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

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GENEVA LAKE ASTROPHYSICS AND STEAM

GLAS Education

- STEM Accessibility for BVI/deaf students
- STEAM after school activities for local high school students
- Public Outreach and Education
- Astronomy research and access
- Dark Skies Office
  - LENSS
 - Internships
  - Data Collection

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 |
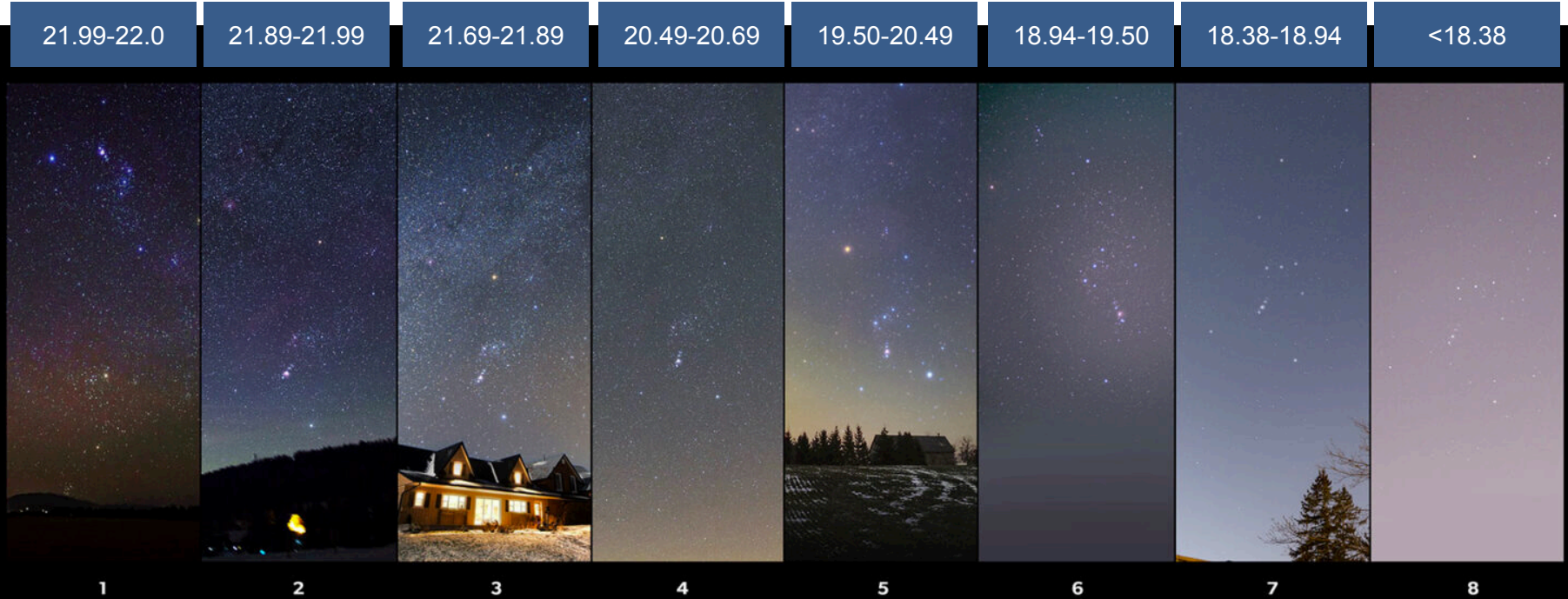
Bortle Scale

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

What is light pollution?

Sky glow

Glare

Light Trespass

Clutter

Zenith sky brightness
magnitude/arc second²

22.0 21.9 21.7 20.6 18.5 <17.5

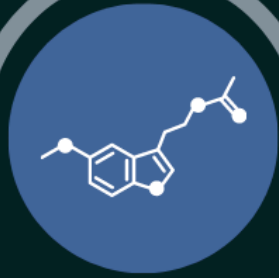from: https://www.lightpollutionmap.info
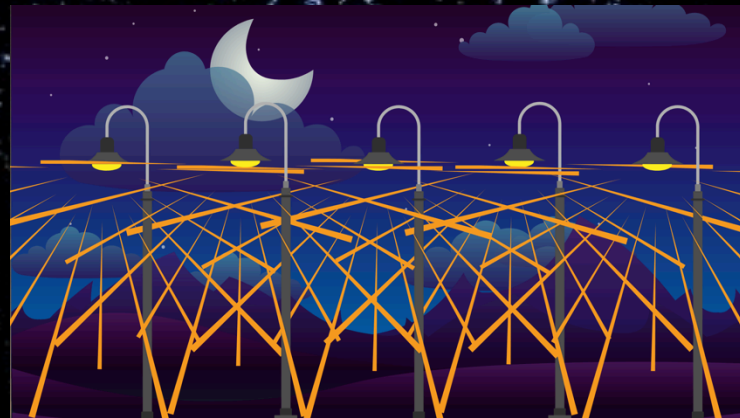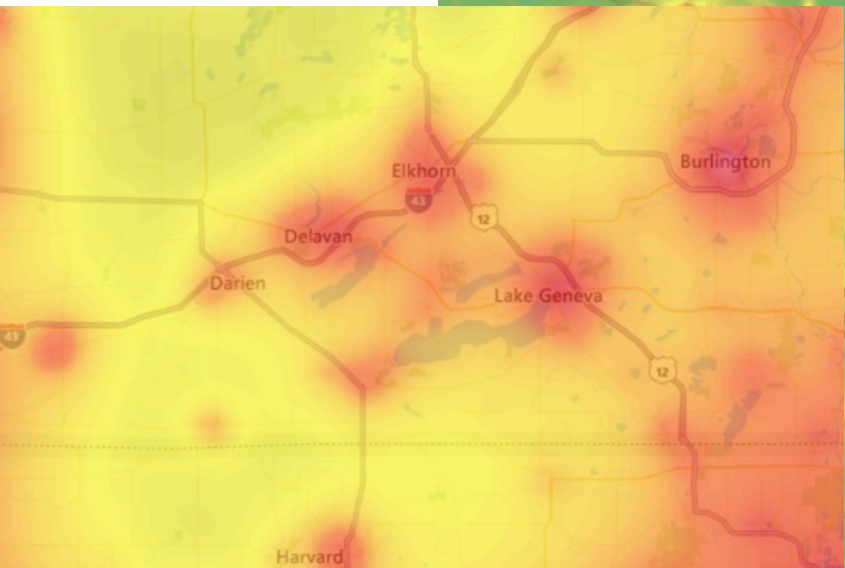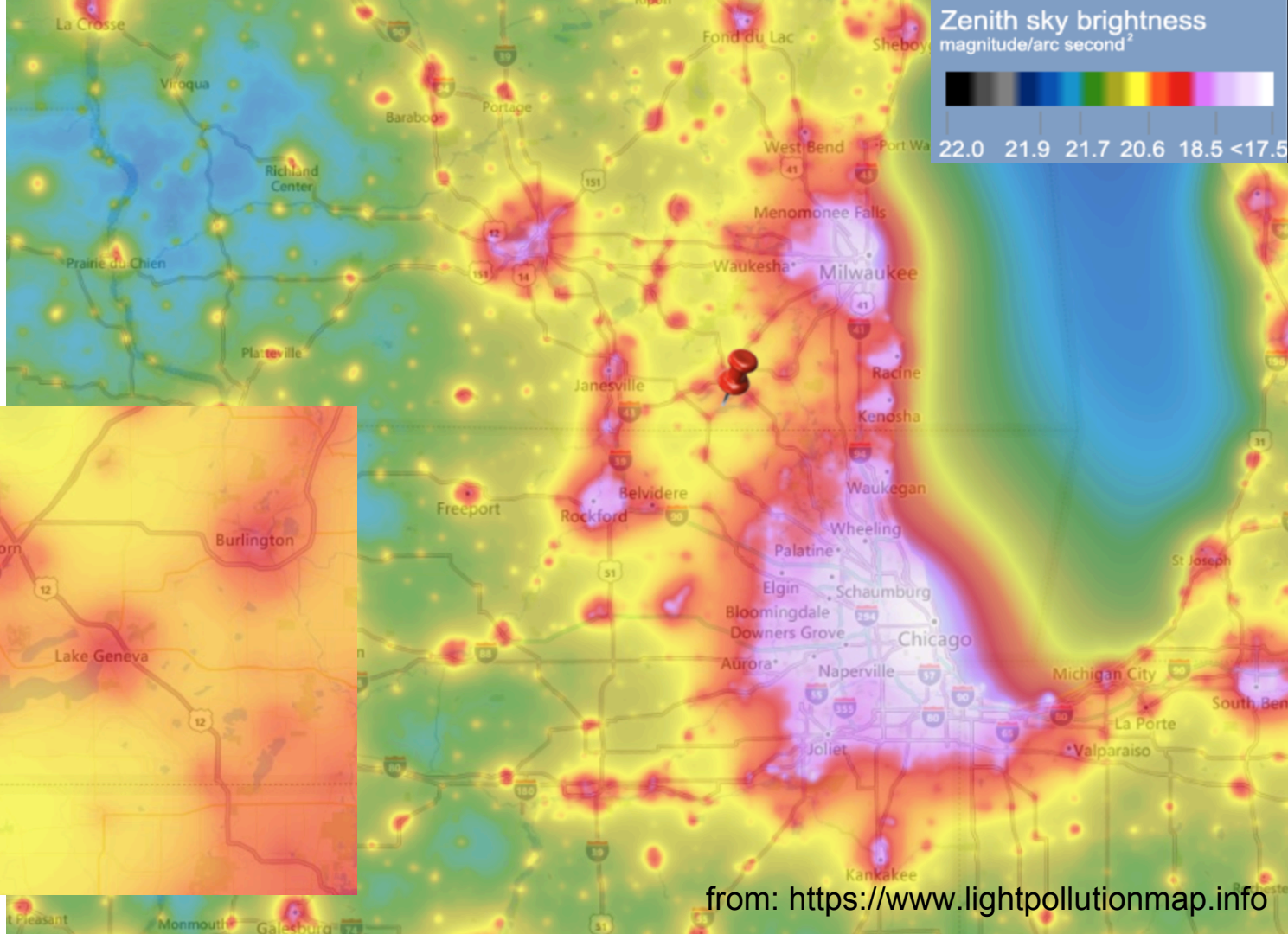
Zenith sky brightness info (2015) ⓘ ✕

Coordinates	42.71723, -88.30525
SQM	20.55 mag./arc sec^2
Brightness	0.651 mcd/m^2
Artif. bright.	480 µcd/m^2
Ratio	2.80
Bortle	class 4
Elevation	242 meters

Light Pollution & People

Impaired night vision

Decreased melatonin production

Disrupted circadian rhythms

Blue light strain

Suppressed regulation of bodily functions

Increased risk of cancer

Potential overproduction of estrogen

Depression

Insomnia

Cancer

Cardiovascular disease

Damage to retinal cells

Macular degeneration

Glaucoma

Possible blindness
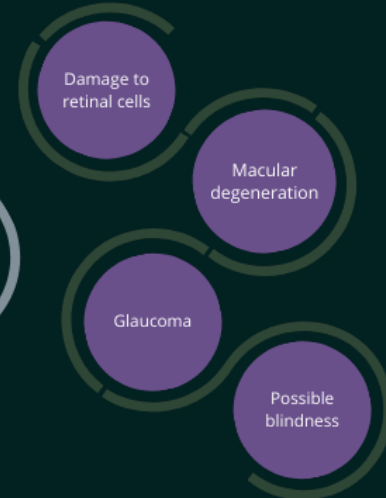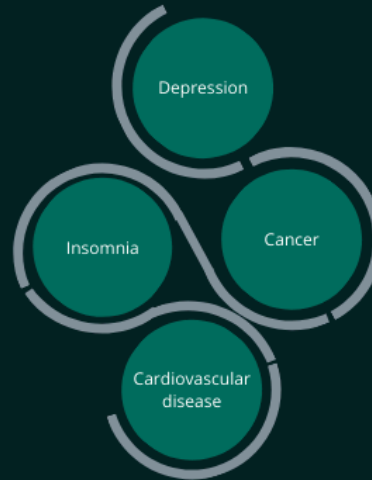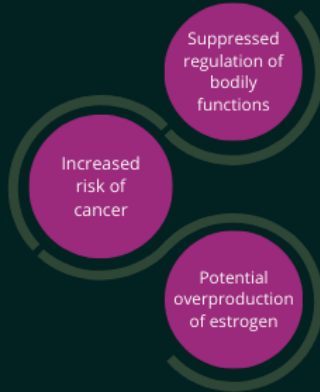
Ecosystem Impacts

Light pollution

Reduced populations, reduced ecosystem services

Increased ambient light

Corals
- disturbance in biological clocks
- decreased spawning

Trees
- reduced photosynthetic efficiency
- Altered growth patterns

Bees
- Disruption of nighttime foraging and pollination activities

Mammals
- increased competition for food resources
- decreased foraging activity

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

Insects
- gathering around lights leading to increased predation
- communication impediments

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

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

Disrupted Behavior
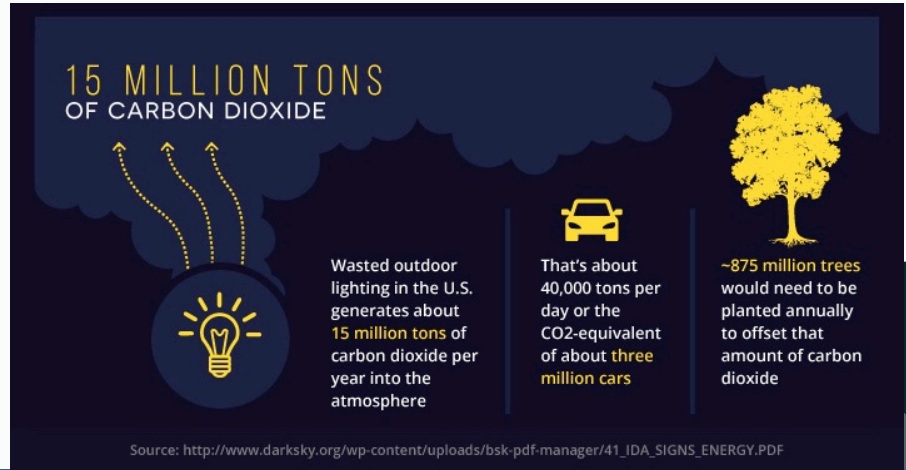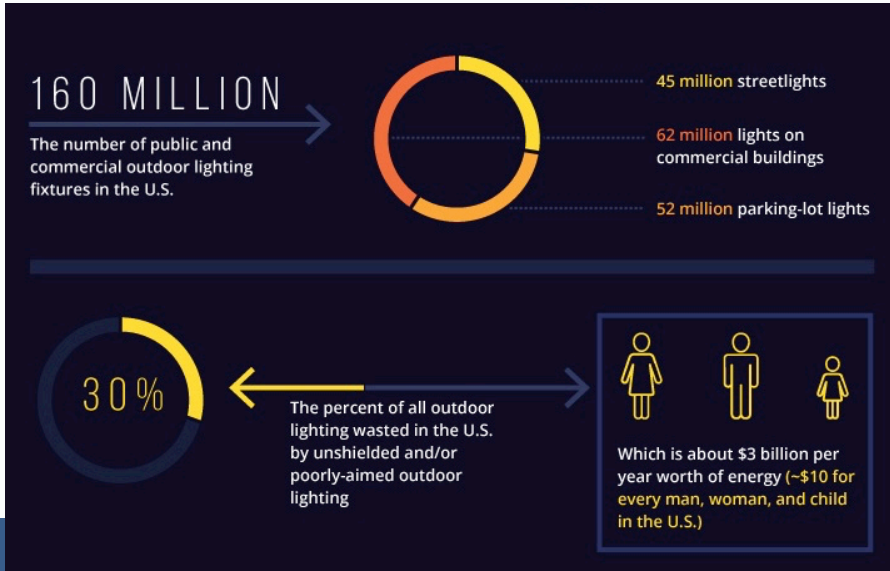
George Fleenor

George Fleenor

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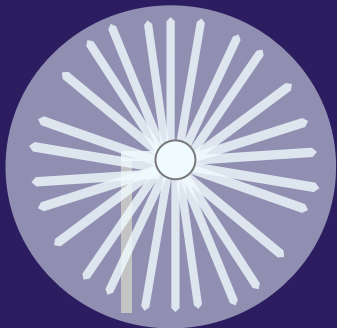
Energy Waste

- 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
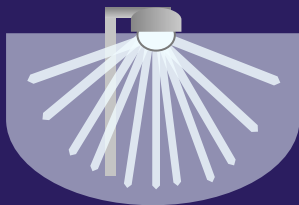

160 MILLION

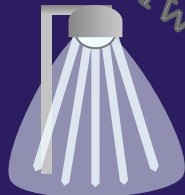The number of public and commercial outdoor lighting fixtures in the U.S.

- 45 million streetlights
- 62 million lights on commercial buildings
- 52 million parking-lot lights

30%

The percent of all outdoor lighting wasted in the U.S. by unshielded and/or poorly-aimed outdoor lighting

Which is about $3 billion per year worth of energy (~$10 for every man, woman, and child in the U.S.)

15 MILLION TONS
OF CARBON DIOXIDE

Wasted outdoor lighting in the U.S. generates about 15 million tons of carbon dioxide per year into the atmosphere

That's about 40,000 tons per day or the CO2-equivalent of about three million cars

~875 million trees would need to be planted annually to offset that amount of carbon dioxide

Source: http://www.darksky.org/wp-content/uploads/bsk-pdf-manager/41_IDA_SIGNS_ENERGY.PDF

Correlated Color Temperature

DIRECT light downward

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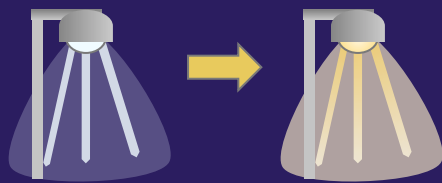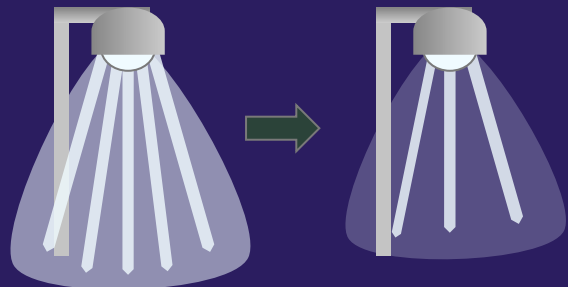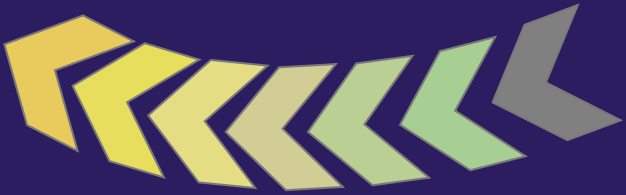
Decreasing the temperature (Kelvins) of a light creates a warmer light that is less harmful to eyes (human and animal!). Aim for 3000K or less.

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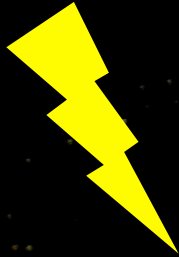
DECREASE
light temperature

DIM
the lights

Measuring Light: Watts vs. Lumens

Watts: how much <u>power</u> 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 <u>light</u> 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, 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?

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