

MANMADE LIGHT AT NIGHT:

Perils and Promises

Summary of a Public Symposium held on
March 11, 2010

on the campus of Lewis University, Romeoville, Illinois,
presented by

The Illinois Coalition for Responsible Outdoor Lighting
and

Lewis University



Introduction:

The Illinois Coalition for Responsible Outdoor Lighting (I.C.R.O.L.) and Lewis University joined forces in early 2010 to present the first public symposium to be held in Illinois on the topic of the effects of contemporary outdoor lighting practices on the environment.

Speakers were invited from across the U.S. to lecture on different core issues relating to the topics which I.C.R.O.L. addresses in its work, including manmade light's effects on natural ecosystems, lighting practices and energy waste, lighting and safety, "light pollution" and the loss of the night sky, and manmade light and human health; I.C.R.O.L. and Lewis University are grateful to these specialists for making the day-long event an important, information-filled event.

Also featured were representatives of a number of different organizations which are taking serious looks at how contemporary lighting practices are effecting their special areas of concern; we thank them, too, for their insightful offerings, presented during their introductions of the main speakers.

Some of the speakers have provided written synopses of their presentations, which are included herein.

Presentations:

Introduction

Dr. Jerry Kavouras - *Asst. Professor of Biology, Dir. Environmental Science, Lewis University*

Welcome

Brother James Gaffney - *President, Lewis University*

The Environmental Consequences of Contemporary Lighting Practices

Pete Strasser - *Technical Director, International Dark-sky Association*

With introduction by

Rita Renwick, *Conservation & Programs; Will County Audubon Society*

Light at Night's Impact on Science and Culture

Mark Hammergren, PhD - *Astronomer and Director Astro-Science Workshop, Adler Planetarium, Chicago*

With introduction by

Steve Miller, *President; Naperville Astronomical Assn.*

The Road to Sustainable Lighting Practices

Drew Carhart - *Executive Board Member, Illinois Coalition for Responsible Outdoor Lighting*

With introduction by

Nancy Williamson, *Co-chair Chicago Wilderness Sustainability Team & Illinois Department of Natural Resources Regional Watershed Coordinator for Northern Illinois*

Municipal Solutions for Fiscal and Environmental Responsibility

from the City of Santa Rosa, California:

Rick Moshier - *Director of Public Works*

from the Village of Homer Glen, Illinois:

James Daley - *Mayor*

Margaret Sabo - *Village Trustee*

Edmond Cage - *Community Development Director*

With introduction by

Andy Robinson, LEED AP - *SEDAC Smart Energy Design Assistance Center, University of Illinois*

Light at Night and Human Health

Steven Lockley, PhD - *Division of Sleep Medicine; Harvard Medical School*

With introduction by

Barry D. Dickinson, PhD., *Dir., Science & Biotechnology, and Secretary, Council on Science and Public Health; American Medical Association*

Closing Remarks

Kate Tomford - *Director of Sustainability, Office of Illinois Governor Pat Quinn*

With introduction by

Debra Lazar Pearl, *Executive Board Member, Illinois Coalition for Responsible Outdoor Lighting*

Speaker Biographies:

Edmond Cage

Edmond Cage is the Village of Homer Glen Community Development Director. Edmond's professional background includes positions as Village Planner for the Villages of Carpentersville, Long Grove, and Warrenville. These experiences provided a wealth of knowledge and insight for economic development, planning, zoning and land use. Edmond obtained his Business Diploma at Kent College in Maidstone, England, a BA (Honors) in Planning from the University of Westminster, London, England and MA in Urban Planning from the University of Illinois at Chicago.

Drew Carhart

Drew Carhart is a founding executive board member of the Illinois Coalition for Responsible Outdoor Lighting (2008). Mr. Carhart is committed to reducing wasteful outdoor lighting practices within Illinois through education, building public awareness, promoting the adoption of statewide policies and engineering assistance to municipalities and businesses, and promoting lighting-related actions by like-minded civic and conservation organizations. A 51 year resident of the Naperville area, he was a founding member of the Naperville Astronomical Association (1973). Mr. Carhart works in the Insects Division of the Field Museum of Natural History, still helps run the Naperville astronomy organization, and is the webmaster for the I.C.R.O.L. website.

Mark Hammergren, PhD.

Dr. Mark Hammergren is an Astronomer and Director of the Adler Planetarium's Astro-Science Workshop, a challenging astronomy program for high school students, sponsored by the Adler and the National Science Foundation. His research interests include asteroids, meteorites, impacts and mass extinctions. Dr. Hammergren is the Principal Investigator on the NASA-funded research program to characterize the composition of basaltic asteroids – objects that had been completely molten shortly after their formation. He also works with the Chicago non-profit educational organization "Project Exploration" to help lead teams of Chicago Public School teachers to the Montana Badlands, to dig dinosaur fossils in the daytime and learn astronomy at night.

Steven Lockley, PhD.

Dr. Lockley is currently an Associate Neuroscientist at Brigham and Women's Hospital (BWH), Boston and an Assistant Professor in Medicine at Harvard Medical School. He graduated with a degree in Biology from Manchester University in the UK in 1992 and completed a PhD at the University of Surrey, UK entitled "Sleep, melatonin and other circadian rhythms in the blind" in 1997. In September 2000, Dr. Lockley joined the BWH as a Research Fellow in Medicine and was appointed

to the faculty there in January of 2003. Dr. Lockley's research, published in more than 40 original reports and book chapters, has primarily focused on the role and properties of light (spectrum, timing, intensity, duration, history) on the control of sleep, alertness and circadian rhythms.

Rick Moshier

Rick Moshier is Public Works Director for Santa Rosa a City of 165,000, north of San Francisco in the beautiful California wine country. He manages the City's engineering, road maintenance, traffic and fleet operations. Rick's department prides itself on being "*Stewards of the public infrastructure and environment*". Mr Moshier is a registered Civil Engineer with 29 years in the municipal engineering field. He manages a department of about 200 employees.

Margaret Sabo

Margaret Sabo has a Bachelors of Science Degree from Ball State University in Muncie, Indiana. Margaret is a recipient of the Will County Historical Society Colonel Fredrick Bartleson Award and the Lewis University Frank J. Lewis Philanthropist of the Year Award 2004. She is recognized as one of the "Founding Fathers" of the Village and has been a Homer Glen Trustee and Chairman of the Environment Committee since 2001 upon incorporation. Some Village involvements include Green Vision of the Homer Glen Community, Lighting, Tree, and Water Resource Ordinances. Community involvements consist of Homer Township Open Space Committee, Associate Board member of The Conservation Foundation, and establishment of the national Historic District in Lockport.

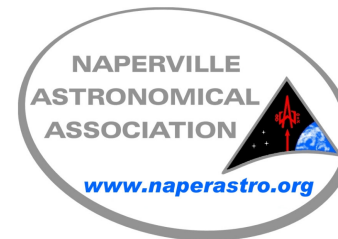
Pete Strasser

Pete Strasser is Technical Director of the International Dark Sky Association. Pete travels the world to discuss common sense about bad lighting practices and simple ways to mitigate them. He is head of IDA's Fixture Seal of Approval program, which now certifies products from over 90 lighting manufacturers worldwide. He is Chairman of the International Commission on Illumination (CIE) Technical Committee on the Effects of Artificial Light and the Natural Environment. He works closely with the Illuminating Engineering Society of North American and the U.S. Department of Energy on lighting-related issues. An astral photographer since age five, Pete Strasser has long been interested in the practical and aesthetic effects of light. A degree in plant pathology from the University of California, Davis imparted detailed insight in the composition and effects of different light sources.

Kate Tomford

Kate Tomford is the Director of Sustainability for Illinois Governor Pat Quinn. She manages the Illinois Green Governments Coordinating Council, a 15-agency council established in Illinois statute to improve the environmental sustainability of state government operations and policies. Prior to joining the Governor's Office and former Lt. Governor's Office, Kate worked in the Mayor's Office at the City of Chicago and served as a contractor to the U.S. EPA for the Great Lakes Regional Collaboration. Kate holds a bachelor's degree in geochemistry and a master's degree in environmental science and policy.

Symposium Sponsors:



Exhibitors:

Chicago Bird Collision Monitors
Chicago Wilderness
City of Santa Rosa, California
Illinois Coalition for Responsible Outdoor Lighting
International Dark Sky Association
Kankakee Area Stargazers
Let There Be Night
Lewis University
Naperville Astronomical Association
Village of Homer Glen, Illinois
Will County Audubon Society

About Lewis University:

A Catholic university sponsored by the De La Salle Christian Brothers. Lewis offers nearly 80 undergraduate majors and programs of study, accelerated degree completion options for working adults, various aviation programs and 22 graduate programs in nine fields. The ninth largest private, not-for-profit university in Illinois is being honored (2010) for the sixth consecutive year by *The Princeton Review* and *U.S. News & World Report*. For more information please visit www.lewisu.edu.

About the Illinois Coalition for Responsible Outdoor Lighting:

The Illinois Coalition for Responsible Outdoor Lighting is a not-for-profit group of Illinois citizens who share a commitment to work toward the reduction of wasteful lighting practices within our state.

We believe that responsible lighting practices must include consideration of energy efficiency, of light trespass, which impacts the natural environment, human health, and the human experience of the night sky and night itself, and of both safety and esthetics.

Our projects include:

- Raising public awareness;
- Serving as a resource for home owners, business owners, municipalities, and state and local agencies;
- Working for the development and implementation of responsible lighting standards;
- Promoting the adoption of state-wide policies of engineering assistance and environmentally responsible outdoor lighting practice.

For more information, please visit www.illinoislighting.org.



Presentations

The Environmental Consequences of Contemporary Lighting Practices

Pete Strasser - *Technical Director, International Dark-sky Association*

introduction by

Rita Renwick, *Conservation Chair; Will County Audubon Society:*

"Good Morning and Welcome!

My name is Rita Renwick and I am Conservation Chair of the Will County Chapter of the Illinois Audubon Society. Our Chapter is one of 20 Chapters throughout the state.

The Illinois Audubon Society is an independent non-profit conservation organization founded in 1897 and is not affiliated with the National Audubon Society. Our mission is to promote the appreciation of native plants and animals and the habitats that support them. IAS worked to save Plum Island across from Starved Rock State Park and it is now one of its sanctuaries. It has added acreage to Prairie Ridge State Natural Area -an important nesting area in Jasper County for the Prairie Chicken and is currently sponsoring Flying Wild workshops throughout the state – just some of the Society's recent projects.

Locally, our chapter provides programs and field trips monthly September through May and 30 members volunteer as interpreters at Lake Renwick from May thru mid August on Saturdays and Wednesdays. This is a Forest Preserve District of Will County site and an Illinois Nature Preserve located just east of the intersection of Renwick Rd. and Rt. 30 in Plainfield, IL.

As part of a local and statewide conservation group who helped sponsor today's symposium, I'm looking forward to learning more about how humans effect the environment through their lighting practices and I am pleased to introduce the perfect person to enlighten us!

Pete Strasser has been with the International Dark Sky Association for 3 ½ years and as their technical director travels the world spreading common sense about bad lighting practices and simple ways to mitigate them.

He serves on the Illuminating Engineering Society of North America/International Dark Sky Joint Model Lighting Ordinance task force and their Research Committee as well as The Aviation Lighting Recommended Practices Group.

He is Chair of the Technical Committee on the Effects of Artificial Light and the Natural Environment for the International Commission on Illumination (CIE).

Pete has worked closely with the Dept. of Energy and EPA to establish criteria for their Energy Star Programs related to Outdoor Solid State Lighting.

He has a degree in Plant Pathology and retired to Tucson, Arizona in 2004...although from what I've just enumerated, this doesn't sound like retirement!

Please join me in welcoming Pete Strasser!"

summary of Mr. Strasser's presentation:

In opening, Mr. Strasser discussed the contemporary practices of outdoor lighting. While to be environmentally responsible, we should provide light when you need it, where you need it, in just the amount necessary -- and no more, these three fundamental principles are commonly ignored.

Strasser discussed the history of electric streetlighting, noting that the practice did not originate from a public demand, but as a way for power companies to create a load for their generators during the late-night hours. He then discussed and illustrated a number of related issues, including how increased outdoor illumination is often credited with a *perception* of increased safety, even when safety is not statistically improved, and how a tremendous amount

of study needs to be done to determine just what applications of artificial light, at what levels, provide optimum safety.

Strasser illustrated a number of locales which have adopted lighting standards and practices which differ, sometimes widely, from those often referenced, often involving less application of artificial light; he reported how safety levels were not reduced in those instances (and sometimes were improved). He also illustrated how engineering solutions for improving lighting practices were readily available.

Moving on to the nocturnal ecological environment Strasser noted that just as the public can understand habitat disruption and reduction in ecologies such as wetlands and forests, they can understand that the nighttime is also a type of "habitat" which can be disturbed by man. Examples of how manmade light can affect a nocturnal habitat include:

Attraction-- drawing creatures to light source:

- Can be good or bad
- Nightjars at streetlights; good for the bird, bad for the bug.
- Sea turtle hatchlings cued to moon over water. They need this cue.
- Polarized light dark surface = water
- This cue is disrupted most often in nocturnal habitat impact

Avoidance-- creatures fleeing from light source

- Disrupts predators ability to find prey
- Photoperiodism-- response to day length
- Change in day length through the year
 - Affects both plants and animals
 - Alteration can delay onset of migration, and senescence or flowering initiation
 - Alteration of seasonal behavior

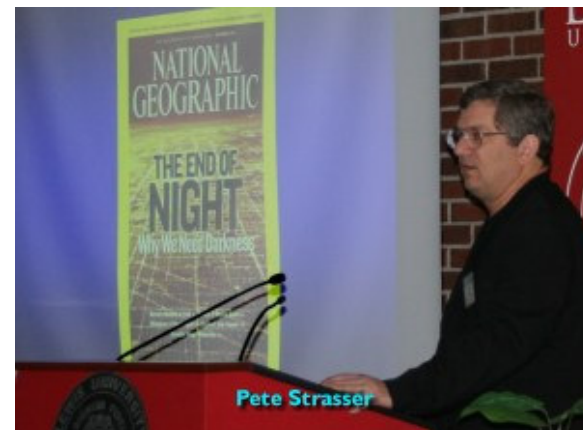
Spectral Quality-- the wavelength balance of the intruding light

- Both plants and animals
- Principle reason for no blanket answers
- Hindered research
- New technology can refine characteristics

- May need to redo known issues and solutions
 - Much more important with new lighting technologies
- Interlunation-- the monthly cycle of Moon phases
- My observation with birds and coyotes
 - Fish spawning
 - Fish migration
 - Sea turtle hatchlings
 - Corn Earworms, other noctuid moths

Strasser noted a number of different groups of organisms which studies have shown to be disrupted by manmade light in their environment; these include sea turtles, birds (especially during migration), salmon and other fish, various insects, amphibians, and bats. He noted how difficult it is to study the effects of manmade light in the environment, as laboratory experiments do not precisely duplicate actual field conditions, and field studies are faced with many uncontrolled variables. Still, it is critical that many more comprehensive studies be funded and undertaken, to give us a clearer grasp of the environmental impact of outdoor lighting practices.

Strasser explained the committee work on CIE TC 5-27, the International Commission on Illumination's report on Artificial Lighting and its Impact on the Natural Environment, which is tasked with providing guidance on ways to minimize the effects of artificial lighting on the natural environment.



Light at Night's Impact on Science and Culture

Mark Hammergren, PhD - *Astronomer and Director Astro-Science Workshop, Adler Planetarium, Chicago*

introduction by

Steve Miller, *President; Naperville Astronomical Association:*

"The Naperville Astronomical Association is a society of amateur astronomers from the Chicago area. Astronomers were some of the first people to raise the alarm about the unfortunate side effects of the outdoor lighting boom. Over just the past few decades, we have watched the nighttime skies over the areas we live in change from being star-filled to glowing with a perpetual twilight; where the children of a generation ago could stand in their backyards and see the Milky Way and thousands of stars, the children of today can see a glowing sky and only a handful of stars. Our organization is proud to be a sponsor of this symposium, and looks forward to a future where the right to enjoy a beautiful nighttime sky is returned to the citizens of Illinois.

It is my pleasure to introduce the next speaker, Dr. Mark Hammergren, from the Adler Planetarium and Astronomy Museum. At Adler, Dr. Hammergren directs the Astro-Science Workshop, a challenging astronomy program for high school students that originated more than 40 years ago. His research interests include asteroids, meteorites, impacts and mass extinctions, and the history and sociology of the flying saucer phenomenon. His position as both an astronomer and an expert in outreach to students and the public makes him particularly well suited to talk to us about his topic for today, Light at Night's Impact on Science and Culture."

summary of Dr. Hammergren's presentation:

Dr. Hammergren addressed the impact of light at night on astronomy particularly for amateur astronomers, and also the corresponding impact on our human culture. He began with the question of: "Why is a dark sky important for astronomy?" The objects that we observe are far away, faint, small, and at the limit of

our visibility he says, and that we "need dark skies for cutting-edge astronomy".

Sky glow is caused by air glow, fluorescence from sunlight, and artificial light in urban areas. An assessment of various wavelengths of artificial light shows high pressure sodium as one of the most prevalent and detrimental to visibility, whereas (by contrast) low pressure sodium lights would be preferred by astronomers.

Satellite images show Chicago to be one of the worst offenders of "light pollution", requiring a 2-hour drive from the city in order to see the Milky Way. Various photographs show aerial distribution of artificial light and the resulting negative impact on professional observatories - Yerkes in Wisconsin, Mt. Wilson and Palomar in California, Kitt Peak National Observatory in Arizona, and Apache Point in New Mexico.

He cited the importance of the many contributions made by the amateur astronomer community including education, outreach, and variable star observations.

Dr. Hammergren, in relating light at night's impact on culture, concludes that astronomy is "the common heritage of humanity". Furthermore, all of humanity has previously participated in looking up to the heavens; except in the last 150 years. Archeological evidence can be seen from 25,000 BCE and before, such as cave paintings in France depicting celestial objects and constellations.



The Road to Sustainable Lighting Practices

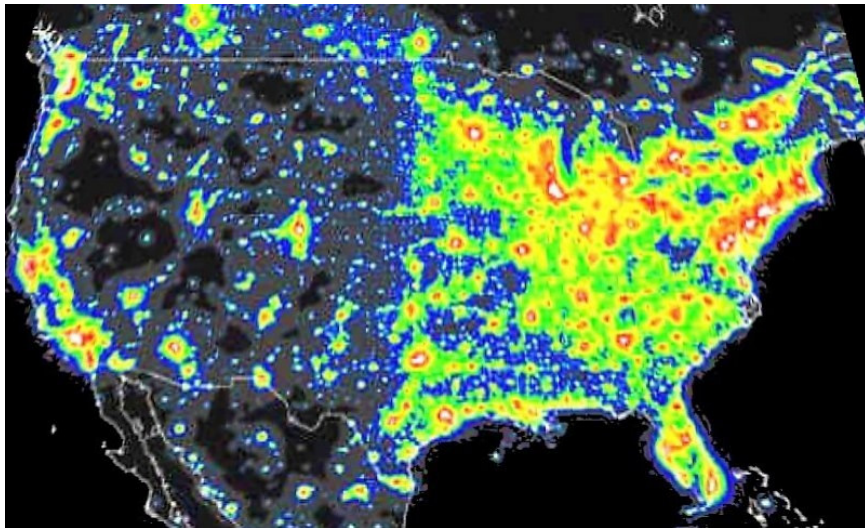
Drew Carhart - Executive Board Member, Illinois Coalition for Responsible Outdoor Lighting

summary of Drew Carhart's presentation, by Mr. Carhart:

"Currently, nearly all the outdoor lighting we use draws power from the electrical grid; this will continue to be true for a long time to come. So, we can't be truly 'sustainable' in that pursuit-- we can only approach sustainability. In application, this involves two practices:

- *Maximize energy efficiency, minimize waste*
- *Minimize environmental impact*

A study for the U.S. Department of Energy estimated that 58,000,000,000 kilowatt-hours of electricity were used in the year 2002 for fixed outdoor lighting in the U.S. By looking at the relative sky brightness over the nation, we can see that a substantial amount of that illumination ends up in the sky, rather than in the areas of intended illumination (data in this graphic from 1995):



The level of use of artificial light, and of waste of light and energy has been exploding over the past few decades. An estimate of the

sky brightness from just a few decades earlier looks quite a bit different (estimate of early 1960s relative sky brightness):



By looking at common contemporary lighting installations at night from overhead, we can readily see some of the sources for this sky-illuminating, energy-wasting light. In my presentation, I illustrated several different types of common outdoor luminaires, showing how they disburse their light output, and how some focused much of that output on the intended target areas, while others wasted most of their energy elsewhere.

I also illustrated how not all energy waste shows up in sky brightness-- many luminaires direct large amounts of light to the side, where, instead of constructively adding to area illumination, it creates glare and trespass onto adjacent properties. Overall, a summary of the light output by a luminaire looks something like:



I addressed some of the common reasons why our lighting practices are so inefficient and environmentally damaging, including the fact that we like to emulate the lighting fixtures of earlier centuries, but that those fixtures were never engineered for either energy conservation nor intensely brighter modern light sources.

A key, critical need for today is a standardized system for rating the energy efficiency of outdoor luminaires, akin to the miles-per-gallon fuel efficiency rating for vehicles. It is crucial to rate the full luminaire-- the lamp and fixture operating together-- rather than just the lamp (as is often mistakenly done). I described the NEMA Target Efficacy Rating metric, and how it can be used to fill this bill. I illustrated by showing the rating analysis of a current production model luminaire, which features a lamp with an efficacy of 106 lumens/watt, while the luminaire's overall Target Efficacy Rating is a horrible 9 lumens/watt.

I touched on two other major contributing factors to energy waste and light trespass: lighting when not needed, and over-illumination. And, since safety issues are always raised when lighting is discussed, I suggested that safety should be addressed using real-world data, rather than from an assumption that somehow darkness is inherently dangerous, and light automatically safe.

To explore that last concept, I noted the vehicular accident data totals for Illinois in 2007:

*2007: 422,778 accidents on Illinois roadways
65% occurred in daylight
16% on lighted roadways at night
13% on unlighted roadways at night
4% at dawn or dusk*

These figures in themselves do not support the proposition that unlighted roadways are the breeding ground for most accidents. Similarly, I returned to a comparison of the graphics of relative sky brightness from the 1960s through the 1990s, and looked at how much the national crime rate changed in the interim, as the use of outdoor lighting exploded across the nation:

U.S. national crime rates, per 100,000 population:

	<i>Violent Crimes</i>	<i>Property Crimes</i>
<i>1962</i>	<i>162.3</i>	<i>1,857.5</i>
<i>2002</i>	<i>494.4</i>	<i>3,630.6</i>

Again, this is a generalized look, but it gives no overt indication that the tremendous increase in outdoor lighting over a few decades brought any corresponding decrease in crime.

In conclusion, to achieve "sustainable" lighting practice, these are the basic goals which must be achieved:

- Only illuminate the designated target area*
- Provide no more than the minimum level of illumination needed for the tasks*
- Illuminate only at the times of activity in the area*
- Illuminate with the most energy efficient luminaires available"*



Municipal Solutions for Fiscal and Environmental Responsibility

--from the City of Santa Rosa, California:

Rick Moshier - *Director of Public Works*

summary of Rick Moshier's presentation, by Mr. Moshier:

"Like many others, the City of Santa Rosa experienced severe budget cuts the last few years. One of many strategies to deal with this is to reduce our street light electricity use, turning off many street lights and using timers on many others, while maintaining public safety. The City owns 16,000 street lights, with an annual energy bill of \$800,000, a significant share of the \$7.5 million annual streets operating budget. The street light reduction program will cut energy costs in half, saving \$400,000 annually.

The Need for a Change

Like many other cities, Santa Rosa has recently experienced historic budget cuts. In the last few years the City's annual general fund revenues have fallen \$33.4 million dollars, 23%.

Cuts of this magnitude have caused departments to look closely at all expenses. Cuts have been made in every part of the Public Works Department. The street light energy bill was \$800,000 per year, more than 10% of the City's annual streets operating budget. If not addressed, cuts to other vital operations such as road maintenance, flood control, and traffic signal operations would be even more severe.

Based on these facts Public Works determined that the street light energy bill must be reduced significantly in parallel with the department's other budget cuts.

The Details of the Program

About 40% of the City's street lights will remain on for safety reasons. Another 40% will be turned off. 20% will be put on timers that reduce energy use by 50%.

The basic logic is as follows:

Safety lighting at traffic signals will remain.

Lighting at pedestrian activated flashers or mid-block crosswalks will remain.

Lighting in high pedestrian zones, such as downtown, will remain, but will be reviewed for efficiency.

One light will remain, where one exists today, at all un-signalized intersections.

One light will remain at key traffic safety locations where there has been a documented incident history.

Lights in designated Neighborhood Revitalization Program (NRP) zones will remain, but will be reviewed for efficiency. NRP zones are designated by City Council as areas warranting special attention by all departments to address possible crime and blight issues.

On long blocks, where application of the above rules would result in no light for over 300 feet, one light will be left on mid-block, controlled by a programmable photo-cell timer.

On even longer blocks, where application of the above rules would result in no light for over 600 feet, one light will be left on mid-block. In this case the light will be left on, not on a programmable timer.

The work of turning off and retrofitting the photo-cells will occur over four years. The program has been underway for less than a year, and about 20% of the City has been addressed to date.

Programmable Photo-cells

Using the criteria described above, about 20% of the City's 16,000 lights will be put on programmable photo-cells. The photo-cells will reduce energy consumption by 50%. The lights would remain on during normal active hours (dusk to

midnight, and 5:30 a.m. until dawn) and off during less active hours (midnight to 5:30 a.m.)

Like many street light systems the City pays a flat rate per light, and the energy use is not metered. The City's energy provider, Pacific Gas and Electric Company, was very helpful in establishing a new 50% rate for these programmable photo-cell operated lights, and getting approval for that rate from the Californian Public Utilities Commission.

Green House Gas (GHG) Emissions

A significant side benefit of the program is a reduction in GHG emissions. City Council adopted a goal of reducing emissions by 25% of 1990 levels by 2015. To achieve this difficult goal the City must tackle GHG emissions from all sources, large and small. The street light reduction program will reduce GHG emissions by 1,000 tons per year.

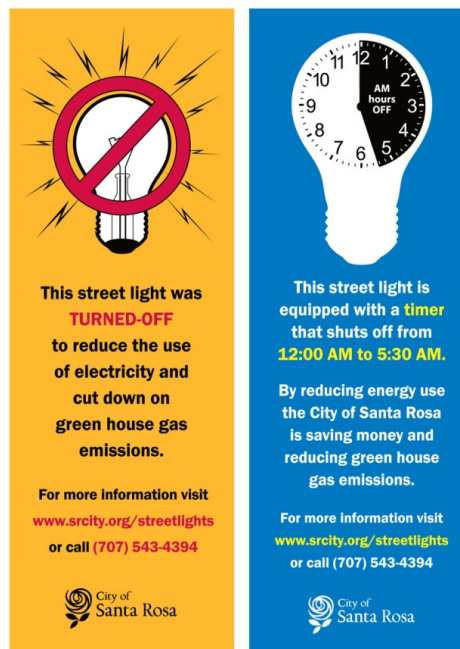
Public Safety

Public Works staff worked closely with the Police Department and City Attorney before proposing this program. Published studies show no direct correlation between increased street lighting and reduced crime. Some studies indicate the introduction of street lighting can increase crime because perpetrators can monitor their target without the use of flashlights or other lighting tools. Street lights are not designed to provide security lighting for private property. Security lighting for private property is better if designed for that purpose. Often the use of motion detector activated lighting is most effective in deterring crime while also conserving energy.

Public Outreach

The following methods of public outreach are being used:

- Webpage describing program- www.srcity.org/streetlights
- Posted feature news article on City Homepage



- HTML based e-mail communications to neighborhood groups
- Worked with local radio and newsprint media to disseminate information about program
- Decals on affected light poles

Responding to Questions and Complaints

When electrical crews are active turning off lights and applying decals in a particular neighborhood we receive about one call

or e-mail inquiry per day. After being told about the reasons for the program and its details, about 80% of the citizens calling are satisfied that the program is being undertaken for good reasons and in a responsible manner. About 20% ask that their specific concern be looked at more closely.

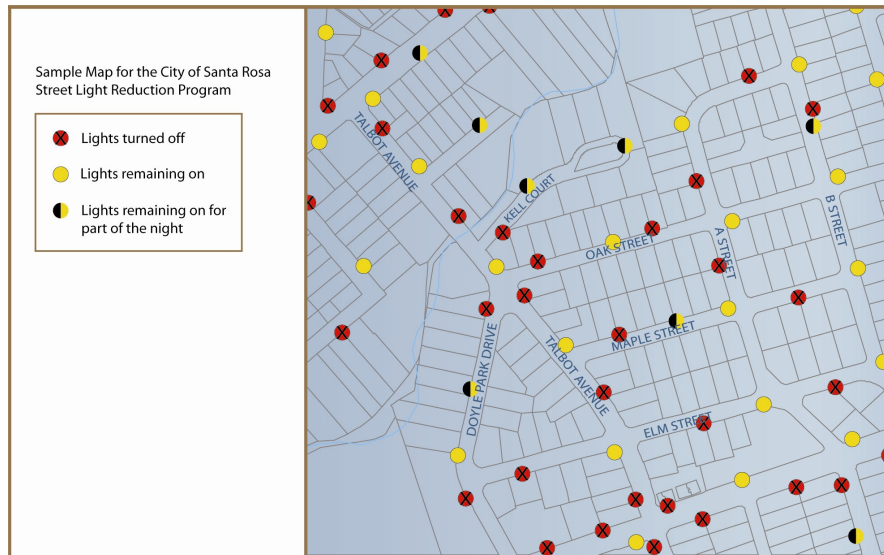
In each of those cases a senior staff member reviews the situation in the field at night. The basic criteria that is used for this review are:

- Is it safe to drive?
- Is it safe to bike?
- Is it safe to walk without a flashlight?

In some cases changes are made to the lights based on this public input and staff review. The most common change is to swap a light that was turned off for another, based on a neighborhood preference.

An example

The following example shows a neighborhood, and indicates the lights that were left on, turned off, and put on timers.



Note that the mid-block light on A Street between Oak and Maple was turned off. But also note that B Street between Oak and Maple never did have a mid-block light. The same is true of A Street between Maple and Elm, and B Street between Maple and Elm.

The residents of these adjacent blocks never had a mid-block light, and it was not missed. The resident of A Street between Oak and Maple did have a mid-block light, and they were very upset when that light was turned off, even though that change made their block similar to its neighbors.

Crime and accident statistics for these four similar blocks have historically been very similar.

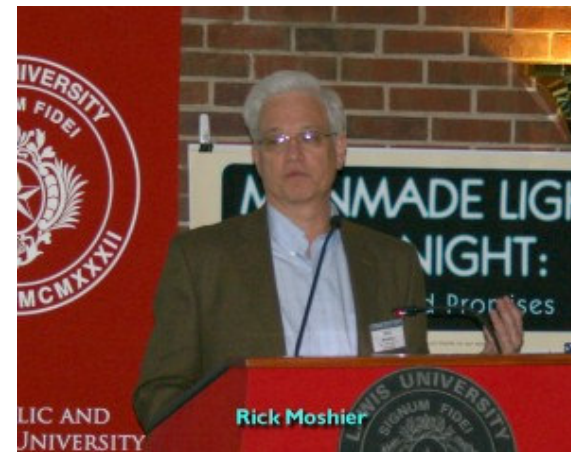
Other related initiatives

The City is also looking at other means of conserving street light energy. A test area, with LED, induction and high-pressure sodium lights on adjoining blocks has been installed in

conjunction with Pacific Gas And Electric Company. The City also plans to test photo-cell timers which can be controlled remotely, and provide wireless information when lights burn out.

Conclusion

With the support of one's City Council, Police Department and City Attorney, a reduction in street lighting can maintain public safety while delivering considerable savings. Street lighting has many technical aspects, but it is also an emotional issue for many residents. For this reason active involvement of senior staff is needed. This can be time consuming, but the potential savings are considerable."



--from the Village of Homer Glen, Illinois:

James Daley - Mayor

Mayor Daley's opening remarks:

"Thank you all very much for coming today. It is impressive to see the interest that this issue of responsible outdoor lighting has raised. As the Mayor of Homer Glen, I am very proud of our village's strong environmental ethic. Our board continues to support environmental

protection, energy conservation and of course responsible outdoor lighting. As you will hear today, the Village has passed a landmark ordinance for the state of Illinois. Trustee Margaret Sabo, has been a leader in environmental issues in our community for as long as I can remember. As chair of the Environment Committee she has lead our Village in several sustainable initiatives including the adoption of our sustainable water resource ordinance, drafting of a sustainable landscape and tree preservation ordinance, attainment of gold level for clean air counts and of course the Lighting ordinance. Debra Norvil is a member of her Environment Committee who was instrumental in the drafting of this ordinance as well as coordinating this seminar today. I believe you will be very impressed with what you hear today. This is an important issue for all of us. We need to adopt a sustainable perspective in all that we do, every day, in everything we are involved in. It is important that we work together on this issue; we share one earth, one sky. Let's all be good stewards and practice responsible outdoor lighting.

Remember:

'We do not inherit the earth from our ancestors; we borrow it from our children.'"



Edmond Cage - *Community Development Director*

summary of Mr. Cage's presentation:

The Village of Homer Glen decided to create a stand-alone outdoor lighting ordinance to address several key issues:

- Poorly designed outdoor lighting wastes approximately \$2billion a year in lost energy.
- The effects of light pollution from cities can be seen from approximately 300 miles away.
- In 2002, CNN reported that 2/3 of the world's population cannot see stars at night.
- Approximately 67% of the US population can no longer see the Milky Way.
- Wasted lighting in the US releases approximately 38million tons of CO₂ into the atmosphere on an annual basis.

The timeline which the lighting ordinance followed was this:

2001: Trustee Ward suggests lighting ordinance for Homer Glen.

2002: Environmental Committee creates Lighting Subcommittee.

2002-06: Village & Lighting Subcommittee worked w/ Flagstaff, AZ & International Dark Sky Association researching lighting ordinances with the help of Debra Norvil.

2006: Draft Lighting Ordinance presented to Village Board.

2007: Trustee Knaack & Trustee Sabo work with Environment Committee on lighting ordinance

2007: Homer Glen Outdoor Lighting Ordinance approved on December 18, 2007.

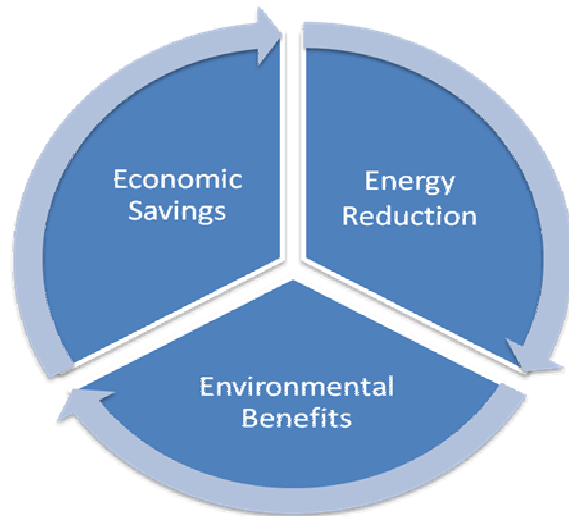
2010: Updated amended Lighting Ordinance approved.

The main ordinance standards:

1. Light Trespass: Except for streetlights, the ordinance requires no more than 0.5 foot-candles at the property line when adjacent to commercial property and 0.1 foot-candles when adjacent to residential property.

2. Full-Cutoff: Commercial property and streetlights are required to use full-cutoff fixtures regardless of the height of the fixture.
3. Amortization Period: Any existing non-conforming lights within the Village shall comply with the Lighting Ordinance by 2018 at the latest.
4. Commercial Lighting: Lighting levels within a commercial lighting zone shall not exceed 100,000 lumens per net acre.
5. Fixture Height: A maximum fixture height is set at 20-feet for residential and 25-feet for commercial lighting zones.

Why is adopting a lighting ordinance important? The major reasons for adopting a lighting ordinance are the three E's. By adopting an ordinance to control excess light you are realizing economic savings, environmental benefits, and energy reduction.



Lessons learned during the Homer Glen project:

1. Check Fixtures: It is important to confirm that all of the proposed fixtures meet the ordinance because a change to the proposed fixture can make a significant change to the photometric plan.

2. Photometric Plan: The photometric plan should be submitted early on in the development and planning process. This allow for some time to make plan and design revisions and to make the applicant fully aware that the lighting ordinance is a priority relating to new development within the Village.
3. Maximum & Minimum: It is important that the applicant focus on both the maximum and minimum lighting levels as together they make a compliant photometric plan.
4. Education: It is important that residents, business owners and prospective applicants are made aware of the lighting ordinance and what is expected of them to meet the ordinance. This should be achieved through meetings, press releases, developer handbooks and the Village website.

The Village of Homer Glen has received widespread recognition for creating one of the few comprehensive, stand-alone municipal outdoor lighting ordinances in the United States.



Light at Night and Human Health

Steven Lockley, PhD. - *Division of Sleep Medicine, Harvard Medical School*

summary of Dr. Lockley's presentation:

Dr. Lockley began by addressing the presence of multiple circadian (day-length) clocks in the human body, and some of the various fluctuations they cause on roughly 24-hour cycles. Cycles which have been studied effect thought and memory performance, sleepiness and wakefulness, reaction time, and even the onset of heart attacks.

One "master clock", located in the suprachiasmatic nucleus (SCN) of hypothalamus within the brain, regulates all the other circadian clocks in the body, keeping them in step. The SCN clock, in turn, is set on a daily basis by signals from the retina in the eye; this system works by following ambient light and dark (the natural daytime/nighttime), keeping the human clock in step with the world around it. Without interference of artificial light, this system has kept the human body's various physiological functions in tune with the natural environment for millions of years, making us active and alert in the daytime, and allowing rest, sleep, and regeneration at night.

Manmade light during the naturally dark hours of night can and does disrupt the internal circadian clock, since the clock is evolved to be regulated by a light/dark day/night cycle. The resulting disruption of the circadian pacemaker results in sleep disorders, fatigue, performance problems, hormone and metabolic disorders. Common examples include the circadian de-synchronization caused by shift work, jet-lag, and Advanced- and Delayed Sleep Phase Disorder.

The day/night light detection in the eye does not come from the vision-producing rod and cone cells in the retina. These 'non-visual' effects of light are mediated by a novel photoreceptor located in the ganglion cell layer of the eye. These photosensitive ganglion cell contain a novel opsin, melanopsin, to detect light which is

maximally sensitive to short-wavelength (blue) visible light (~480 nm). To determine how much (or how little) light exposure at night is needed to cause disruption of the circadian clock, we need to study how much light is needed, of what color, and at what times the exposure has the most effect.

Dr. Lockley spent some time describing ongoing research addressing these questions about real-world effect of exposure of various types of light at various times. Some of the major points learned so far include that melatonin suppression and phase shift commonly occur with exposure to light levels around (and below) 100 lux (9.2 foot-candles), and that the peak sensitivity of the melanopsin-based photoperiod sensing system is around 460nm (in the blue spectrum), and much less strong even at 555nm (in the green).

Effects of exposure to light during the dark period of the night do not require a long period of exposure; even short exposure can disrupt melatonin production. And light exposure in the nighttime hours before 6:00am tends to delay the circadian master clock, while exposure after that time tends to advance the clock.

Dr. Lockley then addressed real-world application of this knowledge about light's effects on the human circadian cycle. In summary:

Light exposure AT NIGHT stimulates multiple circadian, hormonal and behavioral responses in humans:

- Phase-shifting the timing of the circadian pacemaker
DESYNCHRONIZES INTERNAL CIRCADIAN RHYTHMS
AND DISRUPTS SLEEP AND HORMONE SIGNALS
- Suppression of pineal hormone melatonin at night
ABOLISHES BIOCHEMICAL SIGNAL OF DARKNESS
- Enhancement of alertness and neurobehavioral performance
ALERTS THE BRAIN AND DISRUPTS SLEEP

- Stimulation of hormone cortisol in the morning
 - Increase in heart rate and temperature at night
- WIDESPREAD IMPACT ON PHYSIOLOGY, METABOLISM, AND GENE EXPRESSION BRAIN- AND BODY-WIDE

Dr. Lockley then addressed the question of “How much sleep do we need?” In general, especially in young people, studies find that we are culturally quite far behind on getting as much sleep as our bodies need. Strong ties exist between sleep shortage and disruption and a wide range of problems, from automobile accidents and other mishaps related to drowsiness, to multiple physical problems, including increased development of heart disease, and reduction in the ability to resist and combat some forms of cancer.

In overall summary, Dr. Lockley noted:

- Circadian and other ‘non-visual’ biological systems are exquisitely sensitive to light, especially during the night
- Light exposure, even at dim levels commonly experienced indoors from artificial sources, has widespread effects on human physiology and metabolism
- Chronic disruption of circadian rhythms and sleep has serious health consequences
- Light pollution has the potential to harm human health by disrupting circadian rhythms, hormone levels, metabolism and sleep
- More research is required to understand the amount of light people are exposed to at night and during sleep, and the effects on their biology and psychology
- Light days and dark nights are required

and in conclusion:

“Live a sleep and melatonin-friendly lifestyle.”

