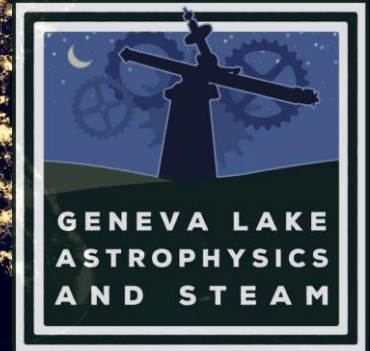


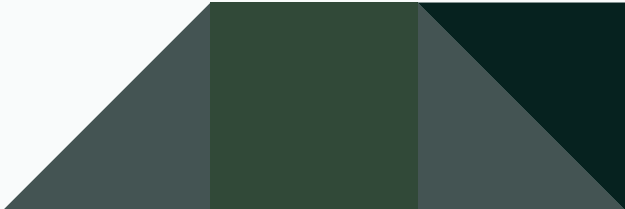
Dark Skies: Light Pollution & What We Can Do About It

Adam McCulloch



What is Light Pollution?

Light where it is not intended to be

- **Skyglow** - Light directed upward towards the sky
 - **Glare** - Light emitted at horizontals, causing blurred vision
 - **Light Trespass** - Light from a nearby property illuminating another property
 - **Clutter** - An excessive use of light with many fixtures illuminating the same feature
- 

Measuring Sky Quality

Approximate Sky Quality Measurements (SQM) in mag/arcsec²

21.99-22.0

21.89-21.99

21.69-21.89

20.49-20.69

19.50-20.49

18.94-19.50

18.38-18.94

<18.38



1



2



3



4



5



6



7



8

Bortle Scale

Photo by AstroBackyard from <https://astrobackyard.com/light-pollution/>

What is light pollution?



Sky glow



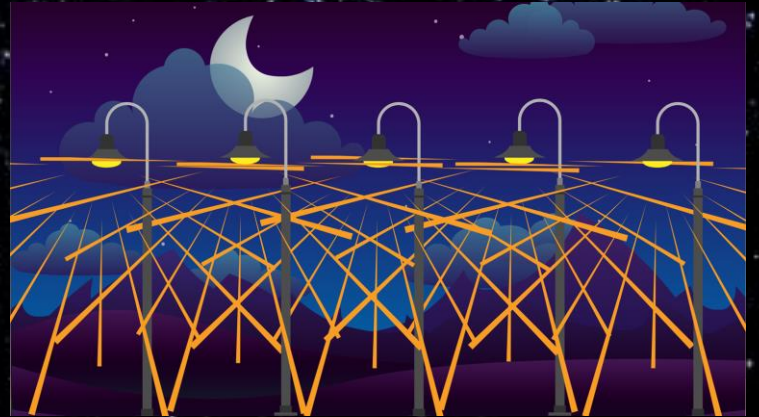
Glare

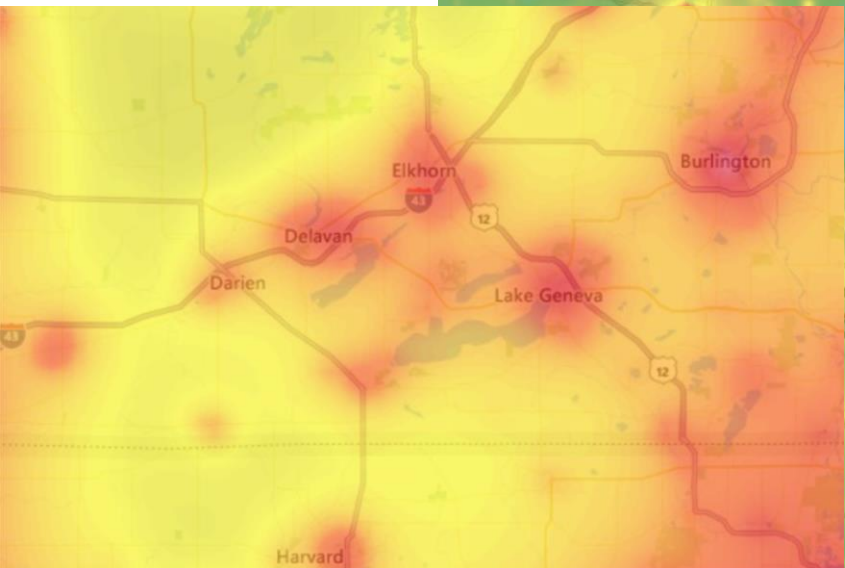
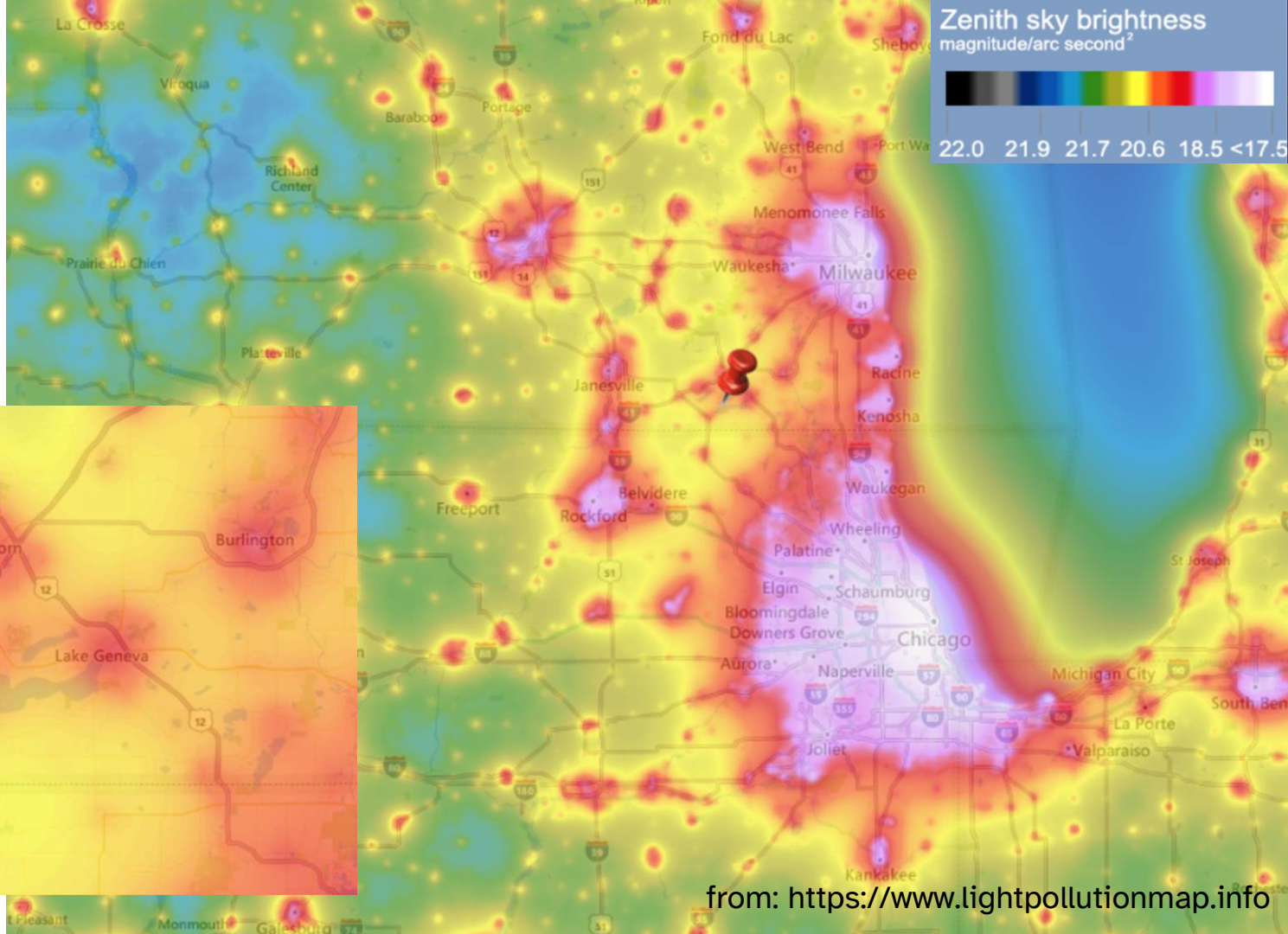


Light Trespass



Clutter





Zenith sky brightness info (2015) ℹ ✕

Coordinates 42.59529, -88.43189

SQM 19.71 mag./arc sec²

Brightness 1.41 mcd/m²

Artif. bright. 1230 μcd/m²

Ratio 7.22

Bortle [class 5](#)

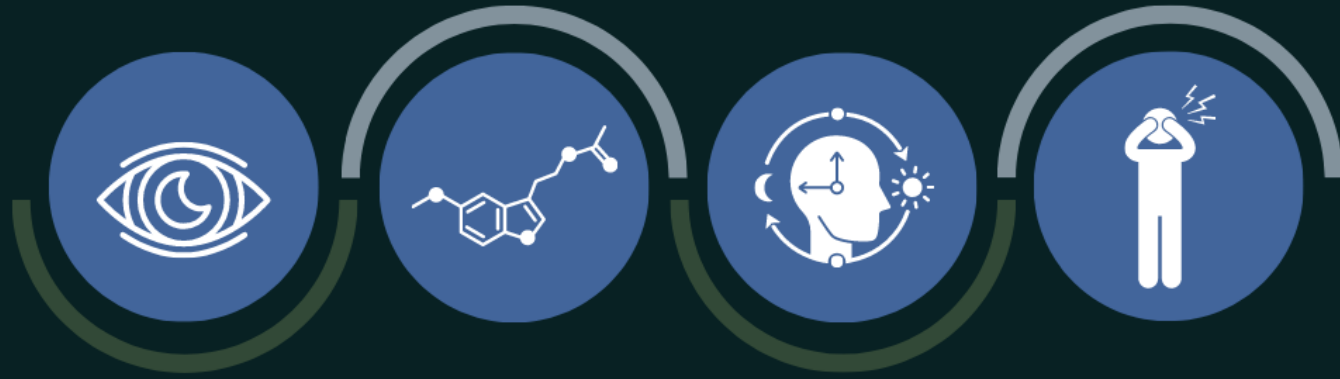
Elevation 266 meters

Current Standards

Purpose. The purpose of this section is to regulate the spillover of light and glare on operators of motor vehicles, pedestrians, and land uses in the vicinity of a light source in order to promote traffic safety and prevent the creation of nuisances. A further purpose of this section is to regulate outdoor night lighting fixtures to preserve and enhance the area's dark sky while promoting safety, conserving energy, and preserving the environment for astronomy and to reduce collisions and save birds lives during spring and fall.

[Ord. No. 14-12]





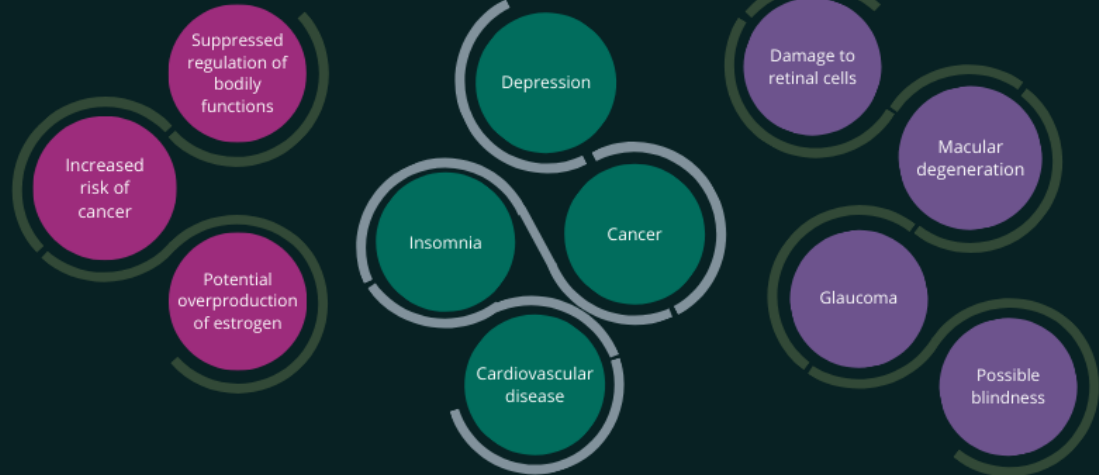
Impaired night vision

Decreased melatonin production

Disrupted circadian rhythms

Blue light strain

Light Pollution & People



Ecosystem Impacts

Reduced populations, reduced ecosystem services



Corals

- disturbance in biological clocks
- decreased spawning

Mammals

- increased competition for food resources
- decreased foraging activity

Frogs

- disrupted reproductive behaviors, including fewer mating calls
- increased predation due to gathering around and under light sources
- delayed metamorphosis or slower growth



Trees

- reduced photosynthetic efficiency
- Altered growth patterns

Birds

- disorientation during night-time migration
- reduced nesting densities
- attraction to and collision with lights
- disruption of ability to sense earth's magnetic field



Bees

- Disruption of nighttime foraging and pollination activities



Insects

- gathering around lights leading to increased predation
- communication impediments

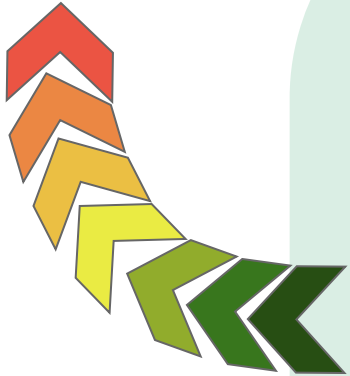
Sea Turtle Hatchlings

- inability to find the ocean due to confusion from lights
- altered behavior causing them to dwell near the surface of the water and remain visible to predators

Light pollution

Increased ambient light

Disrupted Behavior



George Fleenor



George Fleenor



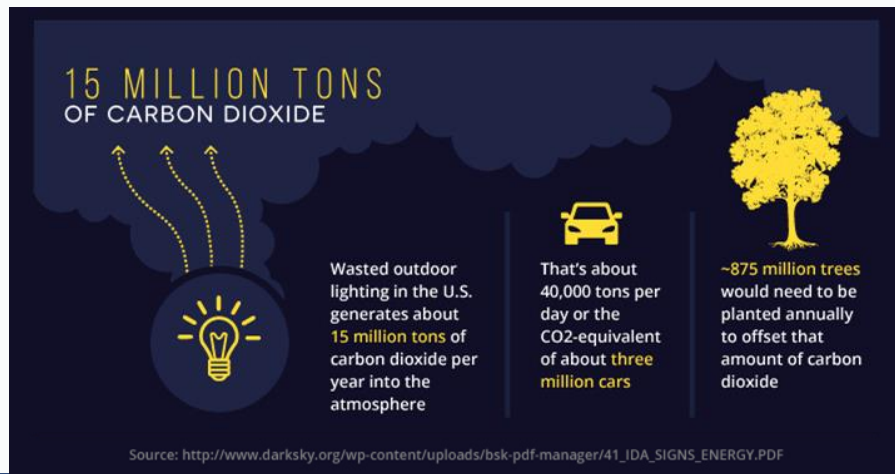
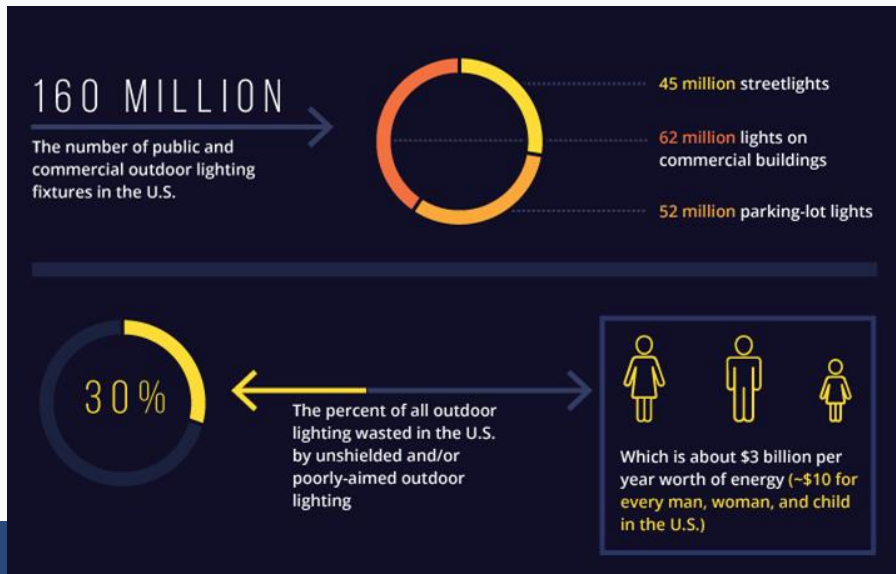
SAFETY

Poor outdoor lighting can cause glare which impedes visibility and actually makes it harder to see at night

<https://www.darkskydefenders.org/light-pollution.html>

Energy Waste

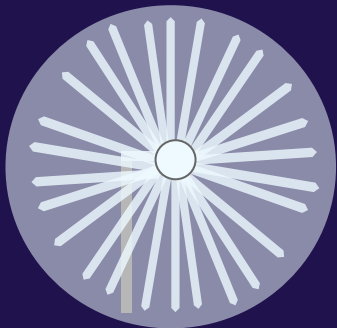
- As much as 50% of outdoor lighting in the US is wasted by sending light into the night sky.
 - estimated cost: \$2.2 billion every year
- LA LED Streetlight Program
 - Cost \$57,000,000 to replace 140,000 bulbs
 - Annual savings of ~\$10,000,000



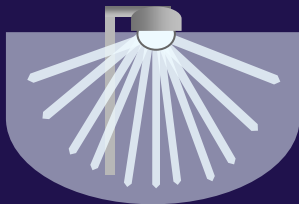
Correlated Color Temperature



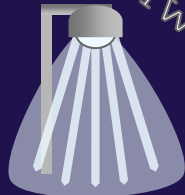
DIRECT



light



downward



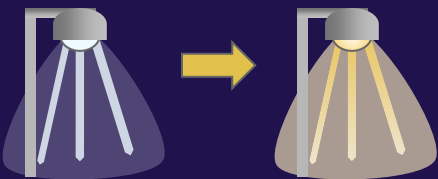
3D's

for reducing
light
pollution

Decreasing the temperature (Kelvins) of a light creates a warmer light that is less harmful to eyes (human and animal!). Aim for 3000K or less.

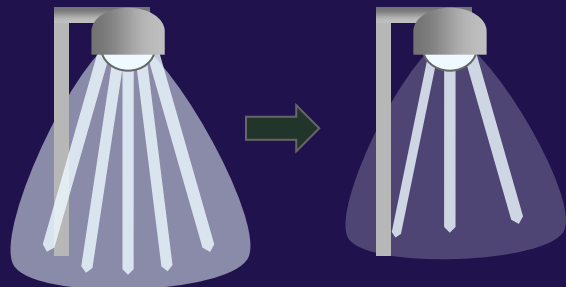
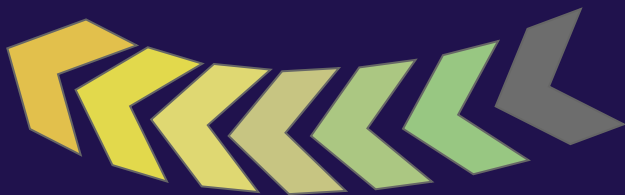
Shielding lights reduces the amount of light projected into the sky and keeps light directed where it needs to be, protecting against sky glow and light trespass.

Using lower wattage lights, low power settings, and/or motion sensors will save energy and reduce glare.



DECREASE

light temperature



DIM

the lights

Measuring Light: Watts vs. Lumens

Watts: how much
power is used



“the SI unit of power, equivalent to one joule per second, corresponding to the power in an electric circuit in which the potential difference is one volt and the current one ampere.”

Lumens: how much
light is emitted



“the SI unit of luminous flux, equal to the amount of light emitted per second in a unit solid angle of one steradian from a uniform source of one candela.”

Measuring Light: Watts vs. Lumens



“60-Watt Incandescent S60
Vintage Squirrel Cage Medium
Base Light Bulb”

**60-Watt delivers 245
lumens**



“60-Watt Equivalent A19 Non-
Dimmable Energy Saving LED
Light Bulb Soft White”

**60-Watt delivers 800
lumens**

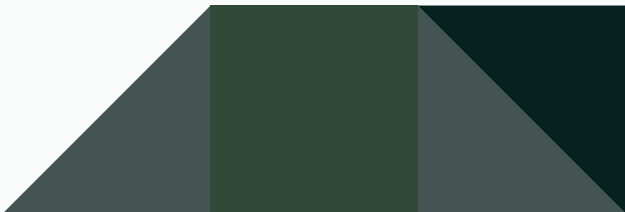
- Although these two light bulbs have the same wattage, but they produce different numbers of lumens because of efficiency differences.
- Light ordinances that restrict usage based on wattage will allow for the LED loophole, where more efficient bulbs can meet power requirements AND create vastly more light.
- Orienting ordinances to restrict light by measuring lumens instead of Watts will more effectively limit light pollution.

Goals

Suggested IDA and IES ordinances:

- Assessment by lumens instead of watts
- Regulate the total number of lumens permitted
- Lighting Zones

Additionally:

- Reduce light temperature to 3000K or less
 - Use covered lights for all municipality provided light sources
 - Promote downward facing lights in the community
- 

Questions?

Contact: Adam McCulloch, adam@glaseducation.org