To light or not to light: Exterior illumination of tall buildings and bridges and its negative impact on the life of birds and fish.

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REVIEW
PLDC 2013
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Exterior illumination of tall buildings and bridges and its negative impact on the life of birds and fish – what professional lighting designers need to know.

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Over the last hundred years, people have radically altered the appearance of the night sky. The development of industry, change in lifestyle and mass consumption depending on the time of day – have all contributed to the loss of natural darkness in vast areas of our planet. The studies conducted so far indicate that lighting installations visible after dark negatively impact flora and fauna [1].

Artificial lighting disrupts the functioning of specific organisms such as birds, fish, bats and insects. Observations have shown that too much artificial light, especially coloured light, can have a huge impact on nocturnal species, misaligning their circadian rhythm. Animal preference for nocturnal activity may be due to factors such as avoiding predators, aversion to heat, safer feeding or reproduction. Also changes in the intensity of ambient light at night may lead to problems with reproduction, avoidance of suitable habitats, changes in seasonal migration routes, and to a reduction in numbers or even the extinction of certain species.

In spite of the fact that increasingly more research has been performed on the negative impact of external illumination on flora and fauna, unfortunately it is rarely considered in professional lighting design practice; the reason being that researchers and scientists focusing on biodiversity do not share the findings of their scientific work with those who design the lighting – professional lighting designers. On the other hand, lighting designers lack any information available on the above topic and there are no established guidelines to follow. With this article I would like to start a discussion based on the relatively recent discoveries of how much all life on earth relates to natural light, and to question the idea that evolution has embodied within all living organisms a natural sensitivity towards their native environment, in particular towards white and coloured light. Additional-ly, I would like to establish a set of guiding principles on how to reduce the negative consequences of external illumination on the lives of birds and fish.

Illumination of tall buildings and structures

Since the invention of the electric bulb the concept of exterior illumination on buildings has captured the imagination of architects, buildings owners, lighting designers and the general public. Exterior architectural lighting is associated with power and prestige. However, with the change in people’s perception of the environment and ecological issues it has become a “hot” topic.

For millions of years birds have evolved under a day-night cycle, where the bright light of the sun during the day was replaced at night by weak light from the moon, stars and planets. This situation ended very recently when humans started to artificially light the nighttime sky, which is most visible in industrialized areas. Globally, hundreds of millions of migratory birds are affected by the presence of artificial light in a yearly basis during their spring and autumn migration, many of which do not survive the encounter. The attraction of birds to light has been known for a long time. High bird mortality rates have been recorded in connection with lighthouses [2], illuminated television towers and other uplit structures and buildings [3]. According to researchers, many hundreds of species of birds typically migrate at night [4], using the stars as a way-finding system.

When the moon and the stars are shining and there are no clouds, and the night sky seems to be clear, the birds fly over the roofs of buildings, towers and bridges, avoiding the risk of collision. Most migrant birds soar to a height of about 450 metres [5], but some species soar below 90 metres when the visibility is good [6].

It is known that the reaction of local and migratory birds to artificial light is largely dependent on the characteristic wavelength of the light source. Birds also appear to have excellent colour vision, which attracts them to coloured light (they have five different types of visual pigment and seven different types of photoreceptor).

According to research, the long wavelengths such as red and white have disorienting effects on migratory birds due to light frequencies. Hardly any noticeable effect on orientation was recorded under short wavelength light (such as blue and green light) [7].

Depending on the wavelength, artificial light may interfere with the functioning of the internal compass in a bird’s brain, a key orientation mechanism. When there is no indication in the sky and the stars are obscured by clouds or fog, the...
magnetic orientation serves to help migratory birds (11). Artificial light under moonless conditions impairs birds’ ability to orient themselves. Due to brightly, externally lit glass buildings, birds can become confused and fly into lit windows. At lower levels of the buildings, they may also fly into images of trees reflected in the glass. Laboratory experiments have shown that migratory birds require light from the blue-green parts of the spectrum for magnetic compass orientation (16). The use of magenta, blue and indigo light has a minimal effect on their disinclination, and red and white has a negative impact – the birds are “trapped” in a lit area, they cannot return to the darkness – the birds are “trapped” in a lit area, they cannot return to the darkness.

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distribution of freshwater and estuarine fish, which are all affected by natural diurnal and lunar cycles of light (21). Artificial light from a single source and equivalent to the intensity of starlight (0.0005 to 0.001 lux) is sufficient to affect the behaviour of some freshwater fish (22).

Therefore artificial light from illuminated bridges can have a significant impact on the migration of certain fish. Young salmon species migrate through streams and rivers to the oceans and sea, the adult fish migrating upstream to spawn. These fish migrate at night, cued by artificial light levels when the natural lighting is reduced – for the fish, the easiest way to avoid the predators and increase their chances of survival. Observations have shown that artificial illumination of many bridges presents a possible predisposition for wild salmon migrating from areas above the bridges. Predators position themselves under lights on a bridge to locate and catch the fish. Hunting increases the migrant shoal, and artificial illumination of many bridges and increase their chances of survival.

Glasgow Bridge, Glasgow UK. In blue and white light reflected in the water, which attracts fish.

**Calatrava.** This unique pedestrian bridge designed by architect Antonio Gaudi effects associated with the use of artificial light. Artificial lighting of many bridges and increase their chances of survival. Through streams and rivers to the surface, causing constant illumination of the water surface. The Sutlej Crossing project in the Royal Botanic Gardens in Kew, near London, is an excellent example of the application of exterior illumination in a ecologically sensitive zone. Kew Gardens is a vast complex of landscaped gardens and greenhouses. The beautiful, sculptural, S-shaped bridge spans the surface of the lake blending harmoniously with the environment. In night-time appearance the result of a cooperation between architect (John Pawson), lighting designers (Speirs and Major Associates), luminaire manufacturer (ACDC Lighting) and ecologists from the Royal Botanic Gardens. Based on the examples presented above it is obvious that during the design phase it is important to understand whether the object is located in a town or city centre with a high level of night-time urban activity where there is already light pollution or whether it is a naturally dark landscape such as a national park, or an area of outstanding natural beauty where illumination may have negative consequences for the environment.

**Guidelines for fish-friendly illumination**

- **design a development that considers fish life when applying artificial lighting**
- **avoid sticky paint and light green which attracts and deters fish**
- **use intelligent lighting control systems to allow maximum control of lighting during dark hours**
- **switch off any lighting compo-nents which are focused directly onto the water or reflected by the water surface during migratory periods as well as every night from midnight onwards**
- **switch off lighting between midnight and dawn when most migrations occur**
- **always shield light sources**
- **propose the use of non-reflective surfaces, finishes and pants to archi-tects to minimize the reflectance of light**
- **seek advice from specialists such as ichthyologists about migratory times**

Today incorrectly applied exterior illumination to tall buildings, structures and bridges is adding to light pollution. This term is often used to describe excessive artificial lighting at night, especially in large urban agglomerations. Contamination of this kind makes it difficult for astros- nomers to observe the sky, and has a negative impact on the flora and fauna which are naturally nocturnically active. This effect is most pronou-nanced in developed and densely popu-lated cities in North America, China and Asia.

The graph on the right-hand page shows the development of exterior illumination in cities in developed and developing countries based on the increased light pollution of the earth’s atmosphere. The extent of future exterior illumination will definitely continue to increase due to new developments in major cities around the world.

**Conclusion**

In recent years we have already witnessed a shift in the approach towards exterior illumination with a focus on understanding what the negative consequences of using artificial lighting at night are. How-ever, many designers do not pay suf-ficient attention to the impact of our artificially lit surroundings and how they influence flora and fauna with negative consequences for evolutionary development. Artificial lighting is applied on towers and bridges almost nonchalance with the sole purpose of achieving beauty-fying effects.

It is also necessary to understand that the only way to minimise such negative issues will be for cities to implement lighting masterplans developed by professional independent lighting designers commissioned by city representatives. Documents in the form of a trend guidelines will be helpful for lighting designers, engineers, architects and other members of the design teams responsible for the lighting design and construction of projects with problematical issues. They would also support planning authorities.

Furthermore, other vital docu-ments forming part of environmental impact assessment of future external illumination in major cities based on the degree of their sensitivity should be established after thorough consulta-tion with ornithologists and ichthyolo-gists as well as other consultants from the biodiversity field defining the migratory times, when light should be switched off completely during the night and early hours of the morning and during non-migra-tory periods special procedures’ designs should be in place to reduce the mortality of birds and fish.

Based on the above examples it is clear that anyone designing lighting has a social and environmental responsibility. It is our obligation as experts to be aware of the latest research, continue our environmental development by expanding our existing knowledge, and frequently question our approach towards the projects we are involved in.

**References**


