

# Protecting Our Night Skies Over New Mexico

New Mexico League of Zoning Officials

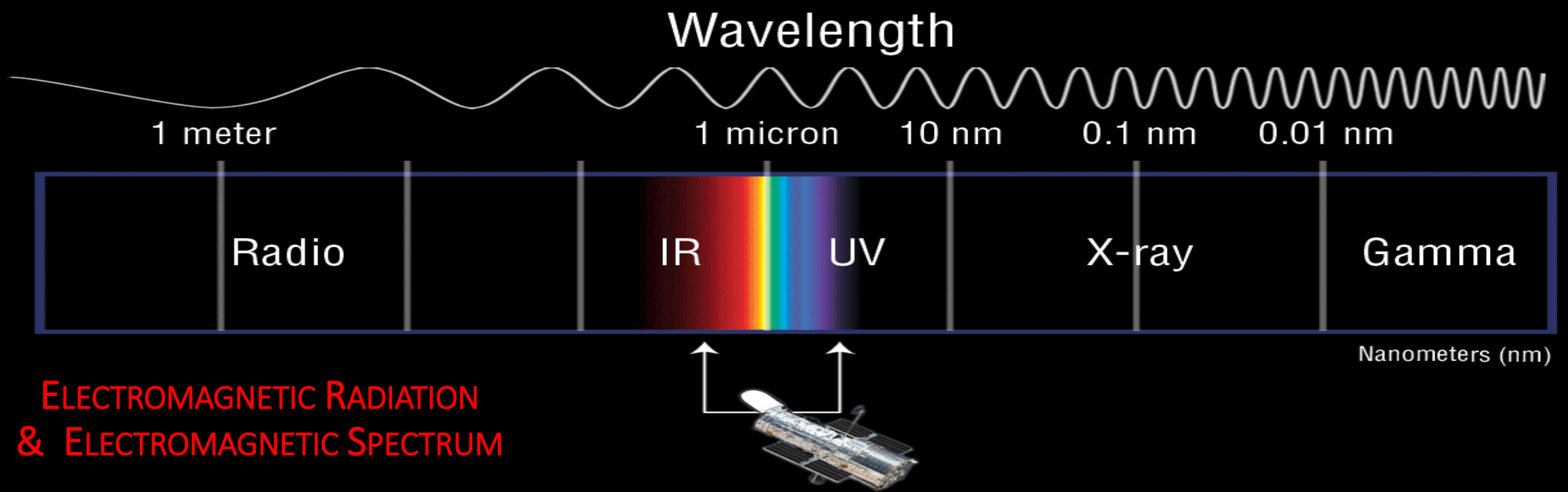
Annual Conference

September 11-13, 2024

Carlsbad, New Mexico

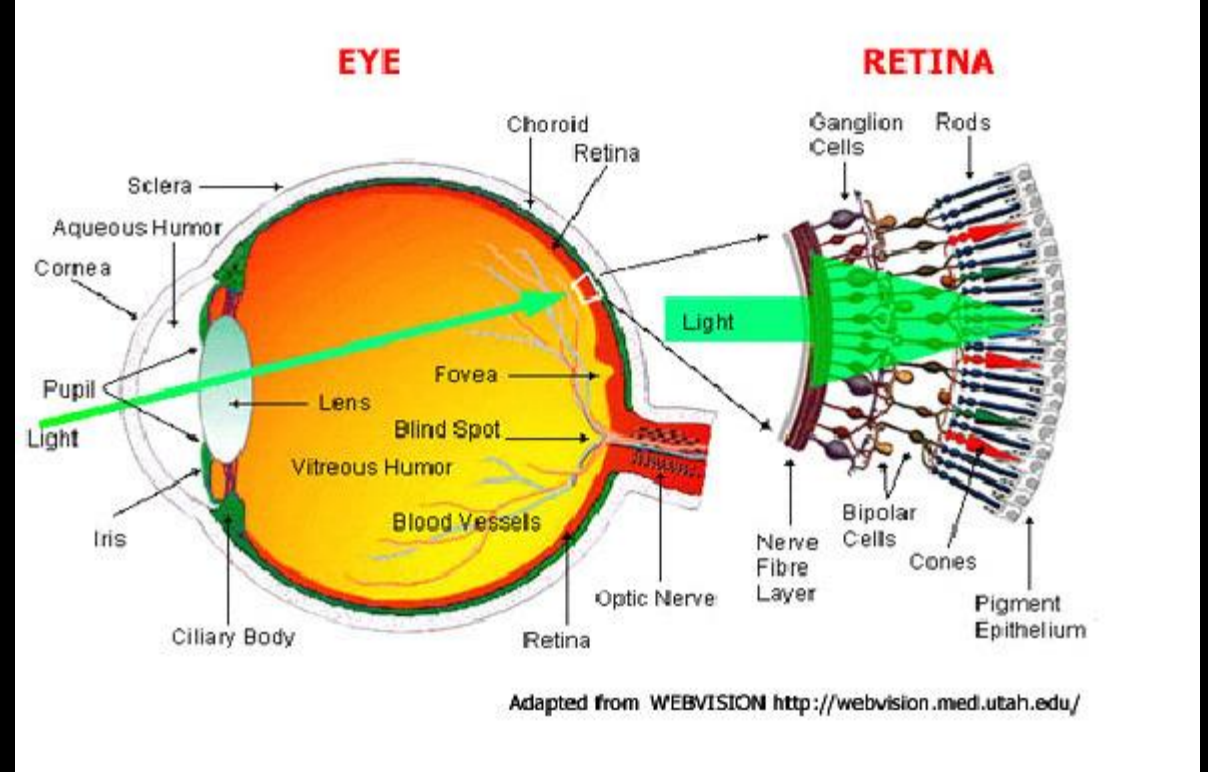
# Disclaimer

The information presented here is a culmination of my experience, observations, and interpretations. It may not be entirely correct, but it will be an interesting story.



Electromagnetic radiation travels in waves, just like waves in an ocean. The energy of the radiation depends on the distance between the crests (the highest points) of the waves, or the wavelength. In general the smaller the wavelength, the higher the energy of the radiation. Gamma rays have wavelengths less than ten trillionths of a meter which is about the size of the nucleus of an atom. This means that gamma rays have very high-energy. Radio waves, on the other hand, have wavelengths that range from less than one centimeter to greater than 100 meters (this is bigger than the size of a football field)! The energy of radio waves is much lower than the energy of other types of electromagnetic radiation. The only type of light detectable by the human eye is visible light. It has wavelengths about the size of a bacteria cell, and its energies fall between those of radio waves and gamma rays.

The human eye can see between 30 and 60 frames per second.



During the day, or bright light, the muscles in the iris shrink the size of the pupil (a hole) to keep the eye from being overwhelmed from too many light rays. The eye **cones** primarily respond to colors, and during the day, in bright light, colors appear vibrant.

During the night, or dim illumination, the muscles of the iris open the pupil (a hole) to let in more light. With less light the **rods** take over, they work well in poor light, but the rods don't detect colors like cones, so this explains why you don't see colors as well in the dark.

# Light and Light Pollution

Some light is necessary

To much light is pollution

## Five principles of responsible lighting

Useful – All light should have a clear purpose.

Targeted – Light should be directed only to where needed.

Low Light Levels – Light should be no brighter than necessary.

Controlled – Light should be used only when it is useful.

Color – Use warmer color lights when possible. Limit blue-violet wavelength light.



# What are the effects of light pollution?

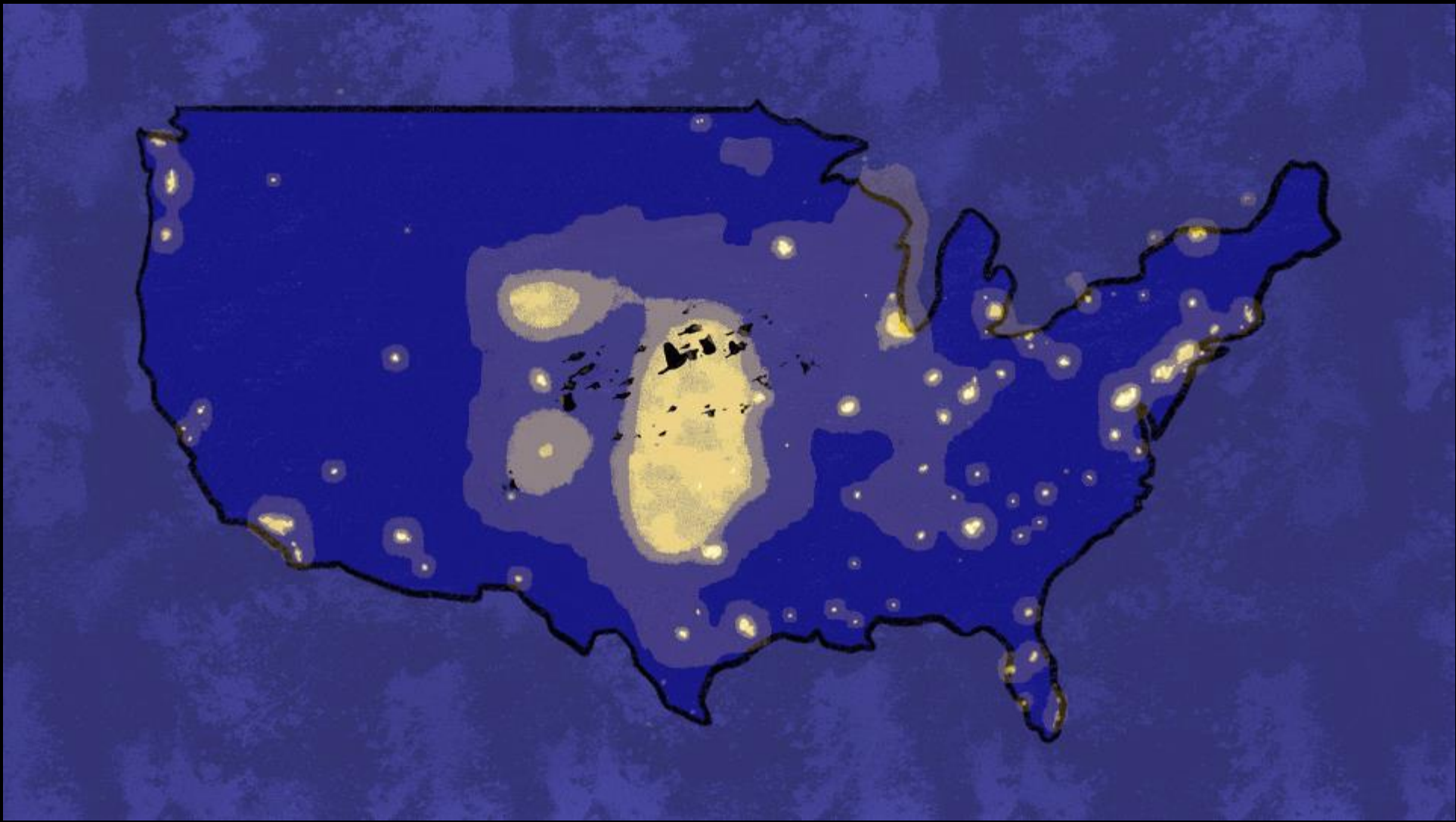
**Wildlife and ecosystems** - Scientific evidence suggests that artificial light at night has negative and deadly effects on many creatures, including amphibians, birds, mammals, insects, and plants.

**Human health** - Many studies have shown that exposure to artificial light at night negatively affects human health, including increased risk for Sleep Disorders, Depression, Obesity, Diabetes, Heart disease and Cancer.

**Energy and climate change** - DarkSky estimates that at least 30 percent of all outdoor lighting in the U.S. alone is wasted, mostly by unshielded lights. That adds up to \$3.3 billion and the release of 21 million tons of carbon dioxide per year.

**Crime and safety** - There is no clear scientific evidence that increased outdoor lighting prevents accidents or deters crimes. It may make us feel safer, but it has not been shown to make us safer.

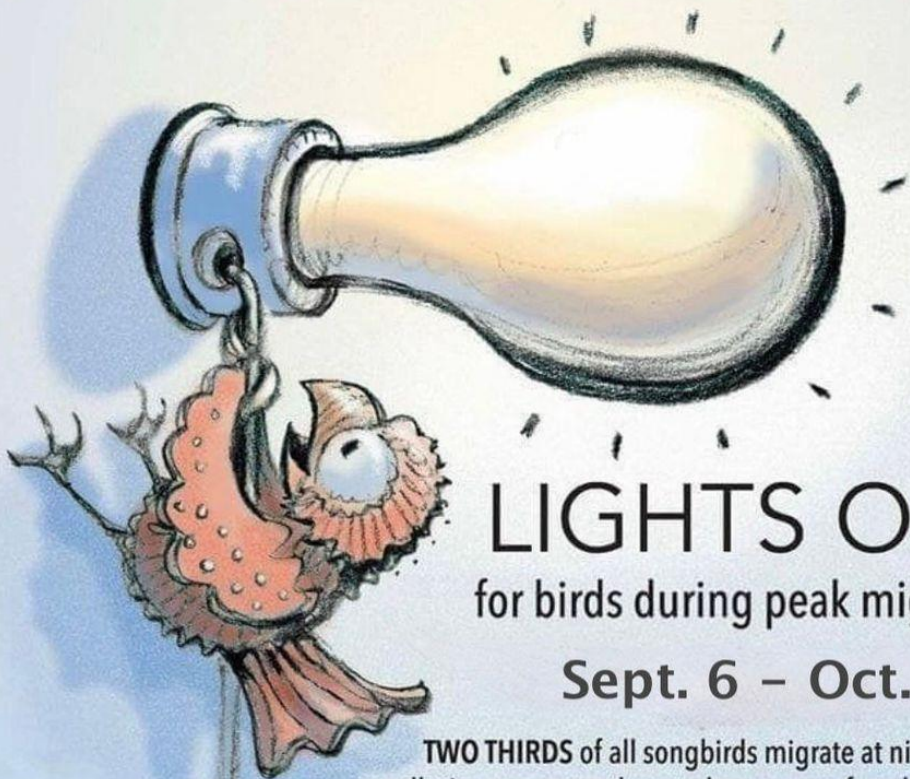
**Night sky heritage** - The natural night sky is our common and universal heritage, yet it's rapidly becoming unknown to the newest generations.



### **Night Moves**

Light is a very dangerous threat to birds that migrate at night. Researchers are using weather radar to track birds and provide “lights out” forecasts to help keep their paths clear of visual distraction. Artificial light disorients migratory birds, sending them off course and causing collisions with stationary objects..





## LIGHTS OUT

for birds during peak migration

Sept. 6 – Oct. 6

**TWO THIRDS** of all songbirds migrate at night. Light pollution can cause them to become confused. TRACY AVIARY encourages everyone to turn off all unnecessary lights. If this is not an option, use warm white or yellow colored light bulbs, shield your light bulbs to direct light down, and install motion sensors. If working indoors at night, close the drapes.



COLDER BLUISH WHITES

**WORST**



WARMER YELLOWISH TONES or RED

**BETTER**



SHIELDED

**BETTER**



MOTION SENSORED

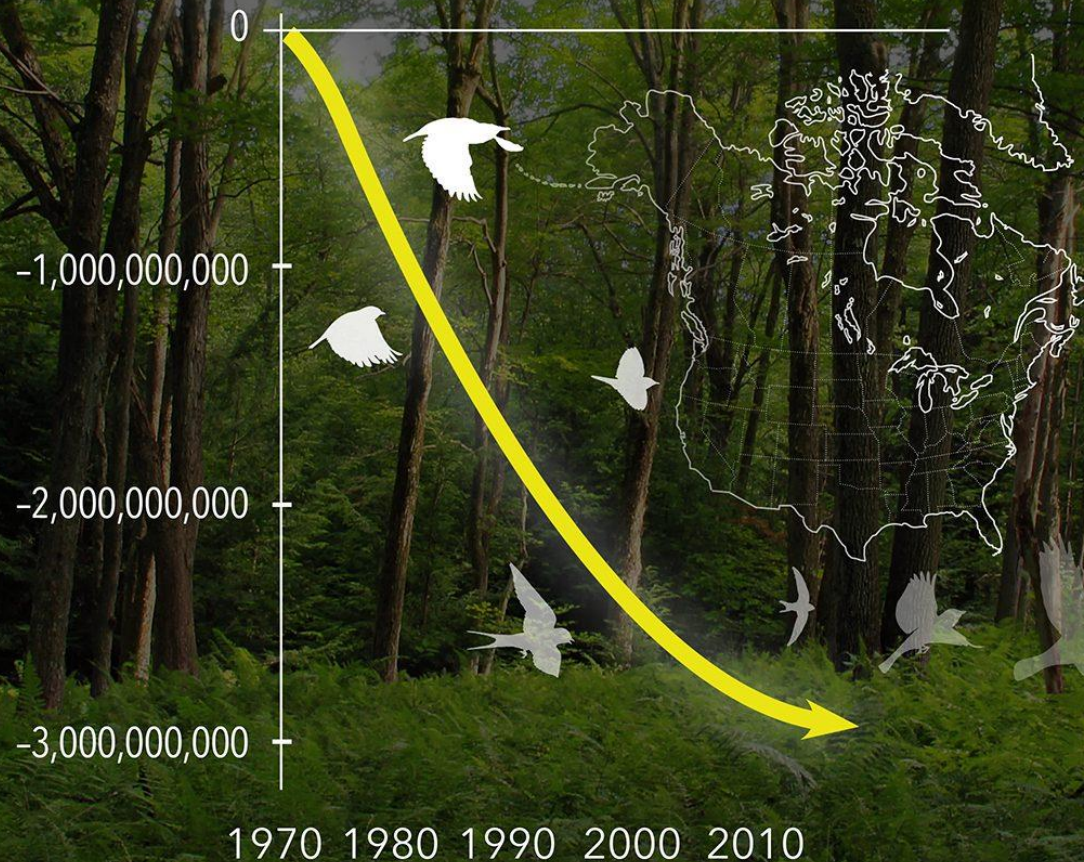


OFF

**BEST**

# 2.9 billion

birds gone since 1970



Courtesy of the Cornell Lab of Ornithology. Source: Science, 2019



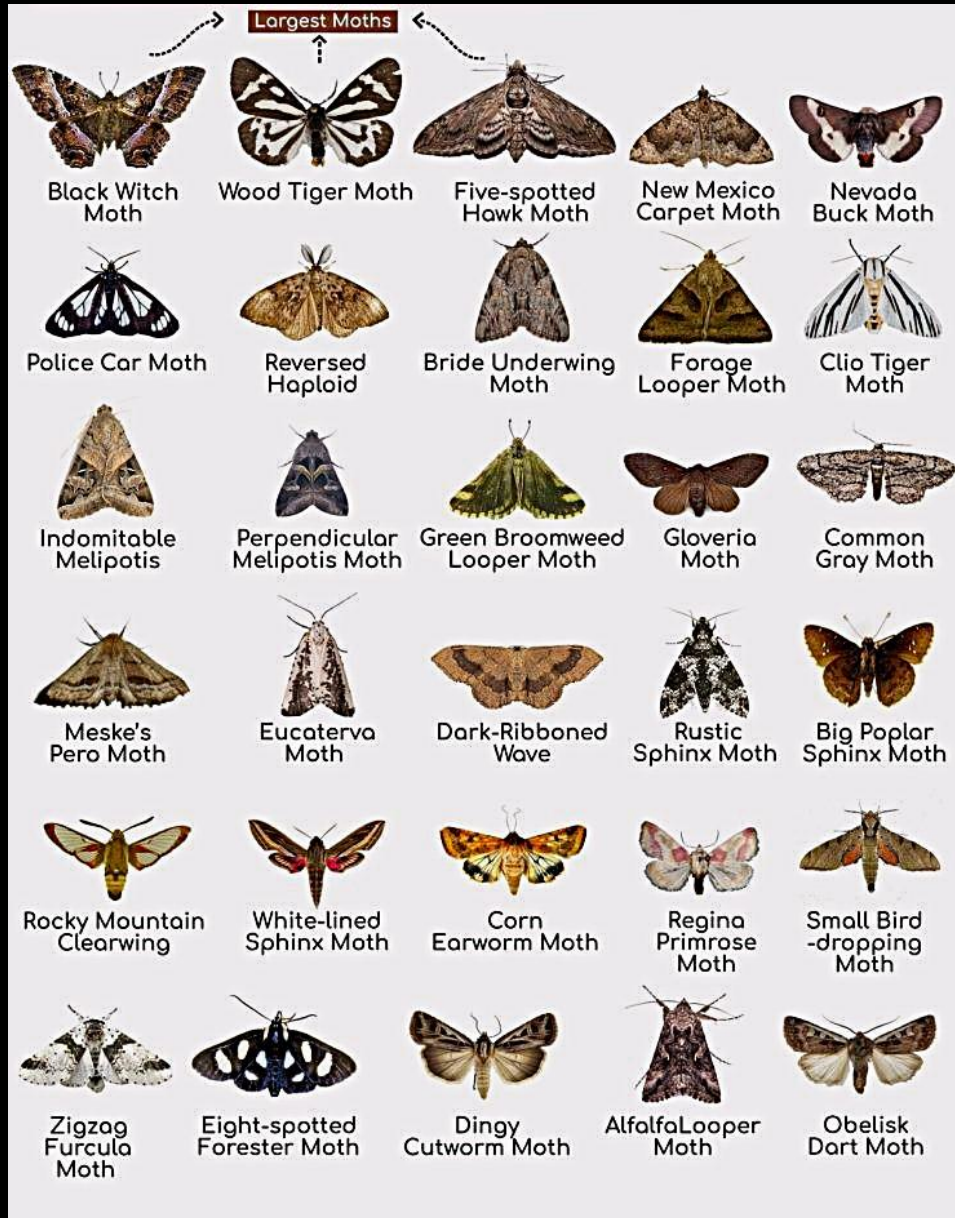
# Pollinators/Insects

The attraction to light can have fatal consequences for the insects involved. Exhaustion, increased predation, and a disrupted ability to navigate are just some of the reasons why up to a third of insects attracted to lights die.

Light pollution is reducing the nocturnal pollinator visits to flowers by 62% in some areas.







No moths in  
the backyard  
2024

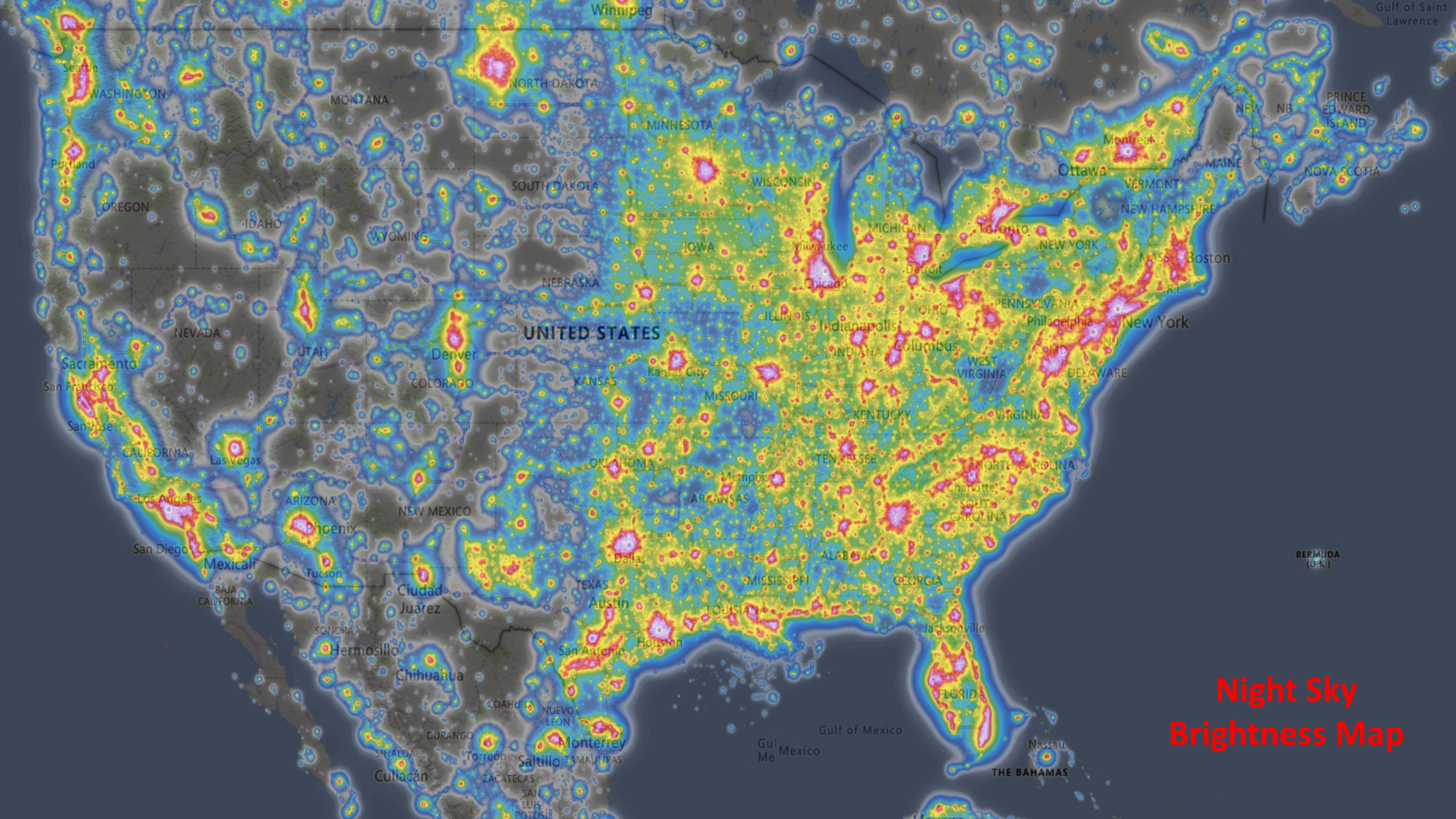


The darker the  
sky, the more  
astronomical  
objects are  
visible



**Bortle  
Scale**  
9  
8  
7  
6  
5  
4  
3  
2  
1





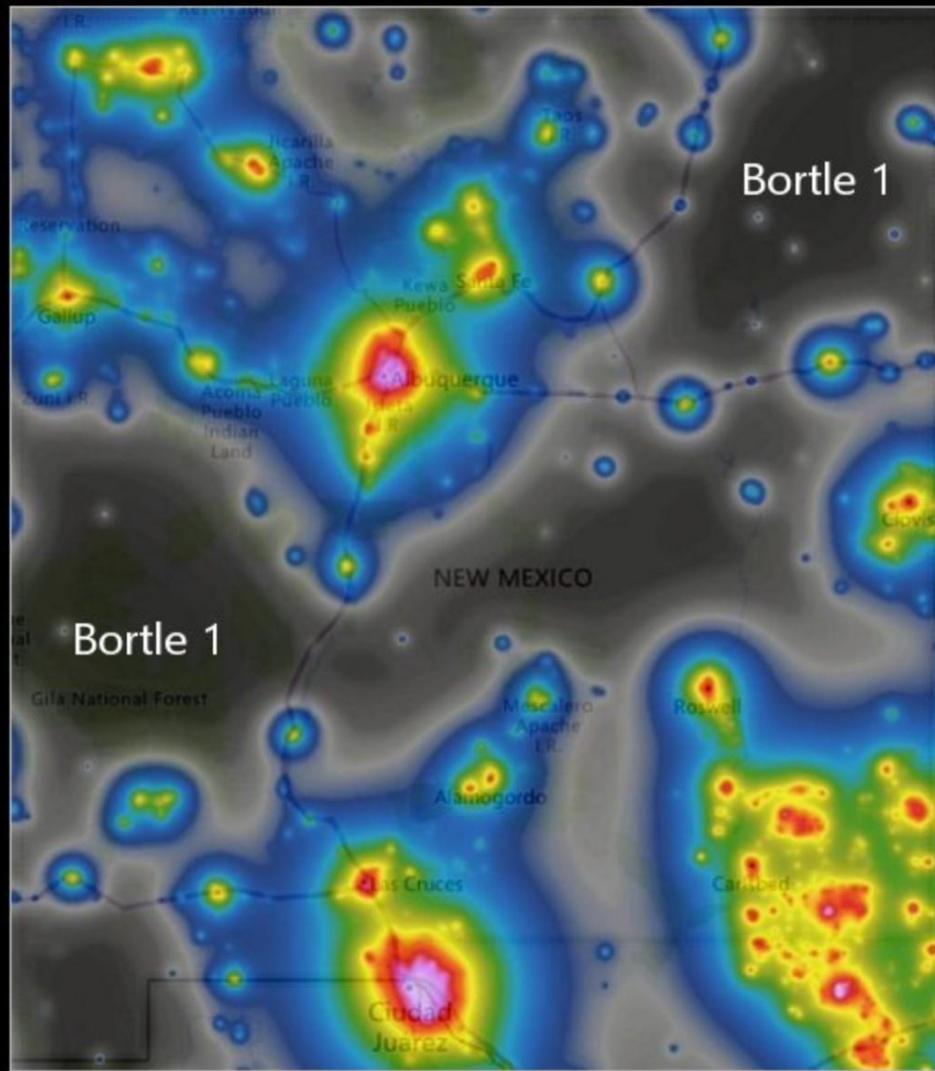
**Night Sky  
Brightness Map**



# Night lights satellite image



# Night sky brightness map



## NM dark skies for stargazing

Darkest



Brightest

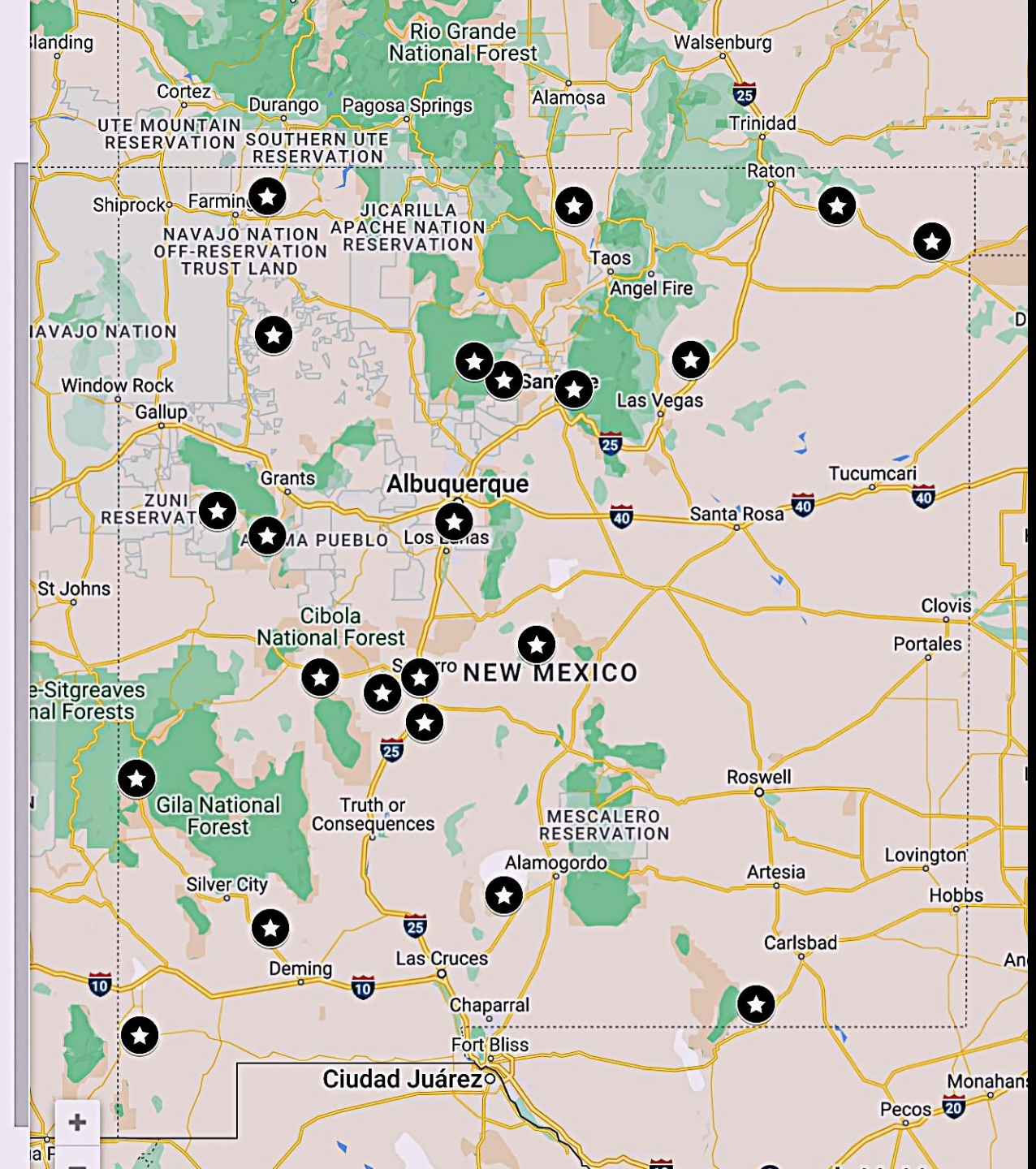
Bortle scale -	1	2	3	4	5	6	7	8,9
SQM value -	22.0	21.99	21.9	21.7	20.5	19.5	18.9	18.4



## Stargazing Spots in New Mexico

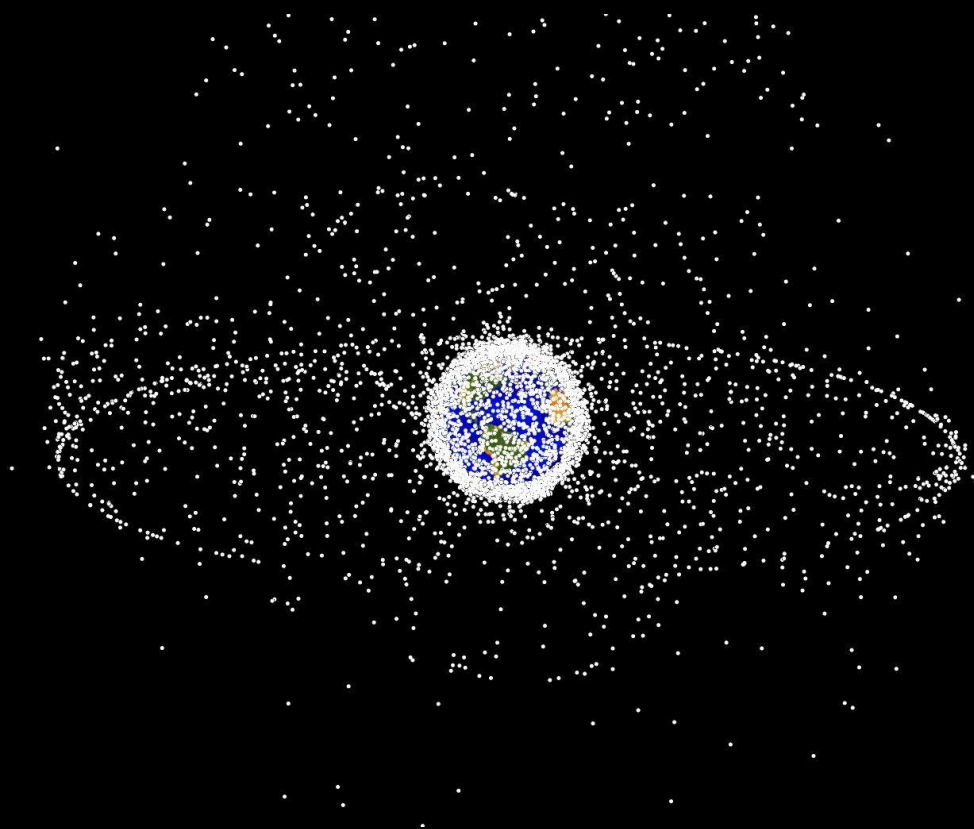
- ★ Aztec Ruins National Monument
- ★ Bandelier National Monument
- ★ Bosque Del Apache National Wildlife Refuge...
- ★ Capulin Volcano National Monument
- ★ Carlsbad Caverns National Park
- ★ Chaco Culture National Historical Park
- ★ City of Rocks State Park
- ★ Clayton Lake State Park and Dinosaur Track...
- ★ Cosmic Campground
- ★ Dark Sky New Mexico
- ★ El Malpais National Monument
- ★ El Morro National Monument
- ★ Frank T. Etscorn Campus Observatory
- ★ Fort Union National Monument
- ★ Hyde Memorial State Park
- ★ Magdalena Ridge Observatory Interferometer
- ★ Rio Grande del Norte National Monument
- ★ Salinas Pueblo Missions National Monumen...
- ★ Valles Caldera
- ★ Valle de Oro National Wildlife Refuge
- ★ NRAO Very Large Array
- ★ White Sands National Park

**Cosmic Campground International Dark Sky Sanctuary (CCIDSS) is the first International Dark Sky Sanctuary located on National Forest System lands and also in North America. It is also one of only 14 certified IDA Sanctuaries in the world. International Dark Sky Sanctuaries are lands possessing an exceptional or distinguished quality of starry nights.**





# Satellites



Mega-constellations, also known as low earth-orbit (LEO) satellite constellations, are webs of networked satellites that orbit the Earth at altitudes of 2,000 km or less, providing global telecommunications services. The brightness and frequency of the objects have caused concern among the astronomy community and the general public.

The sheer number of satellites, combined with the brightness of the objects and the frequency of sightings, is a serious threat to the dark sky community. Astronomers, astrophotographers, and stargazers have all shared concerns about satellite mega-constellations polluting the night sky.

DarkSky is especially concerned about the threats that satellite mega-constellations pose to International Dark Sky Places. These places have taken measures to protect natural darkness, and offer millions of people around the globe the opportunity to observe the splendor of the night sky.

By the end of 2030, it's projected that 50,000 satellites will be in low Earth orbit — a 2,400% increase in a single decade. The reflected light from these satellite swarms may increase the night sky's brightness by 250% — *erasing 50% of all stars from view.*

# Satellites



7 Satellites









August 18, 2023

40 miles north of Roswell, NM, 3 miles west of HWY 285 on Stargrass Road, 9:30 pm, no Moon.  
Southwest view, El Paso is 167 miles away.



August 18, 2023

40 miles north of Roswell, NM, 3 miles west of HWY 285 on Stargrass Road. 9:30 PM, no Moon.





August 18, 2023 20 miles north of Roswell, NM on Greggia Road, west of HWY 285. 10:00 pm, no Moon.



Supernova 2023ixf  
Type II - Single Supergiant Star  
First Observed on May 19, 2023

Pinwheel Galaxy  
Messier 101  
Face-on Spiral Galaxy  
Distance - 20.9 Mly  
Diameter - 169,300 ly  
Number of Stars - +1 Trillion







# **2021 New Mexico Statutes**

## **Chapter 74 - Environmental Improvement**

### **Article 12 - Night Sky Protection**

**Section 74-12-1 - Short title.**

**Universal Citation:** NM Stat § 74-12-1 (2021)

This act [74-12-1 to 74-12-11 NMSA 1978] may be cited as the  
"Night Sky Protection Act".

## **Section 74-12-2 - Purpose.**

**Universal Citation:** NM Stat § 74-12-2 (2021)

The purpose of the Night Sky Protection Act is to regulate outdoor night lighting fixtures to preserve and enhance the state's dark sky while promoting safety, conserving energy and preserving the environment for astronomy.

## **Section 74-12-3 - Definitions.**

**Universal Citation:** NM Stat § 74-12-3 (2021)

A. "outdoor lighting fixture" means an outdoor artificial illuminating device, whether permanent or portable, used for illumination or advertisement, including searchlights, spotlights and floodlights, whether for architectural lighting, parking lot lighting, landscape lighting, billboards or street lighting; and

B. "shielded" means a fixture that is shielded in such a manner that light rays emitted by the fixture, either directly from the lamp or indirectly from the fixture, are projected below a horizontal plane running through the lowest point on the fixture where light is emitted.

## **Section 74-12-4 - Shielding of outdoor light fixtures.**

**Universal Citation:** NM Stat § 74-12-4 (2021)

All outdoor lighting fixtures installed after January 1, 2000 shall be shielded, except incandescent fixtures of one hundred fifty watts or less and **other sources of seventy watts or less.**

# Shielding





 greenlite™

15W LED

100W Equivalent  
Household Bulb

Non-Dimmable LED

 15,000 HRS 3000K



Damp Location



Enclosed Fixtures



Shatterproof



2  
PACK  
BULBS

### Lighting Facts Per Bulb

Brightness 1600 lumens

Estimated Yearly Energy Cost \$1.81

Based on 3 hrs/day, 11¢/kWh  
Cost depends on rates and use



Life

Based on 3 hrs/day

13.6 years

Light Appearance

Warm

Cool

3000 K

Energy Used

15 watts

70w  
Exemption

$$70/15 = 4.66$$

$$100w \times 4.66 = 466 w$$

$$1,600 \text{ Lumens} \times 4.66 = 7,456 \text{ Lumens}$$

## **Section 74-12-5 - Nonconforming light fixtures.**

**Universal Citation:** NM Stat § 74-12-5 (2021)

A. In addition to other exemptions provided in the Night Sky Protection Act, an outdoor lighting fixture not meeting these provisions shall be allowed, if the fixture is extinguished by an automatic shutoff device between the hours of 11:00 p.m. and sunrise.

B. No outdoor recreational facility, whether public or private, shall be illuminated after 11:00 p.m. except for a national or international tournament or to conclude any recreational or sporting event or other activity conducted, which is in progress prior to 11:00 p.m. at a ballpark, outdoor amphitheater, arena or similar facility.

## **Section 74-12-6 - Use of mercury vapor lighting fixtures.**

**Universal Citation:** NM Stat § 74-12-6 (2021)

No new mercury vapor outdoor lighting fixtures shall be sold or installed after January 1, 2000.



## **Section 74-12-7 - Exemptions.**

**Universal Citation:** NM Stat § 74-12-7 (2021)

A. The following are **exempt** from the requirements of the Night Sky Protection Act:

- (1) Outdoor lighting fixtures on advertisement signs on interstates and federal primary highways;
- (2) Outdoor lighting fixtures existing and legally installed prior to the effective date of the Night Sky Protection Act; however, when existing lighting fixtures become unrepairable, their replacements are subject to all the provisions of the Night Sky Protection Act;
- (3) Navigational lighting systems at airports and other lighting necessary for aircraft safety;
- (4) Outdoor lighting fixtures that are necessary for worker safety at farms, ranches, dairies, feedlots or industrial, mining or oil and gas facilities.

B. The provisions of the Night Sky Protection Act are cumulative and supplemental and shall not apply within any county or municipality that, by ordinance or resolution, has adopted provisions restricting light pollution that are equal to or more stringent than the provisions of the Night Sky Protection Act.

## **Section 74-12-8 - Construction industries division; duties.**

**Universal Citation:** NM Stat § 74-12-8 (2021)

The construction industries division of the regulation and licensing department shall review the outdoor lighting provisions in the uniform building codes used in New Mexico and make recommendations for appropriate changes to comply with the provisions of the Night Sky Protection Act and shall permit and inspect, to the standards set forth in the Night Sky Protection Act, all construction of and on state-owned buildings that is subject to permit and inspection under the Construction Industries Licensing Act [Chapter 60, Article 13 NMSA 1978].

## **Section 74-12-9 - Costs of replacement; recovery.**

**Universal Citation:** NM Stat § 74-12-9 (2021)

If public utilities are required pursuant to the provisions of the Night Sky Protection Act or by local government ordinances to accelerate replacement of lighting fixtures, the cost of such replacement shall be included in rates approved by the public regulation commission.



**Section 74-12-10 - Violations; penalty.****Universal Citation:** NM Stat § 74-12-10 (2021)

Any person, firm or corporation violating the provisions of the Night Sky Protection Act shall be punished as follows:

A. for a first offense, the offender may be issued a warning; and

B. for a second offense or offense that continues for thirty days from the date of the warning, twenty-five dollars (\$25.00) minus the replacement cost for each offending fixture.

**Section 74-12-11 - Enforcement.****Universal Citation:** NM Stat § 74-12-11 (2021)

In order to promote the purposes of the Night Sky Protection Act and to provide uniform minimum outdoor lighting standards throughout the state, the construction industries division of the regulation and licensing department shall enforce the Night Sky Protection Act as it pertains to public buildings subject to permit and inspection under the Construction Industries Licensing Act [Chapter 60, Article 13 NMSA 1978] and each political subdivision of the state shall fully enforce the provisions of the Night Sky Protection Act.



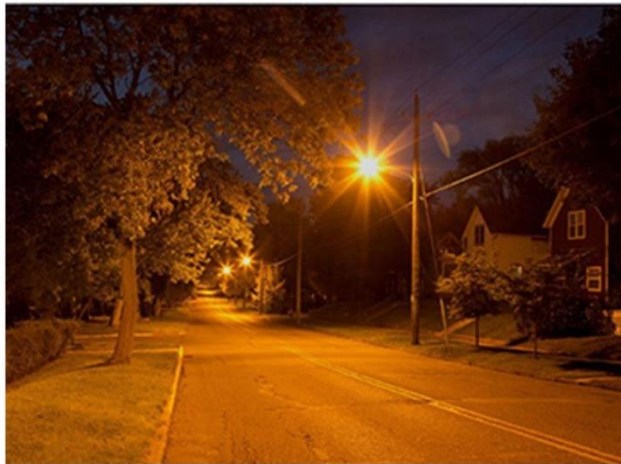
**Before**



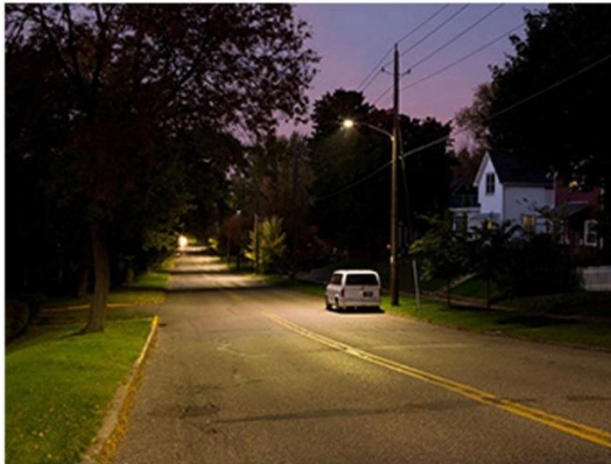
**After**



**Before**



**After**



LEDs have better, broad spectrum lighting than traditional high pressure sodium cobra head-style streetlights which spill excessive yellowish-orange light away from the street and into neighboring yards and windows. Because existing poles are not being moved, any unlit areas between poles (corners and mid-block locations) are unchanged. However, due to the uniformity of the light from LEDs, the difference between lit and unlit areas is accentuated.

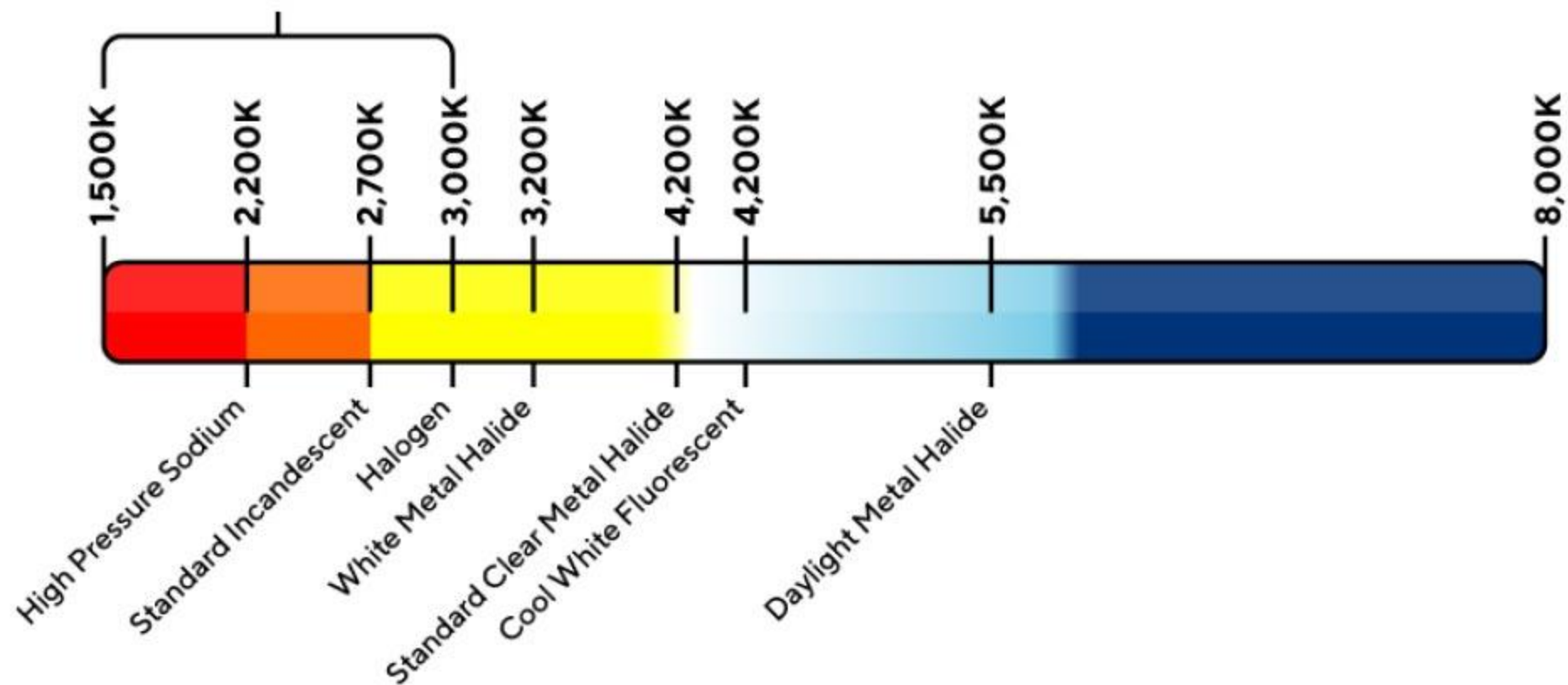
All of our LED lighting is also "Dark Sky" compliant which is a designation given to outdoor lighting fixtures that meet the International Dark Sky Association's requirements for reducing the waste of ambient light.



## Kelvin temperature chart

### Eligible for DarkSky Approved status

3,000 and lower (up to 3220K actual measured value)



# Autobahn Series ATB0 Roadway Lighting

## Color Temperature (CCT)

(Blank) 4000K CCT, 70 CRI Min.

27K 2700K CCT, 70 CRI Min.

3K 3000K CCT, 70 CRI Min.

5K 5000K CCT, 70 CRI Min.

CRI – Color Rendering Index

## Series LED Performance Package ATBO Autobahn LED Roadway

P201 5,369 lumens nominal

P202 6,943 lumens nominal

P203 10,056 lumens nominal

P204 12,176 lumens nominal

P205 13,767 lumens nominal

P301 10,367 lumens nominal

P302 12,185 lumens nominal

P303 15,351 lumens nominal

P304 17,714 lumens nominal

P305 19,893 lumens nominal

P451 16,320 lumens nominal

P452 19,087 lumens nominal

P453 23,592 lumens nominal

P454 25,070 lumens nominal

P455 27,091 lumens nominal

P456 28,347 lumens nominal

P457 29,715 lumens nominal





# Definitions

BUG (Backlight, Uplight, Glare) Rating – The quantity of light within various beam angles.

Backlight – the percent lamp lumens or the luminaire lumens distributed behind a luminaire between zero degrees vertical (nadir) and 90 degrees vertical.

Uplight – the percent lamp lumens or the luminaire lumens distributed above a luminaire between 90 and 180 degrees vertical.

Glare – the percent lamp lumens or the luminaire lumens distributed between 60 and 90 degrees vertically in front of the luminaire.

Candela (cd) – The unit of luminous intensity. A common wax candle emits light with a luminous intensity of roughly one candela.

Footcandle (fc) – A unit of illuminance. One footcandle is one lumen per square foot ( $\text{lm}/\text{ft}^2$ ).

Lumen (lm) – The luminous flux emitted within a unit solid angle by a point source (one steradian) having a uniform luminous intensity of one candela (cd).

Luminance (candelas per square meter,  $\text{cd/m}^2$ ) - The luminous intensity of any surface in a given direction per unit of projected area of the surface as viewed from that direction; i.e., the apparent brightness of a surface.

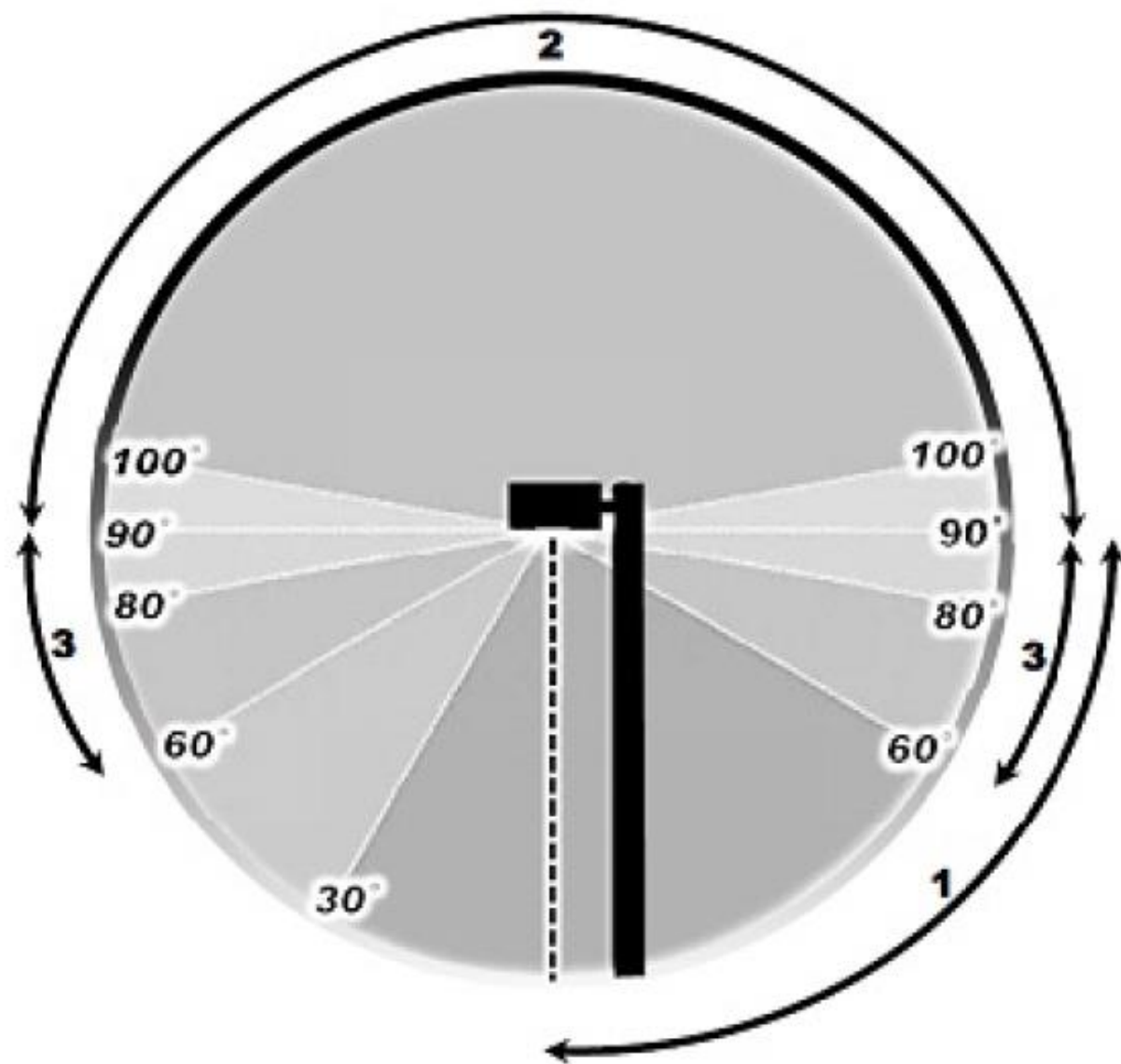
Luminous Flux (lumen,  $\text{lm}$ ) - A unit of measure of the quantity of light. One lumen is the amount of light that falls on an area of one square meter, every point of which is one meter from a source of one candela. A light source of one candela emits a total of 12.57 lumens. Light sources are rated in terms of luminous flux.

Lux – 1 lumen/ $\text{m}^2$

Luminous Intensity (candela,  $\text{cd}$ ) - The candela is the basic unit of light quantity. The candela is historically related to the light emitted by a candle flame and was once known as candlepower. The candela can be thought of as the number of photons per second emitted by the light source. (A photon is a subatomic particle with zero mass that carries the energy of light and all other forms of electromagnetic energy.)

Steradian - can be defined as the solid angle subtended at the centre of a unit sphere by a unit area on its surface. For a general sphere of radius  $r$ , any portion of its surface with area  $A = r^2$  subtends one steradian at its centre.





### **1. Backlight**

All illumination behind a luminaire, also causing light trespass, which occurs when light spills into unwanted areas.

### **2. Uplight**

Excess light directed upwards into the night sky, above 90 degrees, causing night pollution or artificial sky glow.

### **3. Glare**

Caused by light emittance between 60 and 90 degrees around a luminaire, which can be uncomfortable and even hazardous.

# Dark Sky International

[darksky.org](https://darksky.org)

In 2014, the DarkSky Approved Lighting program (then known as the Fixture Seal of Approval) updated our certification standard to require that certified lighting have a correlated color temperature (CCT) no higher than 3000 K (up to 3220 K actual measured value — ANSI C78.377). DarkSky seeks the best possible scenario for new LED installations and retrofits to:

- 1) Replace old technology without increasing light output;
- 2) Minimize short-wavelength emissions; and
- 3) Decrease operational costs and energy consumption.



# Light Trespass





**Angle Lighting**







**Multiple Levels of lighting**

# Unshielded Lights





## Advertising and Storefronts





## LED Signs

(Dimmers & Timers)







**Consider Existing Infrastructure**



# Conclusion

Over the past few years, the Roswell sky glow has doubled from the conversion to LED street lights.

From mid November to mid January the sky glow doubles due to unshielded Christmas decorations.

The New Mexico Dark Sky Protection Act has very few guidelines.

The new LED lights produce more Lumens and a broad-spectrum light. Maybe fewer lights are necessary.

Any new projects with additional lighting should take into account the existing infrastructure.

# What Can We Do?

Personnel – Dedicated position to monitor, evaluate and enforce.

Measure – Determine the lumens and determine if they are appropriate.

Inspect – Every lighting installation should be inspected.

Evaluate – Usefulness, targeted, light level, controls and color.

Sunset Clause – Time limits to conform to regulations.

Legislate – State and local laws to better define lighting standards.



If you don't have a lighting ordinance, get one.



**Illuminating**  
ENGINEERING SOCIETY



**JOINT IDA - IES**  
**MODEL**  
**LIGHTING**  
**ORDINANCE**  
**(MLO)**

**with USER'S GUIDE**

**June 15, 2011**

# Questions

How much light is enough?

