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Project Proposal

Abstract

Little brown bats have been studied extensively, as they are a common species in North America and frequently used in labs. However, the impact of artificial light on the habits of this species has not been studied as thoroughly. This study will identify if artificial light impacts key variables in the habits of the little brown bat, including diets, feeding patterns, and roost locations. The overall purpose of this study is to determine how humans interact with and affect the habitats of the little brown bat.

Introduction

Artificial light at night (ALAN) has seriously impacted the natural sleeping, feeding and mating cycles of many organisms (Gaston). ALAN has changed habitat dynamics very quickly by introducing “light in places, times and intensities at which it does not naturally occur” and by introducing wide-reaching skyglow (Gaston). ALAN effects terrestrial ecosystems in three main ways: individual health, time partitioning and interspecific interactions (Gaston).

Organisms exposed to “brief periods of high-intensity ALAN, or to prolonged periods of low intensity, has been shown in the laboratory to be capable of substantially altering patterns of circadian clock gene expression and melatonin production” (Gaston). Artificial lights not only change organism behavior, but also their gene expression and ability to produce melatonin, which directly impacts ability to maintain regular sleep patterns. Poor sleep hygiene can also lead to lower immune system function and increased stress (Gaston). Artificial lighting has affected the dawn songs of at least four common songbird species (Kempenaers). Over a seven-year span, five commons songbird species, the chaffinch, the blue tit, the great tit, the blackbird, and the robin, were observed in suitable habitat, edge habitat with artificial light, and edge habitat without artificial light. In four of the five species, "males near street lights started singing significantly earlier at dawn than males elsewhere in the forest," (Kempenaers). Street lights also caused females to lay eggs "on average 1.5 days earlier" (Kempenaers). The findings support that "light pollution has substantial effects on the timing of reproductive behavior and on individual mating patterns" (Kempenaers) and on the sleep schedules of individuals near artificial light sources.

ALAN also decreases an organism's ability to partition time into day and night. Dawn, dusk and day length are used as indicators by many species to find food, reproduce and migrate (Gaston). ALAN can make days seem longer and "hold off" the night, which can keep organisms from completing many tasks, the most time sensitive being finding food. Artificial lights have a negative effect on loggerhead reproduction and survival rates (Price). There was "a negative relationship between nest-site selection and the intensity of artificial luminance, such that the brighter zones along the beachfront had fewer nests." Along with this relationship, the higher the intensity of artificial light, the less dense loggerhead nests became (Price). The few hatchlings from these more intense light regions were more disoriented and less likely to survive (Price).

These two categories can lead to shifts in a community structure, either directly or indirectly. (Gaston). These interspecific interactions can have long term impacts on a habitat's biodiversity and sustainability.

Moths are more attracted by light with small wavelengths (Langevelde). In systems with artificial lights, this impact on moth populations does not end with moths but has the potential to impact its predators and the entire system, depending on how drastic the change. This study will contribute to the broader understanding of how artificial lights affect little brown bats and their ecosystems.

The objective of this study is to determine whether various artificial light sources impact where little brown bats hunt, live and feed. First, we will establish current little brown bat activity levels in Fordland, MO. Variables observed will include diet composition, feeding patterns, and roost locations. Then we will determine if various artificial light sources impact those variables by exposing the same little brown bats to different controlled artificial light sources, including long-wave and short-wave radiation lights.

This study will to develop a better understanding of how artificial light sources affect local bat populations, including the differing levels of bat predation on local insects. Urban planners will be able to better create environments that do not negatively affect local bat populations. This could include changing the light sources near little brown bat habitats. Street lights, for example, may need to be put on timers to not interfere with bat hunting grounds. Neighborhoods near critical bat populations may need to consider switching to different light sources, depending on the results of this study.

Materials & Methods

Three two week-long studies will be conducted starting in the first week of July and end the last week of August. The first two-week study will be with a control group, without any interference from artificial lights. The second two-week period will be studying the effect of short-wave lights. The third two-week period will be studying the effect of long-wave lights. There will be a week between each period to keep the bats from habitually coming to the site because of past experiences. Little brown bats are most active at night during July and August, as higher temperatures result in increased and prolonged foraging activity (Barclay) (Fenton). In addition, female bats spend less time roosting during the later summer months, as they are not caring for young (Barclay).

Note that all handling of the little brown bats observed and analyzed will follow the Standard Operating Procedures outlined in the Standard Operating Procedure for the Study of Bats in the Field. This will include procedures for capturing through mist nets, handling, marking and tagging, and sampling (Ellison).

These three studies will show the effect different kinds of artificial light have on little brown bat feeding habits. Mist nets will be used to monitor bat activity. The nets will be constantly monitored for five hours, beginning at sunset, to make sure that bats do not get tangled or attract predators while they are trapped. To keep disease from spreading, such as white-nose syndrome, the nets will be soaked in hot water for 15 minutes or disinfected with Lysol after each use. (Ellison)

Little brown bats will be captured along the transect every three days and their diets will be analyzed through fecal testing. The bats will be held in a sealable plastic bag for 5-10 minutes with holes for breathing, and the bag will be covered with a cloth to help prevent stress. Bats will defecate in the bag and when the bat is released, the plastic bag can be resealed, labeled with the group and date, and stored until analysis (Ellison). DNA analysis of the feces will show the composition of the bats' diets. The bats will be weighed to see if there is a trend of bat weight going up or down throughout the week. Each bat will be tagged with a PIT tag. (Ellison) This is to keep teams from unintentionally catching and analyzing the diet composition of the same bats repeatedly and skewing the data gathered.

The captured bats will also be tagged with fluorescent dust. This will allow for their roosting habits to be observed. In the nights following the release of the bats, researchers will go into area with UV lamps mounted on poles to reveal remnants of the bioluminescent dust on roosting bats. These poles, fitted with cameras, will be used to find the bats with fluorescent dust in roosts (Goodyear). Bat roosting behaviors will be studied in this manner between the hours of 1:00 AM and 4:00 AM, the hours that bats most commonly roost on summer nights (Barclay). This information will show if there is any effect in roost placement in relation to the artificial light.

Statistical Analysis

We will run several tests on the data we gather to test our hypotheses and see if artificial lights impact the behavior and feeding of little brown bats in Missouri.

First, we will use a nonparametric ANOVA test to see whether there is a difference between the number of bat visits per night when there is no treatment, short-wave radiation lights present, and long-wave radiation lights present. We will use the data gathered while mist netting the bats to evaluate this. If there is a difference between treatments, we will use a Tukey's pairwise comparison to see which treatments influenced bat visits.

Second, we will use a Hutcheson t-test to determine whether little brown bats feed opportunistically on whatever insects are present at artificial lights, or they selectively choose their prey. We will calculate a Shannon's diversity index for the insects captured at short-wave radiation lights, and a separate Shannon's diversity index for the insects identified in the feces of the bats under that treatment. We will compare these two diversity indices with a Hutcheson's t-test and repeat the entire process with the long-wave radiation treatment. If the indices are similar, bats diet may be determined by what insects are attracted to the lights.

We will also use Shannon's diversity indices to compare the insects found in the diets of the bats of all three treatments. We will use an ANOVA test and a Tukey's pairwise comparison test to see if the type of light present affects the bats' diets.

Finally, we will use ANOVA to evaluate whether there is a difference between the average straight-line distance between the roosts of bats tagged with bioluminescent dust and the treatment area (where the lights are placed). If there is a difference, we can use Tukey's pairwise comparison to see if which treatments affected the distance from the treatment site to the roosting area.

Discussion

If it is found that different light sources affect the little brown bat, certain courses of action should be undertaken. Firstly, if it is found that any light source has a negative effect, regardless of the wavelength, then we would recommend that artificial light sources near endangered bat populations be set on timers to turn off as much as possible. We understand that lights can also be necessary for human safety, so we would recommend that lights be turned off only after major traffic in the area has gone down significantly. This would be up to the discretion of local officials.

Secondly, it may be found that one light source is harmful, when the other is beneficial or neutral. In such a case, we would recommend that all artificial light sources in the area be switched over to the beneficial/neutral light. This would benefit bat populations, with no detriment to human communities. It could also be the case that there is no difference in effect between natural darkness, short-wave lights and long-wave lights. In such a case, we would recommend no changes to the light sources.

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