

# The dark threats of artificial light – ecological light pollutions

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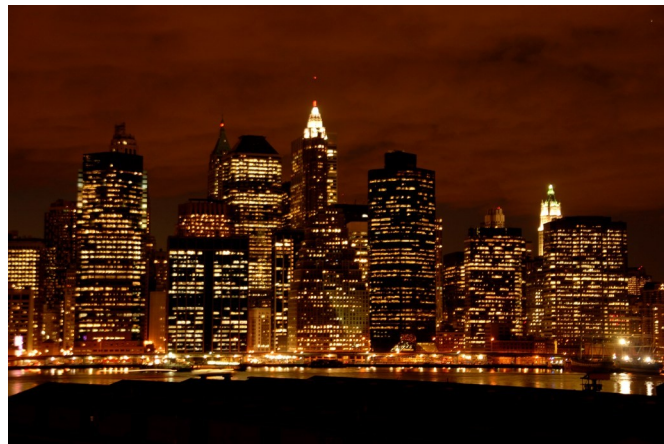
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*Following the earthquake in California on January the 17th 1994, emergency centers all over Los Angeles received calls from terrified locals reporting a strange phenomena: a huge cloud of silver floating in the sky. The giant cloud of silver turned out to be nothing less than the Milky Way, visible for the first time in many years due to the power outage caused by the earthquake. Today, two thirds of the US population and over half of the population in Europe live in places where the night sky is polluted by lighting, to the degree that the Milky Way is no longer visible. Astronomers all over the world have long been aware of this problem and they are escaping the boundaries of society in order to find places unaffected by night-time lighting. However, the effects of artificial night lighting stretches beyond the borders of the human species. The ecological consequences of light pollutions are now of growing interest in the scientific community. The effects can be immediately fatal, such as the well-studied deaths of thousands of sea turtle hatchlings on the beaches of Florida, but the scientific focus is beginning to shift towards the less conspicuous effects. These include changes in the biological clock, reproductive behaviour and disrupted patterns of interactions between different species.*

## What are light pollutions?

For billions of years, organisms have been living with a daily rhythm of variation in light conditions: the day was bright and the night was dark. Since the introduction of gas lighting and electricity in the 19th century, the natural pattern of light and darkness has been disrupted. This pollution in form of ambient lighting of the night sky can be found anywhere close to (and not so close to) human settlements. Light pollution also includes road lighting, horizon sky glow from cities and point sources of light like communication towers and oil rigs.

As light in many ways provide a behavioural clue for animals in different aspects of their life such as navigation, predation and reproduction, the effects of changes in the light environment can be harmful and even fatal. The impact on animal life ranges from direct attraction to artificial light sources to other kind of behavioural changes: avoidance of lighted areas, disruption/displacements of daily activities etc.



Photograph by Tomas Lara

## Through an animal's point of view

How do animals perceive light? The answer obviously depends on the species of animal. It can help us decide how light will influence its behaviour and how to minimize the effects of light pollutions. Humans can see light in the spectral range from 400 – 700 nm, and other species have a wider or a smaller range or a different sensitivity for wavelengths than we do. Many nocturnal animals, such as rodents, have weak color vision, while birds and reptiles in general have a well-developed ability to distinguish between colors. The ability to see ultraviolet light is wide-spread in the animal kingdom, shared by species such as mouse, pigeon and salamander. Recently, there has also been a growing understanding for the importance of polarization of light and how animals perceive this. Especially insects and birds feeding on them seem to have a perception for polarization in different planes.

## Fatal attraction

In the early 60's, a mysterious mass extinction took place on the beaches of Florida. Thousands of newly hatched sea turtles was found dead or exhausted on roads, in gardens and on sand dunes, apparently incapable of finding their way back to the sea. The disturbance in orientation ability was found to be caused by lights from roads and properties, misleading the turtles or disrupting their movement, causing them to wander in circular paths. As the misguided turtles wandered off, they became exhausted and dehydrated, making an easy target for predators and traffic. Intense research on the field lead scientists to conclude that the turtles navigated to the sea by turning to the brightest part of the horizon, away from silhouettes. On a beach unaffected by artificial light sources, the water surface is reflecting the most light, becoming the brightest point in the surroundings. Unfortunately, the light of houses, gardens and roads close to the beach, as well as the distant lights from cities, lead the turtles away from the sea and towards their much too early death. Since the mid 90's, the use of lights on beach properties is closely regulated by law in an attempt to bring down mortality numbers in hatchlings and an alternative, embedded type of road lighting is being tried out.



*Photograph by Scott Robinson*



*Photograph by David Et Magalie*

## A crash course in bird collisions

Sea turtles are not the only animals being fatally attracted to light: each year millions of birds collide with man-built buildings and light is an important contributing factor. Night-time migrating birds are often drawn to cities by the sky glow. They seem to be captured in the lighted areas and as night turns into day they crash into windows of the city buildings. A study in central Toronto revealed that the number of bird kills related to just a few tall buildings was over 700 per year. The direct effect of light attraction is even more obvious when considering the mass collisions with communication towers. On overcast nights, birds are drawn to the red and white warning lights on high communication towers and collide with the supporting guy wires and each others. On a particular night in January 1998, between 5000 and 10 000 birds of the species lapland longspur died from collisions with three communication towers in one area in Kansas. Why birds are attracted to light is still being debated. Some explanations concern their navigation system: either relating the effects of light to disruption of the magnetic sense of orientation, or to confusing the artificial light sources with celestial bodies. Another theory explains the phenomena as "light capture": when a bird enters a lighted area it stays there, reluctant to fly out into the darkness. Passerines, particularly warblers, thrushes and sparrows, seem to be especially prone to light attraction and fatal collisions. However, on the islands of Hawaii, seabirds such as petrels and shearwaters are dying in thousands each year due to their attraction to light. As the young birds leave the nests, making their first flight to the sea, they are drawn by the lights from coastal cities and collide with buildings or die from exhaustion.

## When the lights are turned off...

Even though the direct attraction to light sometimes result in events of mass death, as with the turtles and migrating birds, these may not be the most serious effects of light pollution. Light-induced changes in behaviour may possess an even greater risk, even though it rarely results in immediate death for the individual. As the mating season arrives, changes in the night-time environment can bring about serious effects on nocturnal animals. Frogs are known to change their behaviour under the influence of light and this include their mating behaviour. They make less mating calls, move around a lot more, and simply don't mate as frequently as in dark conditions. As a lot of frogs and newts are nocturnal, this could make them particularly vulnerable to light pollutions. Amphibians all over the world are declining in huge numbers and the potential hazard of artificial light need to be carefully investigated. The necessary studies on large scale effects are still missing, but the matter deserves attention: could light pollutions actually be an important source of reproductional hazards to amphibians?

## Light pollutions makes city birds more attractive

One of the more surprising aspects of light pollutions involves our most common birds and their singing. Artificial night lighting actually influences the time of dawn song among several species. Blue tits, great tits, blackbirds and robins all start to sing much earlier in the presence of streetlights during the night – and the males who start to sing early make more attractive partners to the female birds. Male birds living in cities and suburbs start to sing earlier in the morning, under the influence of streetlights, than male birds living in the forests where the night-time environment is unaffected by artificial light. As a result, the city males appear more attractive to the female birds and are chosen for mating more often than the forest males. Artificial night lighting also triggers the breeding season and egg-laying to an earlier start, something that could result in mismatch with environmental factors such as temperature and availability of food sources. This could be a risk for the breeding of the birds, affecting survival rates and viability in nestlings.



*Photograph by Christian Hauzar*

## Dinner is served - under the streetlight

Some species do benefit from the artificial light sources. Have you ever seen the swarms of moths under a streetlight during night-time? You're not alone: bats, birds, frogs and spiders have seen them as well! Bats in particular excel in exploiting these human-created sources of prey – under each streetlight there's a veritable buffet of nocturnal insects. In fact, some of the lights used in lampposts makes the hunt even easier. Certain moths have a way of detecting the ultrasonic sound of bat echo location, thereby evading bat attacks. But mercury vapour lamps seem to interrupt this ability, making the moths easy targets for preying bats.



*Photograph by Michaela Korbyakov*

However, all bat species aren't equally skilled in using streetlights for feeding. Some of the bat species in Scandinavia are better than others at feeding under streetlights and these are actually the ones that have increased in numbers during the last decades. Is it possible that these bats have benefited from the great expansion of road structures during the last decades? And what will happen with the bats who can't feed under streetlights – especially as the populations of moths are experiencing a world wide decline. Will these bat species suffer great losses in numbers as their most important food source continues to decline?

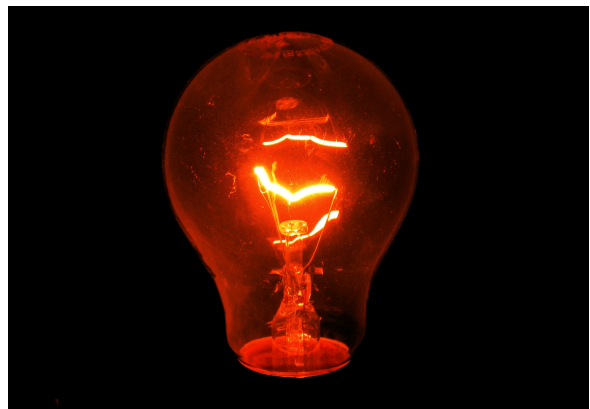
### **Light pollutions may increase algal blooms**

Green fields, white beaches and clear blue lake water. A well-known summer scenery - but it might be threatened by the impact of light pollutions. An ecosystem service is defined as a natural process that in some way benefit human well-being, and one of them is the maintenance of the clear, high quality water in our lakes, provided by zooplankton feeding on algae. During daytime, the zooplankton stays in the deep of the lake, in order to avoid predation by fish. But as night falls, they move up into the surface layers and feed on algae, thereby preventing harmful algal blooms. In lakes close to cities, artificial night lighting can prevent the zooplankton from migrating to the surface and the algal growth can go on uninhibited. This is just one example of how ecosystem services may be affected by light pollutions, but it's clear that disturbances and disruptions will be an effect of the impacts on species and species interactions.

### **Turn off lights to save lives!**

The most obvious solution to the light pollution-problem is to shield and turn off unnecessary lights. In Florida, the coastal lighting near beaches where turtles nest is closely regulated by law. Lights on beach properties have to be turned away from the beach and directed downwards. As turtles to a lesser degree are drawn to red and orange lights, these are the only types of lamps that are allowed.

The bird collision issue is receiving attention in big cities around North America. Campaigns like "Lights Out Toronto!" focuses on making property owners and companies turning off lights on buildings during spring and fall bird migration. A special kind of window glass with built-in UV-patterns, visible to birds only, has recently been introduced on the market and can hopefully help to stop birds from crashing into buildings.



*Photograph by abcdz2000*

As many of the long-term ecological effects of light pollutions are not yet fully investigated, redundant light should be avoided as safety precaution. Much of the light produced could be turned off, turned down or shielded without any inconvenience, in order to save both wildlife and energy. The next time you install new garden lights or porch lights, make a wise decision and don't spread more light than you have to. Remember – there's a dark side of light as well!

### **Further reading**

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