

Public art on The Fair-Haired Dumbbell building in Portland, OR, with uplighting that casts light unnecessarily into the sky

Photo: Mary Coolidge

LOSS OF NIGHT

Ecology, human health, and culture

For 4.5 billion years, there was no electric light on Earth. Biological systems on this planet evolved under regular cycles of naturally dark nights and bright days. Virtually all biological processes are governed by those cycles—a relationship known as circadian rhythm. But by the late 1800s, the first electric streetlights were installed in Paris and London, and over the course of the last 140 years, we have lit up the night on a truly global scale. Gone are our naturally dark nights in many places on the planet.

The use of light at night only continues to increase today. Light pollution has grown and expanded with

By Mary Coolidge

the expansion of cities, electrification across more of the planet, availability of increasingly inexpensive sources of light, and now, the ubiquity of LEDs that produce blue-rich white light. While light trespass was once primarily the bane of astronomers, the issue has become a much broader cultural and ecological one as light pollution increases at nearly 10% per year.¹

The contemplation of the night sky is both ancient and modern. Our human ancestors experienced nights under impossibly star-studded skies, a reality that influenced farmers, storytellers, astronomers, nautical explorers, poets, and painters. What happens to us culturally when our urge to look up at night is met not with a sky full of stars but a cloak of light pollution? "The New World Atlas of Artificial Night Sky Brightness"² reveals that more than 99% of people in the U.S. live under light-polluted skies, and 80% of us reside in places from which we can't see the Milky Way. The more we become habituated to degraded night skies, the less connected we are to the starry wonder

that has influenced humanity for millennia. Many of us don't even know what we're missing.

Light at night is, of course, incredibly useful. As a predominantly diurnal and visually-reliant species, humans need light at night to facilitate after-dark activity. This includes lighting the way for pedestrians, cyclists, and drivers, increasing our sense of safety, supporting economic activity, improving wayfinding, and even introducing beauty into the built environment. But there is also a cost to light at night. Light can act as a pollutant in the nighttime environment, with serious affects not just on our culture but also on our health, as well as a range of impacts—from subtle to catastrophic—on the biology and ecology of at least 200 different species of animals, including amphibians, birds, fish, invertebrates, mammals, and reptiles.

Unintended Consequences

Part of the problem is that most people, including lighting designers and engineers, aren't aware of the unintended consequences of artificial light in the nighttime environment, and so our lighting is too often poorly aimed, poorly shielded, too bright, and turned on when we aren't using it. This happens in the name of perceived safety or commerce, guided by the old axiom that if some is good, more must be better, rather than by nuance and mindfulness about responsible design approaches. What's more, the shift to more energy-efficient LEDs was expected to reduce light pollution on the planet; instead, the rebound effect—the tendency to use more of something when it is less expensive—is resulting in excessively bright and unnecessary lighting. It may be cheaper, but at what cost?

Another issue driving increases in light pollution has been the use of higher CCT lighting with shorter wavelength light that scatters more readily in the atmosphere than longer wavelength light. Fuller-spectrum LED lighting, especially blue-rich white light with a spike in the spectral output around 450 nm (the peak wavelength sensitivity of most vertebrates) poses a significant threat to biodiversity and ecosystem conservation. When we introduce artificial light at night, particularly lighting that mimics daylight or emits a lot of short wavelength blue light, the complex choreography of ecosystem dynamics is jeopardized. Hundreds of peer-reviewed, published papers have demonstrated deleterious impacts of light at night on every taxa—including humans and plants. Light at

night has been shown to reduce melatonin secretion, interrupt sleep, confuse celestial navigation, cause misorientation in nocturnal movements, result in attraction and repulsion behaviors, create habitat fragmentation, reduce fledgling success, increase stress hormones, reduce disease immunity, interfere with predator/prey relationships, extend activity of diurnal species into nighttime hours, and skew timing of breeding, nesting, migration, foraging, bud burst, and leaf drop.

Research published by the National Institutes of Health has drawn correlations between exposure

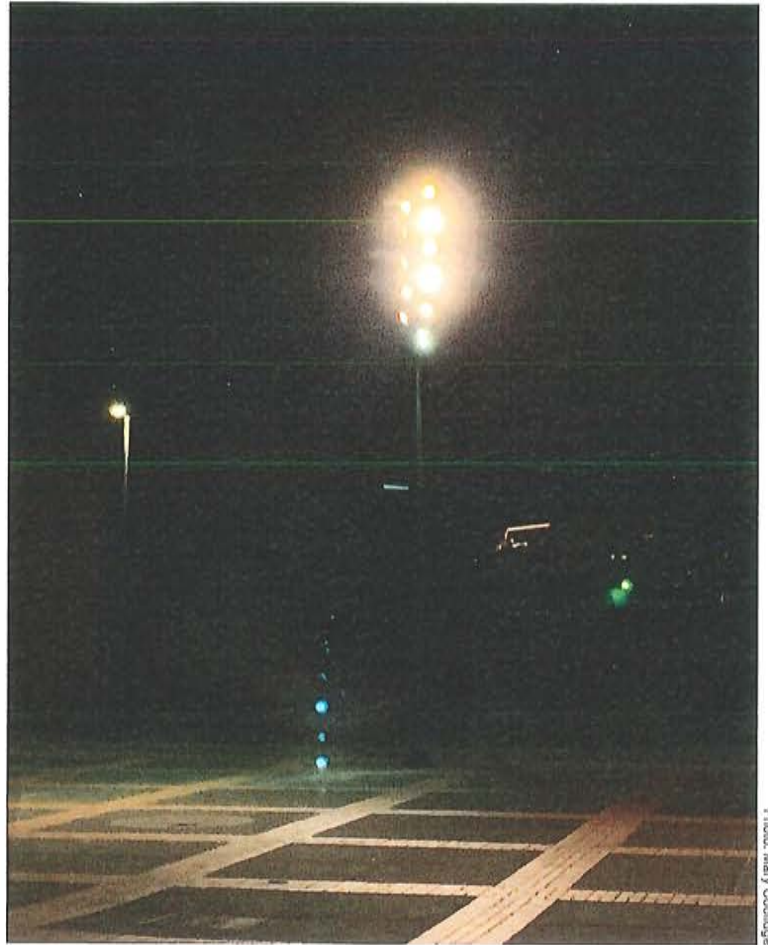


Photo: Mary Coeidge

The Oregon Museum of Science and Industry spire creates significant glare in an area along the Willamette River that might otherwise be appealing for an after-dark walk.

to light at night and adverse health outcomes, including breast cancer, prostate cancer, and non-Hodgkin lymphoma. The Centers for Disease Control and Prevention considers night work a probable carcinogen, citing research by the International Agency for Research on Cancer concluding that there is “high confidence” that persistent night shift work that results in circadian disruption can cause human cancer. The American Medical Association has also published guidance recommending that municipalities convert their street lighting to 3000K or below lamps that minimize blue-light emissions.



Humans themselves are subject to the unintended consequences of all this light.

Migratory Bird Navigation

One example of ecological light pollution is the impact of light at night on migratory birds. Many people are surprised to learn that most birds migrate at night and use star maps as an important component of their navigation system. But these migrants are increasingly encountering sky glow from cities along their migratory routes, which drowns out the stars they are using to navigate, draws them into our cities where they can die colliding with lit structures, or circle endlessly in lit areas until they collapse from exhaustion. On any given night in the spring and fall, millions of birds are aloft across our North American skies. This migration is largely unseen, unless you happen to be one of the elite few aeroecologists who watch bird movements on radar maps, having learned to decipher the unique signatures of birds that differentiate them from precipitation, bats, and bugs.

Researchers on Cornell University's BirdCast team and in Colorado State University's AeroEco Lab are doing just that. They use the hundreds of doppler radar stations around the country to track bird migration, and build models using conditions like precipitation, wind, and temperature to help them predict large movements, then broadcast Lights Out Red Alerts on nights when they anticipate movements of large numbers of birds in our airspace. These Red Alerts help building owners and residents reduce their unnecessary overnight lighting at key times: at least on big movement nights or—even better—during the entire month-long



Photo: Mary Goodidge

Top: A nighttime view of a building in Portland, OR, with the lights on (left) and off (right).

Right: Top-lit billboards help reduce unnecessary light trespass into the sky.

peaks of spring and fall bird migration. This collective action helps reduce the risk of mass attraction and collision events like those that have been seen in Charlotte, NC; Chicago; Galveston, TX; and New York City, in recent years and which have been documented since the late 1800s at lighthouses, the Statue of Liberty Torch, and airport ceilometers (lights used to measure cloud height).

There are active Lights Out programs in dozens of cities across the country. The public can subscribe to <https://birdcast.info/migration-tools/local-migration-alerts/> to receive e-mail red alerts. As an even better practice, adopting the habit of reducing unnecessary overnight lighting all year long helps mitigate the many other ecosystem level impacts that occur throughout the seasons... and your neighbors might just love you for it.

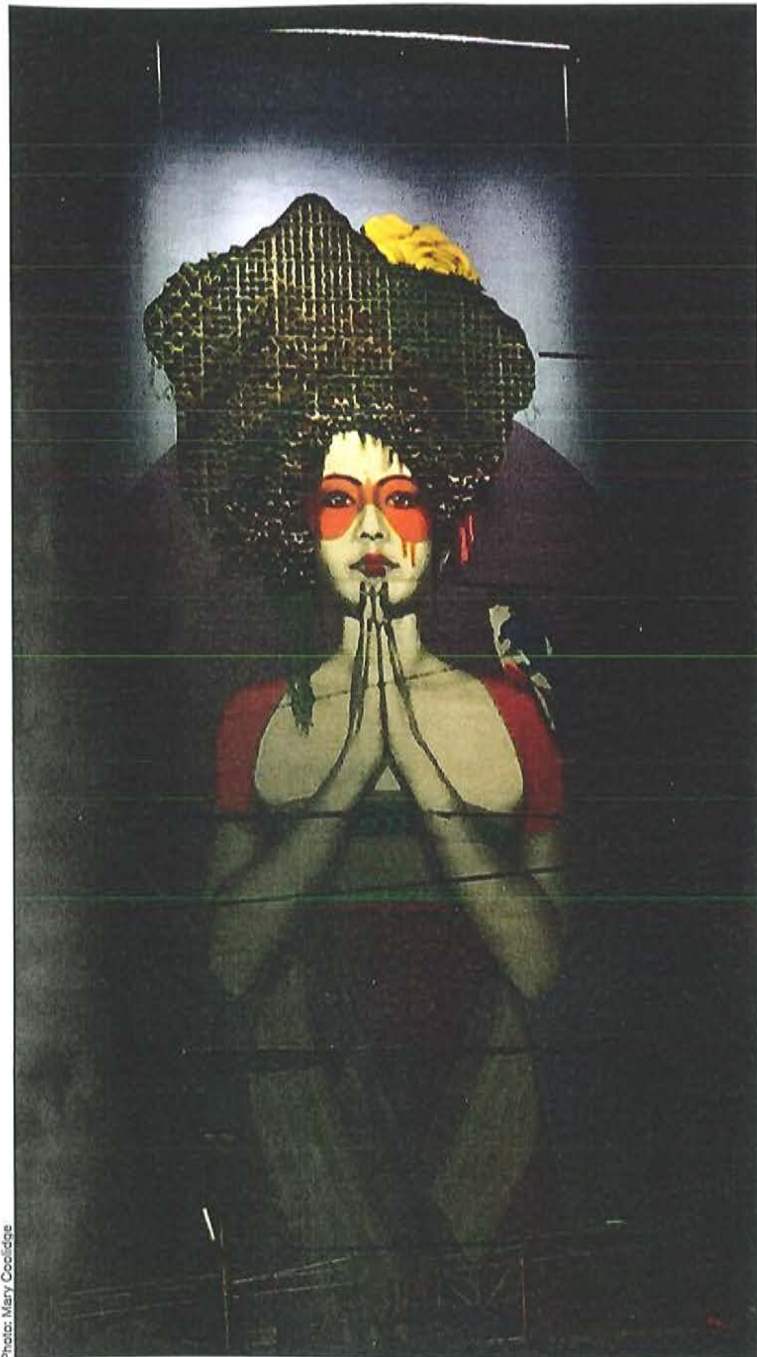


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Evolving Research

The field of research on the impact of LEDs on the biology and ecology of species has exploded in recent years, and there are veritable volumes of information on the topic at our fingertips. That said, there is yet to be a concise and comprehensive synthesis of this information to help inform lighting decisions by designers, biologists, planners, and land managers. Travis Longcore at the University of Southern California has researched and written extensively on ecological light pollution and has produced guidance on lamp color spectrum impacts.³

Mother Earth painting in Portland with top-down lighting, which highlights the art and illuminates the sidewalk below without casting light up into the sky.

While there is no single CCT that works best for mitigating impacts on all biological systems or taxa, the best advice on color spectrum is to select narrowband amber lighting wherever possible—2200K to 2700K or below. But color temperature is only one of several practices that should be used to mitigate the unintended impacts of light at night. The IES and DarkSky International have developed a list of fundamental best practices known as the Five Principles of Responsible Outdoor Lighting:

- Minimize any unnecessary lighting.
- Target lighting with full shields and aim it down.
- Limit the total brightness—use only as much light as is needed.
- Use adaptive controls like timers, motion sensors, and dimmers.
- Choose warm color temperatures (3000K max) to limit blue-light output.

Minimizing Unintended Impacts

As more lighting designers, engineers, and end users become aware of the unintended consequences of overlighting our nights, and embrace the need for more thoughtful lighting practices, we move closer to a safer, more vibrant, and more ecologically-balanced future. Lighting can be beautiful, warm, layered, visually interesting, aid in wayfinding, and help create a sense of place, all while following best practices and reducing light pollution. We have access to all the tools we need: new, highly tunable LED lighting technology; increasing information on good, multi-objective lighting practices; sensible outdoor lighting standards in a growing number of jurisdictions; and the Five Principles of Responsible Outdoor Lighting. Together, these offer the potential to realize all the benefits of light at night while simultaneously minimizing the unintended impacts of artificial light in the nighttime environment. ©

THE AUTHOR | Mary Coolidge is the BirdSafe Campaign coordinator for Bird Alliance of Oregon. She is dedicated to improving efforts to make urban environments more hospitable to wildlife and helping to connect people to nature.

References

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