ED-14 Effects of Nighttime Lighting on Wildlife – An Introduction

When we think of artificial light at night, we hardly think about how – or even if – it affects wildlife. What little research has been done in this interesting and important area has been carried out in response to specific problems. Much more needs to be done to protect our ecosystem – and us – from the effects of artificial light at night.

What has been shown is that wildlife — including insects, amphibians, birds, and mammals — need both daylight and darkness for normal functioning. Organisms, from a single cell to humans, have a daily or annual rhythm that corresponds to the cycles of light, temperature, availability of food, and other factors affecting behavioral and physiological functions.

The biological clock, a genetically determined internal mechanism for regulating the time, is responsible for these rhythms. This clock needs regular adjustment through the light-dark cycle. Disruption of this clock can lead to a lack of rest or sleep, which in turn leaves the animal less alert and in poorer physical condition.

The length of the day is also rhythmic throughout the year and regulates activities of animals, such as procreation, migration, and hibernation. The biological calendar, an internal mechanism, is responsible for the hormonal, physiological, and anatomical preparation that these activities require.

Neuroendocrine processes are responsible for the day-night and seasonal rhythms in behavioral and physiological functions of organisms. These processes are controlled by an organ in the brain particularly sensitive to light, the pineal gland. The pineal gland produces the hormone melatonin, the key to the transfer of external light stimuli to an animal's hormonal system.

If their darkness is disturbed by light, all organisms may experience: attraction, fixation, and repulsion; improvement in orientation, or disorientation; disruption of biological rhythms; and change in habitat quality.

While light may help some animals move during darkness, it causes disorientation in others, resulting in higher energy consumption (i.e. exhaustion) or a more "reckless" behavior, increasing the animal's likelihood of being preyed upon or run over. Lighting can disrupt the movement of some animals and may reinforce the barrier effect of roads and road traffic.

Effects of nighttime light on wildlife include:

· Loggerhead, green, leatherback, and other **sea turtles** nest on the coast of Florida. Lights along the beach may keep females from coming to shore and nesting. Lights can be deadly to hatchling turtles, which come out of the nest when it is cooler, generally at night, and orient themselves toward the brightest area. On natural beaches this light comes from the night sky reflecting off the ocean. However, where beach areas are highly populated and overlit, the hatchlings become disoriented and crawl away from the ocean and toward the lights, often dying from exhaustion, dehydration, being eaten by predators, or being run over by cars.

· Fledglings of the Newell's Townsend's shearwater (*Puffinus auricularis newelli)*, a threatened Hawaiian **seabird**, make their first flights using light to guide them. Under normal conditions, the light is reflected from the water, and they fly toward the horizon, out to sea. But when the moon is not full or visible, the birds tend to fly toward the lights of resorts and towns, where they crash into structures or drop from the sky. Two other species, the dark-rumped petrel (endangered) and the band-rumped storm-petrel (rare), have similar problems on Kauai, especially in autumn.

· Thousands of **birds** collide with communication towers and buildings each year. Albert M. Manville II, in an article in the *Proceedings of the Avian Interactions Workshop* held in December 1999 in South Carolina, and others reported on bird collisions with communication towers. Some 350 species of songbirds breed in North America in spring and summer and migrate – generally at night and at low altitudes – to the southern U.S.A., the Caribbean or Mexico. Some of these songbirds, especially thrushes, vireos, and warblers, are very susceptible to collisions with lit towers and buildings during storms and other low-visibility conditions during their spring and fall migrations.

The U.S.A. has some 75,000 towers; one estimate is that an average of 2,500 birds die at each tower a year. Another estimated 98 to 100 million birds die each year when they fly into windows, usually of tall buildings. Collisions with lighthouses are a problem, though less severe, and airports attract birds, as well. (For details, see www.flap.org and www.jmu.edu/wmra/engineering/bibliography.html).

Researchers have noted that, during or near a full moon, birds seldom or never fly into towers, suggesting that moonlight offsets the disorienting effects of artificial light on their migration.

Night light may disrupt the biological calendar, resulting in early brooding and the bearing of offspring when weather and food supply are not optimal. British scientists have observed robins singing at night when streetlights are in their territories. Scientists have also noticed nesting by other birds in the fall instead of the spring. One explanation is that too much light in the area has "reset" the birds' biological clocks.

· Certain **bats** in Europe and North America are attracted to moths and other insects at lights, which offer a steady supply of larger insects. In a 1996 article in the journal *Bats*, researchers Jens Rydell and Hans J. Baagøe worry that the species that take over lighted areas displace other species of bats. Entomologists are concerned about the bats' decimating insect populations.

Species of slow-flying bats are sometimes seen around lights, Rydell and Baagøe noted. Rather than flying around in the light, however, their hunting strategy is to turn up very briefly in the light cone, grab a moth, and then disappear again into the vegetation. These slower bats, which may be more vulnerable to the owls that frequent open, lighted areas, are found among the most threatened species in Europe.

· **Moths** are attracted to light at night, as nearly everyone has observed. Kenneth D. Frank, a physician and amateur moth enthusiast in Philadelphia, Pennsylvania, pointed out that scientists have found that outdoor lighting disrupts moth navigation and suppresses flight, thus interfering with mating, dispersal, and migration. The energy a female expends in flying around a light may cost her the chance to attract a mate. Researchers have found that light can interfere with the females' finding prime spots to lay their eggs, thus giving larvae inadequate conditions to develop. Artificial light also disturbs feeding, nocturnal vision, and, possibly, circadian rhythms of the moths. It exposes the moths to predation by bats, birds, and others.

German scientists G. Eisenbeis and F. Hassel found that various lights attract **insects** differently. Sodium vapor lamps reduced the attraction of insects by more than 50 percent and of *Lepidoptera* (i.e., moths) by about 75 percent, compared to the older high-pressure mercury lamps. This means that proper light selection can minimize risk to the moths and other insects while still providing visibility for human needs.

· Artificial light may have an impact on **fireflies**. James E. Lloyd of the University of Florida at Gainesville has suggested that the chemiluminescence fireflies use for sexual communication in dimly lit or dark environments has similar spectra to incandescent light. This is an area still to be researched and documented.

· Researchers Barbara Nightingale and Charles Simenstad of the University of Washington in Seattle write that studies in the Pacific Northwest show potential changes in **fish** migration behavior and the distribution of fish in areas lit at night. These changes could increase the mortality risks for salmon, herring, and sand lance. Juvenile chum and their predators appear to congregate below night security lights, perhaps delaying migration.

The hatching of halibut eggs can be controlled by exposure to light, which delays the process. Light also influences the amount and the depth at which halibut swim. Norwegian studies (http://miljolare.no/virtue/newsletter/00_09/curr-holm/more-info/halibut.php) showed that halibut tend to swim most actively in the dark; artificial light keeps the fish at the bottom and slows them down, thus causing them to grow more. And another study shows that, in salmonids (including salmon and trout), spawning can be manipulated through light. All this may be desirable in aquaculture, but not necessarily in nature.

Artificial light is often used to keep fish and some freshwater crustaceans away from the intake valves of hydroelectric plants or to guide them through migration barriers, fish ladders, spillways, and bridges. However, using light in this manner can have an effect on the entire lake ecosystem, since it affects the behavior of the fish. Young chinook and coho salmon smolts (about two years old) are normally passive at night. However, exposure to mercury lights at night increases activity by 90 percent (see Nemeth and Anderson, article cited in abstracts at www.urbanwildlands.org/nightlightbiblio.html). Young fish may be attracted to the lights—along with their predators.

· Most **frogs** are thought to be at least largely nocturnal. Experiments and anecdotal evidence show that frog reproduction, foraging, predator avoidance, and social interactions are affected when a dark area is illuminated artificially. The frogs may be temporarily blinded by the light, leaving them vulnerable to predation and unable to see prey.

· Nocturnal **salamanders** may face similar problems. Increased lighting is useful for locating prey, but it is also useful for their predators. Increased light may alter the outcome of territorial contests. Light near ponds may attract or repel adults that migrate to the ponds to breed and lay their eggs.

Although the moon and stars provide illumination, this changes each night. Artificial lighting gives off a different type of light – constantly. The natural daylight/darkness rhythm probably developed as life began, while artificial light – in the quantities now used – has only been around for the last four or five generations. To expect any short-term adaptation to such changes would be unrealistic.

Research continues to address specific light-related problems, such as the decline of sea turtles along the Florida coast, and problems related to human activities, such as building and operating power plants. Much more needs to be done, including making current research results more widely known and available.

All of the above information can be found in the "Links" area on the IDA home page. The following, which were valid in spring 2003, are of special interest and are the sources for specific information:

www.urbanwildlands.org/nightlightbiblio.html Proceedings of the Conference on the Ecological Consequences of Artificial Night Lighting (ECANL)

www.sciencenews.org/20020420/bob9.asp Article covering ECANL above

www.flap.org Fatal Light Awareness Program, leading info site on bird kills

www.jmu.edu/wmra/engineering/bibliography.html Bird Kills at Towers and Other Man-Made Structures, bibliography and abstracts

http://fwie.fw.vt.edu/jlw/light.htm Light Effects on Wildlife References

www.batcon.org/batsmag/v14n4-4.html Bats and streetlights

Southern Arizona Chapter of the IDA web: sa-ida.org
International DarkSky Association, Inc - 3225 N. First Avenue - Tucson, AZ 85719-2103
520-293-3198 (voice) - 520-293-3192 (fax) - web: www.darksky.org - email: ida@darksky.org