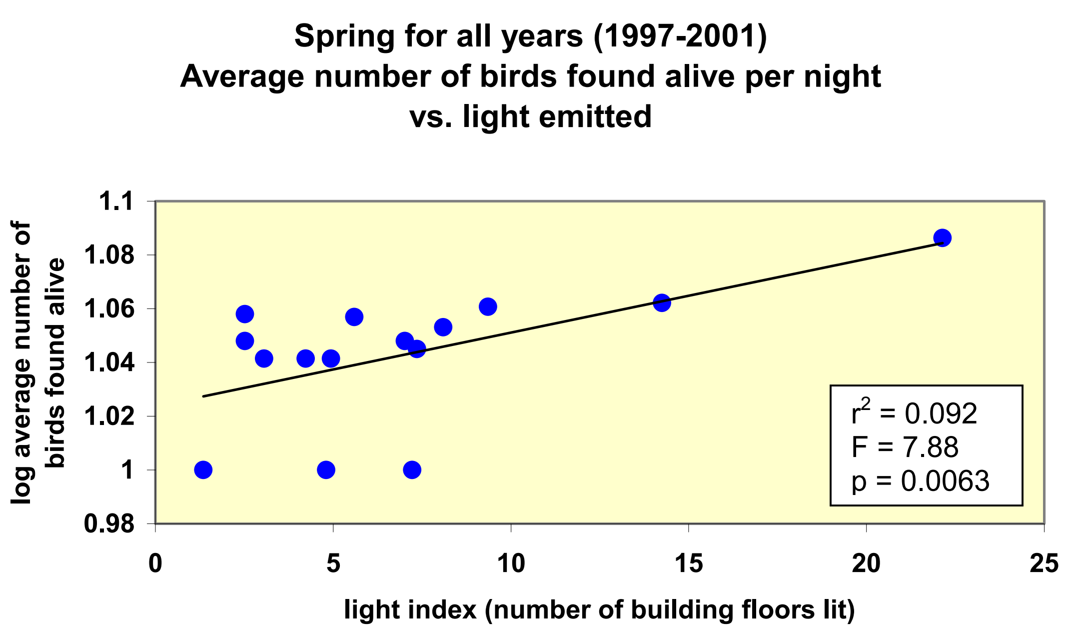

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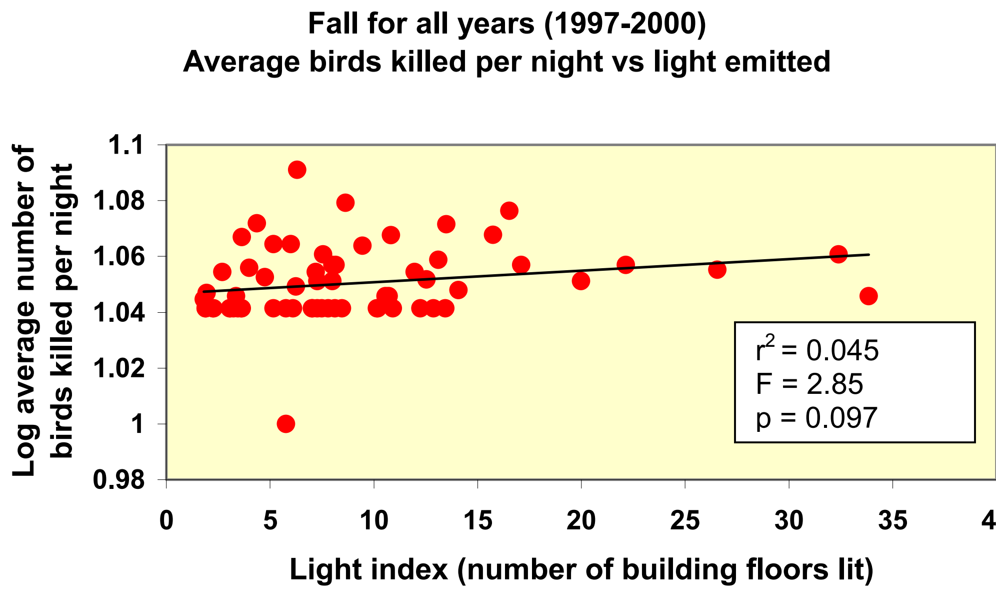

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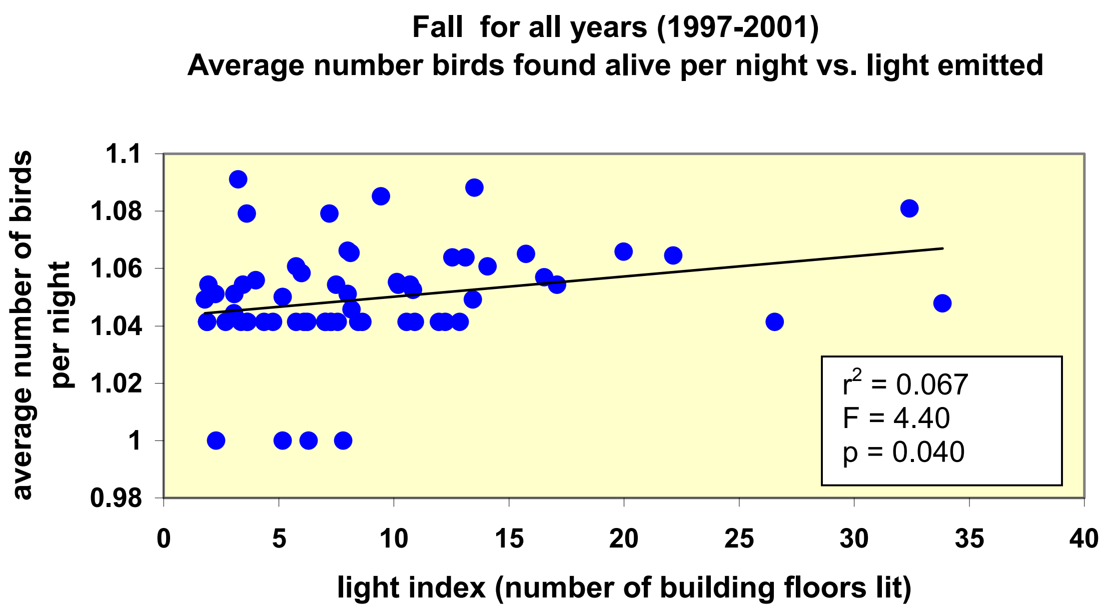

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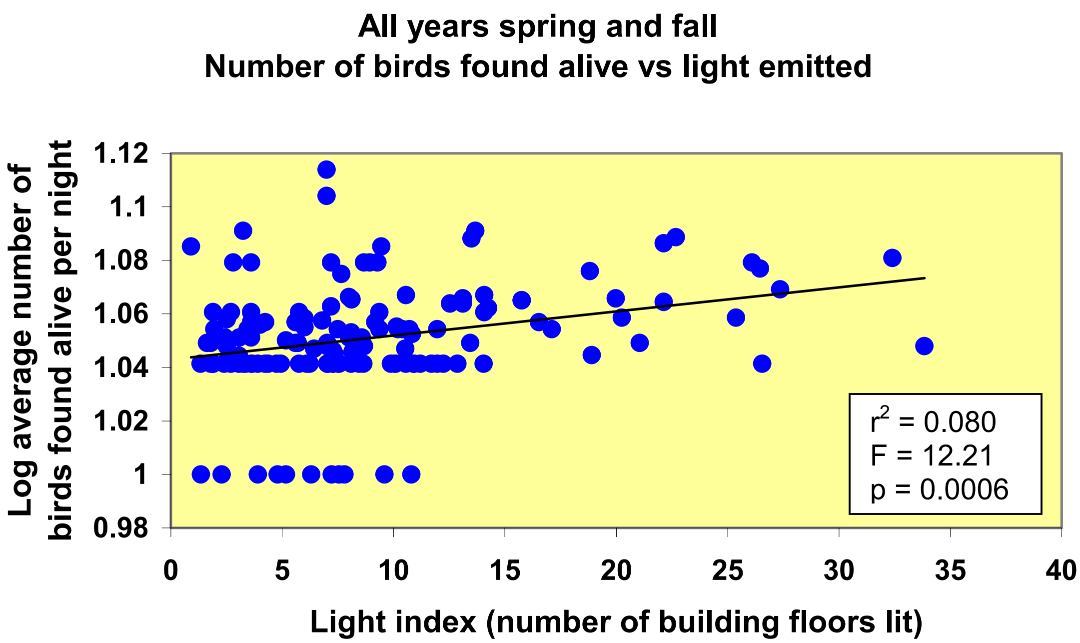

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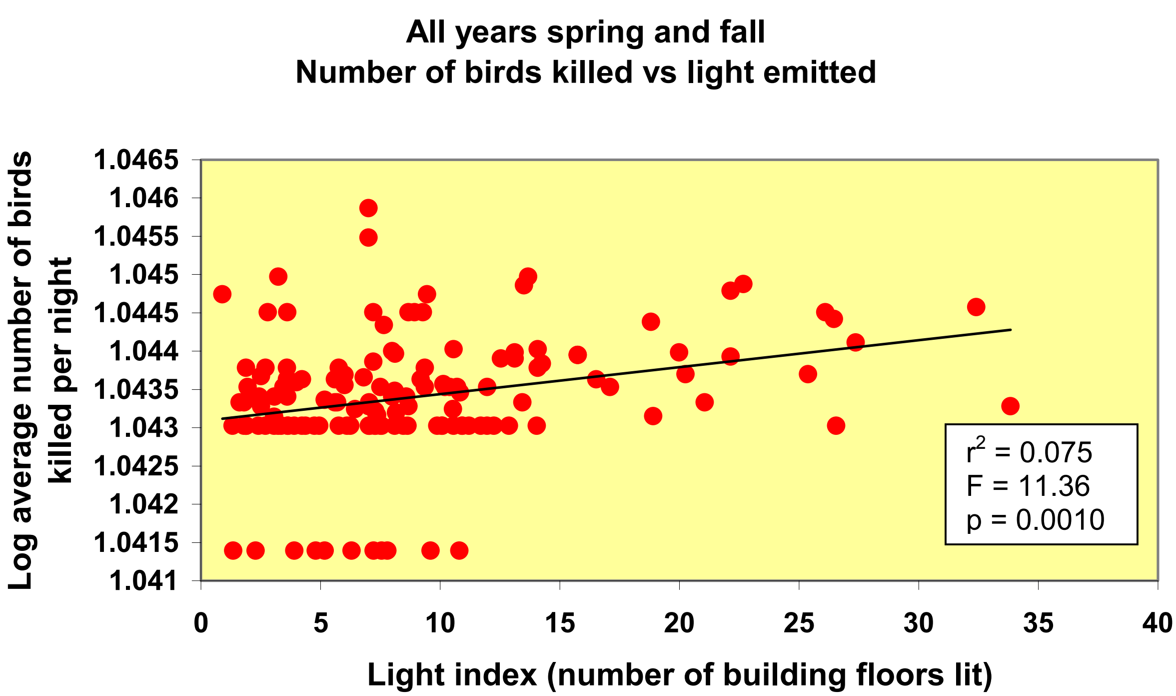

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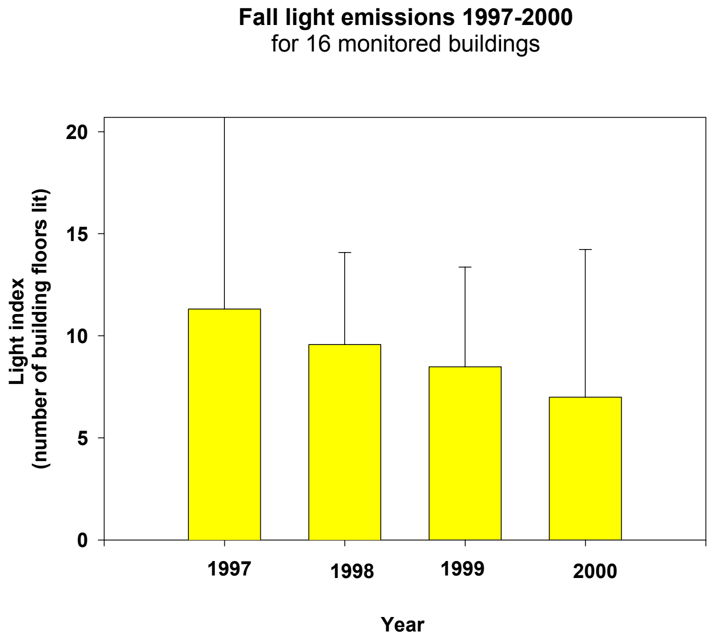

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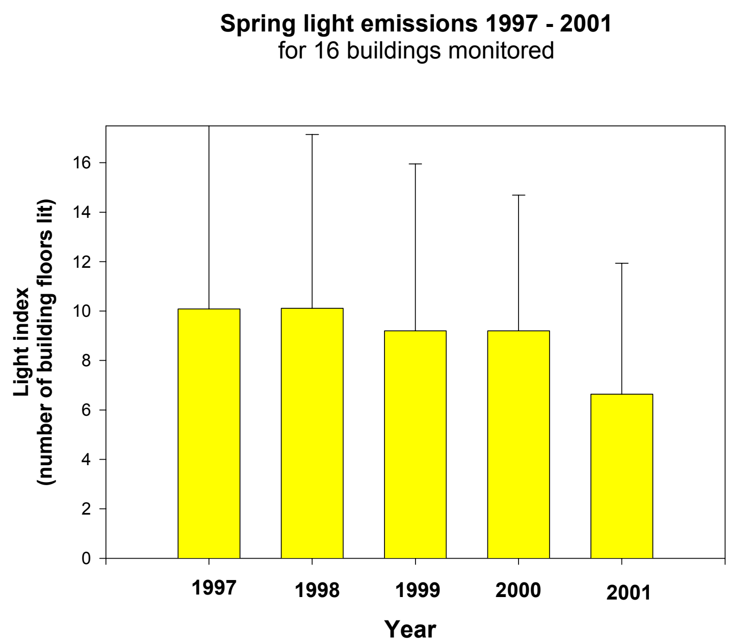

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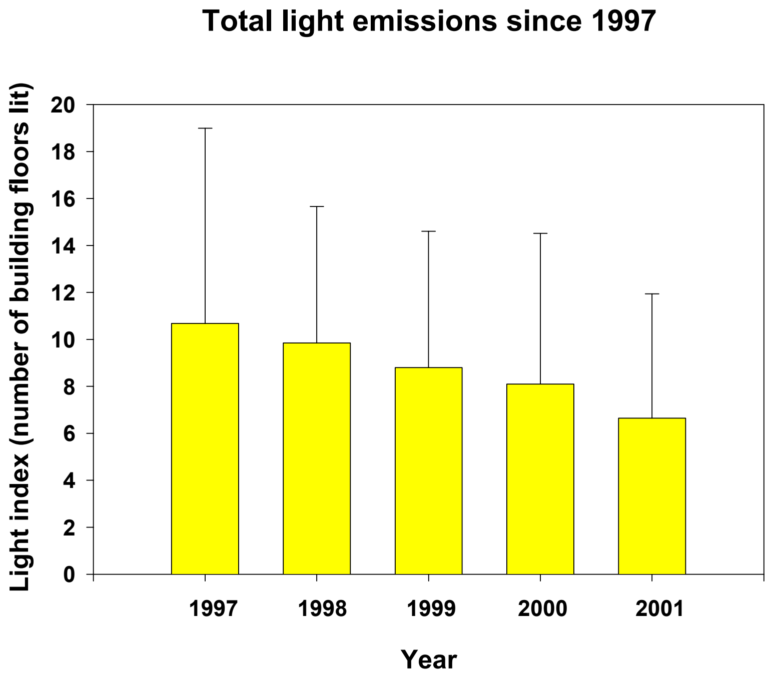

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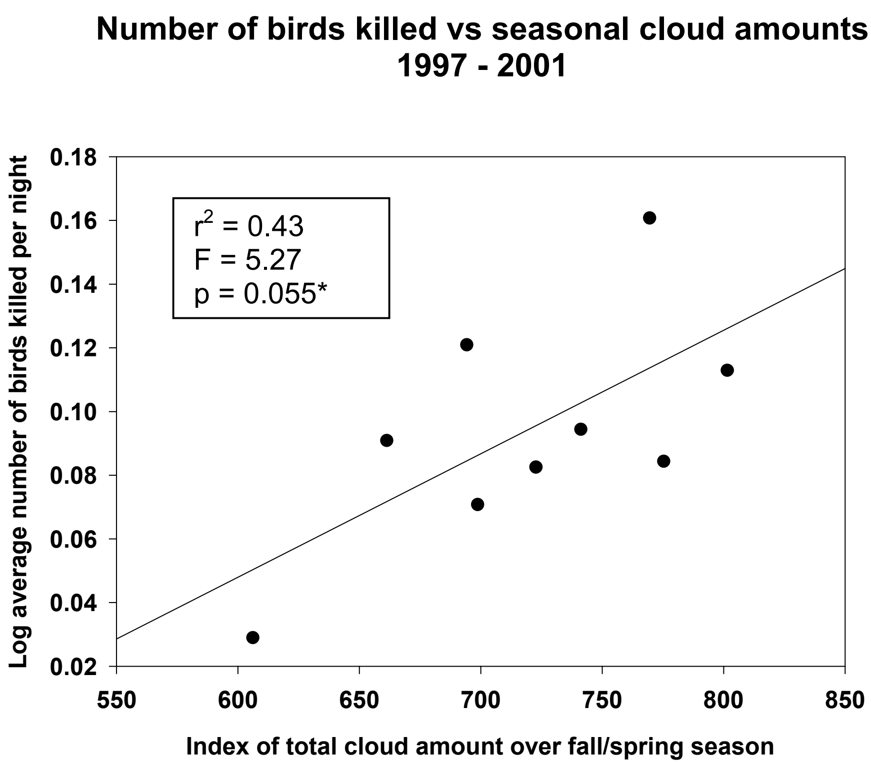

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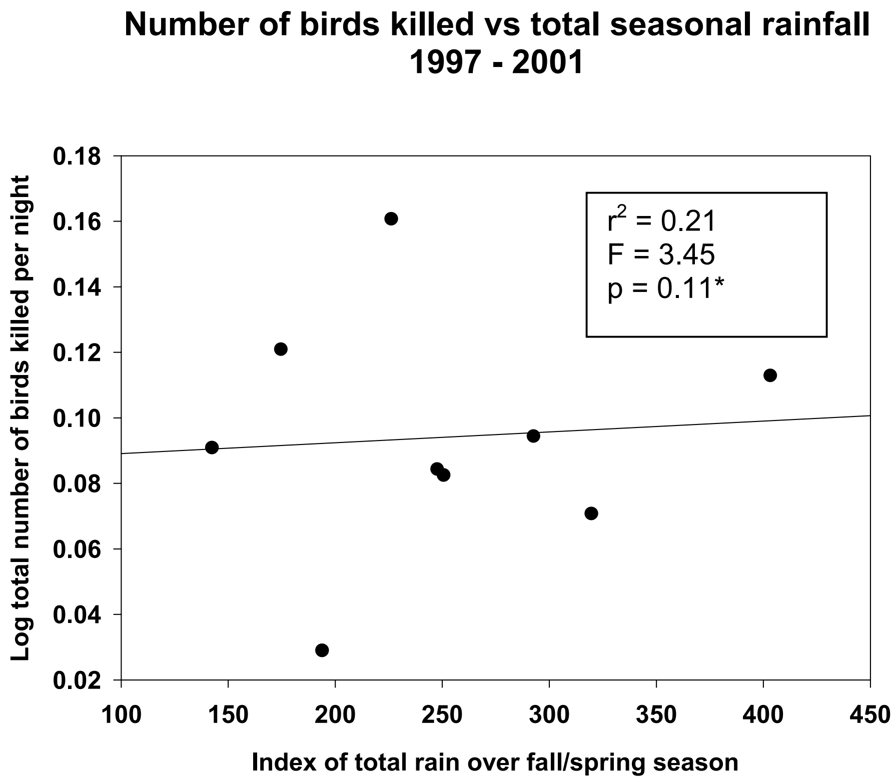

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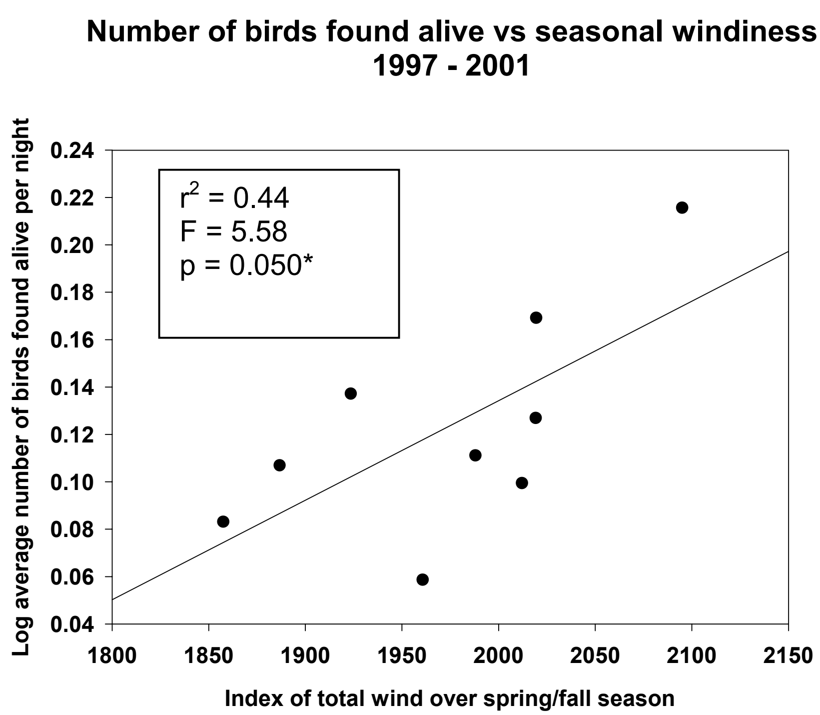

Figure 20

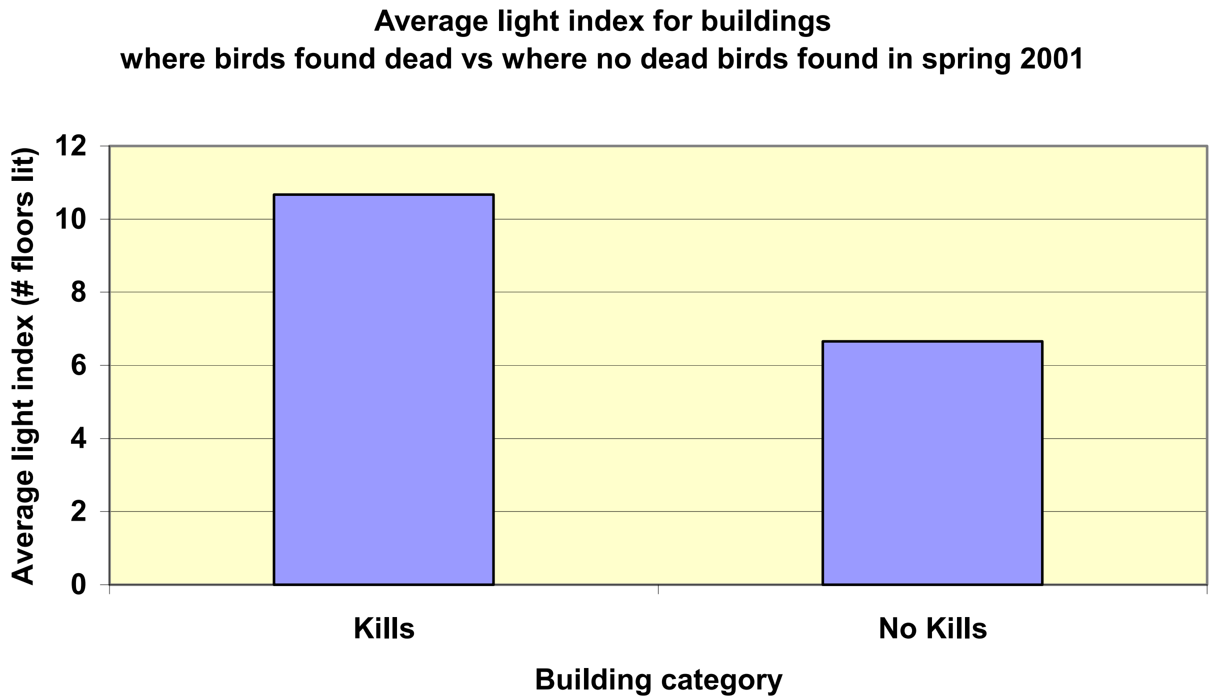

Figure 21