CCM-101

City of Cambridge

~~O-2.~~
Calendar Item #3
IN CITY COUNCIL

~~March 25, 2002~~
April 8, 2002

COUNCILLOR DECKER
VICE MAYOR DAVIS
COUNCILLOR GALLUCCIO
COUNCILLOR MAHER
COUNCILLOR MURPHY
COUNCILLOR REEVES
COUNSILLOR SIMMONS
MAYOR SULLIVAN
COUNCILLOR TOOMEY

WHEREAS: Uncontrolled exterior lighting is extinguishing the night sky as well as wasting energy and producing unnecessary glare; and

WHEREAS: In just the past decade, sky glow has doubled in intensity; and

WHEREAS: Controlling sky glow not only brings back the stars, it improves safety, health, energy conservation, fiscal responsibility and protection of the natural environment (see attached); and

WHEREAS: Several cities, including Raleigh, North Carolina, Flagstaff, Arizona, Taos, New Mexico, and Melbourne, Australia, have enacted ordinances to set standards for exterior lighting; now therefore be it

RESOLVED: That the City Manager be and hereby is requested to confer with the Assistant City Manager for Community Development, the City Solicitor and other appropriate staff to report back to the City Council on what other communities have done and what Cambridge can do to control exterior light, including a draft ordinance or suggestions for an ordinance, along with possibilities for other actions such as public education and incentives to make progress on this important issue.

In City Council April 8, 2002.
Adopted by the affirmative vote of eight members.
Attest:- D. Margaret Drury, City Clerk.

A true copy;

ATTEST: D Margaret Drury

D. Margaret Drury
City Clerk

THE TAOS NEWS

The Taos News MENU GUIDE

FAVOR Y CONTRA

Jan. 17-23, 2002

Keeping competition out does not mean keeping business in!
Juan's Wanderings

Success Stories

New Feature
MEMORIALS

Breaking News

Calendar

El Mercado
MarketPlace

Tempo
Entertainment

Editorial

Time for county to turn its eyes to dark-skies issue

The nighttime skies over Taos afford us a view of the natural light show produced by stars and the moon. Those views are a little bit better today than they were three years ago when a task force launched efforts to tone down excessively bright lights in town.

But the work is not complete. A county-wide dark-skies ordinance is still needed.

The fight against the onslaught of light pollution has, in the terms of one activist, been modestly successful.

The Town of Taos passed its ordinance in May 1999, about a month after the state passed its Night Skies Protection Act. Armed with the ordinance, task force members have been able to convince managers of several businesses to voluntarily tone down their bright lights -- Holy Cross Hospital, Taos Professional Building, Taos Detoxification Center, New Mexico Human Services Department's Mary Medina Building, and the Cielo Azul Housing Complex.

The comprehensive town ordinance, hailed as one of the best in the nation at the time it was passed, affords citizens a venue to protest against "light trespass" -- light that spills over property lines, illuminating adjacent areas in an objectionable manner.

Any new lighting installed must conform to the regulations, and while pre-existing lights were grandfathered in, the ordinance does require them to be brought up to new standards when they become inoperable and must be replaced.

The town's dark-skies ordinance does a good job of balancing the needs of lighting for security and recreation purposes with protecting the beauty of the nighttime skies. By requiring lighting that is aimed downward and is shielded, the bothersome and potentially dangerous glare of outdoor lights is reduced, and views of the gorgeous skies above our town are enhanced. The ordinance also promotes energy conservation, which is increasingly important to consumers. Kit Carson Electric recognizes this and has been an active partner in the dark-skies endeavor.

But if the state has an ordinance, why is it necessary for the county, or the town, to pass its own?

The state ordinance is weak and doesn't go far enough. One task force member characterized it as a piece of legislation that does little more than outlaw mercury-vapor lights.

That's not enough.

Repeated attempts to get an ordinance passed at the county level have failed, but those efforts should not be abandoned.

Task force members have spent the past year drumming up support from outlying communities and neighborhood associations -- a task they were given by county planning board members. To date, they have secured letters of support from Peñasco, Amalia and Costilla and about half of the neighborhood associations.

That's impressive. It's enough support to warrant a more serious look by county planning board members and commissioners, who should turn their eyes to the skies to better understand why such an ordinance is important.

* The fight against the onslaught of light pollution has been modestly successful the past three years, but a county-wide dark-skies ordinance is still needed. The state has an ordinance, but it is weak and doesn't go far enough. That's why this issue warrants a more serious look by county planning board members and commissioners, who should turn their eyes to the skies to better understand why such an ordinance is important.

Want to write a letter to our editor?
Click here.

TRNonline

February 28, 2002

Times Record News
Wichita Falls, Texas

- Classifieds
- News
- Business
- Entertainment
- Sports
- Opinions
- Obituaries
- Community
- Features
- Special Sections
- Health Library
- Contact Us

search: go

Current Lake Levels

TRN front page in pdf format

Click here to get Adobe Acrobat

Shop online locally at ShopWF.com!

Recipes Online - Click here for a Taste of Today!

TRNautomall-Search OnLine for your next vehicle!

Weddings, Anniversaries and Engagements

Subscribe to The Times Record News

AP MoneyNews

AP Photo Week

AP Faith

AP Travel

Today in History

NEWS

REGIONAL NEWS

Sun, February 3, 2002

Night lights dimming area's new economic horizons

Hanaba Munn Noack, Times Record News

QUANAH - Light pollution - phenomenon of progress - is the biggest threat to the bright new star on the Quanah-Crowell economic horizon: astronomy.

From truck stops to dairies, new business shine against the night sky. But as long as the light shines down - not up - no one's complaining.

Jeri Turner leads star walks at Copper Breaks State Park during warm months of the year.

"Astronomy is a big draw," Turner said. "We expect more than a thousand people, primarily from the Dallas area, to visit the park to check out the dark skies this year. We're seeing big jumps in attendance at the star walks."

Copper Breaks lies about half-way between Quanah and Crowell - an economically-depressed part of Texas where civic leaders smile at the thought of a new dairy or a prison.

Turner does too.

Besides leading star walks at the park, she is the new executive director of both the chamber of commerce and industrial foundation in Crowell.

Astronomy and industry can co-exist, she said. But she keeps an eye out for light pollution - spillage and glare that spoil the night skies for star viewing.

Properly shielded lights keep beams from shooting up into the night sky.

"To preserve natural resources and responsibly develop business in the same area, you have to plan it," she said. "Planning is the key."

The Texas Department of Transportation is playing by new rules to stem light pollution.

At two new rest areas TxDOT is building on U.S. 287 southeast of Quanah, lights have sprung up like tall weeds with one, two and three pods each. When TxDOT flips the switch, the lights will welcome security-conscious nocturnal travelers.

The new lights conform to Texas House Bill 916, legislation effective Sept. 1, 1999. Under the law, the lights meet anti-pollution standards.

"When we put lights in, the requirements are a cutoff luminaire if the output of the outdoor light fixtures is greater than 1,800 lumens," said Barbara Seale, TxDOT public information officer at Childress. "The ones at the new park will be built to these specifications."

Weather

42°F
P/SUNNY

Radar Forecast

Game Day Heroes

TRN Travel

CuteCritters.com

Reunion Listings

Lueck in the News

TX Lottery Results

How Now Joe Brown

TRN Top J

Ribbons & Rebukes

Ribbon for a lone ranger. Mike McGrath, Montana's attorney general, didn't need a white steed to take a stand. McGrath filed a brief with a federal appeals court supporting President Clinton's rule protecting roadless areas of national forests, and in the process took on an entire posse of Western state officials who object to the plan—including his own governor.

Ribbon for doing diaper duty (in a big way). Santa Clarita, California, put up $250,000 toward the country's first-ever disposable-diaper recycling plant. If a diaper-collection pilot program set to begin by next summer is successful, the plant will keep 6,700 tons of the most regrettable aspect of parenting out of landfills each year.

Rebuke for plane speaking. Responding to criticism that his company's new sub-supersonic passenger plane is environmentally insensitive—because it will guzzle 35 percent more fuel than its peers—Boeing vice-chairman Harry Stonecipher was quite blunt. "There's plenty of fossil fuel still around," he said, leaving listeners to wonder if he, himself, was one of those fossils.

Rebuke for kowtowing to the bottom line. Two days after *Wall Street Journal* employees received a memo telling them to turn off their computers at night to save energy, they received another one instructing them to keep their PCs running. Why the sudden flip-flop? Insiders say the financial paper had conducted one of its beloved cost-benefit analyses—and determined that saving electricity wasn't worth the two minutes of work time each employee would lose waiting for the morning boot-up. —J.B.

ANTHONY RUSSO (ILLUSTRATION); TIM BENKO

NIGHT LIFE

The Mission of Madame Darkness

Nancy Clanton sometimes hangs out in parking lots at two in the morning. Alone. But instead of fear, what the forty-eight-year-old outdoor lighting designer encounters, she says, is awe. "There's just one or two cars there, but every single light is on. And I'm sitting there looking out over the cityscape and asking, 'Why?'"

Clanton is part of a team helping to carry out an order by California governor Gray Davis: Cut the state's outdoor-lighting energy consumption. No one knows exactly how much energy the country uses on nighttime lighting, but in California, her team has found lighting levels at up to a hundred times the recommendations. "I don't believe in this kind of waste," says Clanton, a twenty-six-year member of the Illumination Engineering Society of North America (IESNA) and head of its Outdoor Environmental Lighting Committee. The advice the Colorado designer gives to Governor Davis will cut light pollution, promote higher-quality lighting, and reduce light trespass—when illumination from one area, such as a brightly lit car dealership, spills into another, such as your bedroom.

Nancy Clanton, watt chopper

Clanton also has something else to consider: the psychology of lighting security. Most people still equate brighter lights with greater safety. In reality, blasting light into an area can make it less safe: It creates glare, which impairs vision; and an unevenly lit parking lot is full of shadows, the lurking places of car thieves and their ilk. Adding top shields to spread the light uniformly over the ground and lowering the wattage corrects these problems. But Clanton also wants people to feel safe. How much can she cut before the fear factor kicks in?

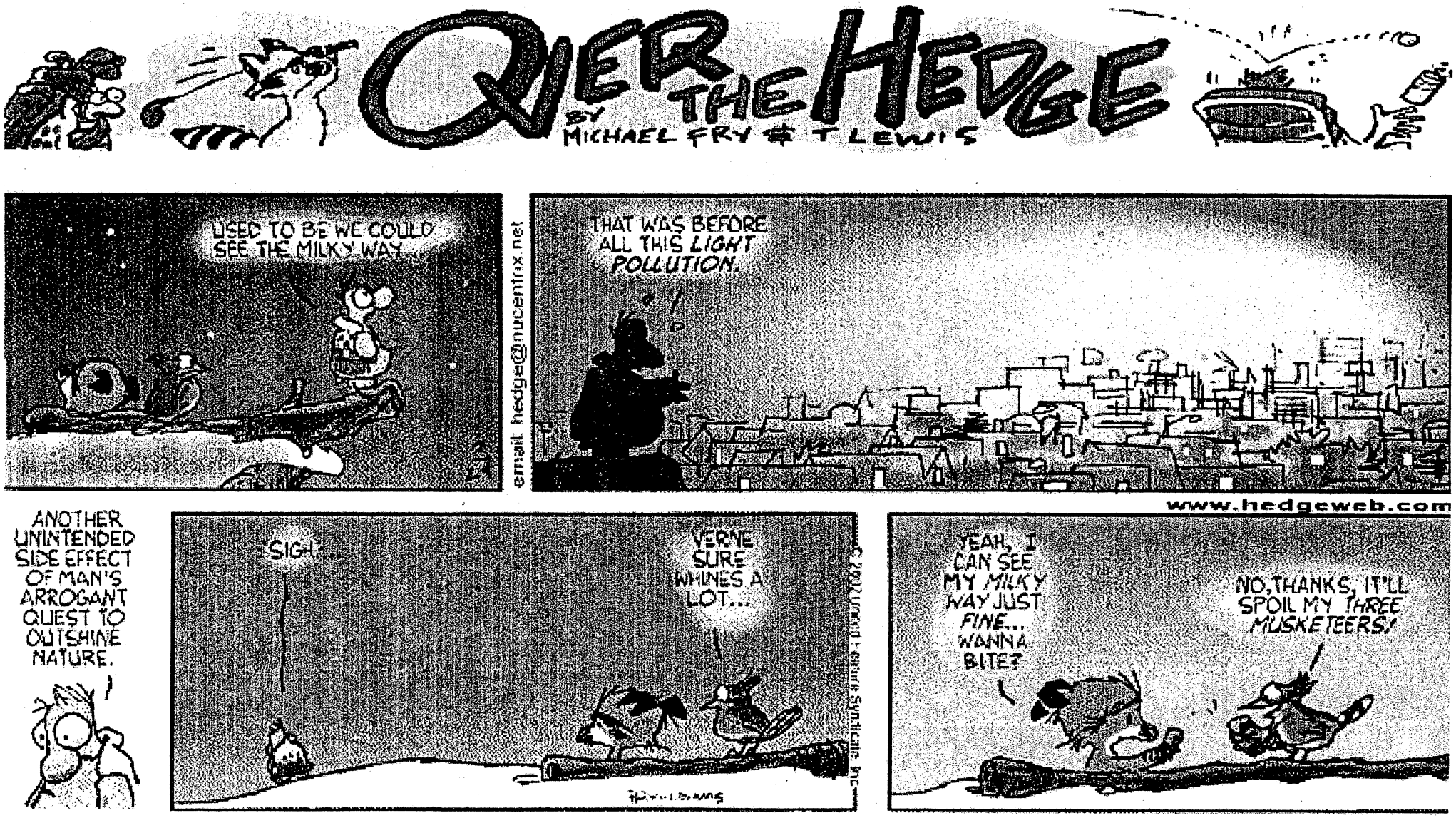
To find out, Clanton and her team are talking to passersby in parking lots of fast-food restaurants and car dealerships, asking how safe they feel and what they can see. By comparing those subjective answers with precise measurements of light uniformity, overall illumination, and glare, they hope to determine the safety threshold.

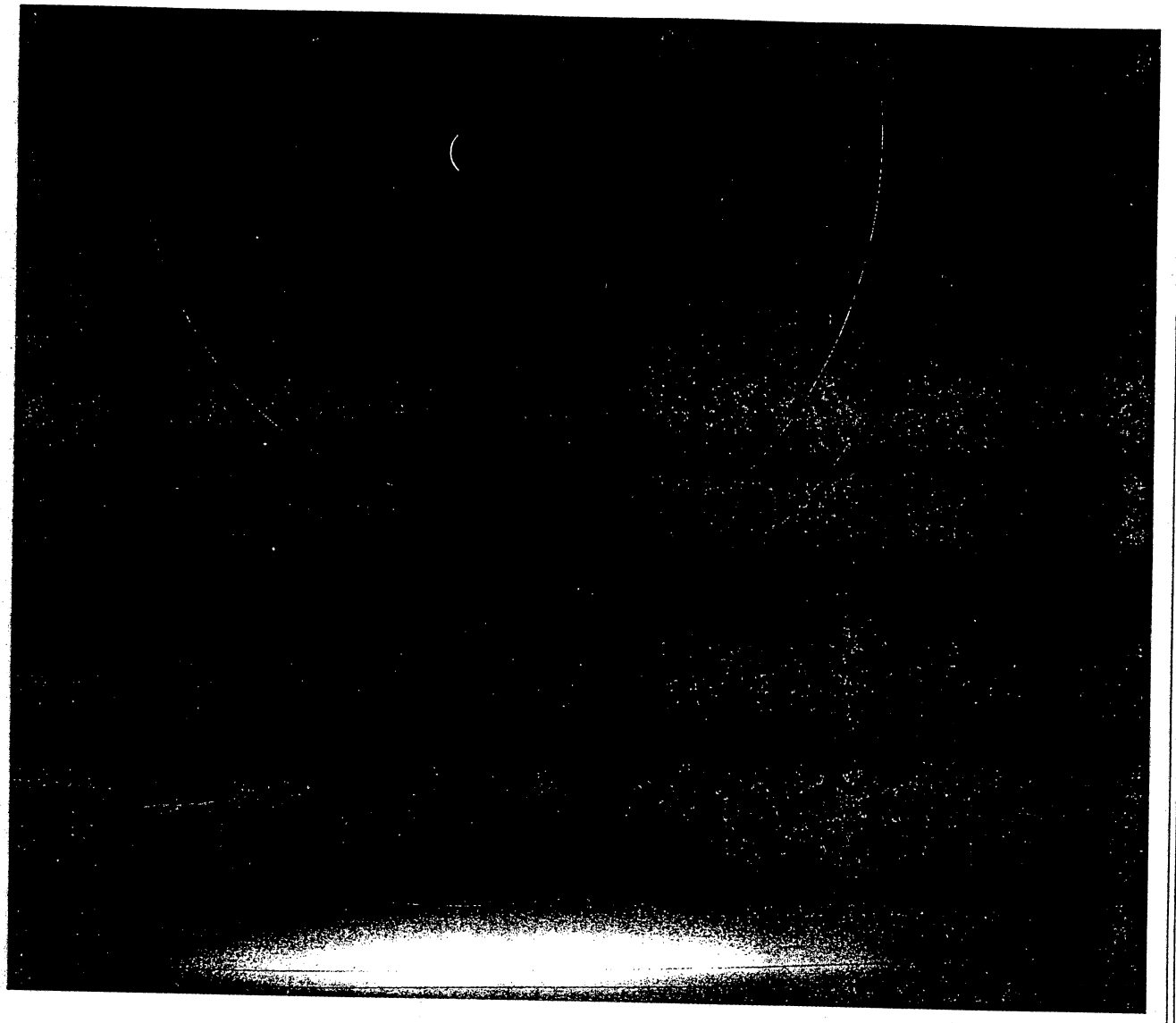
So far, Clanton's research shows that the biggest problem is glare, which heartens her because it means that we may ultimately feel safer in areas lit with fewer—not more—watts. "People are starting to say no to intrusive lights," she says. "That will save energy. But it might also let our kids see the stars again." —Rachel X. Weissman

ON GLOBALIZATION

While we are all competing, when will there be time for sex or music or books? Stop the world, I want to get off.

HOWARD STRINGER, CHAIRMAN OF SONY AMERICA





Photographer:
Richard Misrach
Title: Polaris Over Ak-Chin, 1.28.98–1.29.98, 9:03 P.M.–4:18 A.M.
Camera: Deardorf 8x10 with 300mm lens
Film: Kodak VPS negative color film, ISO100
Exposure:
7 hours, 15 minutes at f5.6

BACK IN 1955, RAY BRADBURY, MASTER OF HEAVENLY TALES FOR GROWN-UPS, WROTE a book for small children entitled *Switch on the Night*. It was the story of a lonely little boy who didn't like the Night, didn't like light switches, and wouldn't go out to play with other children after dark. Then late one evening, when the boy had all the house lights blazing, a strange little girl named Dark came to visit and showed him how "You can turn the Night off and on, just like you can turn a light off and on. With the same switch!" And when you switch on the Night, she explained, "You switch on the stars. The light stars, the bright stars, the true stars, the blue stars!" Stars like Polaris and others that etched the fine circular lines in this seven-hour exposure of the northern heavens over the Arizona desert, taken from photographer Richard Misrach's *The Sky Book* (Arena Editions).

Unfortunately, the stars are fading from view, and the reason is severe light pollution. A recent study revealed that the Milky Way can no longer be seen by two-thirds of the world's population. "Whole generations of kids in cities and suburbs are growing up seldom if ever having seen what a sky full of thousands of stars might look like," says Timothy Ferris, author of best-selling books on the cosmos. It could be a big loss, we're told, because young skywatchers are the ones who grow up to be poets, philosophers, explorers, and scientists. The stars, of course, are still burning bright. They're just waiting for grown-ups to switch on the Night.

—Les Line

Volume 104, Number 1, January-February 2002. *Audubon*, ISSN 0097-7136, the magazine of the National Audubon Society, is published six times a year (January, March, May, July, September, November). Editorial and advertising offices: 700 Broadway, New York, NY 10003; 212-979-3000. Membership: $35 a year. Canadian and other foreign members add $10 for postage. Single copies: $5. Periodical preferred postage paid at New York, NY, and additional mailing offices. Canadian GST Number is R127073195. Canada Post International Publications Mail (Canadian Distribution) Sales Agreement No. 190314. Postmaster: Send address changes to National Audubon Society, P.O. Box 52529, Boulder, CO 80322-2529.
Printed in USA

Outdoor Lighting Code Handbook

Version 1.13
December 2000 / January 2002

International Dark-Sky Association
3225 N. First Ave., Tucson, AZ 85719 U.S.A.
E-mail: ida@darksky.org
WWW: http://www.darksky.org

Abstract

This Handbook discusses issues relative to outdoor lighting codes, their effectiveness, implementation, and enforcement. A "pattern code" is included, both as a starting point for communities who wish to consider a lighting code and as a way of discussing many of the issues that arise. This pattern code is not to be considered as a model code to be implemented as-is. Each community will have different needs and different priorities. The Handbook is written mainly for communities in the USA, but many of the issues are the same for other applications, such as state codes or codes outside the USA. Appendices include forms useful for administering a code, descriptions of several recently adopted lighting codes, and other information. The Handbook is intended to be a dynamic document, and it will be revised regularly as new information is developed in the effective application of lighting codes, and the science and art of outdoor lighting.

CONTENTS

1 Introduction

Though comprehensive outdoor lighting codes originated with the pioneering efforts of western American communities with significant astronomical research facilities, the issues are much broader than the darkness of the night sky and the effectiveness of astronomical research, making lighting codes relevant for all communities. All of us live under the sky (even non-astronomers), and all of us need quality outdoor lighting (even astronomers). Careless use of outdoor lighting damages the night time environment in many ways for everyone, often decreasing security and safety or even creating hazards through glare and distraction where none would exist without the lighting. But the loss of the naturally dark star-filled sky is a tragic consequence for the environment and the human soul, akin to the loss of our forested landscapes or even the loss of fresh air to breathe. The night sky has been a canvas of our hopes and inspirations since we have been aware enough to raise our eyes from the ground. But our children are more and more growing up never seeing the stars, robbed of this inspiration of the ages.

It need not happen.

Careful and considered use of lighting at night, using light only when it is really needed, where it is needed, and as much as is needed and no more, would unblanket the stars in all but the largest cities. Compared to typical outdoor lighting practices, such "quality lighting" on average puts less than half the light into the sky, in some cases even less than one-tenth as much. Imagine it - in a city of 100,000 residents, effective lighting could bring back the starry skies of a town of 10,000. The town of 10,000 might see the endless skyways of a village of 1,000. The universe above could return to our towns and homes, to inspire the coming generations as it inspired the creators of Orion the Hunter with the Golden Fleece of stars tightly in his grip.

Quality lighting brings other substantial benefits as well. Lack of glare and excessive contrast brings improved visibility, especially to the aging eye. Elimination of wasted light saves money, energy and resources, which in turn reduces air pollution, water pollution and carbon dioxide emissions caused by energy production and resource extraction. Good lighting returns a sense of balance to the night, and gives a quality appearance to our towns and cities when the sun goes down.

But poor lighting practice is rampant. Careless and excessive use of lighting in our outdoor environments causes extensive damage to the aesthetics of the night, at the same time that it compromises safety and utility, the very uses for which it is usually installed. Bad lighting hurts everyone. It starts a cascade of negative consequences - beginning with the loss of our views of the heavens, continuing through falling levels of safety and utility, irritation of neighbors and wildlife, disturbance of the rhythms of day and night that are vital to many natural systems, damage to the aesthetic appearance of our communities, wasted monetary and natural resources used to produce wasted light, and increased air pollution and carbon dioxide levels from wasted fossil fuels. There is nothing good that comes from bad lighting.

Most bad lighting can be blamed on the fact that the user is unaware of the issues of visibility and utility, how they are enhanced by good lighting and compromised by bad. Much is known about how lighting affects our ability to see, to be safe, and to use the nighttime environment. Much remains to be learned. Though the science of lighting has made tremendous strides in the understanding of quality lighting and visual perception, our communities will not benefit from this knowledge until we raise our awareness and expectations, and demand both quality lighting and dark skies.

A lighting code is the vehicle for a community to express its expectation for quality lighting and dark skies. If it is well written, implemented and enforced, the amount of improvement that can be achieved for most communities is nothing short of phenomenal, both in reduction of sky glow and improvement in visibility on the ground. Effective shielding standards, as recommended in this Handbook, will reduce the amount of light escaping into the sky by fifty percent or more compared to typical unregulated lighting practice. In the majority of cases, these shielding standards will also virtually eliminate glare. In applications where overlighting has become a common practice, such as in service station canopy and much convenience store lighting, the overall lighting limits recommended in the USA Pattern Lighting Code, expressed as lumens per acre caps, will reduce unnecessary lighting, glare and stray light by even greater proportions. And, unlike other forms of pollution, the elimination of light pollution in all its forms actually saves money. Quality lighting costs less than bad lighting, in the long term and even usually in the short term. Everyone wins when lighting is done right.

The IDA Lighting Code Handbook is a response to the many requests for information on lighting codes and assistance in composing lighting codes from the increasing numbers of communities interested in addressing these issues in outdoor lighting. Many issues related to outdoor lighting use and the means of decreasing obtrusive side effects of its use through effective regulation are discussed. The Handbook is not a guide to other related issues or subjects such as efficient energy use, lighting system construction, design standards in general, or interior lighting. It is intended as an aid to communities that are recognizing the value and beauty of dark skies and the effectiveness of quality outdoor lighting, that are seeking to take control of their outdoor lighting, to "take back the night" that is being lost unnecessarily to careless and excessive use of outdoor lighting.

2 Structure of the Handbook

The next section (*How to Use the Handbook and USA Pattern Lighting Code*) is a general overview of how the Handbook can be used as an aid in the process of drafting an outdoor lighting code. Following this is a section (*Topics in Outdoor Lighting and Lighting Codes*) with discussions of several general issues related to lighting and lighting codes, and the approaches that are most effective and why. There are no perfect lighting code solutions to all lighting problems, and several problem areas are discussed in *Practical Issues and Problem Areas for Lighting Codes*. After adoption of a lighting code, the issues of ongoing enforcement and adaptation must be addressed, and the section on *Ongoing Education in Outdoor Lighting* describes an effective way to keep the community involved.

Next is the *USA Pattern Lighting Code*, a generic code embodying the principles of light pollution control described in the Handbook. All section titles within the Pattern Code are linked to *Section Overviews*, where general issues related to the section are described.

Within each section are links to *Notes* that follow the USA Pattern Lighting Code, each addressing specific issues related to the code text, such as alternative versions, issues that should be considered if the text is modified, and examples of codes that use similar text or from which the pattern text has been borrowed. Different communities will have different goals and priorities, and alternatives may be offered where a different emphasis or

approach can be taken. Sometimes the implications of alternative approaches or modifications may not be obvious, and the notes will describe some of these. Examples are used to show what has worked, where, and why.

All such links are indicated by the usual hyperlink color and underline convention using *this color* (if not yet "visited") and *this color* (if already "visited"), and also by *italics*, so that they may be evident in black and white hardcopies.

Following the *Notes* are short sections covering a few technical *definitions* used in the Handbook but not included in the Pattern Code Definitions - if you come across a term you don't understand in the Handbook, check for it here and in *Section 16*; a brief description of the primary reference sources and organizations serving as background for the Handbook; and an example *Lighting Advisory Committee Proposal*.

Next are Appendices. *Appendix A: Administrative Forms* includes forms that can be used in the process of administering a lighting code based on the Pattern Code. *Appendix B: Example Applications of Section 4* summarizes how the shielding and lumens per acre standards of Section 4 apply to residential and commercial land uses in the various Lighting Zones. *Appendix C: Example Lighting Codes* includes brief descriptions and links to several real in-place lighting codes. Some have been written using this Handbook, or an earlier version; some have used other guides. These examples illustrate on-the-ground solutions to outdoor lighting problems in communities with differing size, location, history, composition, and goals.

3 How to Use the Handbook and USA Pattern Lighting Code

The IDA Lighting Code Handbook does not intend to offer a single solution appropriate for all communities or situations. It offers instead a comprehensive guide describing issues relevant to the control of the obtrusive aspects of outdoor lighting, and a list of effective regulatory approaches to mitigate these aspects. The Handbook is intended for use by any community of any size or locale in the USA seeking to produce a new or update an existing lighting code. It can also be a valuable guide for communities outside the USA, though IDA intends to supplement this Handbook with pattern codes and discussions more directly applicable to other countries as time and resources permit.

To begin the process of getting a lighting code for your community, you must first seek to establish a consensus that there is a problem and that something needs to be done (see also *What Makes a Lighting Code Effective*). Educate yourself about the issues, using this Handbook and the materials on the *IDA website*. Especially valuable are the IDA Information Sheets *IS #6: Advice on Working with Community Leaders, Officials and Others*, and IS #96: How to Get an Outdoor Lighting Ordinance. Meet with others of like mind, perhaps members of a local astronomy club, staff and users of local natural parks or areas, members of local environmental groups, civic groups, lighting engineers and designers. Meet also, early on, with the planning staff and the city council or other governing board of the community, tell them what you see as the problems, and seek their input on what they see as the problems. Give talks to local groups about the issues.

When enough people are concerned about the state of outdoor lighting, then a group can be formed to investigate solutions. Members should include yourselves, members of the planning staff, perhaps council members, lighting designers, sign manufacturers, electrical or lighting contractors. Membership should be broad, but the committee must also keep clear what the problems are and not let the committee steer away from effective answers to the problems.

As a beginning point, your committee and community must define the problems it wants addressed, and rank them where appropriate in order of priority. Is energy conservation a principle concern? Sky brightness? Is there a concern in the community about overlighting, or perhaps underlighting, or both? Is there a significant senior population who is likely to be more sensitive to glare than younger citizens? How sensitive is the community to the aesthetic appearance of the community at night? In which situations or locations does the community place a high priority on the preservation of starry skies, and in which on the illumination of the built environment such as buildings and landscaping?

Collect information to begin considering for your lighting code - beginning with lighting levels and practices in your community, any local lighting codes, and also examples of other lighting codes, particularly for your state or for communities of similar size from within your state if any are available (see the *IDA website* for many links to lighting codes and other resources.)

Any code prescribing something as complex and diverse as lighting practices will naturally be somewhat complicated. Complicated codes can be difficult codes - difficult to understand and difficult to apply, demanding considerable and perhaps unexpected resources of community planning departments. Good lighting codes recognize these facts, and seek approaches to the issues that are as simple to understand and apply as is possible while maintaining effectiveness.

Before modifications are attempted to form your code from the information in this Handbook, the USA Pattern Code, and other codes you may be using as guides, the information and codes must be understood. Then modifications appropriate to the local situation, attitudes and laws must be devised that will produce a lighting code that defines what your community wants and expects of its lighting. The perspective of the planners that will implement the code is vital, and they must be involved in this process, the earlier the better. At all times, be sure you understand the implications of the approaches chosen, both technically in terms of lighting specifications and practically in terms of applicability, practicality, enforceability, and cost.

The implementation of a lighting code will require administrative procedures and forms. The forms contained in *Appendix A* should be modified to suit the code you have written and the style of implementation favored by your planning department. In most cases this will mean much shorter and

The Urban Wildlands Group

and

Ecological Consequences of Artificial Night Lighting

February 23-24, 2002
Los Angeles, California

Catherine Rich & Travis Longcore
Conference Co-Chairs

Abstracts

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
260 Panama Street, Stanford, California 94305, USA
Tel: (650) 325-1521 x207, Fax: (650) 325-6857

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.

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
106 Central Street, Wellesley, Massachusetts 02481-8203, USA
Tel: (781) 283-3098, Fax: (781) 283-3642

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.

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, D-55099 Mainz, Germany
Tel: +(49) 6131-39-22574, Fax: +(49) 6131-39-23835

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 disorientated 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 CO2 emissions significantly. The modernization of public lighting is beneficial both for township budgets and for the agenda of nature conservation, especially of insects.

Impact of artificial lighting on moths

Kenneth D. Frank
Philadelphia, Pennsylvania, USA

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.

Stray light, fireflies, and fireflyers

James E. Lloyd
Department of Entomology & Nematology, University of Florida
Building 970, Natural Area Road, Gainesville, Florida 32611, USA
Tel: (352) 392-1901 x124,

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.

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
1600 Burrstone Road, Utica, New York 13502, USA
Tel: (315) 792-3131, Fax: (315) 792-3831

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 ne illumination. Permanent increases in nocturnal illumination may facilitate or inhibit a variety of behaviors. Foraging may be facilitated in frogs that hu 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.

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
1600 Burrstone Road, Utica, New York 13502, USA
Tel: (315) 792-3356, Fax: (315) 792-3831

Little is known of the direct influence of artificial illumination on the biology of nocturnal salamanders. However, several studies provide evidence tha 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 foragin 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.

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

Michael Salmon
Department of Biological Sciences, Florida Atlantic University
Box 3091, 777 Glades Road, Boca Raton, Florida 33431, USA
Tel: (561) 297-2747, Fax: (561) 297-2749

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.

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

Barbara Nightingale and Charles Simenstad
University of Washington, School of Aquatic and Fishery Sciences
324A Fishery Sciences, 1122 Boat Street, Box 35502, Seattle, WA 98195-5020, USA

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.

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
Clemson, South Carolina 29634-0326, USA
Tel: (864) 656-3584

Hundreds of species of birds typically migrate at night, and it 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 the evening of 28 September. Exactly 110 years later a report for World Wildlife Fund Canada and the Fatal Light Awareness Program details 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.

Artificial lighting and the decline of seabirds

Richard Podolsky
Avian Systems
279 Melvin Heights Road, Camden, Maine 04843, USA

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.

Road illumination and black-tailed godwit

Johannes G. de Molenaar, Dick A. Jonkers and Marlies E. Sanders
Alterra, research institute for the green environment
P.O. Box 47, 6700 AA Wageningen, The Netherlands
Tel: +(31) 317-47-77-31, Fax: +(31) 317-41-90-00

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.

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
4202 E. Fowler Avenue, SCA 238, Tampa, Florida 33620, USA
Tel: (813) 974-7459, Fax: (813) 974-2184

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.

January 31, 2000

Bag Those Beams

Who cares about light pollution? Astronomers, sure. But also folks who just want to see the stars again

BY DAN CRAY/LOS ANGELES

For years, the towering buttes along Interstate 40 in Arizona were surpassed in majesty only by the desert's night sky--a ceiling of ink glittering with stars and frosted with iridescent wisps of Milky Way. Today, however, the once pristine views from I-40 and various scenic byways across the U.S. are being whitewashed by floodlit roadside businesses whose commercial glow obscures the heavenly lights for miles around.

"The stars are an endangered species," complains Wini Brewer, a Morongo Valley, Calif., artist who purchased five acres of desert property for its starry vista in 1996 but is now mired in squabbles with the owners of what she considers grossly over-lit homes and businesses. "Ruining the sky," she says, "is no different from ruining the view of Yosemite."

Light pollution, a term coined by astronomers trying to protect mountaintop telescopes from the encroaching glare of urban sprawl, is fast becoming a national concern. Legislation to "bag the beam," as one campaign refers to it, is pending in four states, including New York and Massachusetts. Last summer Texas and New Mexico enacted tough laws to restrict outdoor lights, and just last week officials in Fauquier County, Va., joining hundreds of regional enforcement efforts, voted unanimously in favor of similar restrictions. Even Inuits living 200 miles north of the Arctic Circle have reportedly begun to complain about the lights.

Thanks in part to the publicity surrounding Comet Hale-Bopp and other heavily hyped celestial events, "light pollution went from a nonissue to something that's on everyone's mind," says Maryann Arrien, a documentary-film maker and an amateur astronomer in Putnam Valley, N.Y. Efforts to curb light pollution are under way from the Australian Outback to Britain's Sherwood Forest, according to the International Dark-Sky Association (I.D.A.), which boasts 3,600 members in 70 countries.

The lights won't wink out without a fight. Homeowners view brightly lighted streets as a crime deterrent and tend to feel more secure when their property shines like a Hollywood stage set. And business owners who pump a lot of money into outdoor signage insist that increased wattage is frequently all that sets them apart from the competition.

But there is such a thing as shining too much light on a subject. The Illuminating

Engineering Society of North America studied commercial lighting and concluded that many companies use five times the amount of light necessary for effective marketing. "Business lights are out of control," says Nancy Clanton, a lighting designer who helped the I.E.S. draft new guidelines recommending that outdoor lighting be reduced as much as 80%.

Antilight activists say it's possible to fight crime in residential areas without whiting out the sky. "We're not suggesting you live in the dark. We're saying it's time to keep lights on the ground where we need them," says Tim Hunter, co-founder of the I.D.A., who contends that at least 30% of all light is needlessly cast into the sky. Indeed, the solution to many light-pollution problems may be as absurdly simple as putting shields around outdoor bulbs to prevent their beams from traveling above the horizon.

ESSAY
BY INVITATION

Bob Crelin

As we stand on the brink of a new century, we find that popular outdoor lighting applications have become inefficient and counterproductive, often working against the laws of human vision and common sense. Glare and light pollution rule the night, and indiscriminate light usage is becoming more of a challenge to the human experience than a benefit.

The goal of this essay is to take another look at conventional exterior lighting. The long overdue "Renaissance" of outdoor lighting will bring about new approaches to lighting design and application— approaches designed to better aid vision, promote efficiency, and help us coexist responsibly with the natural night environment.

What is the problem?

Outdoor lighting is researched by many and understood by few, yet it is freely employed by all. Conventional outdoor lighting wisdom appears to amount to little more than, "Got a dark area? Put a light up—the brighter, the better."

Although research has established a greater understanding of outdoor lighting, the cavernous gap between those who research and those who install couldn't be wider. Lack of awareness has allowed poor lighting to proliferate. As a result, visual perception, safety, and quality of life are increasingly compromised.

How did we get to where we are today?

Since the discovery of fire, we have embraced the presence of light during the night. As electric lighting became widespread, film and television helped to mold the public's fear of the night, using darkness as a foreboding backdrop to terror. As automobiles became commonplace, the streetlight market exploded. New lamps burned longer and brighter, while many fixture designs became less discreet. Where it once was dark, there was light. And that was considered progress.

Addicted to light and conditioned to glare

In outdoor lighting applications today, function lags behind flamboyance and fear. Once installers began flooding outdoor areas with illumination, the results—glare, light trespass, and light pollution—became grudgingly accepted side effects of modern life.

Because most people are now accustomed to glare and excessive brightness during the night, appropriate nightlighting may appear inadequate to them. By pandering to this misconception, outdoor lighting has become commonly measured by sheer quantity, not quality.

Back to square one

In popular outdoor lighting, we commonly overlook some basic, unchangeable facts about ourselves and the world around us. The science of lighting application has become increasingly complicated. In order to grasp the basics, we must take a few steps back and ask: Is the application of outdoor lighting optimized for vision and safety at night? Should we be concerned that indiscriminate lighting is gradually eliminating the natural night environment?

Since the discovery of fire, we have embraced the presence of light during the night.

Glare from this high-wattage floodlight at a car dealership hinders surveillance and annoys passersby at night.

Battling Mother Nature

The human eye was not designed to contend with artificial light at night. While the eye is an extremely complex organ, its ability to address different levels of visible light is fairly basic. Over millions of years, the eye's ability to adapt from the uniform light of day to the darkness of night has evolved.

Because of its design, the eye can only adjust to one light level at a time—which is determined by the brightest level—so it cannot see in bright and dark areas concurrently. That is why we have difficulty seeing peripherally when we experience contrasting brightness against a nighttime scene. Our peripheral vision is critical to navigation, so to compromise peripheral vision is to compromise safety.

Glare

Glare goes a step beyond extreme contrast by dimi-

sure to illumination at night can disrupt normal physiological operations in humans as well.

Efficient energy use

There are few electrically powered devices today that waste as much of their generated product as many common outdoor lighting fixtures. The night sky over most communities is aglow with wasted illumination from misdirected or overdone lighting.

More often than not, lighting is generously applied to an area or subject, with little attention paid to containing light within the task area. The resulting light intrusion into areas outside task areas has created modern-day afflictions called Light Pollution and Light Trespass.

Security lighting or insecurity lighting?

Lighting is often installed to deter or prevent crime. For site security, "maximum coverage" fixtures are typically used like dusk-to-dawn floodlights and unshielded wallpacks. The glare from such lighting causes extreme contrast and promotes low peripheral visibility, thereby defeating its purpose.

Although static, dusk-to-dawn lighting "feels" like a protective measure, it can actually assist criminals more than it deters them. Major studies of the ability of security lighting to deter crime are, at best, inconclusive.[5]

What are the solutions?

Many of the problems associated with outdoor lighting can be solved by using a little common sense.

•The physiology of the human eye must be taken into account when designing outdoor lighting. To best facilitate peripheral vision at night, "contrast" between light sources, lit areas, and dark surroundings must be reduced. Softer, more transitional light levels, which are as consistent as possible from area to area, should be employed. (Recommended levels set by the IESNA should not be exceeded). Also, fully shielded/recessed light sources or "full cutoff" type (FCO) fixtures should be the prevailing choice in all outside installations. Such fixtures and light sources are available from most manufacturers.

•There is no excuse for glare, and it should be avoided in all applications. This is easily achieved by specifying fully shielded/recessed light sources or FCO type fixtures. Any fixture that presents a viewable light source as part of its functional appearance is going to affect visual perception at night by varying degrees.

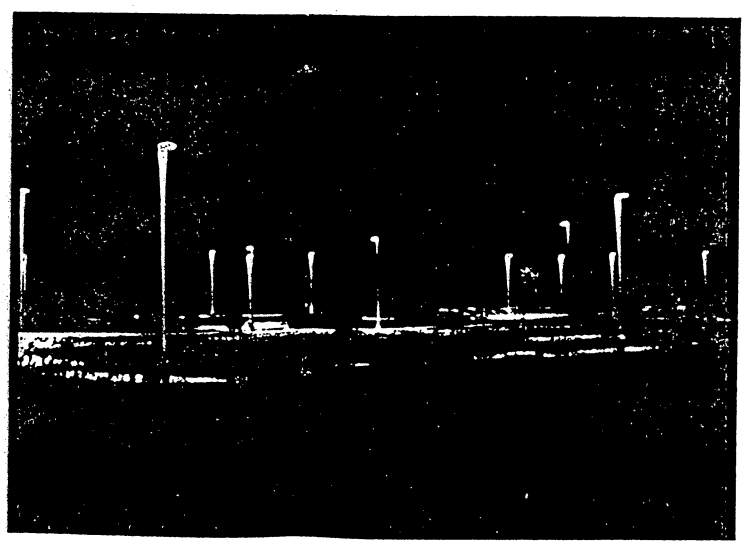
•Epitomizing the problem of outdoor glare is floodlighting. No matter how it is aimed, floodlighting always produces glare, even from extremely off-axis angles. The wide broadcast of light produced by floodlighting regularly affects neighboring areas, roadways, and the night sky—even across large distances. Given its lack of redeeming qualities, floodlighting should ultimately become obsolete.

•Unnecessary and hazardous overlighting, as in commercial "lumen wars," can be avoided by responsibly following guidelines for the maintained illumination levels and uniformity ratios recommended by the IESNA. Again, glare from these sites can be avoided by specifying fully shielded/recessed light sources or FCO type fixtures.

•Simply put, efficient use of energy in lighting is that which (1) applies all or most of its generated light to the task at hand, and (2) uses no more light or energy than is necessary for safety in the task area.

•In the security industry today, professionals will attest that motion or infrared–sensored lighting is more effective than static floodlighting in preventing theft. Since motion or infrared–sensored lighting creates an alerting "change of environment," it draws attention to any activity at a site.

•We must increase awareness. The way to achieve better outdoor lighting is through education. To ignore these many problems and continue pandering to society's "perception" of good lighting is irresponsible.



Well–designed lighting plans, using full color fixtures and proper illumination levels, create excellent visual environments while staying discretely within property boundaries.

In summary

At this juncture, we must look at where we are and learn from our mistakes. Our goal for the future must be to balance the functional needs of lighting with the unchangeable givens of nature's design. Five hundred years ago, a Renaissance challenged convention and illuminated the world. In the next millennium, our challenge is to illuminate it wisely.

References

1. Clanton, N. and Benya, J. 1997. *Outdoor Parking Lot Lighting: An E Source Report.* Boulder, CO: E Source, Inc.

2. Boyce, P. 1997. Light, sight, and photobiology. *Lighting Futures*: vol. 2 (no.3).

3. Upgren, A. 1996. Night blindness. *Amicus Journal*: Winter 1996. vol 17 (no.4): 22.

4. Raloff, J. 1998. Does light have a dark side? *Science News*: 10/17.

5. The National Institute of Justice. 1998. *Preventing Crime, What Works, What Doesn't, What's Promising: A Report to the United States Congress.* Washington, D.C.: The National Institute of Justice.

Tien, J. 1977. *Study of Streetlighting and Crime.* Washington, D.C.: U.S. Dept. of Justice.

PRINT EDITION

Blinded by the light

The glow of city street lamps and office buildings that are fully illuminated around the clock may be doing worse than interfering with astronomers' telescopes. As The Globe's MARTIN MITTELSTAEDT reports, 'light pollution' may also be causing havoc in the animal kingdom, and depression and disease among humans. Could the unnatural death of darkness be hastening our own?

By MARTIN MITTELSTAEDT
Saturday, January 12, 2002 – Page F1

Every urbanite knows that the bright lights of the big city make it impossible to see the stars in the night sky. What most of us don't know is that those lights might also be making us sick.

The cause is light pollution – the unearthly glow of billions of street lamps, security and porch lights, searchlights, office lights and signs left blazing as people everywhere try to dispel the limitations of the night.

For the first time, light is being investigated seriously as a human health hazard, a possible contributor to the sharply rising incidence of breast cancer, depression and other ailments. And for many wildlife species, light pollution seems to be as grave an environmental threat as bulldozed habitats and toxic-chemical dumping.

Until now, the loss of the natural night sky has been mourned mostly by astronomers. But everywhere scientists look, they are finding that night light is more complex than anyone imagined, and more insidious.

"People are beginning to take it much more seriously," said Alan Outen, a British ecologist who has written extensively on the dangers of night brightness. "I think we will look back on this as the aspect of pollution that we have ignored, and I think its implications are far bigger than people have ever really realized."

The ancient Greeks gazed up at night and saw in the planets and the stars the gods and heroes of their legends. The dark sky has prompted poetry and scientific inquiry, inviting each of us every night to ponder humanity's place in the vastness of the cosmos.

But this new, transfigured night is something no living thing has experienced before: For the first time in history, large populations are growing up without the full, awe-inspiring canopy of a truly dark night sky above their heads.

Because of the reflective properties of snow, Canadian cities are particularly awash in light pollution. Some images of Earth from space show that Montreal in winter outglows even New York City.

In a natural night sky, someone looking at the heavens with the unaided eye should be able to see nearly 3,500 stars and planets, and the glow from the Milky Way, our home galaxy. But in cities like Montreal or Toronto, the number of visible stars has dwindled to about 50.

It's a stunning drop, one that has caused Canada's foremost astronomy writer, Terence Dickinson, to lament, "It's now possible to grow up never having been exposed to the natural beauty and inspiration of the night sky."

Nearly two-thirds of the world's population – including basically everyone in the European Union and the United States and 97 per cent of Canadians – lives under night skies polluted by light, according to the first atlas of the world's artificial night-sky brightness, published by Italian and U.S. researchers last year.

In the most heavily urbanized regions of the world, it no longer ever really gets dark at all. Satellite images reveal that night in eastern North America, western Europe, Japan and South Korea has become a constant twilight, an artificial dusk that lasts until sunrise. Seventy-seven per cent of Canadians can no longer see the Milky Way.

The key author of the bright-sky atlas, Italian astronomer Pierantonio Cinzano of the University of Padua, says his work "provides a nearly global picture of how mankind is proceeding to envelop itself in a luminous fog."

The group also found that many people's eyes now never get to the stage where they are fully adapted to darkness. Cinzano has calculated that about one-10th of the people in the world, including 59 per cent of Canadians, have lost much of their night vision.

Of course, there are still vast areas where the natural night sky exists. But it is in places such as the Canadian Arctic, where almost no one lives. For most Canadians, cottage trips and vacations to the north are the only times they might see anything approaching a dark sky.

A hotel in Huntsville, Ont., outside Algonquin Park in an area with an intact night sky, has even capitalized on the fact by opening an observatory with a telescope so that guests can gaze at the heavens. The Grandview Inn is the first resort-based observatory in Ontario, and Dickinson predicts trips to see dark-sky areas will be "part of the ecotourism of the future."

Remarkably, this dramatic transformation of the lightscape has taken place in only a little more than a century. The invention of the incandescent light freed people from smoky kerosene lamps and the fire risks of toppled-over candles, and street lights made urban byways seem safer in the evening.

Electric lighting liberated the night, invented nightlife, and altered our whole approach to the day. The Biblical command of "let there be light" was taken to heart with a vengeance.

Now, there is so much artificial light that it is blurring the boundary between night and day, upsetting the delicate balance every organism uses to navigate between bright and dark.

Some creatures appear to be highly susceptible to this disturbance, and for them, night light can be a quick and efficient killer.

Lighting from modern office towers confuses migratory birds, which fly into buildings lit up at night. Millions of birds are dying from these crashes. In Toronto alone, the handful of big downtown skyscrapers injures or kills about 3,000 birds a year, according to monitoring by the Fatal Light Awareness Program, a local environment group.

Florida researchers have noticed since the 1980s that artificial light along ocean beaches also confuses baby sea turtles. Statewide, more than a million hatchlings are affected. The turtles instinctively crawl to the brightest thing on the horizon – normally the reflection of stars and the moon in the sea. But where beaches are illuminated, baby turtles often crawl toward road lights, where they are flattened by passing cars, or wander in circles on the beach, unsure what direction to turn. Once day breaks, the exhausted baby turtles bake to death in the hot sun.

The toll dismays those working to ensure the survival of the threatened reptiles. "Sometimes the turtles end up on the road and crushed. We end up with people crying and stuff like that," said Karen Moody, an environmental specialist with Florida's Fish and Wildlife Conservation Commission.

Lepidopterists similarly blame night lighting for the decline in moths over the past four decades. In a brief experiment by German researchers, more than 42,000 bugs were collected at 19 lights in a rural area, showing how easily artificial light can disorient insects. It can also cause mated male mockingbirds to sing at night, when normally only unmated ones do, and stop tree frogs from croaking, blocking a key courtship ritual.

Bryant Buchanan, a biology professor at Utica College of Syracuse University in New York, has conducted experiments in which he showed that even the dim light of a child's night light is enough to blind nocturnal frogs, impairing their ability to hunt crickets.

He also observed that when a campus sports stadium lit up for nighttime games, frog courtship stopped dead -- a worrisome development for animals that may breed only a few nights a season

and are subject to declining numbers around the world.

"As dark habitat disappears, clearly if you're reducing the number of nights that a frog can breed, year after year after year, that's going to have an effect," he said.

Biologists say light at night has an effect similar to habitat loss. As surely as development alters habitat, light can render an area unsuitable for wildlife. As well, like many toxic compounds, light has the ability to cause mental distress or impairment in vulnerable species.

Why the effect is so dramatic is not fully known, and may be different depending on the species. But Outen said an intuitive explanation is evolutionary: "Life on Earth evolved in the presence of alternating darkness and light . . . and has adapted to it."

That's true of us as well. Sea turtles and birds are clearly in peril because of light at night, but scientists have begun to study whether humans may share something of the same fate.

Richard Stevens, an epidemiologist at the University of Connecticut, has developed the idea that light at night has the ability to disrupt critical hormone levels that affect human health. Stevens came to this conclusion while trying to solve the puzzle of why breast-cancer risk is five times higher in rich, industrialized societies than in poor, developing countries.

In the early 1980s, researchers speculated that the disparity might have to do with fatty Western diets, genetics or the exposure to toxic chemicals, explanations that have all been found wanting.

Stevens was working at a U.S. Department of Energy laboratory where studies were being done on the biological effects of magnetic fields. Serendipitously, he began thinking about electric currents and the fields they produce.

"It occurred to me that a hallmark of industrialization is the use of electricity," he said. "Then I got to thinking, 'What does that mean? How can electricity cause breast cancer?' The most interesting aspect of electricity is light, the light environment."

Stevens turned to the then-nascent scientific literature on circadian rhythms -- the 24-hour biological clock that guides daily body functions -- and on melatonin, a critical hormone most living creatures produce only while in darkness. Since then, he has been investigating night light, developing the counterintuitive theory that something as harmless as a lit light bulb can make people ill.

In a study Stevens co-wrote in 2001, he concluded that there is "mounting evidence to suggest that disruption of the melatonin rhythm may lead to chronic fatigue, depression, reproductive anomalies, and perhaps even cancer."

Another study Stevens worked on last year presented the unusual discovery that women who work graveyard shifts, such as nurses, have a substantially higher risk of breast cancer. Even one all-night shift a week over a three-year period was enough to increase the risk by 60 per cent.

He was impressed by other research that found breast-cancer risk to be nearly 50-per-cent lower in blind women. The more a woman is visually impaired, the lower the risk of cancer.

"How does light do it?" Stevens asked rhetorically. He thinks the key is melatonin, he said, the hormone that has been popularized as an anti-aging and anti-insomnia potion and as a cure for jet lag. "Melatonin is sort of the chemical expression of darkness -- it's the 'Dracula' of hormones, because it only comes out at night," he said.

Melatonin is produced in the brain's pineal gland, guided by cues from the retinas of the eyes. Melatonin is produced only when the eyes signal that it is dark. Production begins around nightfall, peaks in the middle of the night between 1 and 2 a.m., and shuts off during the day.

This nightly dose of the Dracula hormone tells the body whether it is day or night. Those who work under lighting at night, as in an office or a hospital, might be inadvertently reducing the amount of melatonin they produce. Experiments have shown that melatonin inhibits estrogen from stimulating the growth of breast-cancer cells, among its other healthful effects. This suggests why blind women, who presumably maintain high melatonin levels, are at less risk, while night-shift workers are more susceptible.

Researchers have been able to suppress melatonin production completely by exposing people to

http://www.theglobeandmail.com/servlet/GlobServlet.HTMLTemplate?tf=tgam/common/FullStory.html&cf=tgam/common/FullStory.cfg&configFile=tgam/config&tag=BigAdVariableGenerator&date=20020112&date...

light levels about five times brighter than in a typical office. At lower light exposures, there is a less severe reaction, showing that in some ways light is similar to carcinogenic chemicals such as benzene or asbestos, with a given dose producing a set biological response.

A big question is whether the public is at risk from milder night light, such as the artificial glow of the sky or even a neighbour's light shining into a bedroom. In his research on shift workers, Stevens found that women who reported sleeping in bright bedrooms -- where there was, for example, just enough light pollution at night that they could read -- also had a slightly elevated breast-cancer risk.

That finding suggests that light levels in major cities could be dangerous, although the association was weak and it is too early to draw conclusions. Still, Stevens said, people should take seriously anything that leads to even a tiny change in the level of a critical hormone. "If you have a small suppression of a hormone or a small elevation for many many years, it can have a big impact."

David Blask, a scientist at the Bassett Research Institute in Cooperstown, N.Y., became interested in melatonin after experiments showed that pineal-gland extracts from cows or pigs injected into humans with cancer had some improving effects. "It acts just like a roadblock, just like tamoxifen in slowing down breast-cancer growth," he said.

Blask has been conducting research on rats, and has found that even a slight amount of light at night shuts down production of melatonin in the rodents. He made the discovery by exposing some rats to around-the-clock office light, another group to normal alternating days of living under office lights and nights of total darkness, and a third group to normal days, but with a slight amount of nighttime light.

Surprisingly, the rats exposed to just a tiny amount of night light had the same rate of tumour growth as the rodents exposed around the clock. "It would be the equivalent to being in a completely dark room, with a small light leak coming through a crack in the door. That's the light intensity we're talking about," Blask said.

Luckily for humans, we're far less sensitive to light at night than rats and other lower mammals, nocturnal species acutely attuned to melatonin for reproductive reasons. But the magnitude and duration of their melatonin surge at night are virtually identical to what happens in humans. Blask is currently testing the melatonin hypothesis under a four-year grant from the U.S. National Cancer Institute, trying to zero in on just how dim light has to be before it no longer seems to stimulate cancer-cell growth.

There is much that scientists don't know about melatonin. Some individuals seem to be far more sensitive to the night-light effect, and women appear to be more vulnerable than men. At this point, Blask said, he wouldn't go so far as to advise people to shut off their lights and sit in darkness for health reasons. "But I think there is enough evidence right now to be cautious at any rate and certainly limit our exposure to bright light at night.

"When you think about it," he added, "light at night, except moonlight, is pretty inappropriate. We didn't evolve with artificial light and it's only been in the last 100 years or so that we've had this phenomenon of artificial light."

Not only did people not evolve in illuminated nights, until recently they also did not spend their days bathed in the weak lighting of the typical office (about 200 times less bright than sunlight). To get in sync with nature's rhythms, Blask said, "I think that people should have as dark nights as possible, and as bright days as possible."

Scientists studying light pollution have mostly been working in isolation, and the evidence they have collected on its dangers has never been drawn together. But a conference has been organized for next month in Los Angeles that will gather many of the top scientists studying the impact of night light to compare notes.

The conference, hosted by the UCLA Institute of the Environment and the Urban Wildlands Group (a Los Angeles eco-activist association), could lead to a higher public awareness of light pollution, according to organizers. "In the ecological world, there are very few people who are looking at this in a unified way," said Travis Longcore, a spokesman for the Wildlands Group.

Longcore said light pollution should be receiving the same attention from the public and regulators as other environmental ills. It has been growing relentlessly by about 10 per cent a

year since the 1960s, and only recently have serious efforts begun to try to control it.

In Canada, the Ontario government has set up a nature reserve north of Toronto, the first in the world where the preservation of a pristine night sky was one of the reasons for establishing the park.

Located near Gravenhurst, the Torrance Barrens Conservation and Dark Sky Reserve is just far enough over the horizon from Toronto and other major Southern Ontario centres that its sky remains unpolluted.

Conservationists are hoping to expand the area of preserved night sky around the park to include much of nearby Georgian Bay, the Bruce Peninsula and Manitoulin Island, using municipal bylaws to restrict poorly designed night lighting, the main culprit behind light pollution. If established, it would be one of the largest areas in the developed world of protected night sky.

In the United States, the International Dark-Sky Association has also been campaigning for the use of better-designed street and security lights that won't spill into the night sky. The Tucson-based group views the light above major cities as the glow of wasted energy. It has calculated that in the United States, about $1-billion (U.S.) is spent annually on the electricity wasted to illuminate the sky.

"We tell people all the time that that's just dollar bills burning," said IDA executive director Dave Crawford. The group has championed bylaws requiring "night-friendly" lights, with the bulb recessed into the fixture so that its light does not glare out horizontally or upwards. Unlike the common cobra-head street lamp, lamps that direct a tight beam at the ground use less wattage and save money because they don't uselessly light the sky.

Well-designed lighting can help recover the sky. In Tucson, where night-sky protection rules exist, Crawford said, "on good nights you can actually detect the Milky Way. Remember, this is a city of 800,000 people, whereas in an average town of 50,000, you couldn't do that. So we know these things work."

The association also urges neighbours to complain to those guilty of committing "light trespass" -- lamps on at night whose light intrudes on the properties of others -- and criticizes around-the-clock security lighting, urging people to use motion-activated lights instead to deter crime.

But where people like Crawford see the planet developing a global lighting problem analogous to global warming, others love night lighting, especially some business interests.

In Langley, B.C., city council passed a bylaw last year restricting the use of night-piercing searchlights to 30 evenings a year, after public complaints over light from a new Famous Players "Colossus" movie theatre. While many residents complained that the company was engaging in "celestial vandalism," Famous Players managers thought that the lights lured customers, and they launched court action against the bylaw.

No one seems to like high lighting levels more than big-box retailers. Many now use three times the intensity of shopping-mall lighting in the 1970s. "There is a lot of desire to boost up the light levels," said Tony Rutenberg, sales manager at Rutenberg Sales Ltd. of Mississauga, a major Canadian lighting dealer. "It looks very inviting." The big-box retailer thinks, " 'I'm going to have more people come in,' " he said.

Rutenberg has tried to encourage retailers and other big lighting users to consider sky-friendly products. He tells them it's a money-saving bet in the long run because they use less electricity, while curbing light pollution. "With better design, you absolutely can reduce your energy, lower your costs, and save the sky," he said.

While the health and environmental impacts of light pollution are starting to capture attention, Crawford of the Dark-Sky Association has other concerns. While he, too, worries that lights may be making people sick and harming wildlife, he said the fading of the heavens could also cause a fading of the human imagination -- in many ways, a greater long-term threat.

Writers and other artists have always drawn inspiration from the night sky. "We had the sky up there, all speckled with stars and we used to lay on our backs and look up at them and discuss about whether they was made or only just happened," Mark Twain wrote in *Huckleberry Finn*.

"There have been poems and symphonies and music and art, and van Goghs and other

[masterpieces] all done with the stars up there," Crawford said. "Nobody's done painting like this about street lights or billboards. It's the glamour and wonder of the universe we live in. We've got to preserve that."

If humans can't solve a relatively easy pollution problem, like excess night light, Crawford added, it doesn't bode well. "We're going to lose the Earth eventually because as we lose touch with the environment around us, both the day and the night. We become insensitive to it, and before long, nature kind of rises up and stomps us."

Return to Main Comment Page

Next Story

E-mail this article

Print this article

Subscribe to The Globe and Mail
Sign up for our daily e-mail News Update

7-Day Site Search

SEARCH

Home | Business | National | Int'l | Sports | Columnists | The Arts | Tech | Travel | TV | Wheels

Help & Contact Us | Back to the top of this page

CCM-101

City of Cambridge

O-2.

IN CITY COUNCIL

March 25, 2002

COUNCILLOR DECKER
VICE MAYOR DAVIS
COUNCILLOR GALLUCCIO
COUNCILLOR MAHER
COUNCILLOR MURPHY
COUNCILLOR REEVES
COUNSILLOR SIMMONS
MAYOR SULLIVAN
COUNCILLOR TOOMEY

WHEREAS: Uncontrolled exterior lighting is extinguishing the night sky as well as wasting energy and producing unnecessary glare; and

WHEREAS: In just the past decade, sky glow has doubled in intensity; and

WHEREAS: Controlling sky glow not only brings back the stars, it improves safety, health, energy conservation, fiscal responsibility and protection of the natural environment (see attached); and

WHEREAS: Several cities, including Raleigh, North Carolina, Flagstaff, Arizona, Taos, New Mexico, and Melbourne, Australia, have enacted ordinances to set standards for exterior lighting; now therefore be it

RESOLVED: That the City Manager be and hereby is requested to confer with the Assistant City Manager for Community Development, the City Solicitor and other appropriate staff to report back to the City Council on what other communities have done and what Cambridge can do to control exterior light, including a draft ordinance or suggestions for an ordinance, along with possibilities for other actions such as public education and incentives to make progress on this important issue.

CHARTER RIGHT ON MOTION OF COUNCILLOR MAHER.

CM-80
Cal 3

ORDER #2

The City Manager is requested to confer with the Assistant City Manager for Community Development, the City Solicitor and other appropriate staff to report back to the City Council on what other communities have done and what Cambridge can do to control exterior light.
Councillor Decker

CHARTER RIGHT ON MOTION OF COUNCILLOR MAHER.

In City Council March 25, 2002

In City Council April 8, 2002

ORDER ADOPTED.