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Chicago data suggests light pollution disrupts animals' biological clocks and reduces habitat value

Population growth, economic development, and urbanization mean more ecosystems are lit throughout the night. Ecologists and astronomers, among other concerned folks, have been raising the alarm that "ecological light pollution" is disrupting ecosystems' natural cycles of light and darkness – and that we don't really know how animals, plants, and other parts of these ecosystems might be affected. Light pollution intersects with another growing concern for ecologists: urban wildlife. Still, there aren't many field studies investigating how artificial light affects urban wildlife's behaviors. Our 2019 article is an initial contribution to this discussion, combining laboratory and observational data from field-based camera traps to map how light pollution might affect urban habitat in Chicago, Illinois.

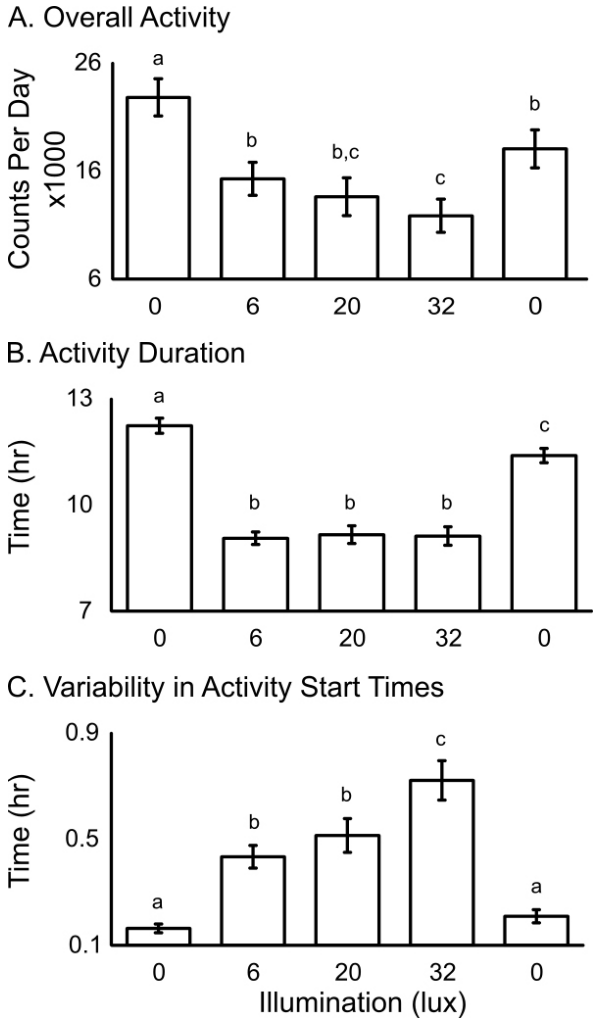

Fig. 1. Mouse activity results from laboratory experiments at nighttime light levels commonly found in Chicago. Letters (a-c) represent statistical significance between groups (bars labelled with the same letter are not statistically different from each other). Lux is a common measure of illuminance.

To get a sense of artificial nighttime light in Chicago, we started by measuring brightness at about 1,000 locations in different parts of the city. Then we exposed laboratory mice to a range of Chicago's typical nighttime light levels, observing how their activity patterns changed. Finally, we compared the changes in activity we saw in the lab to species observations from camera trap data kindly provided by our collaborators at the Lincoln Park Zoo's Urban Wildlife Institute to see if urban wildlife showed similar differences in activity patterns between dark and bright areas of Chicago.

The consistency between our laboratory and field findings suggest significant changes in behaviors in light-polluted areas. The most prominent changes to animals' behavior patterns in the lab and field were decreased overall activity, shorter activity duration, and increased variability in activity start times (Fig. 1). Such changes suggest significant alterations to the timing of their biological clocks. Previous laboratory studies have found that activity changes like these can be associated with disruptions to animals' weight, metabolism, immune function, cognition, anxiety levels, and affective responses, with different effects depending on the species and lighting conditions.

Using imagery from the International Space Station to estimate nighttime light levels across Chicago, we found as much as 36% of the city's greenspace is lit at light levels at which we found behavioral differences in both the laboratory and field (Fig. 2).

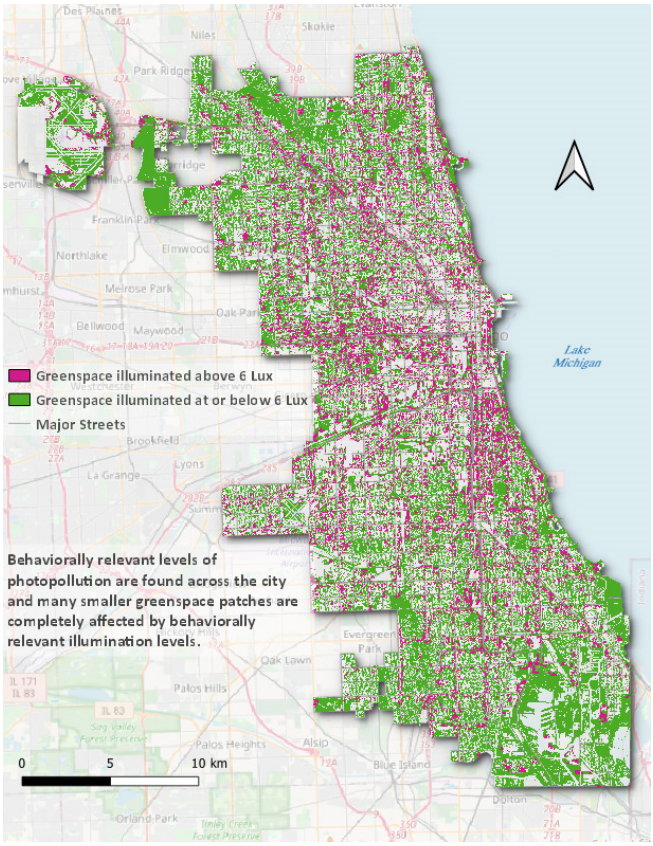

Fig. 2. Photopollution fragments greenspace in Chicago. We mapped areas with illumination above 6 lux, as we found this value to be significant in both the lab and the field, but this should not be taken to imply that areas with less illumination are not photopolluted.

Many of the city's smaller greenspaces are completely illuminated at behaviorally relevant levels, and many large greenspaces are split up by light-polluted areas. If we consider artificial light, Chicago's greenspace is characterized by separate, moderately sized green patches.

While we don't mean to suggest illuminated greenspaces have no conservation value, we do think it's important to consider the presence and spatial pattern of nighttime light when we think about urban habitat. Our findings indicate artificial lighting patterns may influence wildlife behavior throughout urban areas. Furthermore, some studies have found behavioral changes at even lower light levels than we used in the lab. At the light levels at which these studies found impacts on biological clocks, even more of Chicago's greenspace would be compromised. Evidence is mounting that we should be considering these issues in urban greenspace design and urban wildlife policy. Our study is one example of a highly cost-effective research technique that scientists and planners could use to assess how light pollution might affect wildlife in their city. Urban wildlife faces numerous challenges, ranging from roads and traffic, to new competitors and predators, to direct interactions with humans, in addition to light pollution. We are just beginning to understand light pollution's effects, and how it interacts with these other factors. Studies like ours can improve our understanding of how urban wildlife reacts to modified light levels and to support management and conservation decisions.

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