Do energy-efficient LED lights cause unexpected ecological damage?

March 28 2016, by Alexandra (Sasha) Wright

New LED streetlights in the city of Houston, Texas. Credit: meltedpastic

Planet earth runs on light energy. Light energy from the sun powers photosynthetic processes in plants and different wavelengths of light cue these plants to flower, move their leaves, and grow taller. These same

cues influence animals as well. Insects are attracted to narrow range UV lights, based on the evolved sensitivities to UV light in their eyes. Some birds are adapted to only sing mating calls at night based on the light quality from a full moon. High light levels can increase the mating behaviors of some frogs and changes in the quality of light can affect bird nesting behaviors. With so much of the natural world dictated by fine-tuned associations with light quantity and quality, how does the constant light pollution of cities affect the behavior of these organisms? Can different types of light pollution (street lights, billboards, or cars) affect ecological interactions in different ways? And can we design cities to interfere less with these naturally evolved relationships?

Work published this week in *PLoS One* explores the differences between different types of light bulbs (newer LED vs. older low-pressure sodium) on the behavior of suburban bat populations.

Many cities worldwide have begun to shift towards LED light bulbs in streetlights due to improved color rendering (broader spectrum light quality) and increased energy efficiency over time. In fact, the United States Department of Energy reports that residential LED's can reduce energy use by 75 percent and last 25 times longer than traditional incandescent lighting. In places like New York City, these changes are projected to result in up to $14 million annually (energy savings and maintenance) and are a huge step towards to city's goal of reducing carbon emissions 30 percent by 2030.

However, changes in light quality and quantity resulting from widespread changes in streetlight bulbs will almost certainly affect urban populations of plants and animals as well – but maybe not the bats?

This week, Rowse et al. (2015) demonstrated that bat populations in suburban areas of the UK were unaffected by a switch from low-pressure sodium (LPS) bulbs to higher efficiency LED bulbs.

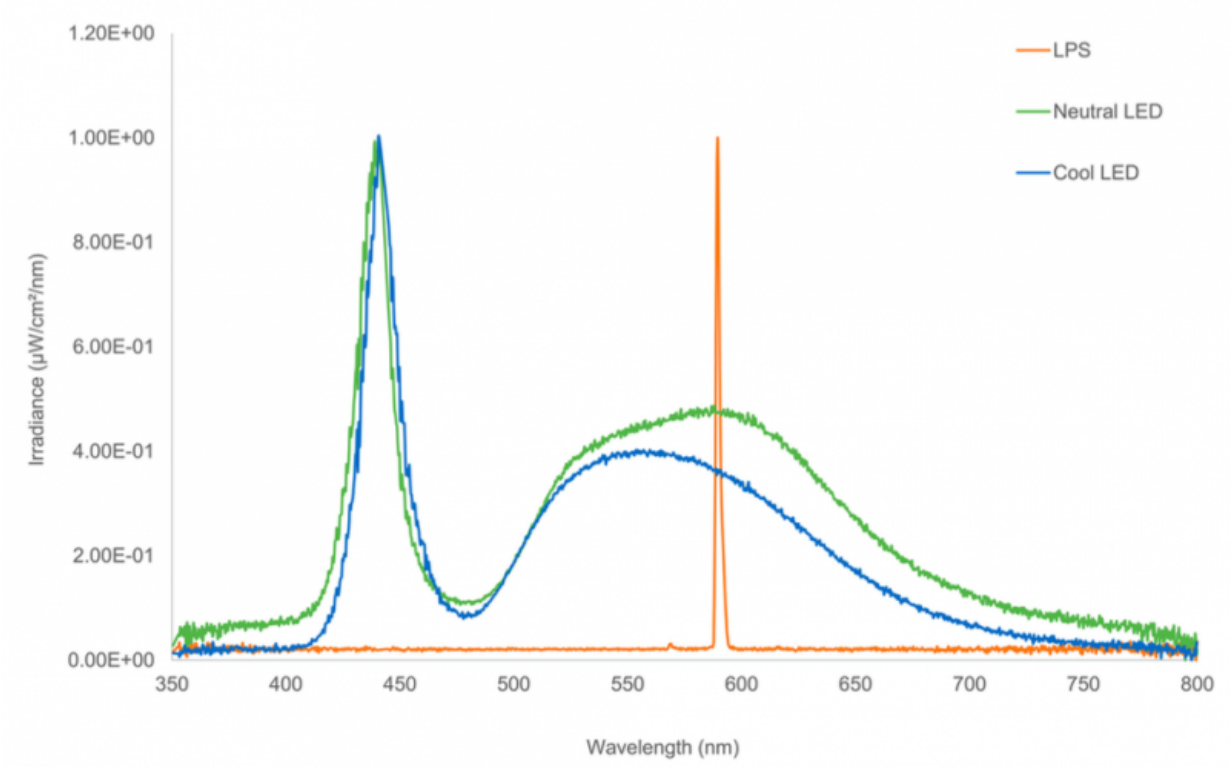

Fig 1. The spectral output of LPS and LED street lights, representative of the lights used in this study. LPS and neutral LED spectral outputs were taken from site J and the cool LED spectral output from site G, shown in Fig 2.

Credit: Rowse et al. 2016

The authors studied bat behavior (bat calls and feeding behavior) before and after streetlight replacements with LED bulbs. Bats are usually attracted to these streetlights due to some combination of (1) the high abundance of food (insects) attracted to these light environments and (2) the ability of some bats, such as vesper bats, to see the UV light emitted from some types of bulbs (e.g. metal halide). The authors suggest that in this comparison between LPS and LED bulbs there is little change in light quantity in the UV range. LPS emits light in a much narrower range, but the cool LED's used in the studied municipalities do not emit in the UV range at all, and the neutral LED's emit at a very low level.

This may mean that in our design of more sustainable cities, the switch to LED's may be a reasonable choice for both energy efficiency and bat behavior.

But the story likely isn't quite that simple – particularly for the insect populations that drive many of these patterns.

Past work in New Zealand indicated that a switch to LED lights can increase insect attraction to artificial lights by as much as 48 percent when compared to high-pressure sodium (HPS).

Common Pipistrelle bat. Credit: BioBlitz Bristol

Conversely, the authors point to a study in Germany showing increased attraction to HPS over LED lighting. These discrepancies may be due to differences in context: the New Zealand study was conducted in rural habitat while the German study was done in the city of Dusseldorf. The picture isn't yet clear.

The design of more ecologically sustainable cities has become a major topic of conversation in recent years. Understanding how a shift in light quantity and quality will affect current plant and animal populations is an essential piece of the puzzle. Importantly, ecological interactions in urban environments are starting in a disturbed state.

It may be tempting to ask: Why aren't we designing lighting solutions that more closely mimic "natural" non-urban environments? In the case of cities, this may be impossible.

attraction to street lamps in Tudela, Spain. Credit: Oiluj Samall Zeid

Natural conditions would be low to no light, and this isn't feasible when we are simultaneously trying to manage for human safety and function.

In the design of sustainable cities the question probably has to be: How do we design lighting solutions that reduce rapid changes from the status of the past several decades? This will mean that we aren't suddenly applying a new environmental filter that affects plants and animals in entirely new and different ways. At the very least this should reduce environmental variability, and will likely lead to more ecological stability over time.

More information: Elizabeth G. Rowse et al. The Switch from Low-Pressure Sodium to Light Emitting Diodes Does Not Affect Bat Activity at Street Lights, *PLOS ONE* (2016). DOI: 10.1371/journal.pone.0150884

S. M. Pawson et al. LED lighting increases the ecological impact of light pollution irrespective of color temperature, *Ecological Applications* (2014). DOI: 10.1890/14-0468.1

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