Hello Darkness, My Old Friend…
By Kathleen Jermstad

I overheard two women conversing in a coffee shop, “I didn’t sleep much last night. Our neighbor put up a security light on their garage and it shines in our bedroom all night!” said the first woman, as she sat down.

“Yikes. It seems that lighting is the *in thing* these days. And as bright and blue as they come! Even someone’s small porch light is so bright it blinds you like brights of an oncoming car!”, her coffee mate responded. “Are you going to talk to your neighbor?”

The first woman replied, “Yeah, that would be the kindest thing to do,” then added, “I need to keep Roger from taking a slingshot to it first!” They laughed and continued their visit as I packed up my laptop.

As I drove away, I reflected on the number of porch lights that blinded me last winter driving the back road that leads home. It *does* seem to be a new trend. When I moved here 52 years ago, there were very few lights visible from the road. Constellations and the Milky Way were easily seen with the naked eye. When listening to the conversation at the coffee shop, I pondered the physiological effect lighting has on humans as well as non-humans. In my pondering I discovered that night illumination has a strong effect on the circadian rhythm of *all* animals and will share some of what I discovered here.

The 24-hour circadian period regulates our rhythm of cortisone and melatonin production, which induces wakefulness and sleepiness, respectively. Melatonin, which is secreted in the pineal gland, is robustly suppressed by artificial-light-at-night (ALAN). That is why health professionals advise us to turn off electronic devices two hours before bedtime, especially ones that produce blue light because of interference with melatonin production. This interference, according to studies, can cause myriad physiological imbalances such as insulin resistance and diabetes. Melatonin is produced in both animals and plants, playing a crucial role in regulating circadian rhythms and other physiological processes.

There are studies describing the effect of ALAN on several classes of animals, and in most cases the effect is deleterious. ALAN not only affects the daily clock in migrating birds but also their annual clock. Eighty percent of the birds in North America migrate with 70% of them doing so at night (Helm et al. 2024). ALAN induces physiological changes that cause birds to sing at night, leaving them exhausted as they remain awake during the day as well. ALAN can also shift the timing of egg laying, which can result in a failed nest. Migratory birds are often drawn to the lights of cities, affecting their navigation, and sometimes causing them to crash into tall buildings (Burt and Horton, 2023). Luckily, there are no tall buildings in our landscape.

When it comes to predators and ALAN, it's a mixed bag. In some cases, the success of a nocturnal predator can be negatively impacted because their eyes are adapted to hunt well in darkness. On the other hand, if their prey happens to be attracted to light, then a predator will take advantage of that. Deer are attracted to lights in the wildland-urban interface because lights are associated with green vegetation. Cougars will follow but are shown to make their kill in the shadows of the landscape (Ditmer et al. 2021). Hence, ALAN can either enhance or diminish hunting success of predators depending on species and location. Either way, it alters predator-prey dynamics. Bats are nocturnal predators and even though they hunt by echolocation and not by sight, artificial illumination can have a secondary effect. Some bats are light-sensitive like the Little and Big Brown bats and avoid lighted areas. However, others, like the Hoary bat, forage on insects that swarm around artificial lights. There is a paucity of studies about the effect of ALAN on smaller predators such as fox, bobcat, ringtail, badger, ferret, weasel, and racoon.

ALAN has been found to strongly affect invertebrates. There has been a 45% decline in insects over the last four decades. Research showed that lowering light levels by 50% attracted fewer omnivores to nocturnal ground dwelling invertebrates (van Koppenhagen 2024). The swarming of aerial insects around outdoor lights depletes their energy, leaving them vulnerable to predators and can potentially cause them to miss courtship cues from mates. ALAN can harm diurnal aerial insects as well. Monarch butterflies, when exposed to

nocturnal light, will flit and flutter when they should be resting, and the next day, they appear to be disoriented from their migration route (Parlin et al. 2022).

I knew from my work with conifers that photoperiod disruption affects growth during controlled cultivation, but I was surprised to learn that plants produce melatonin. As with animals, ALAN can suppress melatonin, disturbing circadian-regulated parameters related to growth, flowering, leaf drop and other important seasonal development (Sun et al.). Specific frequencies of the visible light spectrum (400-700 nm) are used in greenhouses to produce desired effects such as using blue light (400-425 nm) to suppress flowering, and red light (630-660 nm) to promotes flowering and stem development.

A robust study in the *Journal of Neuroscience* (Bedrosian et al. 2013) suggests that light on the blue wavelength end of the spectrum has a greater effect on circadian rhythms (particularly nocturnal behaviors such as sleep), cognition and mood than light on the red end. As for the blue brightness of outdoor lights on my drive home last winter, the *California Energy Commission, Title 24, Section 6.4.1* requires that all marketed outdoor lighting "be high luminous efficacy". However, there are now multicolor LED lights on the market that can be adjusted for color tone as well as brightness.

Back to the coffee shop… in El Dorado County, outdoor lighting for all dwellings require that outdoor luminescence does not encroach or trespass onto adjacent properties or public rights-of-way. The *El Dorado County Outdoor Lighting Standards*, *December 2015* for commercial, single- and multi-residential dwellings *(Section 3.5 A and B)* states that "security lighting shall be activated by motion sensors and remain in the 'on' mode for a maximum of 10 minutes". The *City Code of Placerville, Exterior Lighting Regulations, Section10-4-16* has a minimum and maximum illumination standard on outdoor lighting, and a standard that requires that lighting be off from 11pm to 6am on commercial and multi-residential complexes (with some exceptions). Both El Dorado County and Placerville require shielding or hooding on outdoor lighting and prohibit light trespass onto adjacent property or public rights-of-way. Holiday decorative lights are exempt.

Most residents don't realize the effect that lighting can have on their health and their neighbor's health, both human and non-human. I didn't, until I was prompted by the two women talking at the coffee shop. They didn't realize that there are county standards pertaining to outdoor lighting. The takeaway here is if outdoor lighting is a must, choose motion-sensor lights with automatic shutoff and adjustable multicolor LED hues. If NASA is interested in night lights and the environment (*Black Marble),* maybe we should be as well. Be kind to one another.

Citations

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https://library.municode.com/ca/el_dorado_county/codes/code_of_ordinances?nodeId=TIT130ZO_ART3SIPLPRDEST_CH130.34OULI

El Dorado County Outdoor Lighting Standards
https://www.eldoradocounty.ca.gov/files/assets/county/v/1/documents/land-use/planning/outdoor-lighting-standards-adopted-12-15-2015-fillable.pdf

City Code of Placerville
https://codelibrary.amlegal.com/codes/placervilleca/latest/placerville_ca/0-0-0-8414

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https://naturalbornferret.com/alan