

Monitoring a loggerhead turtle nest before a protected nighttime release, when the beach is quieter and the sea safer.

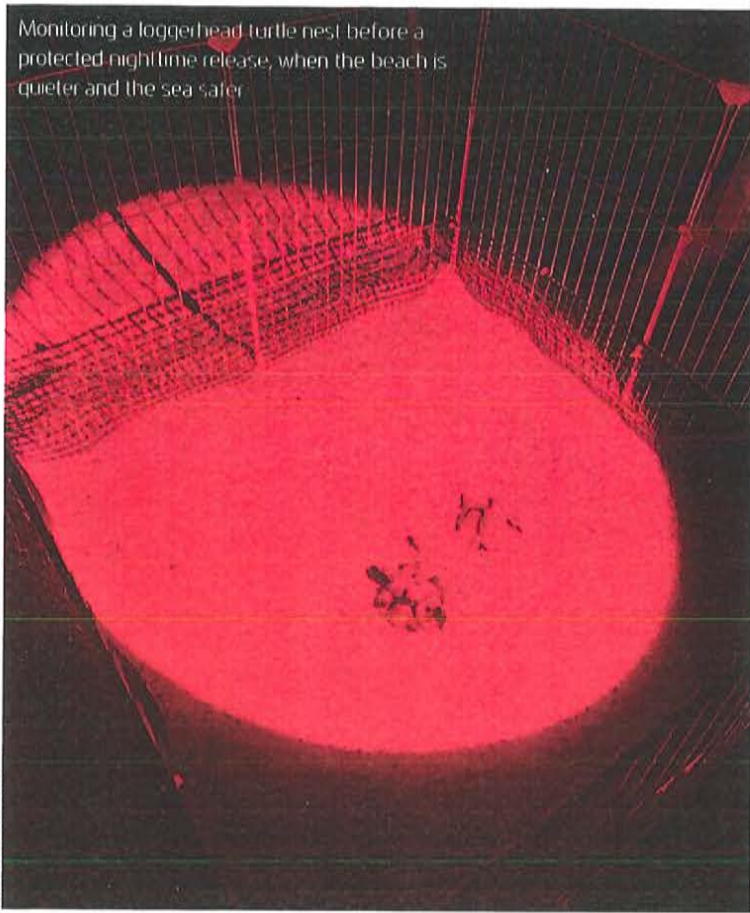


Photo: Chiara Carucci

THE LAY OF THE LAND

Creating harmony as stewards for diverse ecosystems

The lighting industry is undoubtedly aware of the importance of dark skies and the regulations designed to mitigate light pollution. However, beyond these well-known challenges, lies a much deeper task—to understand and respect the environment as a complex ecosystem.

As lighting professionals, our designs affect not only human experience but the intricate web of life that thrives under the natural rhythms of day and night in every setting. This work is so far-reaching

By Chiara Carucci

that it covers dense urban centers to rural farmlands, as well as coastal stretches to inland areas. As a result, the work of lighting professionals must evolve from a narrow focus on individual species or compliance checks to a broader, ecosystem-sensitive perspective.

The first step is to understand how artificial lighting impacts natural surroundings. Artificial light at night (ALAN) is a pervasive environmental stressor. Ecological light pollution disrupts natural light regimes, interfering with the circadian rhythms of animals, plants, and even entire communities. Scientific research has revealed that exposure to ALAN can disrupt mating, foraging, migration, and other critical behaviors. For instance, even low levels of artificial illumination, akin to natural moonlight, can alter the behavior of nocturnal animals and disturb the finely tuned cycles that have evolved over millennia.

Consider the case of migratory birds, whose navigation systems rely on natural light cues. When exposed to artificial lighting, these birds may become disoriented, leading to fatal collisions with illuminated structures. Similarly, loggerhead turtle hatchlings depend on the natural light horizon to find their way to the sea; disorientation caused by coastal lighting can tragically lead to mass fatalities.

The influence of ALAN extends beyond fauna. Plants respond to photoperiods that govern flowering and seeding. When these natural signals are disrupted, the consequences can ripple through entire ecosystems, affecting pollination and the overall balance of species interactions.

In urban areas, sky glow can extend well beyond city limits, impacting green spaces and wildlife even tens of kilometers from urban centers. Urban parks and green corridors, which serve as vital refuges for migratory or light-sensitive species, are at risk when exposed to excessive or misdirected light. In rural settings, linear lighting—for example, streetlights along country roads—can create barriers that hinder the natural movement of smaller animals, impeding their transition between resting and foraging areas.

When considering protected sites, the stakes are even higher. Lighting should be limited to essential safety needs to minimize ecological harm. This is particularly important to understand in aquatic environments, where artificial light behaves uniquely. Light reflecting off water surfaces can spread over vast distances, influencing marine life and organisms with high sensitivity to low light levels.

One prominent example is the LIFE21 Turtlenest pilot project in Italy, which is a conservation effort aimed at mitigating the impact of ALAN on loggerhead turtles. By upgrading to warm-white LEDs and optimizing light distribution, the design supports not only turtle nesting but also dune ecosystems, showcasing a comprehensive ecological approach. Collaborations with marine biologists, local authorities, and community involvement were also key to fostering a balance between human activities and the natural rhythms of coastal ecosystems.

Ultimately, whether it's urban, rural, protected, or aquatic, the ecological impacts of ALAN remind us that light is a potent modifier of natural behavior and ecosystem dynamics.

Looking Beyond Single-Species Solutions

Another important consideration when designing lighting for dark environments is that traditional lighting projects—and choices of products that are often labeled as “friendly” for wildlife—often focus on mitigating harm for one particular species. Yet, whether in a city's green space or a remote forest, ecosystems function as networks of interdependent species and environments.

An urban park might host a variety of species ranging from nocturnal pollinators and birds to small mammals, all relying on a delicate balance of light and dark. Designing lighting that considers only a single species can lead to unintended consequences for others. For example, using specialized spectra, such as red lighting for bats, can create unintentional ecological traps for species that are unable to detect it, potentially increasing their vulnerability to predation.¹ Instead, we need to assess how light influences an entire ecosystem, from microbial communities to top predators.

In a recent project in Sweden, discussions with a city architect, a zoologist, and an ornithologist highlighted a situation where beaver activity was affecting tree health and, by extension, bird nesting sites. This interdisciplinary dialogue led to a lighting strategy that not only minimized disturbance to the affected species but also supported the natural behavior patterns of the entire ecosystem.

In Italy, the Collepardo Caves project demonstrates how lighting design can balance cultural and natural heritage with visitor's needs by reducing lighting operation times, controlling light direction, and maintaining dark aerial corridors for bats. Collaboration with local managers and scientists ensured the ecological integrity of the site.

A true ecosystemic approach involves understanding the local context, recognizing that each site possesses its own unique tapestry of relationships and interdependencies. It means collaborating with ecologists, biologists, conservation architects, and local stakeholders to map out the intricate dynamics at play.

Practical Considerations for Lighting Professionals

For those in the lighting industry, integrating a transdisciplinary approach into our design process may seem challenging, yet it offers immense rewards. For example, Hamngatan and MDU Plaza in Sweden is an urban lighting project that minimized skyglow and spillover onto nearby water surfaces to protect migratory birds and wildlife, while enhancing social connectivity. This project



Photo: Erik Hagström

Hamngatan and MDU Plaza in Sweden: lighting design shaped by ecosystem awareness, with special care for migratory birds.

exemplifies the importance of knowledge-sharing and collaborative dialogue throughout the planning process as essential tools for achieving effective design and long-term sustainability.

As with any change, there are practical considerations.

- Embrace interdisciplinary collaboration: Partner with ecologists, biologists, and local conservation groups to develop lighting solutions that address the full spectrum of environmental interactions.
- Conduct comprehensive ecosystem studies: Understand species behavior, local biodiversity, and seasonal cycles as a backbone of an effective, informed design.
- Implement adaptive management: Take a



Photo: Jansin and Hammarling

flexible approach to the lighting design. Use research and on-site monitoring to iteratively refine lighting strategies as ecological conditions evolve.

- Optimize optics and controls: Combine technologies for precise spatial and temporal adjustments to minimize ecological impacts.
- Embrace constraints: Budget, technical feasibility, and environmental conditions are frameworks within which innovative, sustainable solutions can be developed.

A Call to Embrace Conservation

The future of outdoor lighting lies in our ability to see beyond immediate technical challenges and recognize our role as stewards of diverse ecosystems. Informed lighting design is not merely a technical exercise. By incorporating ecological considerations at every stage of a project, from initial assessment to post-installation monitoring, we can create environments that are comfortable, functional, and environmentally responsible.

Through the work of environmentally conscious organizations, lighting designers will always have inspirational individuals and collectives to which they can turn. The trailblazers in this field help create

Collepardo Caves: the fault line is softly lit only at the end of the tour, preserving dark aerial corridors for bats.

unbiased and accurate guidance, consultancy, and project management based on extensive research and expertise that can benefit and shape the entire lighting industry.

We have the expertise, the innovative capacity, and the responsibility to design solutions that honor the complexity of the ecosystems we impact. Whether designing for a metropolitan street, a rural pathway, or a coastal shoreline, let our lighting designs contribute to long-term sustainability and the potential harmonization between us and the environment, of which we are an integral part. ©

THE AUTHOR | Chiara Carucci is the founder and principal lighting designer at Noctua. Since 2018, she has pushed the boundaries of traditional lighting design to incorporate innovative solutions for architectural and ecological conservation.

Reference:

¹ Annika K. Jägerbrand and Kamiel Spoelstra, "Effects of anthropogenic light on species and ecosystems," *Science*, vol. 380, no. 6650, June 15, 2023.