

Building a Light-Efficient Community

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Light Efficient Communities Coalition (LECC)

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Leduc Environmental Advisory Board (LEAB)

The Leduc Regional Chamber of Commerce, 9 September 2016

Air pollution



Water pollution



Light pollution ???

Light pollution is ...
artificial light that is
used *where* it is not needed,
used *when* it is not needed,
used to *excess*,
trespasses on the property of others,
causes *glare*, etc.

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Wasted energy = wasted money
Adversely affects the environment
Adversely affects human health
Adversely affects safety and security

Light pollution



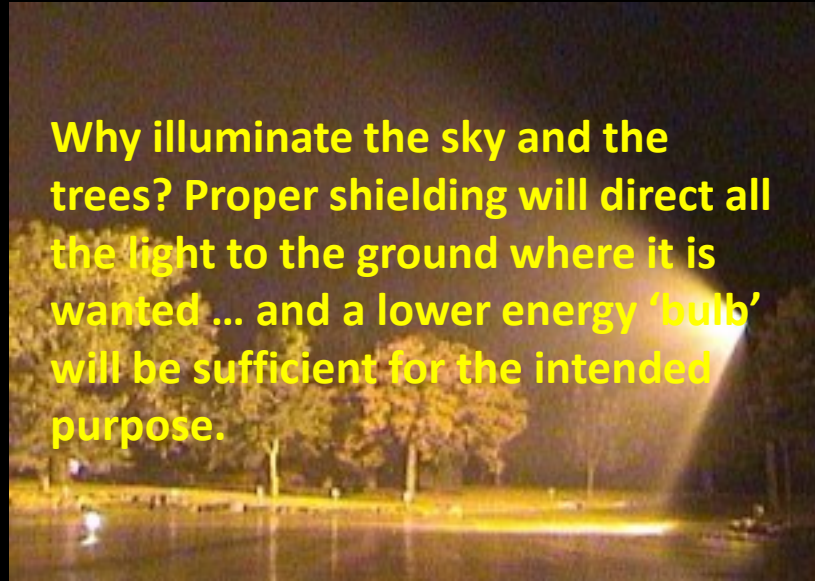
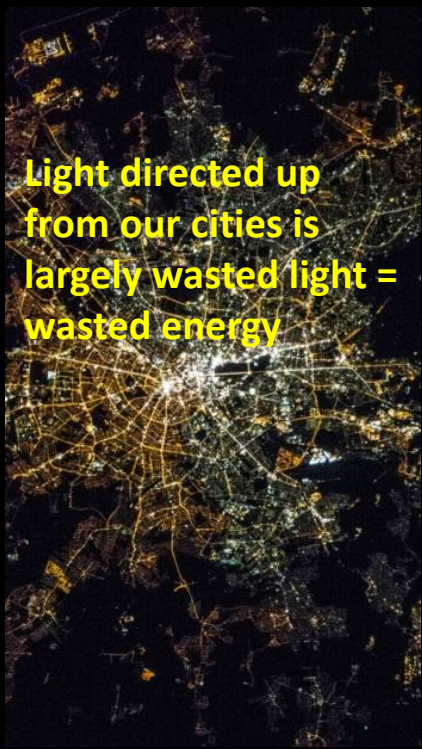
Light pollution

Light directed up from our cities is largely wasted light = wasted energy

Why illuminate the sky and the trees? Proper shielding will direct all the light to the ground where it is wanted ... and a lower energy 'bulb' will be sufficient for the intended purpose.

Excessive light and glare can blind and create an unsafe and insecure situation.

At least 1 billion birds per year die in North America due to the direct and indirect effects of light pollution – confusion and exhaustion in heavily lit cities, window strikes, artificial lights along migration flyways, etc.





WASTED ENERGY
CULTURAL LOSS
SCIENTIFIC LOSS

SKY GLOW

Brightening of parts or the whole night sky. The dome shaped glow can be seen from miles away.



CONFUSION
SAFETY JEOPARDIZED

GLARE

Visual impairment that occurs when the light source is brighter than the light your eyes are accustomed to.



WASTED ENERGY
ADVERSE ENVIRONMENTAL EFFECTS
DISCOMFORT TO NEIGHBOURS

LIGHT TRESPASS

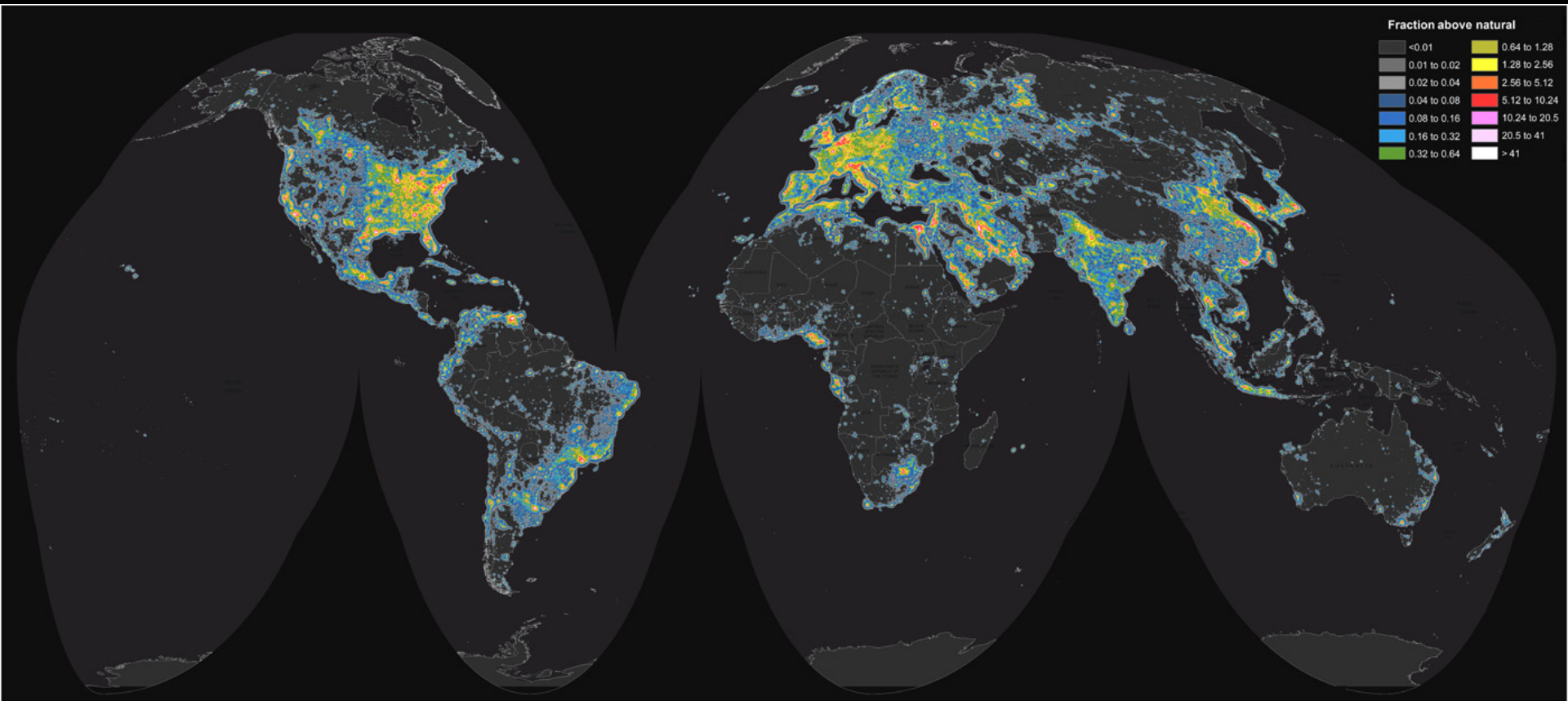
Light that is cast where it's not wanted or needed.



LIGHT CLUTTER

The excessive grouping of lights, which causes distraction.

'The new world atlas of artificial night sky brightness'



The new world atlas of artificial night sky brightness

Fabio Falchi^{1,*},

Pierantonio Cinzano¹,

Dan Duriscoe²,

Christopher C. M. Kyba^{3,4},

Christopher D. Elvidge⁵,

Kimberly Baugh⁶,

Boris A. Portnov⁷,

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with affiliations

“99% of the US and European populations live under light polluted skies”

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DOI: 10.1126/sciadv.1600377

“The Milky Way is hidden from 80% of North Americans”

[Figures & Data](#)

[References](#)

[eLetters](#)

[PDF](#)

You are currently viewing the abstract.

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Abstract

Artificial lights raise night sky luminance, creating the most visible effect of light pollution—artificial skyglow. Despite the increasing interest among scientists in fields such as ecology, astronomy, health care, and land-use planning, light pollution lacks a current quantification of its magnitude on a global scale. To overcome this, we present the world atlas of artificial sky luminance, computed with our light pollution propagation software using new high-resolution satellite data and new precision sky brightness measurements. This atlas shows that more than 80% of the world and more than 99% of the U.S. and European populations live under light-polluted skies. The Milky Way is hidden from more than one-third of humanity, including 60% of Europeans and nearly 80% of North Americans. Moreover, 23% of the world’s land surfaces between 75°N and 60°S, 88% of Europe, and almost half of the United States experience light-polluted nights.

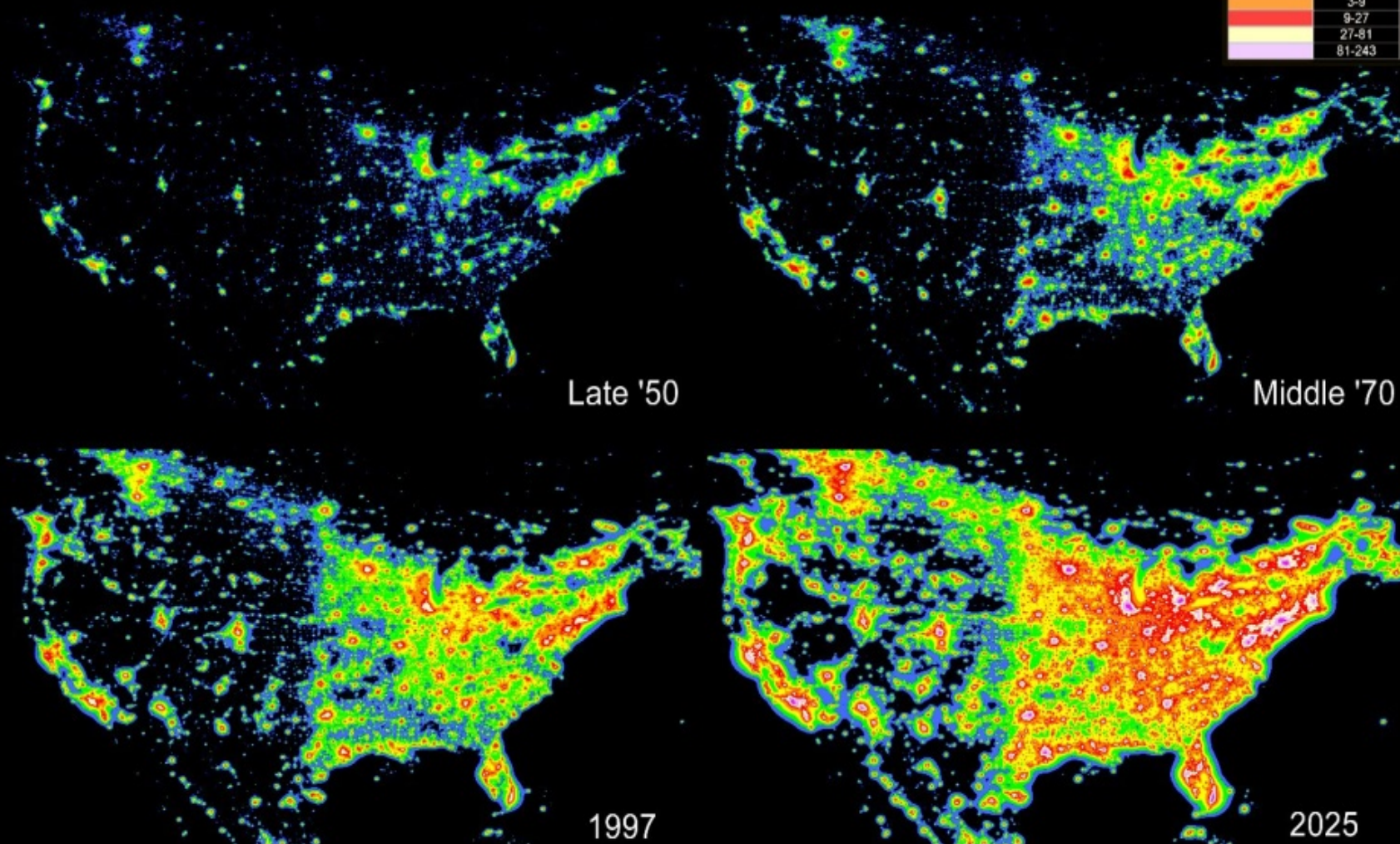
<http://arxiv.org/abs/1609.01041>

Artificial Night Sky Brightness due to Light Pollution in North America

A preliminary picture of the growth from 1950 to 2025

Artificial night sky brightness at zenith, at sea level, for standard clean atmosphere as fraction of the average natural night sky brightness

	<11%
	11%-33%
	33%-100%
	1-3
	3-9
	9-27
	27-81
	81-243

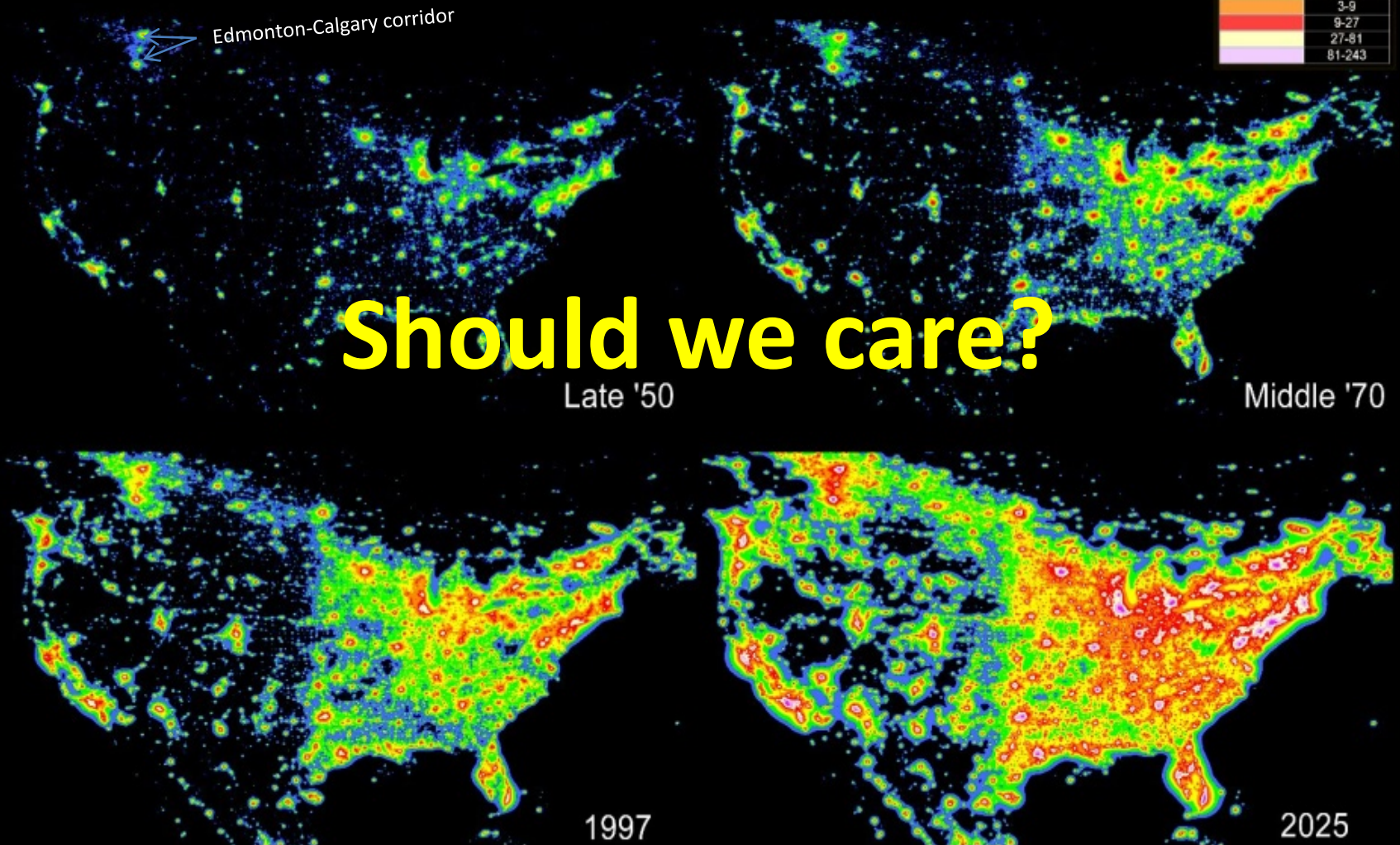


Artificial Night Sky Brightness due to Light Pollution in North America

A preliminary picture of the growth from 1950 to 2025

Artificial night sky brightness at zenith, at sea level, for standard clean atmosphere as fraction of the average natural night sky brightness

Dark Blue	<11%
Blue	11%-33%
Green	33%-100%
Yellow	1-3
Orange	3-9
Red	9-27
White	27-81
Purple	81-243



Light Pollution and the Natural Environment

Most animals and plants have a diurnal cycle that has evolved to require periods of *both* light and darkness for their normal range of activities including migration, growth, avoidance of predation, pollination ...

Simply for **SURVIVAL** most plants and animals
REQUIRE periods of **DARKNESS**

Light Pollution and the Natural Environment

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SCOTOBIOLOGY — The science of light's effects on biological systems

Simply for **SURVIVAL** most plants and animals **REQUIRE** periods of **DARKNESS**

Light Pollution and Human Health

We have evolved a diurnal cycle (biological clock) that responds to, and requires, periods of light and periods of darkness ... periods of activity and periods of inactivity

Our physical and mental health
require darkness for rest and rejuvenation

Light Pollution and Human Health

Hormonal activity is often dependent on light, or on the absence of light: consider the production of melatonin and its influence on the production of other hormones

It is known that breast cancer and prostate cancer have higher incidences of occurrence in shift workers whose natural diurnal cycle is disrupted by light.

Light Pollution and Human Health

American Medical Association:

Shift work and light pollution are
probable carcinogens

The American Medical Association:

“ ... night light increases the incidence of certain cancers, most notably breast cancer ... up to 30% of breast cancers may be due to light at night suppressing circadian rhythm.”

***“ ... circadian-rhythm disruption is a class
2A carcinogen
placing it on the same level of severity as
the effects of tobacco smoke on lung
cancer.”***

“Repeated exposure to light at night markedly suppresses melatonin production. Previous research has shown that this hormone helps the immune system suppress the development of several types of cancers.”

Light Pollution and Human Health

Alzheimer patients have erratic melatonin cycles and easily disrupted diurnal cycles.

Strong light during the day and

total darkness at night are

recommended therapy.

Light Pollution and Human Health

Autistic individuals have abnormal melatonin pathways and below-average levels of melatonin. Research is underway to determine if *light pollution* or an otherwise altered diurnal cycle is a contributing factor in autism.

Artificial lighting in the industrialized world: circadian disruption and breast cancer

Richard G. Stevens

Abstract Breast cancer risk is high in industrialized societies, and increases as developing countries become more Westernized. The reasons are poorly understood. One possibility is circadian disruption from aspects of modern life, in particular the increasing use of electric power to light the night, and provide a sun-free environment during the day inside buildings. Circadian disruption could lead to alterations in melatonin production and in changing the molecular time of the circadian clock in the suprachiasmatic nuclei (SCN). There is evidence in humans that the endogenous melatonin rhythm is stronger for persons in a bright-day environment than in a dim-day environment; and the light intensity necessary to suppress melatonin at night continues to decline as new experiments are done. Melatonin suppression can increase breast tumorigenesis in experimental animals, and altering the endogenous clock mechanism may have downstream effects on cell cycle regulatory genes pertinent to breast tissue development and susceptibility. Therefore, maintenance of a solar day-aligned circadian rhythm in endogenous melatonin and in clock gene expression by exposure to a bright day and a dark night, may be a worthy goal. However, exogenous administration of melatonin in an attempt to achieve this goal may have an untoward effect given that pharma-cologic dosing with melatonin has been shown to phase shift humans depending on the time of day it's given. Exogenous melatonin may therefore contribute to circadian disruption rather than alleviate it.

Keywords: Breast cancer Æ Circadian disruption Æ Melatonin Æ Shift work

Light Pollution and Human Health

Proceedings of the National Academy of Sciences (August 2016):

viruses are more dangerous when the body clock has been disrupted

Both RNA (flu) virus and DNA (herpes) virus are affected

“... people who have a disrupted body clock will be more susceptible to viral diseases.”

Light Pollution and Human Health

University of Alberta (18 August 2016)

If you've got the development blues, get rhythm. A new study from University of Alberta geneticists shows that **our circadian rhythm has a much more important role than previously thought**. It was well established that our internal clock regulates our eating and sleeping schedules, but these surprising new results demonstrate that **circadian rhythms are also essential for the normal development of an organism**.

“Having this clock is an evolutionary advantage because it helps us to anticipate a change before it happens,” says Kirst King-Jones, associate professor in the Department of Biological Sciences and co-author of the study. Our biological clocks allow us to anticipate daily environmental changes such as temperature fluctuations, the approach of day or night, and nutrient availability, and adjust our physiological processes accordingly. “In mammals as in insects, the circadian machinery is present in different tissues,” explains Francesca Di Cara, the study’s lead author.

“There is a general clock that is in the brain and controls the entire body; however, each tissue or organ also has its own circadian rhythm to regulate different processes.” **Human patients with genetic disorders that disrupt the clock machinery have been known to display a range of negative health consequences including abnormal sleep patterns, low energy levels, and impaired immune functions**. Because these disorders always affect both the central and tissue-specific clocks, the question arose: what would happen if a single clock in a specific tissue were disrupted, leaving all other clocks intact?

Kirst King-Jones and Francesca Di Cara: **“Having depleted the one clock while the others are still working is much worse than depleting the clocks everywhere—you have less damage but more harm.”**

CBC News:

“The Danish government compensates women who developed breast cancer after long spells of working night shifts.”

We **REQUIRE** regular periods of light
and of **DARKNESS** for our
COMFORT,
HEALTH
and
SURVIVAL

Light Pollution and Safety

Glare (excess light shining directly into the eye) causes the pupil to contract thereby reducing the ability to see at night which, in turn, reduces safety and compromises security.

Commercial yard lights and commercial building lights that send light beyond the boundaries of the business and on to public roads are a safety hazard for drivers and for pedestrians.

Light Pollution and Safety

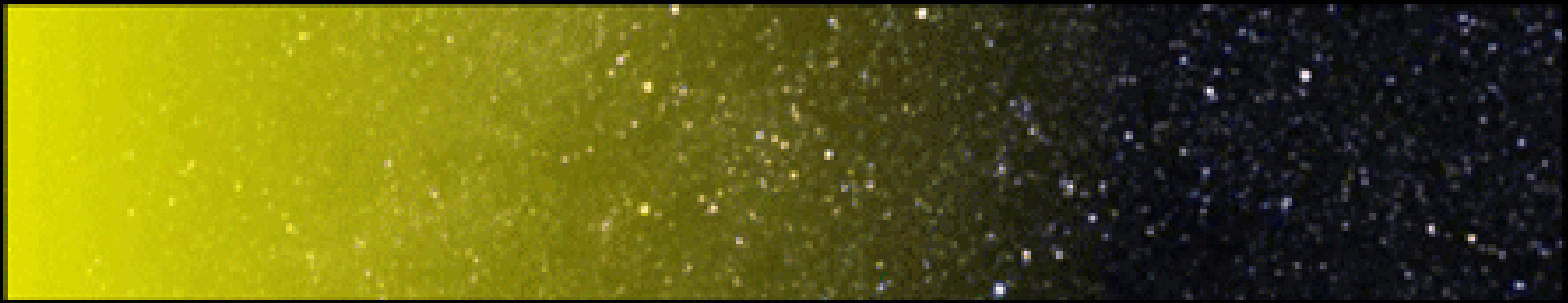
Excessive, poorly shielded, glaring, poorly positioned, and otherwise unnecessary or inappropriate outdoor lighting can result in a false sense of security which, in turn, can lead to complacency when it comes to securing the safety of your property and person.

World Outdoor Lighting Statistics

- ~15% of total energy generated is used for outdoor lighting
- ~60 – 70% of energy used for outdoor lighting is wasted:
 - ~25% not needed
 - ~25% excessive to requirements
 - ~25% not on curfew
 - ~15% glare/trespass
 - ~10% uplight
- Wasted energy ≈ 1.2 million billion watt hours annually
 - > Costs \sim \$120 billion per year

A Light Efficient Community (LEC)

uses lighting intelligently and responsibly,
uses the most efficient, effective artificial
lighting available in order to
minimize energy waste,
minimize glare,
minimize light trespass, and
reduce the carbon footprint.

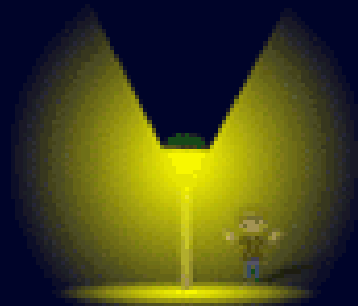


very bad

bad

better

best



GLARE



Seeing what is
meant to be lit:

effective

efficient

comfortable



Seeing the lights
themselves:

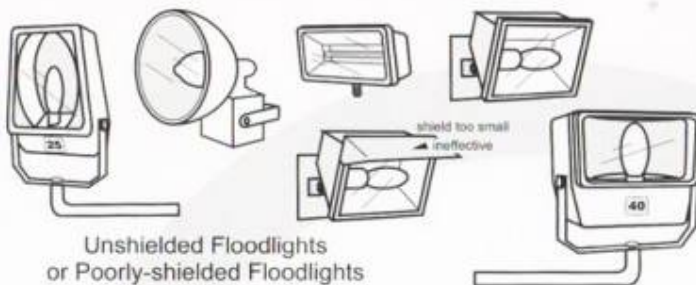
glare

confusion

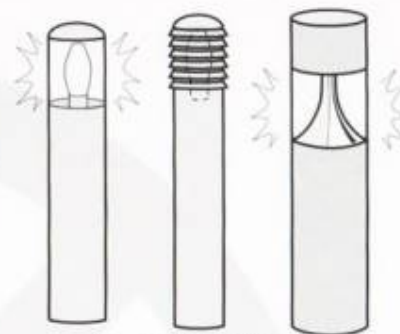
discomfort

UNACCEPTABLE / DISCOURAGED

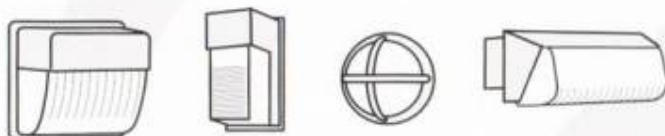
Fixtures that produce glare and light trespass



Unshielded Floodlights
or Poorly-shielded Floodlights



Unshielded Bollards



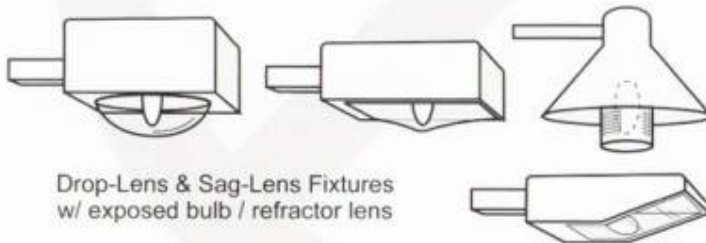
Unshielded Wallpacks
& Unshielded or
Poorly-shielded Wall
Mount Fixtures



Unshielded Streetlight



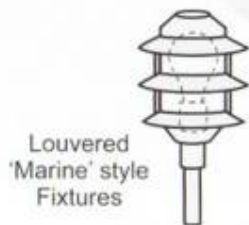
Unshielded Barn
Light



Drop-Lens & Sag-Lens Fixtures
w/ exposed bulb / refractor lens



Unshielded
'Period' Style
Fixtures



Louvered
'Marine' style
Fixtures



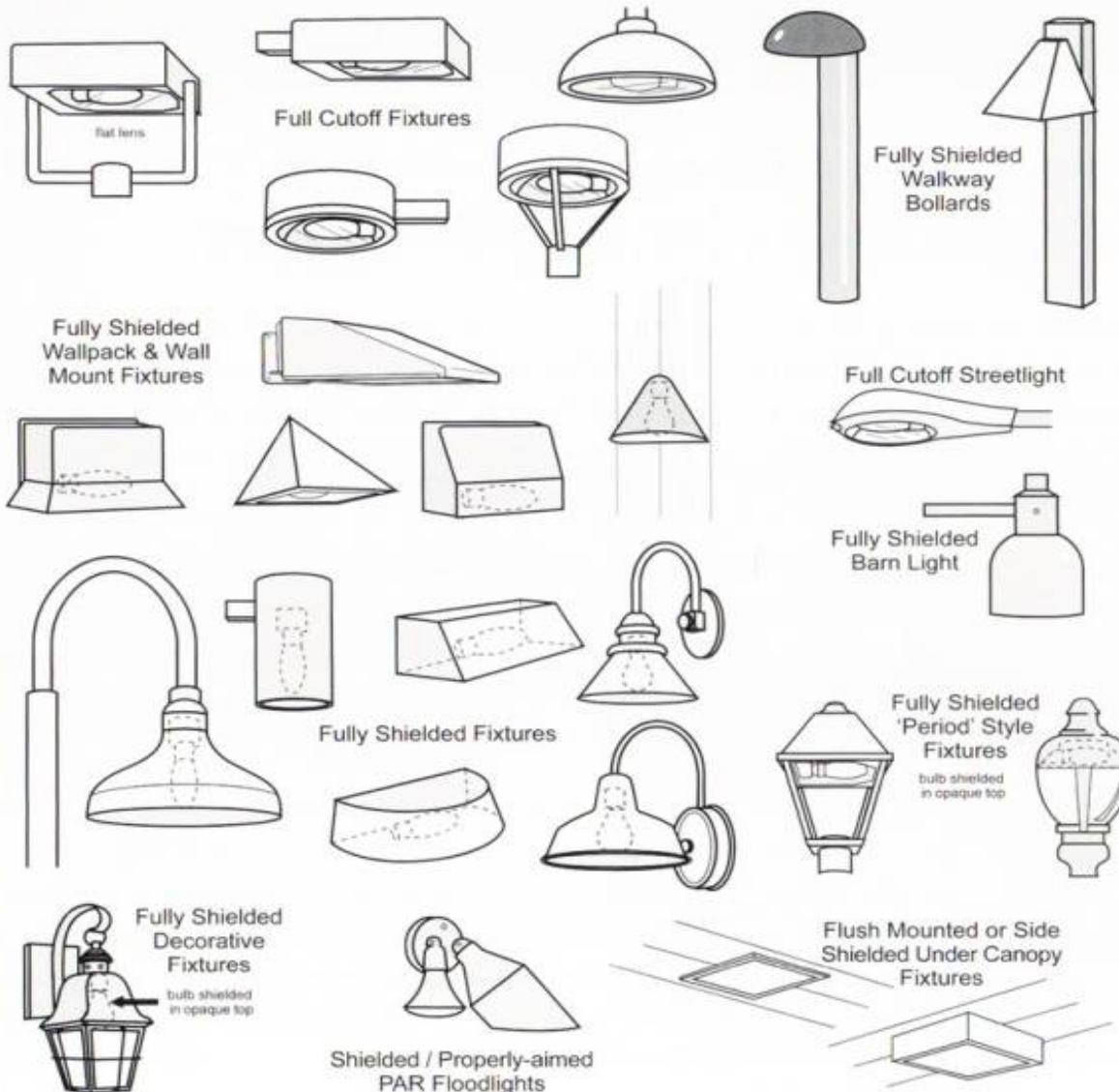
Unshielded PAR
Floodlights



Drop-Lens Canopy
Fixtures

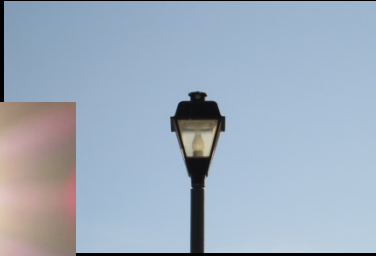
ACCEPTABLE

Fixtures that shield the light source to minimize glare and light trespass and to facilitate better vision at night



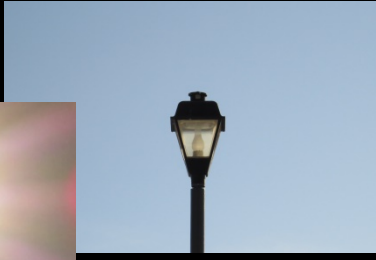
Examples of Bad Lighting in Leduc

Decorative lights that use inefficient (non-LED) sources, put more light into the sky than on the ground, create shadows between the houses, and cause light trespass on neighboring properties.



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A Glaring Welcome to Leduc



Good lighting in Leduc

Modern LED street lights produced by CREE. These can directly replace the old 'cobra heads'.
These new fixtures would be better if shielding extended down from the sides for a distance of a few centimeters.
A change in specifications has been proposed to the 'International Dark Sky Association (IDA)



'Roadway Lighting' Luminaire

- LEDs for low energy consumption
- Full cutoff = no sky illumination
- Shielding permits adequate light spread along road
- Shielding prevents glare in eyes of driver
- Shielding prevents light trespass on property beside road



Improved lighting at the new Leduc Boat Club

Light fixture in the parking area in front of the City of Leduc Operations Building.

*Full Cut-off = no light goes into the sky
Shielded = minimal glare and trespass
LED = energy efficient*

An attractive luminaire day and night



**Almost full cutoff
but in excess(?) of 'need'.**

Full cutoff but ...

A typically glaring and confusing street scene in a large, modern city can be improved by replacing the ubiquitous, inefficient and unshielded cobra street lights with full-cutoff LED light sources.



New street lights (foreground) in an area of west Edmonton generate far less wasted light and glare than do the old 'cobra heads' in the distance.

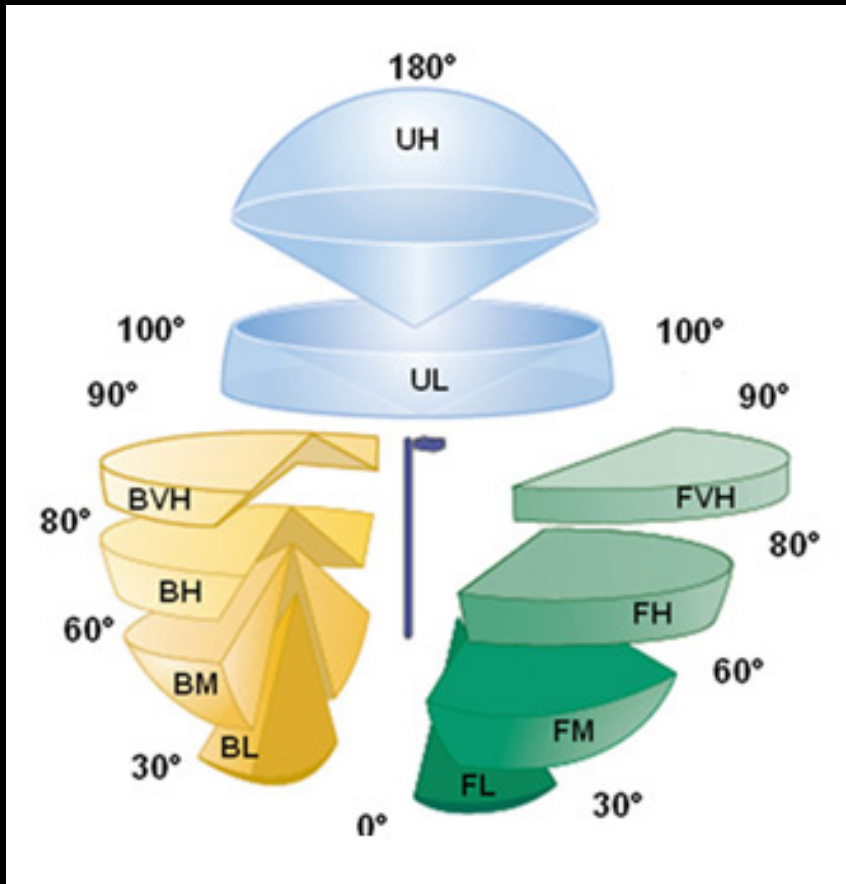
The new lights would be even better if they did not have the decorative descending arms that scatter light in all directions.

The 'BUG' Light Rating System

Backlight, which creates light trespass onto adjacent sites.

Uplight, which causes artificial sky glow. Uplight (UH) is almost all energy waste.

Glare, can be annoying or visually disabling.

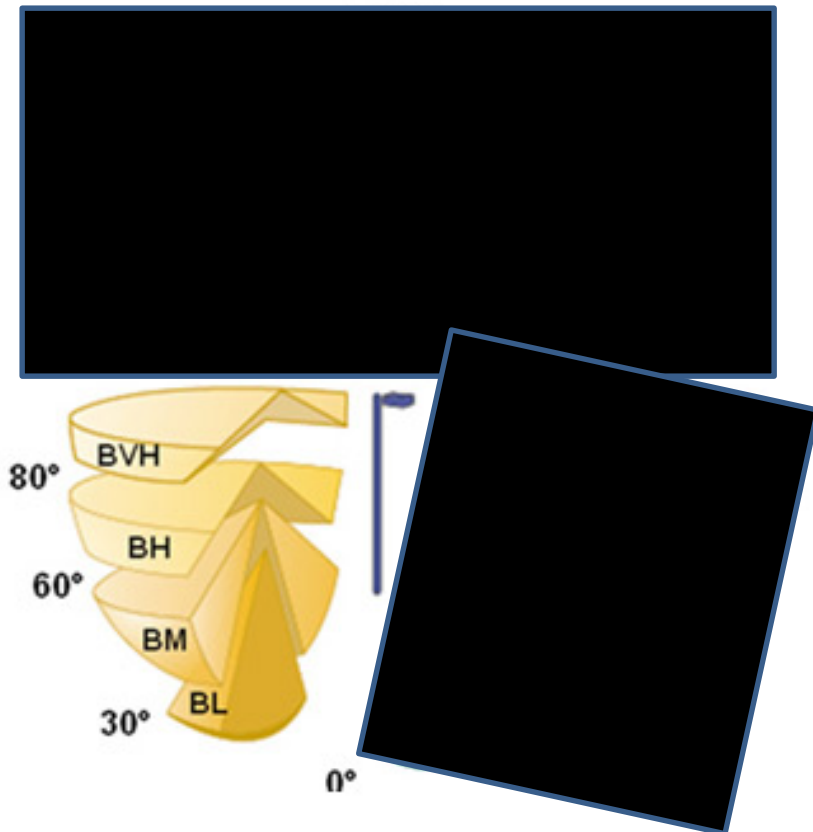


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Full Cutoff lamps eliminate sky glow and the associated energy waste. This is the first and most obvious step to reduce light pollution.

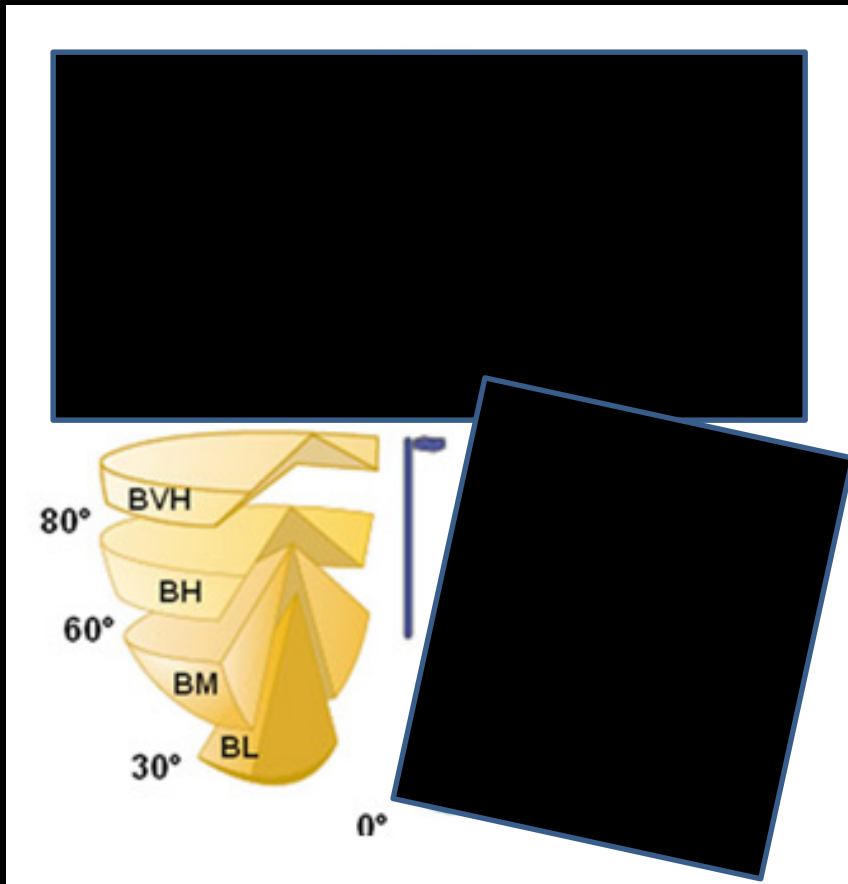
Directional Shielding eliminates trespass, glare and energy waste.

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B-U-G = 0-0-0
SAVE MONEY

“More light is better.”

~~“More light is better.”~~

“More good light is better.”

“More good light is better.”

Good lighting is good for business.

- Reduced Costs

- Socially Responsible: lower GHG emissions, reduced trespass, better security, safety on-site and in neighbourhood*
 - Environmentally Responsible*
 - Healthier for employees*
 - Healthier for general population*

When designing new buildings or when upgrading older buildings ...

Do Not Assume That More Light is Better Light

Do Not Assume That Light Is Necessary For Security

Do Not Assume That Outdoor Lights Are Needed. ↙

'Guidelines' followed by architects, and by roadway lighting engineers and designers are usually just that – guidelines and not regulations.

US National Park Service Night Sky Team:

“Light pollution is not the inevitable side effect of progress, but is instead indicative of wasteful and inefficient outdoor lighting.”

Good Lighting Fixtures/Luminaires:

Full horizontal shielding = *no uplight*

Directional shielding = *no trespass & no glare*

'Cool' LED = *energy efficient & comfortable*

Timing control = *reduced waste*

* * * A Useful Exercise * * *

Inspect the exterior lights of *your* business
at *night*

effective?

excessive?

trespass?

glare?

security?

*Light only what needs to be lit
only when it needs to be lit
with the most efficient light source
of appropriate intensity and
appropriate colour
without creating direct light trespass
and without lighting the night sky.*

To be blunt ...

We should all keep our lights to ourselves!

From within the boundaries of Leduc it is still possible to enjoy some natural attractions in the night sky, but the situation is deteriorating rapidly .

Sky glow from Edmonton, Nisku and Leduc



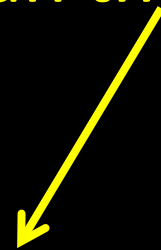
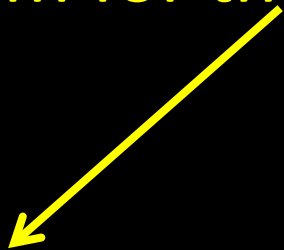


The Milky Way has awed and inspired humanity for millennia.

*It is prominent in the summer sky over Canada,
yet most Canadians have never seen it.*

*We are at risk of losing it forever
in our light-polluted skies.*

Let us aim for *this* rather than *this*.



Useful Resources

Local resource

www.albertadarksky.org

Canadian source of principles and good practices

www.csbg.ca

IDA: It began here

www.darksky.org

www.youtube.com

Search for '*Light Efficient Communities*'

Leduc Environmental Advisory Board Recommendation to City Council of Leduc

Whereas light pollution – artificial lights excessive to need, produced by inefficient sources, that cause glare and trespass -- can have adverse effects on human health, on security and safety, on the environment ...

The LEAB recommends that the City of Leduc adopt policies and establish bylaws that conform to the recommendations of the *International Dark Sky Association* (IDA), and that are consistent with the requirements of a *Light Efficient Community* (LEC).

LEAB will work with the Leduc Environmental Sustainability Office to identify appropriate policies and principles for Leduc.

[Note: Much of the hard work has been done already by other communities in Canada and throughout North America and Europe. They'd be honoured to be copied!]

Selected References:

www.darksky.org

www.light-efficientcommunities.com

www.bonaccord.ca/documents/2015-07LightEfficientCommunityStandardBylaw.pdf

Celebrate the Sky with Your Family

Jasper Dark Sky Festival: An annual event in October

Beaverhills Dark Sky Celebration: An annual event on successive days in early-September at Miquelon Lake PP and Elk Island NP

Solar Observing

Night Time Observing

Guest Speakers

Displays and Educational Activities

