THE URBAN WILDLANDS GROUP
AND
UCLA INSTITUTE OF THE ENVIRONMENT

Ecological Consequences of Artificial Night Lighting
February 23–24, 2002
Los Angeles, California

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Ecological Consequences of Artificial Night Lighting

February 23–24, 2002
University of California, Los Angeles

Program and Abstracts

Catherine Rich & Travis Longcore
Conference Co-Chairs

Sponsored by

The Urban Wildlands Group
and
UCLA Institute of the Environment

Night is certainly more novel and less profane than day.

–Henry David Thoreau (1817–1862) in "Night and Moonlight" (1863)

Ecological Consequences of Artificial Night Lighting

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Program

Saturday, February 23, 2002
UCLA Faculty Center
California Room

7:30–8:00 A.M.
Registration

8:00–8:15 A.M.
Introductions and Announcements

8:15–8:30 A.M.
Welcoming Comments
Hartmut Walter
UCLA Department of Geography and UCLA Institute of the Environment

8:30–9:00 A.M.
Keynote Address
Night lighting: science, politics, and the regulatory process
Sara Wan
Chair, California Coastal Commission

9:00–9:30 A.M.
Plant photoreceptors: proteins that perceive information vital for plant development from the light environment
Winslow R. Briggs
Department of Plant Biology, Carnegie Institution of Washington

9:30–10:00 A.M.
Measuring light pollution in urban lakes and its effects on lake invertebrates
Marianne V. Moore and Susan J. Kohler
Department of Biological Sciences and Nuclear Magnetic Resonance Center, Wellesley College

10:00–10:15 A.M.
Break

10:15–10:45 A.M.
Artificial night lighting and insects in Germany
Gerhard Eisenbeis
Department of Biology — Institute of Zoology, Soil Biology and Soil Ecology Group, Johannes Gutenberg University of Mainz

10:45–11:15 A.M.
Impact of artificial lighting on moths
Kenneth D. Frank
Philadelphia, Pennsylvania

11:15–11:45 A.M.
Stray light, fireflies, and fireflyers
James E. Lloyd
Department of Entomology & Nematology, University of Florida

12:00–1:00 P.M.
Luncheon

1:00–1:30 P.M.
Observed and potential effects of artificial light on the behavior, ecology, and evolution of nocturnal frogs
Bryant W. Buchanan
Department of Biology, Utica College of Syracuse University

1:30–2:00 P.M.
The influence of artificial illumination on the nocturnal behavior and ecology of salamanders
Sharon Wise and Bryant W. Buchanan
Department of Biology, Utica College of Syracuse University

2:00–2:30 P.M.
Lighting problems at Florida's oceanic beaches: lessons learned from sea turtles
Michael Salmon
Department of Biological Sciences, Florida Atlantic University

2:30–3:00 P.M.
Artificial night lighting effects on salmon and other fishes in the Northwest
Barbara Nightingale and Charles Simenstad
School of Aquatic and Fishery Sciences, University of Washington

3:00–3:15 P.M.
Break

3:15–3:45 P.M.
The behavioral responses of migrating birds to different lighting systems on tall towers
Sidney A. Gauthreaux, Jr. and Carroll G. Belser
Department of Biological Sciences, Clemson University

3:45–4:15 P.M.
Road illumination and black-tailed godwit
Johannes G. de Molenaar, Dick A. Jonkers and Marlies E. Sanders
Alterra, research institute for the green environment

4:15–4:45 P.M.
Artificial lighting and the decline of seabirds
Richard Podolsky
Avian Systems, Camden, Maine

4:45–5:15 P.M.
Turning night into day: the effects of artificial night lighting on endangered and other mammal species
Melissa M. Grigione
Department of Environmental Science and Policy, University of South Florida

5:30–7:00 P.M.
Wine and Cheese Reception

Sunday, February 24, 2002
UCLA Faculty Center
California Room

10:00–10:20 A.M.
Progress and challenges in night sky protection
Robert Gent
International Dark-Sky Association (Tucson, Arizona)

10:20–10:40 A.M.
The Fatal Light Awareness Program
Michael Mesure
Fatal Light Awareness Program (Toronto, Canada)

10:40–11:30 A.M.
Panel Discussion

11:30 A.M.–12:00 P.M.
Brunch (buffet)

12:00–3:00 P.M.
Workshop

Keynote Speaker Sara Wan

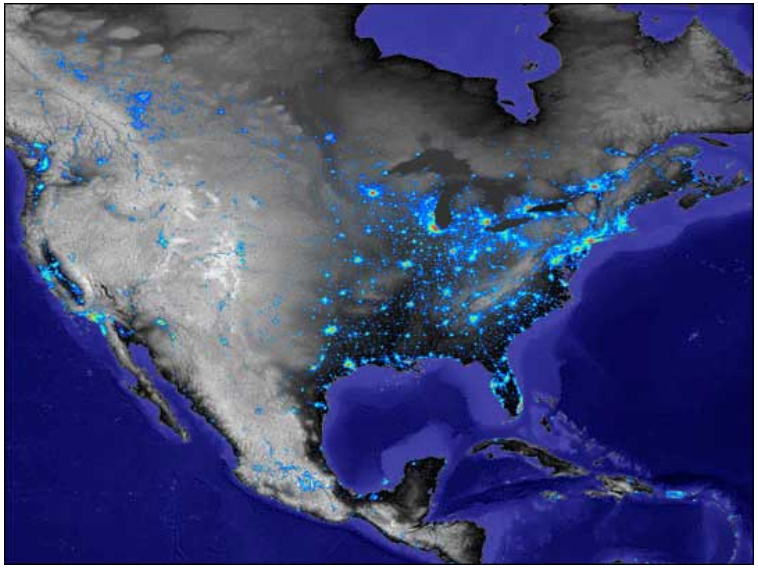
Sara Wan is currently Chair of the California Coastal Commission and serves on the Board of the California Coastal Conservancy. She holds a B.A. in Zoology from Vassar College, an M.S. in Biology from Yale University, and an M.S. in Electrical Engineering from the University of California, Irvine. Mrs. Wan taught electrical engineering at California State University, Long Beach, and was founder and chief executive officer of Maric, Inc., an engineering firm that manufactures electronic timing devices for sports. She worked extensively on land use, energy, oil, marine mammals, and other environmental issues affecting the coast of California before her appointment to the California Coastal Commission in 1996.

The Urban Wildlands Group

The Urban Wildlands Group is a Los Angeles-based nonprofit conservation think tank that studies and works to protect species, habitats, and ecological processes in urban and urbanizing areas. Executive Officer Catherine Rich holds both a J.D. and an M.A. in Geography from UCLA, and Science Director Travis Longcore earned a Ph.D. in Geography from UCLA. Projects and publications can be found online at <www.urbanwildlands.org>.

UCLA Institute of the Environment

The Institute of the Environment ("IoE") was established as a new and unique academic unit devoted to interdisciplinary research and teaching related to environmental issues. The IoE is composed of faculty from a broad range of disciplines — the sciences, public policy, engineering, law, business, public health — working together to provide answers to complex environmental problems. As one of the world's foremost research universities, UCLA is already participating in a wide range of research focusing on the environment. The IoE has the mission of coordinating and expanding these studies, bringing new knowledge to the classroom, and reaching out to the community.



http://www.science.nasa.gov/headlines/images/lights/namer_lights_dem.jpg

Ecological Consequences of Artificial Night Lighting

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Abstracts

Plant photoreceptors: proteins that perceive information vital for plant development from the light environment

Winslow R. Briggs

As sessile organisms, higher plants rely heavily on environmental signals to guide their development. Among the more important environmental signals are those that come from their light environment. Thus in the course of evolution plants have acquired a wide range of photoreceptors that perceive and respond to light signals in the ultraviolet, blue, red, and near-infrared regions of the electromagnetic spectrum. In the model plant *Arabidopsis thaliana*, nine different photoreceptors have been characterized. Those absorbing and responding to UV-A and blue wavelengths of light include two cryptochromes, cry1 and cry2, and two phototropins, phot1 and phot2. Those absorbing in the red and far-red regions of the spectrum are the five phytochromes. There is also evidence for photoreceptors that sense and respond to UV-B, although these remain to be characterized. These many photoreceptors allow the plant to measure and respond to four parameters of the light environment: light spectral quality, light intensity, light direction, and light duration. Sometimes these photoreceptors act independently, sometimes redundantly, sometimes cooperatively, sometimes antagonistically, sometimes at the same stage of development, and sometimes at different stages of development. Some of the responses are incredibly sensitive, responding to levels of light that even the human eye can barely perceive. Among the many processes affected by light are seed germination, stem elongation, leaf expansion, conversion from a vegetative state to a flowering state, flower development, fruit development, and senescence. There is virtually no rigorous research on the influence of urban lighting on plants. There are anecdotal reports of leaves of deciduous trees failing to senesce in proximity to streetlights because they perceive a long day instead of a short one, but little else. While it is highly likely that urban light does affect plant development, research is badly needed to assess what the effects might be.

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Measuring light pollution in urban lakes and its effects on lake invertebrates

Marianne V. Moore and Susan J. Kohler

Lakes or coastal waters in or near cities may experience high levels of artificial light at night, because they are generally not shaded by trees or buildings. Predicting ecological effects of this light on submerged organisms requires estimating the amount of artificial light at the water's surface and the depth of its penetration. This has never been done, in part, because no light meters are available commercially for quantifying such low light intensities either at the surface of aquatic habitats or underwater. We obtained two independent measures of the intensity of artificial lighting at the surface of five lakes by using two different instruments: 1) a custom-built light meter containing a photomultiplier tube, and 2) a modified diode-array spectrometer. The lakes ranged in location from inner city Boston, Massachusetts to within the White Mountains National Forest, New Hampshire. We also measured the spectral distribution of the artificial light, and we estimated its depth of penetration underwater. Spectra of the artificial light striking all urban and suburban lakes were nearly identical, and were dominated by light in the yellow region with a peak centered at approximately 590 nm and a width at halfheight of approximately 55 nm. These spectra closely matched the emission spectrum of high-pressure sodium lamps, the most common street lamp in the USA. Incident levels of artificial light at an urban lake (on the order of 10^{-3} μE m^{-2} s^{-1}) were similar to the light intensity emitted from a full moon and nearly 50 times greater than that of a rural lake illuminated by starlight only. On average, suburban lakes experienced artificial light intensities 5–30 times greater than that of the rural lake. Cloud cover increased incident levels of artificial light two- to threefold. The depth to which this artificial light is biologically detectable underwater by crustacean grazers and fish was estimated to be approximately 3 meters using vertical extinction coefficients determined for the lakes in conjunction with published limits of light detection by aquatic organisms. Potential effects of this light on submerged aquatic organisms and results from field experiments in which artificial light was manipulated will be discussed.

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Artificial night lighting and insects in Germany

Gerhard Eisenbeis

Nocturnal insects are extremely sensitive to outdoor lighting because they have evolved special adaptations of photoreception. They are often attracted to perform endless turns in the light sphere of lamps, but there are other exogenous and endogenous factors that control their behavior. The death struggle of insects around light sources can be described by special effects, e.g. "captivation effect," "crash-barrier effect," or "vacuum cleaner effect." In many cases insects become disoriented by these effects and are no longer able to perform their basic functions of nutrition and reproduction. Some results from a study within a rural landscape of Germany will be presented, showing the impact of different street lamp types on insects during a full summer season. These differences were quantified as capture ratios regarding both the bulk of insect orders or special orders alone. Besides light quality, the habitat characteristics were revealed to be important in this context as well. Additionally, the influence of full and new moon, and of the evening temperature, on the nocturnal activity of insects will be shown. These facts suggest that outdoor lighting may be a serious threat to insects. Based on results from literature an attempt is made to calculate the dimension of insect mortality resulting from a street lamp pool of a larger city up to the whole area level of Germany. Thereafter some examples of how species and populations with different life strategies may be influenced by lighting are considered. Finally, examples of energy savings from converting older street lamp systems into modern systems will be shown, especially the change away from high-pressure mercury lamps, which may reduce energy costs and CO_2 emissions significantly. The modernization of public lighting is beneficial both for township budgets and for the agenda of nature conservation, especially of insects.

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Impact of artificial lighting on moths

Kenneth D. Frank

Artificial lighting has been blamed for decreases in populations of moths. By disrupting moth navigation and suppressing flight, it interferes with mating, dispersal, and migration. It also disturbs feeding, oviposition, nocturnal vision and, possibly, circadian rhythms. It increases predation by birds, bats, spiders, and other predators. It traps moths in buildings, diverts moths into vehicular traffic, and burns or desiccates moths that fly into lamp housings. Almost all of these effects are a consequence of flight-to-light behavior. Most species of macrolepidoptera moths exhibit such behavior, and most kinds of lamps used for artificial lighting elicit it. However, many species of moths thrive near urban and suburban lighting. Destruction of vast numbers of moths in light traps has failed to eradicate moth populations. Extinctions due exclusively to artificial lighting have not been documented. Nevertheless, artificial lighting may weaken or eliminate small populations threatened by other disturbances, particularly in habitats fragmented by urban development. It generates selective pressure favoring evolutionary modification of flight-to-light behavior. Because parasitoids of some moth species fly to light, artificial lighting may disturb natural control of moth populations. Lighting should be restricted where protection of biodiversity is a high priority, such as in unusual ecological habitats, and in certain agricultural and horticultural settings. To limit artificial lighting, light sources should be turned off whenever illumination is not essential. Lamp housings should be sealed tight, and located away from structures that may trap insects. Low-pressure sodium lamps should be used in preference to other kinds of lamps.

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Stray light, fireflies, and fireflyers

James E. Lloyd

Fireflies (Lampyridae, Coleoptera) that use their chemiluminescence for sexual communication have a number of attributes that make them good as well as unique subjects when considering the effects of artificial light in natural environments. First, fireflies may be expected to have inappropriate "innate" responses to foreign light similar to those that occur in other organisms, but because of their conspicuous luminescent signals, some alterations may be more easily monitored and quantified. Second, because much of firefly life activity is mediated through their own pinpoints of light in otherwise dimly lit or dark environments, firefly relationship to light is virtually unique in the terrestrial world; thus, foreign light will have even more serious consequences for them, and they provide a special case for study. Fireflies may be useful as model systems for the study of the long- and short-term consequences of ecological insults that occur in combination. Third, because of their unique place in human culture, fireflies can be used as subjects as well as icons when educating and enlisting the help of the public, especially children and older students, and for reminding them of the continuing attention that is required to improve and then maintain healthy natural environments.

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Observed and potential effects of artificial light on the behavior, ecology, and evolution of nocturnal frogs

Bryant W. Buchanan

Most frogs are thought to be largely or completely nocturnal. About 3500 species of frogs inhabit a wide variety of fossorial, terrestrial, aquatic, and arboreal habitats and possess a wide variety of visual adaptations to these varied environments. Understanding frog natural history, activity patterns, and visual capabilities can greatly facilitate making predictions about the potential effects of light pollution on a given species. Experiments and anecdotal evidence demonstrate that both temporary and permanent changes to the illumination of an area may affect frog reproduction, foraging, predator avoidance, and social interactions. Laboratory experiments have demonstrated that dark-adapted frogs exposed to rapid increases in illumination may be temporarily "blinded" and unable to gather visual information on prey, predators, or conspecifics until their eyes adapt to the new illumination. Permanent increases in nocturnal illumination may facilitate or inhibit a variety of behaviors. Foraging may be facilitated in frogs that hunt around lights because the ambient illumination is increased to a level that allows the frogs to see prey or because lights attract abnormally large quantities of prey (e.g., insects). Reproductive activity may be inhibited in species that normally reproduce only at very low illuminations. Increased illumination may allow predators to see frogs that may not normally be visible to them. Circadian rhythms, activity patterns, and intraspecific visual communication may also be affected by increased illumination. Much more field and laboratory research is necessary to assess the full extent of direct and indirect effects of artificial night lighting on the behavior, ecology, and evolution of frogs.

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The influence of artificial illumination on the nocturnal behavior and ecology of salamanders

Sharon Wise and Bryant W. Buchanan

Little is known of the direct influence of artificial illumination on the biology of nocturnal salamanders. However, several studies provide evidence that artificial light may influence some aspects of their behavior and ecology. In this talk, the role of vision and the influence of light on the activity patterns, prey detection, predator avoidance, agonistic behavior, and orientation of salamanders to breeding ponds will be examined. Nocturnal foraging may be influenced by artificial illumination. In one species, salamanders emerge from refugia to forage within one hour after light levels drop dramatically following sunset. During such foraging bouts, visual information is useful for locating prey. Greater light levels may delay emergence (resulting in less foraging time) but increase the ability of salamanders to capture prey. However, such increases in light levels may also make salamanders more vulnerable to predation. Some salamanders are territorial and aggressively defend areas containing valuable resources. Increased illumination may alter the outcome of territorial contests. Laboratory experiments demonstrate that light levels affect behavioral interactions between conspecifics such that salamanders exhibit more visual displays when more light is available. Finally, many salamanders are terrestrial as adults but migrate to ponds to breed and lay eggs. The orientation of some species away from and toward these ponds is influenced by the spectral characteristics of light. Artificial lights that emit unusual spectra may disrupt these migration patterns. Because many salamanders are nocturnal and use visual cues for so many different biological functions, further experimentation on the influence of artificial illumination on the behavior and ecology of salamanders is warranted.

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Lighting problems at Florida's oceanic beaches: lessons learned from sea turtles

Michael Salmon

Florida's beaches are major rookeries for Western Atlantic loggerhead sea turtles, and minor rookeries for an increasing population of leatherback and green turtles. But coastal development in Florida continues unabated, increasing beach exposure to nocturnal illumination. As a consequence, the Florida coast has become a laboratory for testing methods designed to protect the turtles (nesting females and their hatchlings) from "photopollution." I first review how under natural conditions at night, females choose nest sites and hatchlings locate the sea from the nest. I then describe how both females and hatchlings are adversely affected by exposure to artificial lighting. I next critically evaluate two approaches to protecting hatchlings at local sites: nest manipulation and lighting modification. The second approach is more effective, though not always possible. Finally, I review the design, philosophy, and implementation of broad-scale plans to restore nesting beaches at the coastal community (Patrick Air Force Base), county (Broward County), and state (coastal roadway) levels. I argue that broad-scale planning best protects existing dark beaches, restores those currently exposed to moderate levels of lighting, and controls the lighting environment where new development is anticipated. The beneficiaries are sea turtles and other nocturnally-active organisms, as well as humans residing in coastal communities.

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Artificial night lighting effects on salmon and other fishes in the Northwest

Barbara Nightingale and Charles Simenstad

Teleost fish reaction to light stimulus depends upon fish physiologic adaptation to ambient light levels prior to exposure to light level changes. Laboratory studies examining the use of artificial light to guide juvenile salmon through migration barriers report measurable differences in fish responses to variations in the quantity and quality of artificial light. Studies in the Pacific Northwest report potential changes in fish migration behavior and the distribution of fishes in night-lighted areas. Such changes potentially increase mortality risks for salmon, herring, and sand lance. Juvenile chum and their predators, such as hake, dogfish, sculpin, large chinook, and coho, appear to congregate below night security lights with increased light intensities attracting the chum and potentially delaying outmigration; however, predator stomach analyses have not demonstrated heavy chum consumption in those conditions. In contrast, night lighting has also been found to attract juvenile herring and sand lance along with their predators, with heavy predation occurring on the herring and sand lance populations. Predators have also been known to take advantage of lighting at fish ladders, spillways, and bridges to prey on migrating salmon. The present limited number of *in situ* studies of artificial night lighting, coupled with the spatial and temporal limitations of existing studies, warrants further exploration to identify the extent of fish distribution changes over time and the real harm posed to these fishes. The potential changes in species abundance and dominance resulting from increased prey access under artificial lighting also warrant further exploration.

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The behavioral responses of migrating birds to different lighting systems on tall towers

Sidney A. Gauthreaux, Jr. and Carroll G. Belser

Hundreds of species of birds typically migrate at night, and it is well known that fires and man-made lights attract birds during migration, particularly when the sky is cloudy and the ceiling is low. As early as 1886, E.A. Gastman reported that nearly 1,000 migratory birds were killed around electric light towers in Decatur, Illinois on a single evening. Exactly 110 years later a report for World Wildlife Fund Canada and the Fatal Light Awareness Program detailed the hazards of lighted structures and windows to migrating birds. In an effort to understand why birds are attracted to lights and to assess the influences of different types of warning light arrays on towers, we examined the behavior of nocturnal migrants flying near tall towers with different types of lighting. During spring migration we monitored flight behavior on 9 evenings near a strobe light FM radio tower and over a control area. During fall migration we monitored flight behavior on 14 evenings near a television tower with red lights, near a television tower with white strobe lights, and over a control area that had no tower. We used an image intensifier to monitor birds flying overhead, and coded the flight behavior of migrants into the following categories: linear flight (straight) and nonlinear flight (pause-hover, curved, or circling). During the spring study, the numbers of birds showing nonlinear flight near the tower with white strobe lights was significantly greater than at the control site, but the number of birds recorded at each site was not significantly different. During the fall study the number of birds showing nonlinear flight near the tower with red lighting was significantly greater than those flying near the tower with white strobes. The number of birds showing nonlinear flight near the tower with white strobes was significantly greater than those flying over the control site. Significantly more birds were recorded flying near the tower with red lights than flying near the tower with white strobes and over the control site. The number of birds detected flying near the tower with white strobes did not differ significantly from the number recorded over the control site. The greater number of birds near the tower with red lights is likely the result of "attraction" to the constantly illuminated lights on towers with red light arrays and the proportion of the time the birds showed nonlinear flight behavior. While birds in linear flight spend only a brief instant near the tower and leave the area, birds showing curved, circling, or hovering behavior spend more time near the tower and thus build concentrations of migrants in the area. Once concentrations build, the birds themselves may become collision hazards to other birds.

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Road illumination and black-tailed godwit

Johannes G. de Molenaar, Dick A. Jonkers and Marlies E. Sanders

Black-tailed godwit (*Limosa l. limosa*) is an indicator species for the birdlife of open grassland in The Netherlands. The influence of road lights on the breeding population of this bird was studied in an area adjacent to a busy motorway. We compared one year, when the road lights were switched off, with the next year, when the lights were switched on. In a nearby second area, out of reach of influence of the traffic on the motorway, there were no lights in the first year. Early the next year 24 lights were installed. These were identical to the lights along the motorway and switched on and off simultaneously with them. All grassland parcels were individually characterized to eliminate field conditions that may influence the birds' nest choice. We then established the position of the nests, their distance to the motorway and to the temporary illumination, the measures of the eggs, and the date of laying of the first egg. The results reveal that road illumination has a statistically significant negative influence on the breeding habitat quality, reaching over several hundreds of meters. It is likely that the effect is suppressed by the nest fidelity of the birds, suggesting that the ultimate effect distance will be considerably larger. Moreover, birds that breed early seemed to choose their nest further away from the lights than birds that start later. A negative influence of the motorway (traffic noise) seemed to be absent. Apparently it can be compensated by favorable site factors. That the negative influence of illumination is not compensated suggests that this is stronger than the influence of the road.

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Artificial lighting and the decline of seabirds

Richard Podolsky

With only a very few exceptions seabirds as a group are in decline worldwide. Invariably, human activity is the driving force of this global decline. Artificial lighting is one of a suite of human impacts that together are contributing to the downward trend in distribution and abundance of the world's 300 species of seabirds. Artificial lighting is believed to confuse seabirds while they are migrating long and short distances, especially while they move between urbanized nesting sites to their feeding grounds at sea. Many seabirds are nocturnal and move between land and sea at dusk or at night and as such are particularly vulnerable to artificial lighting. Once they are disoriented they are at risk of colliding with artificial structures such as buildings and transmission towers or of falling onto roadways and being run over by vehicles. One of the more dramatic examples of this is on the island of Kauai where Newell's Shearwater (*Puffinus auricularis newellii*) and Hawaiian Petrel (*Pterodroma phaeopygia sandwichensis*) are estimated conservatively to have declined to a small fraction of their pre-development levels. A community-wide salvage program called Save Our Shearwaters (SOS) has done much over the last 30 years to ameliorate this human-induced mortality as has a program to install shielded lighting around the island. However, these efforts do not appear to provide a sufficient offset to the mortality to ensure the survival of these two endemic Hawaiian seabirds.

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Turning night into day: the effects of artificial night lighting on endangered and other mammal species

Melissa M. Grigione

This presentation will review the major studies designed to measure the effects of artificial lighting on mammals in the field and laboratory. The consequences of artificial lighting include general disruptions in daily activity cycles, and reductions in dispersal, foraging, and reproductive opportunities. Secondary effects on prey species, offspring rearing, and habitat reductions as a result of flooding habitat with lights are largely unexplored. In general, the research effort in this area needs to be further developed and pursued. As habitat continues to be fragmented by roads and other developments, the effects of artificial lighting will be exacerbated. Many species could potentially receive additional protection from habitat alterations, such as lights, if a substantial literature base existed. To demonstrate this point, a case study involving the protection of endangered ocelots in Texas from large floodlights installed at the US-Mexico border will be reviewed. This case study will demonstrate how difficult it is politically to protect a species from artificial lights in the absence of either a significant body of research about the effects of lights on mammals or a detailed study on the specific effects of lights on ocelots. Lastly, we will make recommendations about future studies that need to be undertaken in order to clearly demonstrate the effects of turning night into day for mammal species.

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Night and Moonlight

Henry David Thoreau
(1817–1862)

As printed in *The Atlantic Monthly Magazine*, November 1863, pp. 579–83

Chancing to take a memorable walk by moonlight some years ago, I resolved to take more such walks, and make acquaintance with another side of Nature. I have done so.

According to Pliny, there is a stone in Arabia called Selenites, "wherein is a white, which increases and decreases with the moon." My journal for the last year or two has been selenitic in this sense.

Is not the midnight like Central Africa to most of us? Are we not tempted to explore it,—to penetrate to the shores of its Lake Tchad, and discover the source of its Nile, perchance the Mountains of the Moon? Who knows what fertility and beauty, moral and natural, are there to be found? In the Mountains of the Moon, in the Central Africa of the night, there is where all Niles have their hidden heads. The expeditions up the Nile as yet extend but to the Cataracts, or perchance to the mouth of the White Nile; but it is the Black Nile that concerns us.

I shall be a benefactor, if I conquer some realms from the night,—if I report to the gazettes anything transpiring about us at that season worthy of their attention,—if I can show men that there is some beauty awake while they are asleep,—if I add to the domains of poetry.

Night is certainly more novel and less profane than day. I soon discovered that I was acquainted only with its complexion; and as for the moon, I had seen her only as it were through a crevice in a shutter, occasionally. Why not walk a little way in her light?

Suppose you attend to the suggestions which the moon makes for one month, commonly in vain, will it not be very different from anything in literature or religion? But why not study this Sanscrit? What if one moon has come and gone, with its world of poetry, its weird teachings, its oracular suggestions,—so divine a creature freighted with hints for me, and I have not used her,—one moon gone by unnoticed?

I think it was Dr. Chalmers who said, criticizing Coleridge, that for his part he wanted ideas which he could see all round, and not such as he must look at away up in the heavens. Such a man, one would say, would never look at the moon, because she never turns her other side to us. The light which comes from ideas which have their orbit as distant from the earth, and which is no less cheering and enlightening to the benighted traveller than that of the moon and stars, is naturally reproached or nicknamed as moonshine by such. They are moonshine, are they? Well, then, do your night-travelling when there is no moon to light you; but I will be thankful for the light that reaches me from

the star of least magnitude. Stars are lesser or greater only as they appear to us so. I will be thankful that I see so much as one side of a celestial idea, one side of the rainbow and the sunset sky.

Men talk glibly enough about moonshine, as if they knew its qualities very well, and despised them,—as owls might talk of sunshine. None of your sunshine!—but this word commonly means merely something which they do not understand, which they are abed and asleep to, however much it may be worth their while to be up and awake to it.

It must be allowed that the light of the moon, sufficient though it is for the pensive walker, and not disproportionate to the inner light we have, is very inferior in quality and intensity to that of the sun. But the moon is not to be judged alone by the quantity of light she sends to us, but also by her influence on the earth and its inhabitants. "The moon gravitates toward the earth, and the earth reciprocally toward the moon." The poet who walks by moonlight is conscious of a tide in his thought which is to be referred to lunar influence. I will endeavor to separate the tide in my thoughts from the current distractions of the day. I would warn my hearers that they must not try my thoughts by a daylight standard, but endeavor to realize that I speak out of the night. All depends on your point of view. In Drake's "Collection of Voyages," Wafer says of some Albinos among the Indians of Darien,—"They are quite white, but their whiteness is like that of a horse, quite different from the fair or pale European, as they have not the least tincture of a blush or sanguine complexion. . . . . Their eyebrows are milk-white, as is likewise the hair of their heads, which is very fine. . . . . They seldom go abroad in the daytime, the sun being disagreeable to them, and causing their eyes, which are weak and poring, to water, especially if it shines towards them; yet they see very well by moonlight, from which we call them moon-eyed."

Neither in our thoughts in these moonlight walks, methinks, is there "the least tincture of a blush or sanguine complexion," but we are intellectually and morally Albinos,—children of Endymion,—such is the effect of conversing much with the moon.

I complain of Arctic voyages that they do not enough remind us of the constant peculiar dreariness of the scenery, and the perpetual twilight of the Arctic night. So he whose theme is moonlight, though he may find it difficult, must, as it were, illustrate it with the light of the moon alone.

Many men walk by day; few walk by night. It is a very different season. Take a July night, for instance. About ten o'clock,—when man is asleep, and day fairly forgotten,—the beauty of moonlight is seen over lonely pastures where cattle are silently feeding. On all sides novelties present themselves. Instead of the sun, there are the moon and stars; instead of the wood-thrush, there is the whippoorwill; instead of butterflies in the meadows, fire-flies, winged sparks of fire!—who would have believed it? What kind of cool, deliberate life dwells in those dewy abodes associated with a spark of fire? So man has fire in his eyes, or blood, or brain. Instead of singing birds, the half-throttled note of a cuckoo flying over, the croaking of frogs, and the intenser dream of crickets,—but above all, the wonderful trump of the bull-frog, ringing from Maine to Georgia. The potato-vines stand upright, the corn grows apace, the bushes loom, the grain-fields are boundless. On our open river-terraces, once cultivated by the Indian, they appear to occupy the ground like an army,—their heads nodding in the breeze. Small trees and shrubs are seen in the midst, overwhelmed as by an inundation. The shadows of rocks and trees and shrubs and hills are more conspicuous than the objects themselves. The slightest irregularities in the ground are revealed by the shadows, and what the feet find comparatively smooth appears rough and diversified in consequence. For the same reason the whole landscape is more variegated and picturesque than by day. The smallest recesses in the rocks are dim and cavernous; the ferns in the wood appear of tropical size. The sweet-fern and indigo in overgrown wood-paths wet you with dew up to your middle. The leaves of the shrub-oak are shining as if a liquid were flowing over them. The pools seen though the trees are as full of light as the sky. "The light of the day takes refuge in their bosoms," as the Purana says of the ocean. All white objects are more remarkable than by day. A distant cliff looks like a phosphorescent space on a hill-side. The woods are heavy and dark. Nature slumbers. You see the moonlight reflected from particular stumps in the recesses of the forest, as if she selected what to shine on. These small fractions of her light remind one of the plant called moon-seed,—as if the moon were sowing it in such places.

In the night the eyes are partly closed, or retire into the head. Other senses take the lead. The walker is guided as well by the sense of smell. Every plant and field and forest emits its odor now, swamp-pink in the meadow, and tansy in the road; and there is the peculiar dry scent of corn which has begun to show its tassels. The senses both of hearing and smelling are more alert. We hear the tinkling of rills which we never detected before. From time to time, high up on the sides of hills, you pass through a stratum of warm air: a blast which has come up from the sultry plains of noon. It tells of the day, of sunny noon-tide hours and banks, of the laborer wiping his brow and the bee humming amid flowers. It is an air in which work has been done,—which men have breathed. It circulates about from wood-side to hill-sides like a dog that has lost its master, now that the sun is gone. The rocks retain all night the warmth of the sun which they have absorbed. And so does the sand: if you dig a few inches into it, you find a warm bed.

You lie on your back on a rock in a pasture on the top of some bare hill at midnight, and speculate on the height of the starry canopy. The stars are the jewels of the night, and perchance surpass anything which

day has to show. A companion with whom I was sailing, one very windy, but bright moonlight night, when the stars were few and faint, thought that a man could get along with them, though he was considerably reduced in his circumstances,—that they were a kind of bread and cheese that never failed.

No wonder that there have been, astrologers,—that some have conceived that they were personally related to particular stars. Du Bartas, as translated by Sylvester, says he'll

"not believe that the Great Architect
With all these fires the heavenly arches decked
Only for show, and with these glistering shields,
T' awake poor shepherds, watching in the fields,"—

he'll

"not believe that the least flower which pranks
Our garden-borders or our common banks,
And the least stone that in her warming lap
Our Mother Earth doth covetously wrap,
Hath some peculiar virtue of its own,
And that the glorious stars of heaven have none."

And Sir Walter Raleigh well says, "The stars are instruments of far greater use than to give an obscure light, and for men to gaze on after sunset"; and he quotes Plotinus as affirming that they "are significant, but not efficient"; and also Augustine as saying, "Deus regit inferiora corpora per superiora": God rules the bodies below by those above. But best of all is this, which another writer has expressed: "Sapiens adjuvabit opus astrorum quemadmodum agricola terra naturam": A wise man assisteth the work of the stars as the husbandman helpeth the nature of the soil.

It does not concern men who are asleep in their beds, but it is very important to the traveller, whether the moon shines brightly or is obscured. It is not easy to realize the serene joy of all the earth, when she commences to shine unobstructedly, unless you have often been abroad alone in moonlight nights. She seems to be waging continual war with the clouds in your behalf. Yet we fancy the clouds to be her foes also. She comes on magnifying her dangers by her light, revealing, displaying them in all their hugeness and blackness,—then suddenly casts them behind into the light concealed, and goes her way triumphant through a small space of clear sky.

In short, the moon traversing, or appearing to traverse, the small clouds which lie in her way, now obscured by them, now easily dissipating and shining through them, makes the drama of the moonlight night to all watchers and night-travellers. Sailors speak of it as the moon eating up the clouds. The traveller all alone, the moon all alone, except for his sympathy, overcoming with incessant victory whole squadrons of clouds above the forests and lakes and hills. When she is obscured, he so sympathizes with her that he could whip a dog for her relief, as Indians do. When she enters on a clear field of great extent in the heavens, and shines unobstructedly, he is glad. And when she has fought her way through all the squadron of her foes, and rides majestic in a clear sky unscathed, and there are no more any obstructions in her path, he cheerfully and confidently pursues his way, and rejoices in his heart, and the cricket also seems to express joy in its song.

How insupportable would be the days, if the night, with its dews and darkness, did not come to restore the drooping world! As the shades begin to gather around us, our primeval instincts are aroused, and we steal forth from our lairs, like the inhabitants of the jungle, in search of those silent and brooding thoughts which are the natural prey of the intellect.

Richter says, that "the earth is every day overspread with the veil of night for the same reason as the cages of birds are darkened, namely, that we may the more readily apprehend the higher harmonies of thought in the hush and quiet of darkness. Thoughts which day turns into smoke and mist stand about us in the night as light and flames; even as the column which fluctuates above the crater of Vesuvius in the daytime appears a pillar of cloud, but by night a pillar of fire."

There are nights in this climate of such serene and majestic beauty, so medicinal and fertilizing to the spirit, that methinks a sensitive nature would not devote them to oblivion, and perhaps there is no man but would be better and wiser for spending them out of doors, though he should sleep all the next day to pay for it, should sleep an Endymion sleep, as the ancients expressed it,—nights which warrant the Grecian epithet ambrosial, when, as in a land of Beulah, the atmosphere is charged with dewy fragrance, and with music, and we take our repose and have our dreams awake,—when the moon, not secondary to the sun,

"gives us his blaze again,
Void of its flame, and sheds a softer day.
Now through the passing cloud she seems to stoop,
Now up the pure cerulean rides sublime."

Diana still hunts in the New-England sky.

"In heaven queen she is among the spheres;
She, mistress-like, makes all things to be pure;
Eternity in her oft change she bears;
She Beauty is; by her the fair endure.

“Time wears her not; she doth his chariot guide;
Mortality below her orb is placed;
By her the virtues of the stars down slide;
By her is Virtue’s perfect image cast.”

The Hindoos compare the moon to a saintly being who has reached the last stage of bodily existence.

Great restorer of antiquity, great enchanter! In a mild night, when the harvest or hunter’s moon shines unobstructedly, the houses in our village, whatever architect they may have had by day, acknowledge only a master. The village street is then as wild as the forest. New and old things are confounded. I know not whether I am sitting on the ruins of a wall, or on the material which is to compose a new one. Nature is an instructed and impartial teacher, spreading no crude opinions, and flattering none; she will be neither radical nor conservative. Consider the moonlight, so civil, yet so savage!

The light is more proportionate to our knowledge than that of day. It is no more dusky in ordinary nights than our mind’s habitual atmosphere, and the moonlight is as bright as our most illuminated moments are.

“In such a night let me abroad remain
Till morning breaks, and all’s confused again.”

Of what significance the light of day, if it is not the reflection of an inward dawn?—to what purpose is the veil of night withdrawn, if the morning reveals nothing to the soul? It is merely garish and glaring.

When Ossian, in his address to the Sun, exclaims,—

“Where has darkness its dwelling?
Where is the cavernous home of the stars,
When then quickly followest their steps,
Pursuing them like a hunter in the sky,—
Thou climbing the lofty hills,
They descending on barren mountains?”

who does not in his thought accompany the stars to their “cavernous home,” “descending” with them “on barren mountains”?

Nevertheless, even by night the sky is blue, and not black; for we see through the shadow of the earth into the distant atmosphere of day, where the sunbeams are revelling.

For more information about the life and works of Henry David Thoreau, please contact The Thoreau Institute at Walden Woods, <www.walden.org>.

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