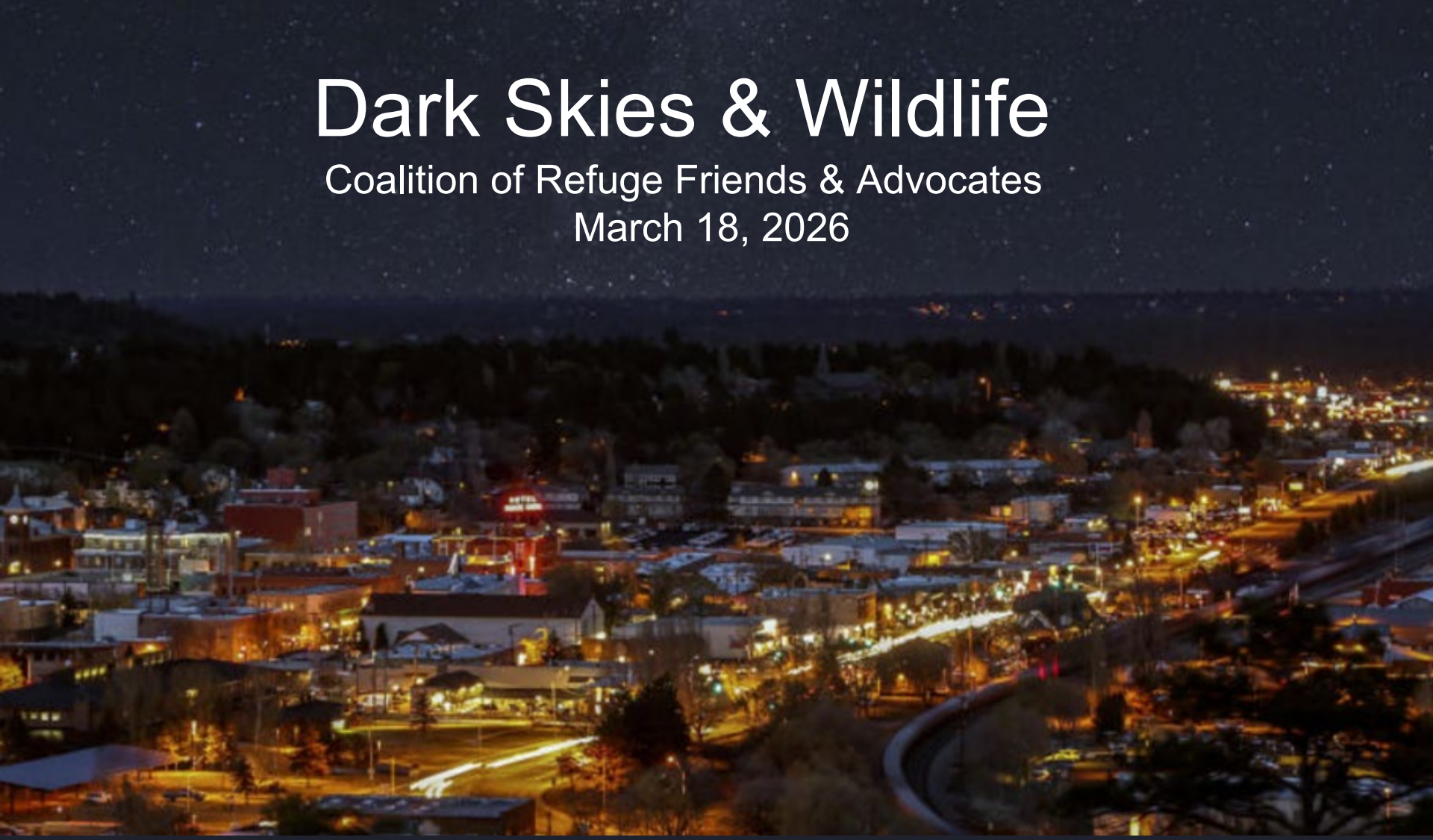
Dark Skies & Wildlife

Coalition of Refuge Friends & Advocates
March 18, 2026



Bill Kowalik, PhD

DarkSky OREGON

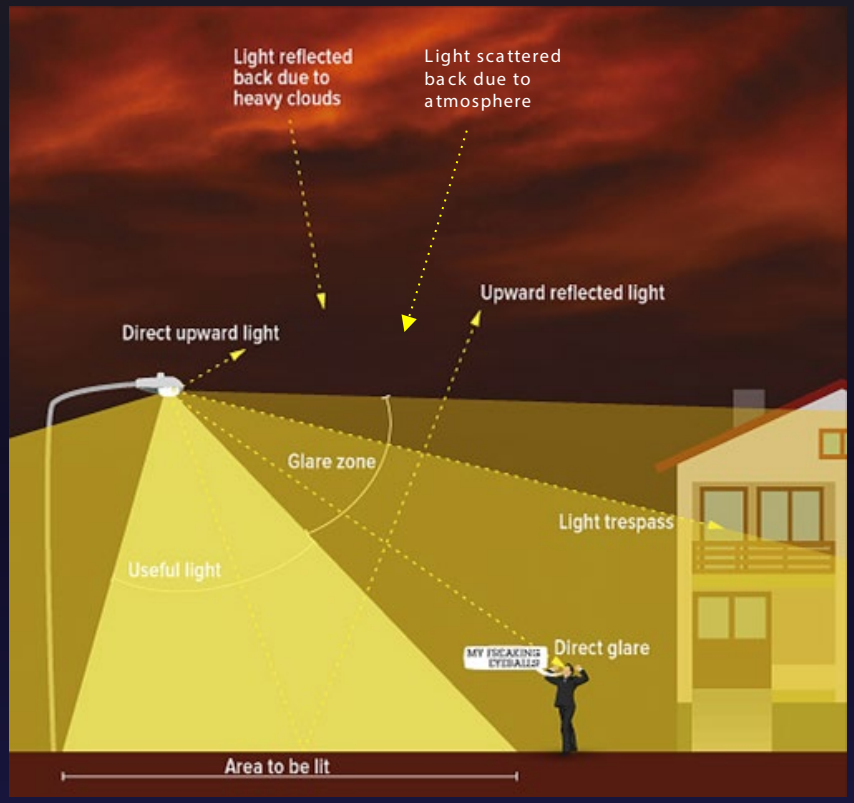
Flagstaff Arizona
The First International Dark Sky Community (2001)
Amber Lighting reduces skyglow, good for the environment
Credit: Flagstaff Dark Skies Coalition

Topics

- Light Pollution - What? Why?
- The Blue Part of Light at Night is a Key Issue
- Impact on Wildlife
- Starry Skies Receding, But we can Bring them Back
- What Can You Do?

What is Light Pollution?

- Skyglow – brightening of the night sky over inhabited areas
- Glare – excessive brightness that causes visual discomfort
- Light trespass – light falling where it is not intended or needed
- Clutter – bright, confusing and excessive groupings of light sources



Why is light pollution an issue?

- Disruption of the ecosystem
- Human health & safety
  - Hazardous glare
  - Light trespass
- Expensive
  - Energy waste
  - Increased carbon footprint
- Not Aesthetic
  - Quality of life
  - Loss of the starry night sky

5 Principles of Responsible Outdoor Lighting

1) **USEFUL**
   All light should have a clear purpose.

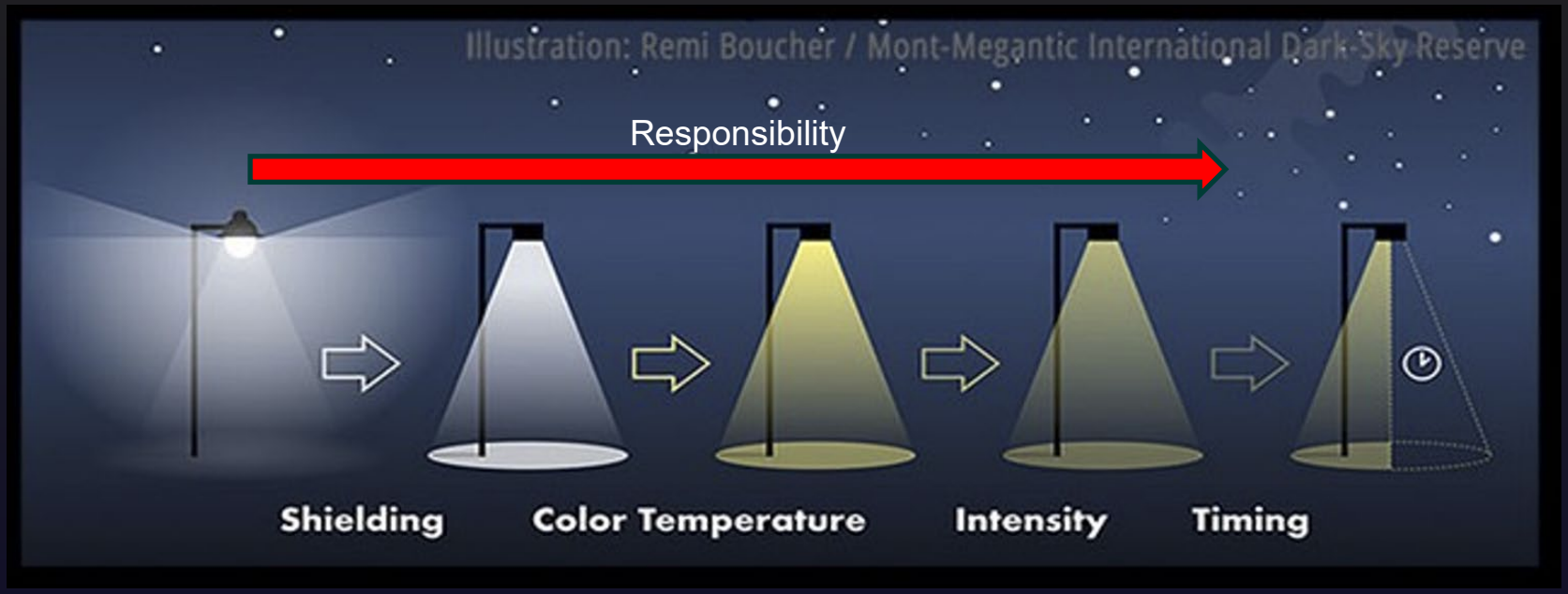
2) **TARGETED**
   Use shielding and careful aiming

3) **LOW LEVEL**
   Use the lowest light level required .

4) **CONTROLLED**
   Use controls such as timers or motion detectors

5) **WARM-COLORED**
   Use Amber or Yellow color lights where possible.

How to Achieve Responsible Outdoor Lighting?



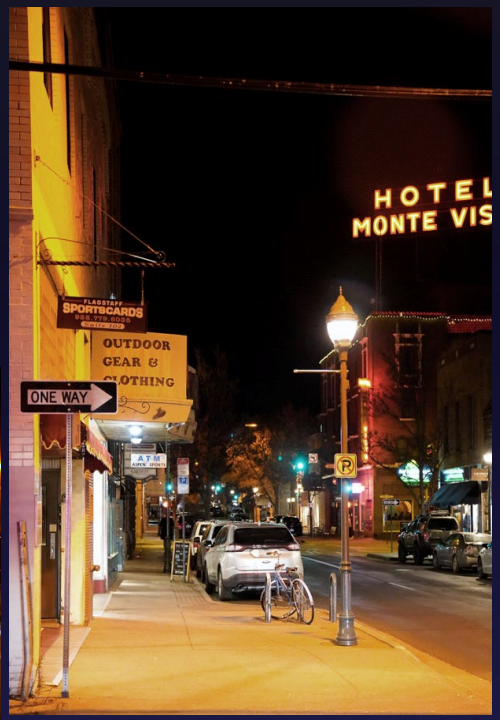
Credit: Flagstaff Dark Skies Coalition

Responsible Outdoor Lighting can create safe, vibrant spaces

Credit: P. Strasser / J. Barentine *22 February 2019*

Responsible Outdoor Lighting

- Much less light pollution
- Less glare
- Main Street is more pleasing to the eye



Night photos from Flagstaff, AZ, First Intl' Dark Sky Community
Credit: Bill Kowalik and Cathie Flanigan, DarkSky Oregon November, 2019

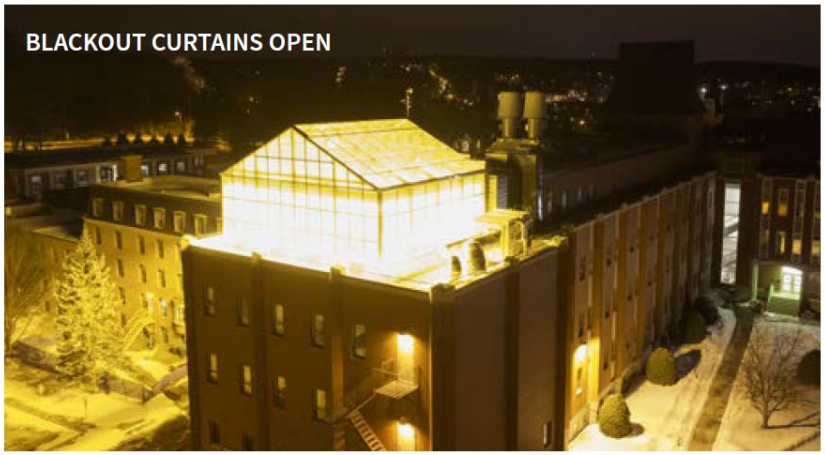
Responsible Sports Lighting - Full Cut Off

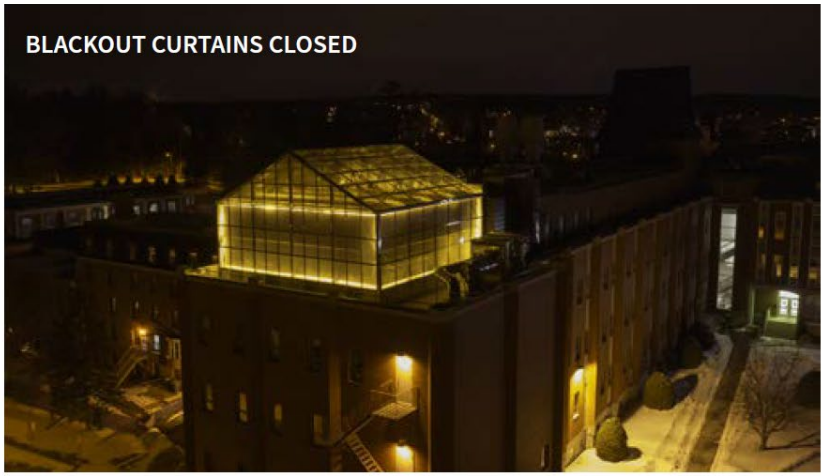

South of Tucson, AZ


Mecklenburg County, NC

Seaside High School, CA

Responsible Lighting - Quebec





FACTORIES AND LOADING AREAS
Replacement of problematic luminaires with fully shielded amber light sources. Improved uniformity in light levels.

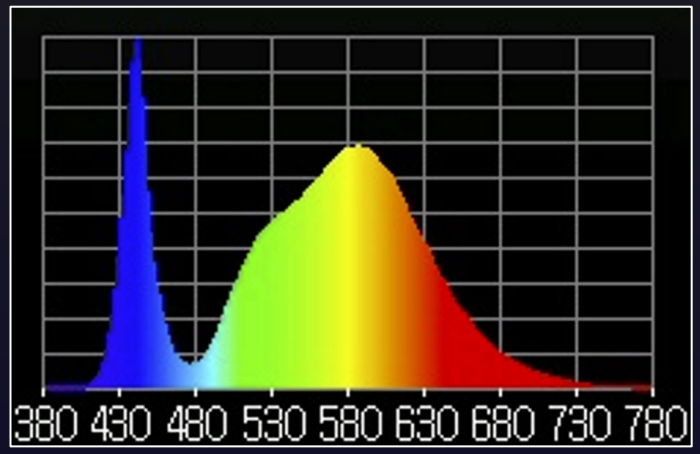
GREENHOUSES
Use of blackout curtains to block light from escaping outside.

Credit: Mont -Megantic International Dark Sky Reserve Lighting Guide

White versus Amber Parking Lot Lights

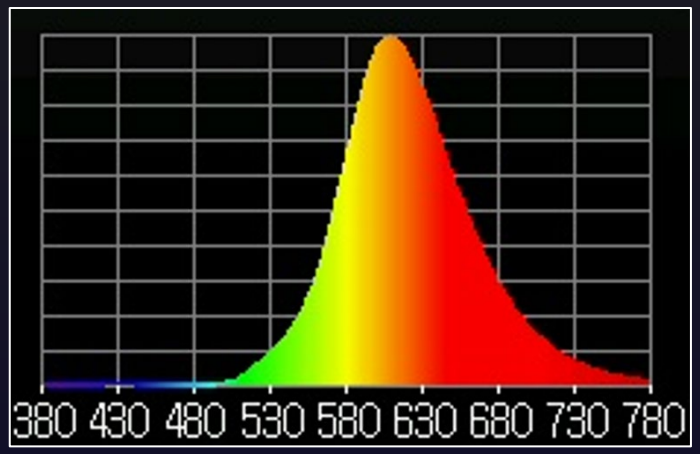
New Costco in Bend

4188K CCT S/P 1.56
(lots of Blue light)



Springhill Mariott in Bend

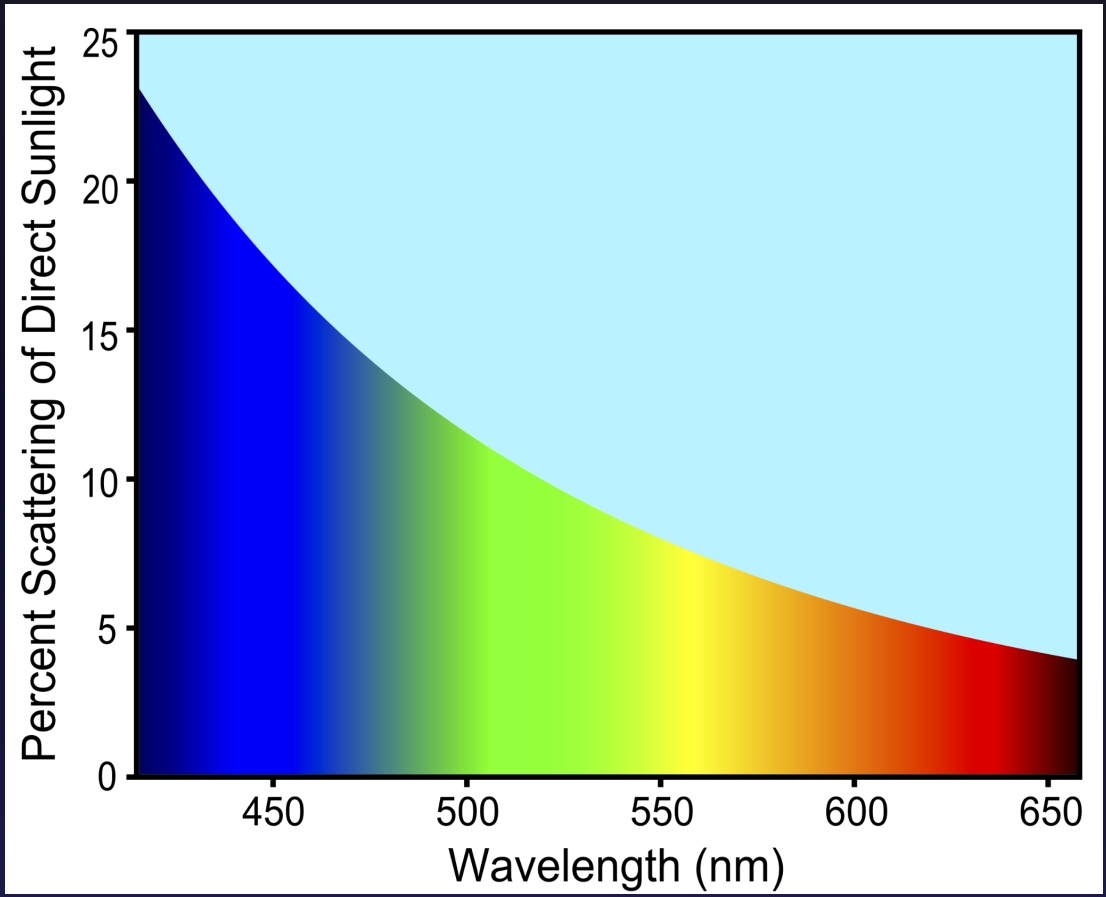
1800 CCT S/P 0.45
(no Blue light)



Credit: Bill Kowalik and Chris Hill, DarkSky Oregon, 2025

Why is Blue Part of Light at night a problem?

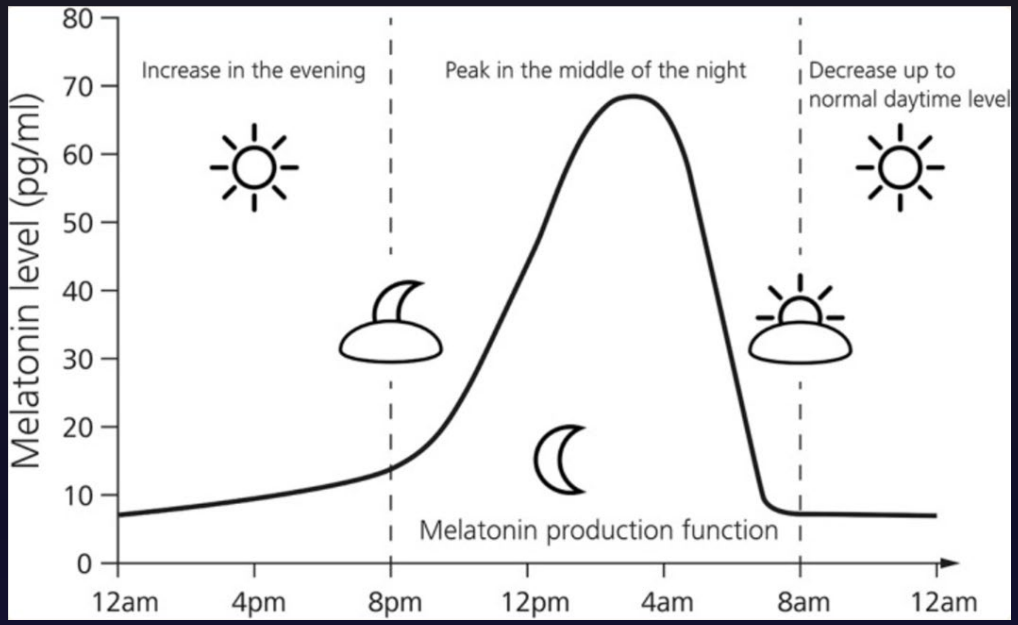
1) Blue light scatters a lot more in the atmosphere, compared to other visible light



Wikipedia

Why is Blue Part of Light at night a problem?

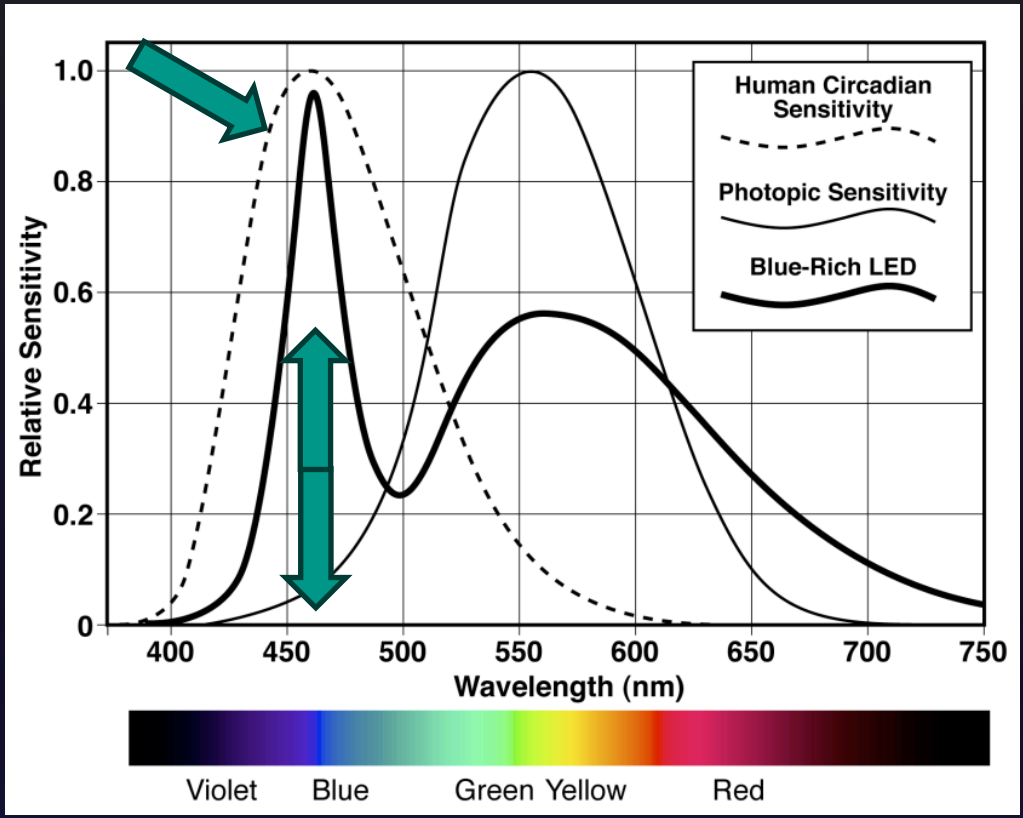
2) Melatonin increases by the absence of blue light at night



The inner clock – Blue light sets the human rhythm
Wahl and others, 2019, Journal of Biophotonics

- The melatonin molecule was keyed by the evolution of life on earth to the absence of blue light during the night.
- There was no blue light at night prior to humans lighting up the night.

2) Blue light at night impairs our sleep



IDA White Paper, 2010

Melatonin, the “Hormone of Darkness” is a hormone that your brain produces in response to darkness. It helps with the timing of your circadian rhythms (24-hour internal clock) and with sleep. Being exposed to blue light at night can block melatonin production.

See NIH, National Library of Medicine

Why is Blue Part of Light at night a problem?

3) Blue light cause glare preferentially

- Glare in human vision, particularly the scattering of light in the eye, is influenced by wavelength.
- Shorter wavelengths, like blue light, tend to scatter more than longer wavelengths like red light.
- This scattering, especially within the lens and cornea, leads to the phenomenon of glare, making it difficult to see clearly, especially around bright light sources

AI Overview

Why is Blue Part of Light at night a problem?

4) Blue light wavelengths contribute to insect decline

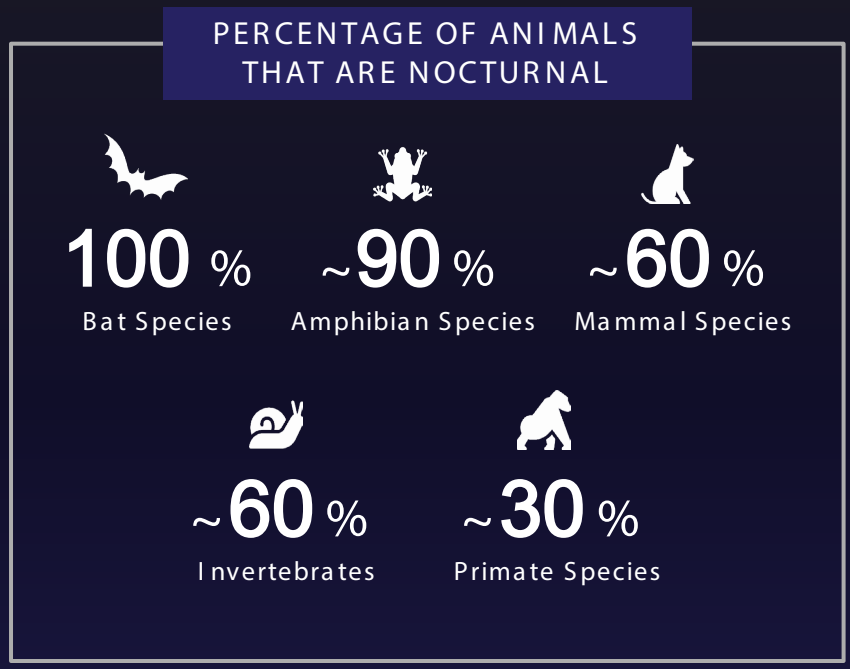
Most insects have color vision, in the Ultraviolet, Blue and Green

They are more likely to be stuck circling white lights - because those lights have blue light in their spectrum. And, because they just don't see lights that look yellow, orange, red to humans

Impact on the Wild Ecosystem

“ Ecosystems are very complex. When artificial light alters light dark cycles, and in turn circadian rhythms, the whole choreography of biological life is jeopardized.” *-T Longcore*

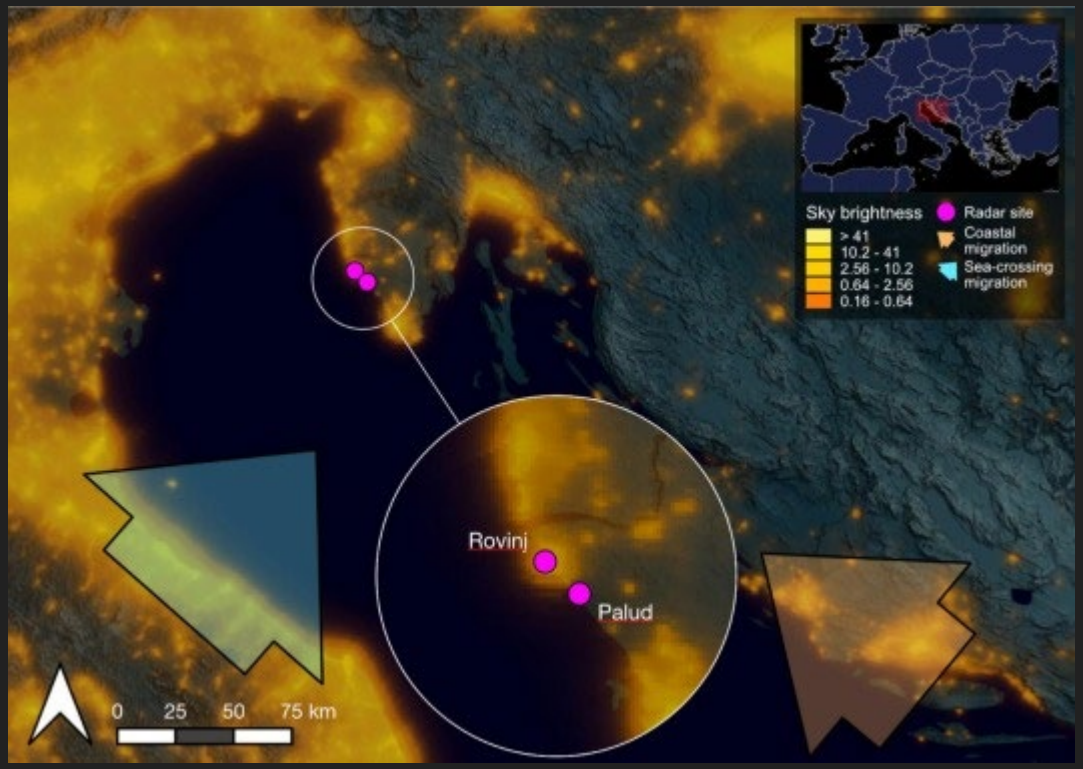
- Confuse celestial navigation in nocturnal and diurnal species
- Cause disorientation or misorientation in nocturnal movements
- Result in attraction/ repulsion behaviors
- Impact predator/ prey relationships
- Extend activity of diurnal species into nighttime hours
- Interrupt circadian rhythms that govern timing of breeding, nesting, migration, foraging



Credit: Mary Coolidge, Bird Alliance of Oregon

Impact on bird migrations

- Birds attracted towards light pollution
- Light pollution reduced airspeeds and altitudes
- Disorientation, increased numbers of bird collisions and impaired visibility, even with lower-intensity light pollution.



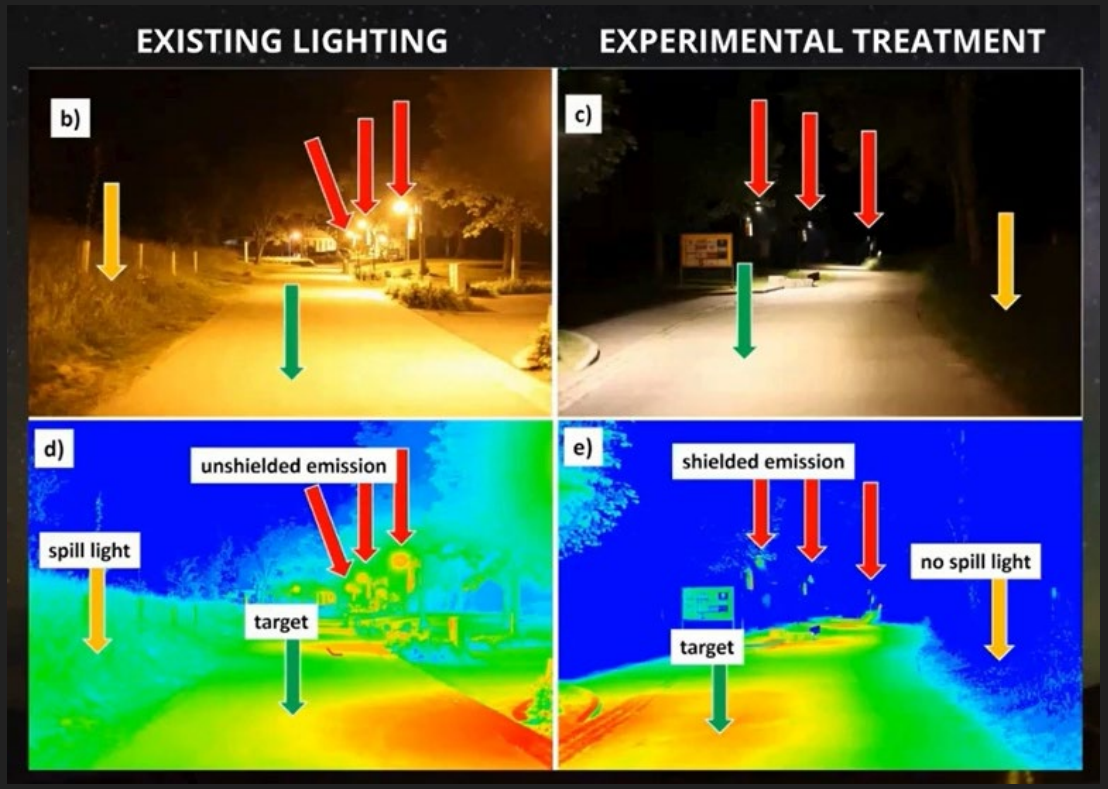
When nocturnally migrating birds encounter low-level light pollution patches: a case study from the Croatian coast; Simon Hirschhofer et al; Biological Conservation, January 2026
https://www.sciencedirect.com/science/article/pii/S0006320725006573

Credit: Rima Givot and Scott Woodford, City of Sisters

Impact on Insects

We see:

Insects see:



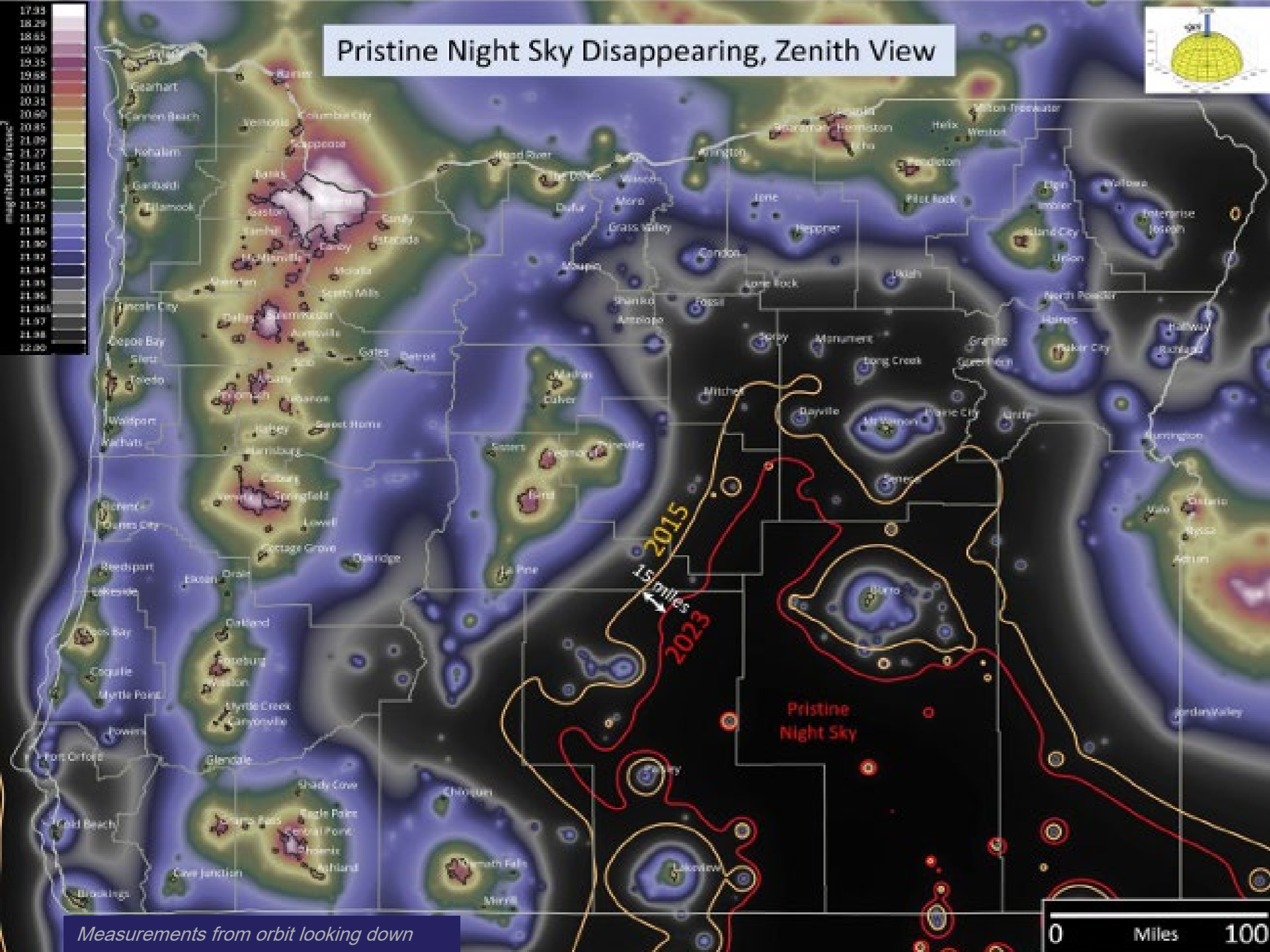
Reducing the fatal attraction of nocturnal insects using tailored and shielded road lights, Dietenberger et al; Communications Biology, 2024
https://www.nature.com/articles/s42003-024-06304-4

Credit: Rima Givot and Scott Woodford, City of Sisters

Starry Night Skies are Receding

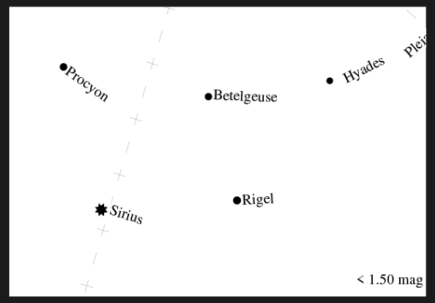
How do we know?

- Satellite images at night looking down
- Human Observations over Years - Globe at Night

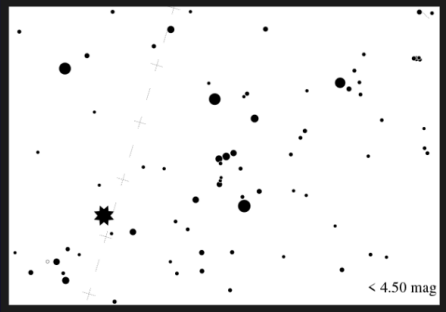

Pristine Night Sky Disappearing, Zenith View
magnitudes/arcsec²
17.93
18.29
18.65
19.00
19.35
19.68
20.01
20.33
20.60
20.85
21.09
21.27
21.45
21.57
21.68
21.75
21.82
21.86
21.90
21.92
21.94
21.95
21.96
21.965
21.97
21.98
22.00
2015
15 miles
2023
Pristine
Night Sky
0
Miles
100
Measurements from orbit looking down

Human Observations of the Night Sky

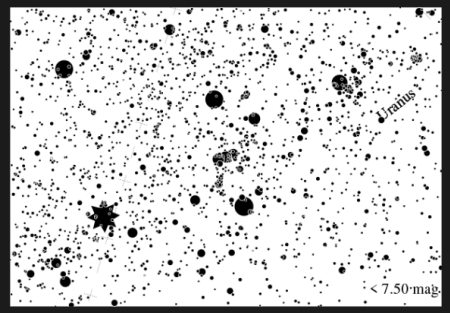
Globe At Night project – naked eye star visibility



Magnitude 1 Chart



Magnitude 4 Chart



Magnitude 7 Chart

Science publication 2023 based on 51,000 observations

- Global skyglow increased ~9.6% per year over 2011-2022
- Previous estimates of ~2% per year from available satellite data
- Accelerating disruption of the night time environment for all life
- A child born where 250 stars are visible will on see 100 by age 18

Citizen scientists report global rapid reductions in the visibility of stars from 2011 to 2022
https://www.science.org/doi/10.1126/science.abq7781

We can bring the Starry Skies back

Starry Night Skies are Receding

But we can bring them back

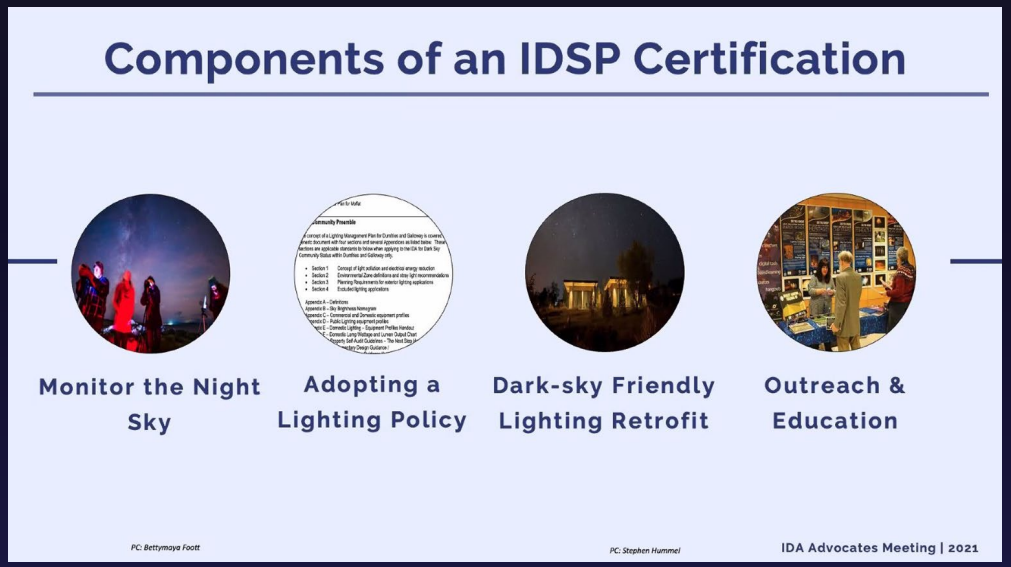
- Education & Outreach
- Certification of Int'l Dark Sky Places
- Economics of Dark Skies
- Potential of Responsible Lighting

We can bring the Starry Skies back

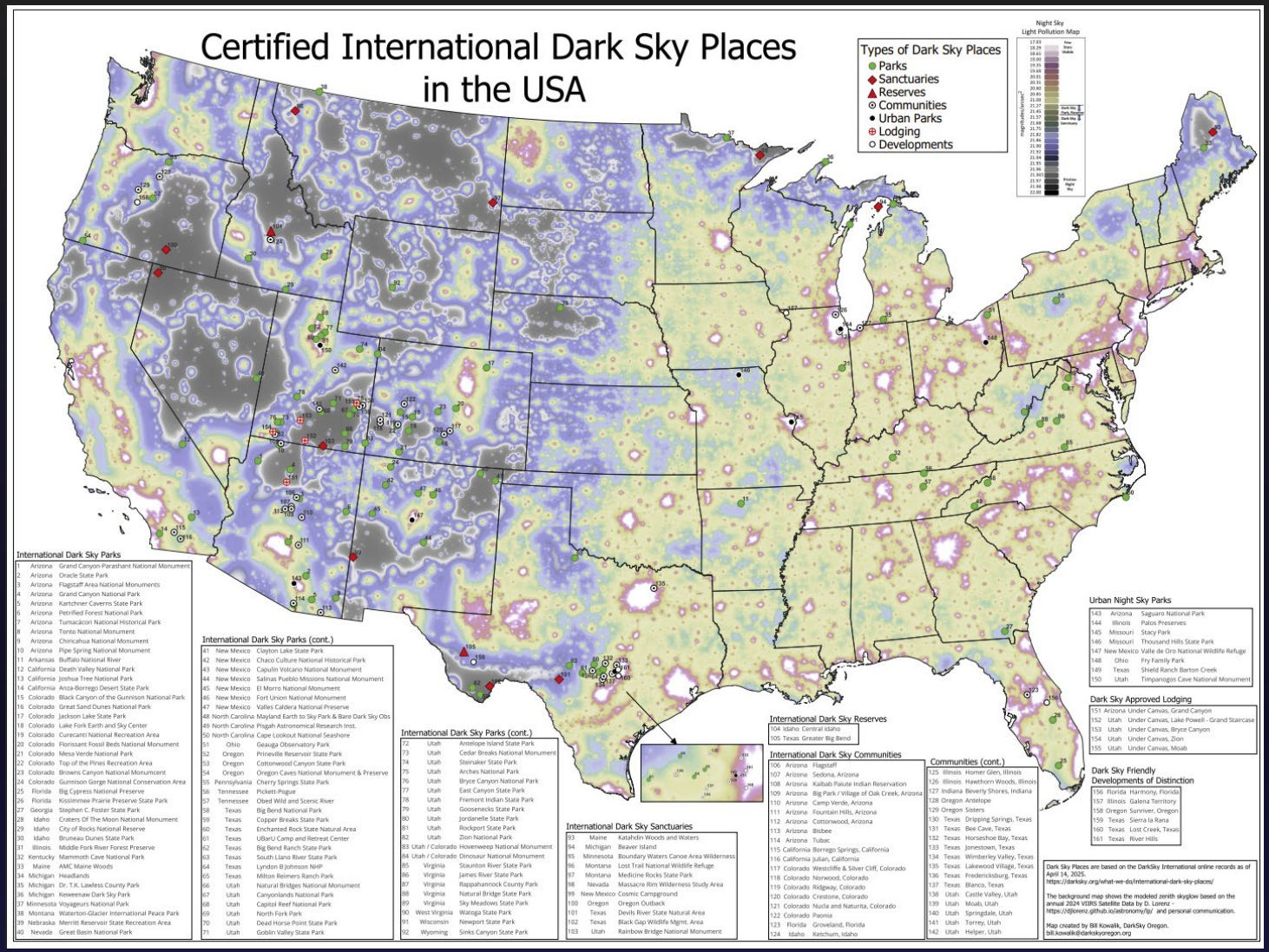
International Dark Sky Places

Program founded in 2001 to encourage communities, parks and protected areas around the world to preserve and protect dark sites through responsible lighting policies and public education.

- Communities
- Parks
- Reserves
- Sanctuaries
- Urban Night Sky Places
- Approved Lodging



https://www.darksky.org/our-work/conservation/idsp/



We can bring the Starry Skies back

Link to PDF of map

Only 2 NWRs are certified as International Dark Sky Places

- Hart Mtn, Oregon
- Lost Trail, Montana

Background Image: "D Lorenz Skyglow 2024"

Economics of Dark Skies

We can bring the Starry Skies back

Astronomy -based recreation and dark sky tourism

- Overnight stays to see the stars
- Visits spread to non-peak tourist seasons
- Dark Sky Tourism is increasingly common
- 80% of people in the US cannot see the Milky Way from home
- Certified Dark Sky Places are particularly searched out

Bandon *Photo credit Dave Horton*

Economics of Dark Skies

We can bring the Starry Skies back

Missouri State Study (2019)

- Astrotourism to National Parks on Colorado Plateau
- Will bring in $580 million/ Year and many jobs

Visit Utah
https://www.visitutah.com › Places-To-Go › Dark-Sky...

Dark Sky Parks & Places - Utah Has The Most On Earth

Utah has the highest concentration of International **Dark-Sky** Association-certified areas. Find a **dark sky** park in every region for the best celestial views.

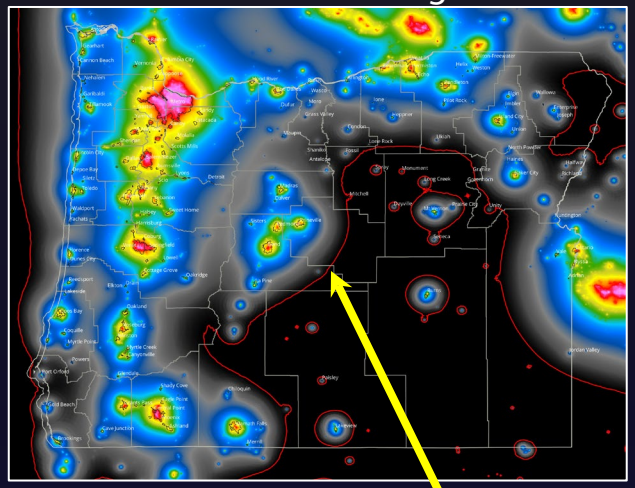
Milky Way from inside the Grand Canyon
John Ashley

Potential of Responsible Lighting

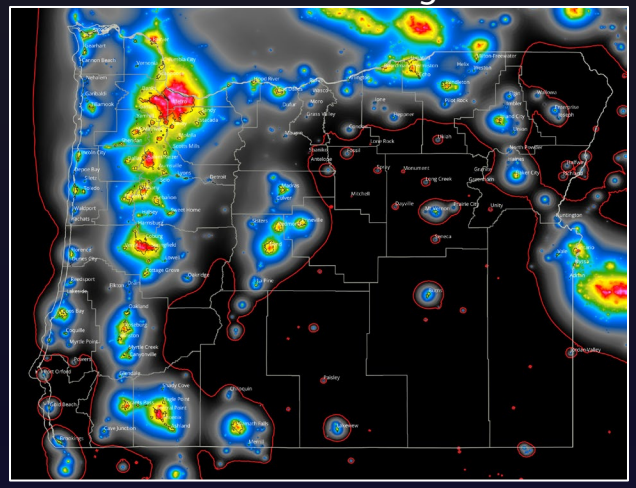
We can bring the Starry Skies back

Models of light pollution – Oregon

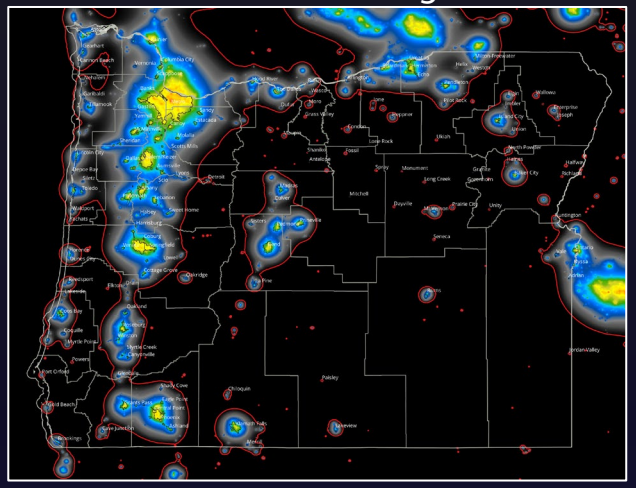
All Lights 3000K but 15% Uplight
Poor Shielding



All Lights 3000K and No Uplight
Full Shielding



Warm Lights
(80% PC Amber, 20% 2700K)
and No Uplight
Full Shielding



Edge of Pristine
Night Sky

Full Shielding & Warmer Lights
Can bring back the Stars

Responsibility

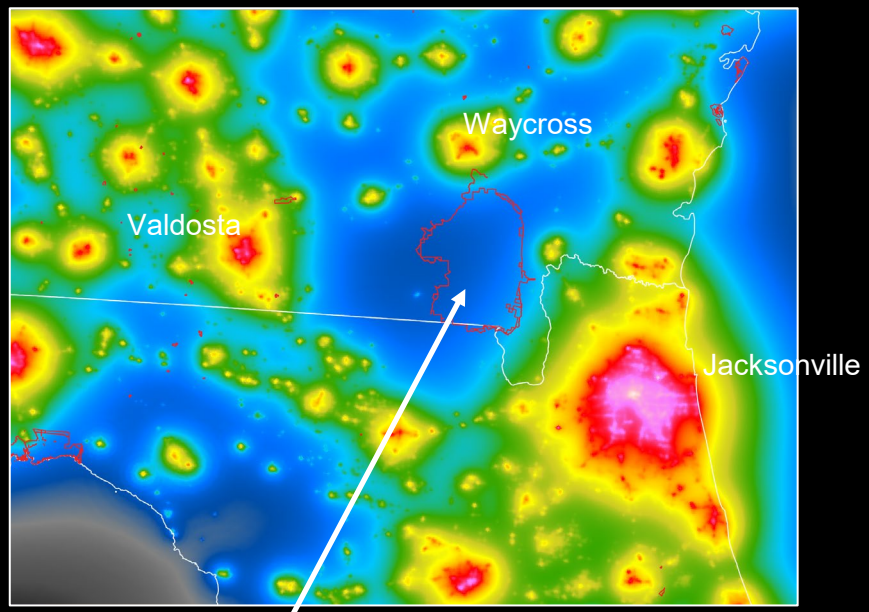
Preliminary Results Courtesy of
Christian Luginbuhl,
Flagstaff Dark Skies Coalition

Potential of Responsible Lighting

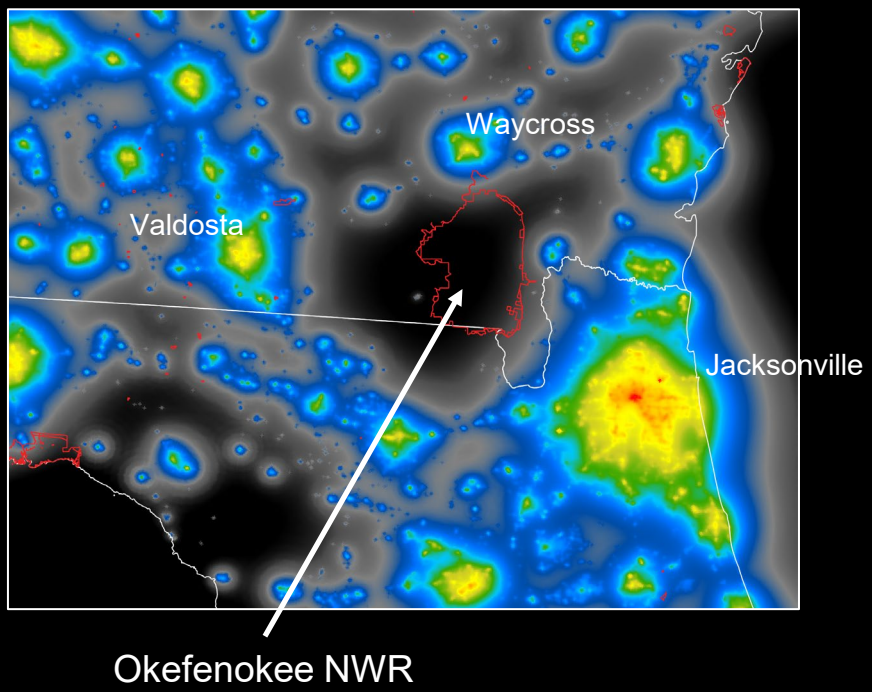
Models of Light Pollution - Okefenokee NWR

We can bring the Starry Skies back

Model Approximates Current Lighting



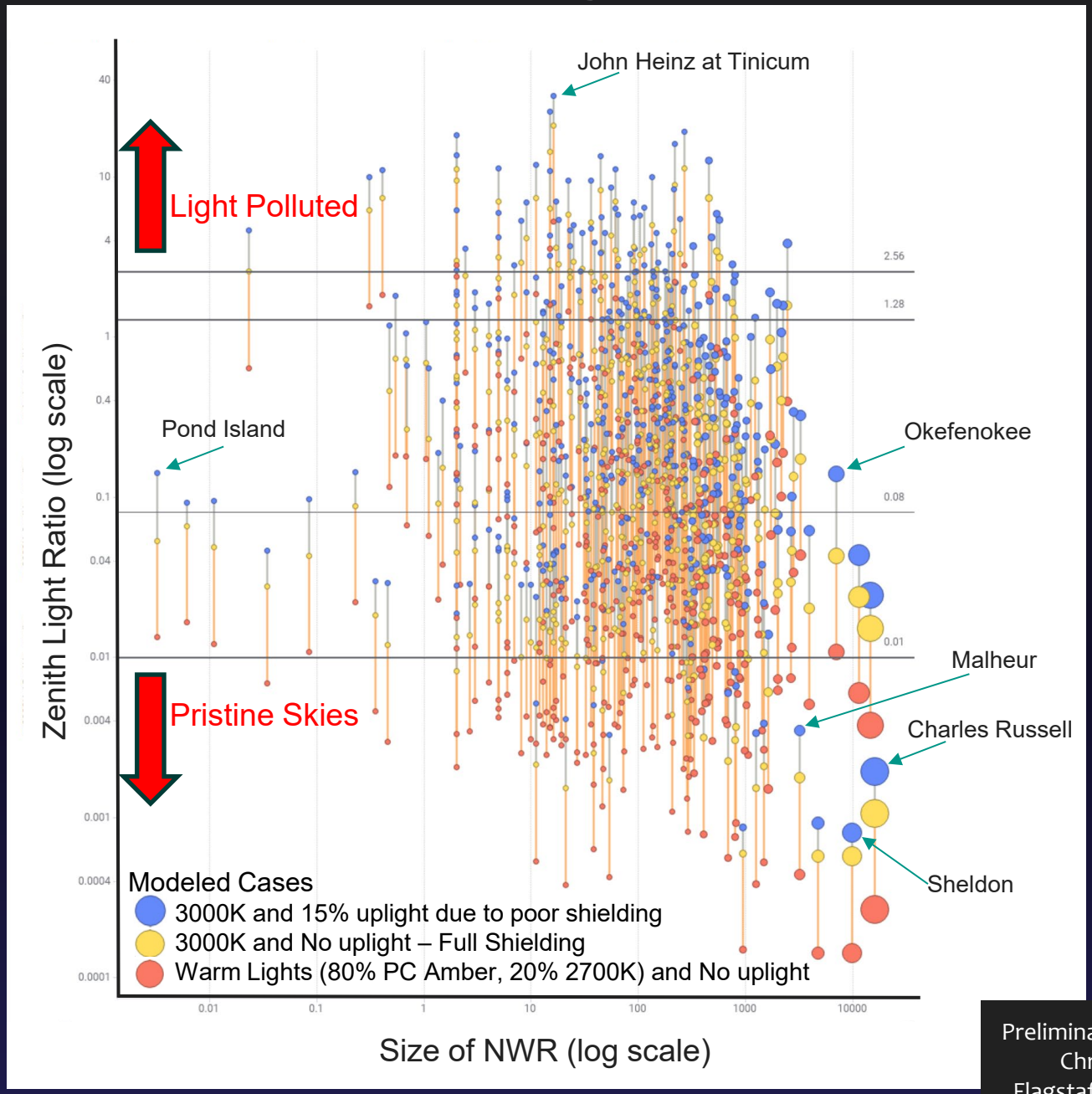
If lights were Fully Shielded & switched to much Warmer (80% PC Amber & 20% 2700K)



Stephen C. Foster State Park, near tip of white arrow
An International Dark Sky Park
2025 SQM readings about 21.4 magnitudes/arcsecond sq

Preliminary Results Courtesy of
Christian Luginbuhl,
Flagstaff Dark Skies Coalition

Potential Reduction of Light Pollution at 533 NWRs



We can bring the Starry Skies back

Preliminary Results Courtesy of Christian Luginbuhl, Flagstaff Dark Skies Coalition

What Can You Do?

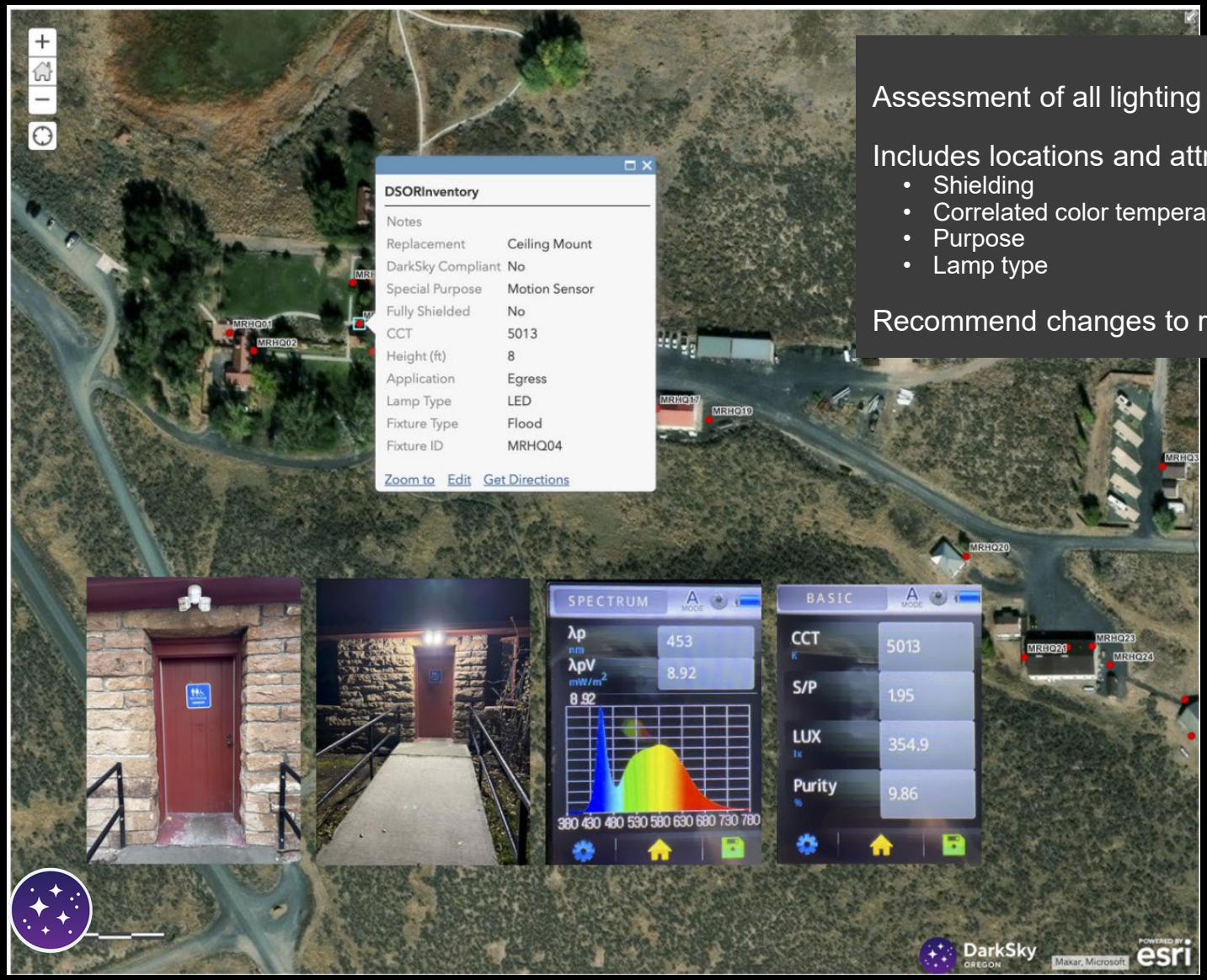
What Can You Do?
Home Lighting Assessment

We can bring the
Starry Skies back

DarkSky Home Lighting

What Can You Do?
Lighting Inventory of your NWR

We can bring the Starry Skies back



Assessment of all lighting in the NWR

Includes locations and attributes of each light
- Shielding
- Correlated color temperature
- Purpose
- Lamp type

Recommend changes to reduce light pollution

DarkSky Assessment Guide

Credit: Michael McKeag, DarkSky Oregon

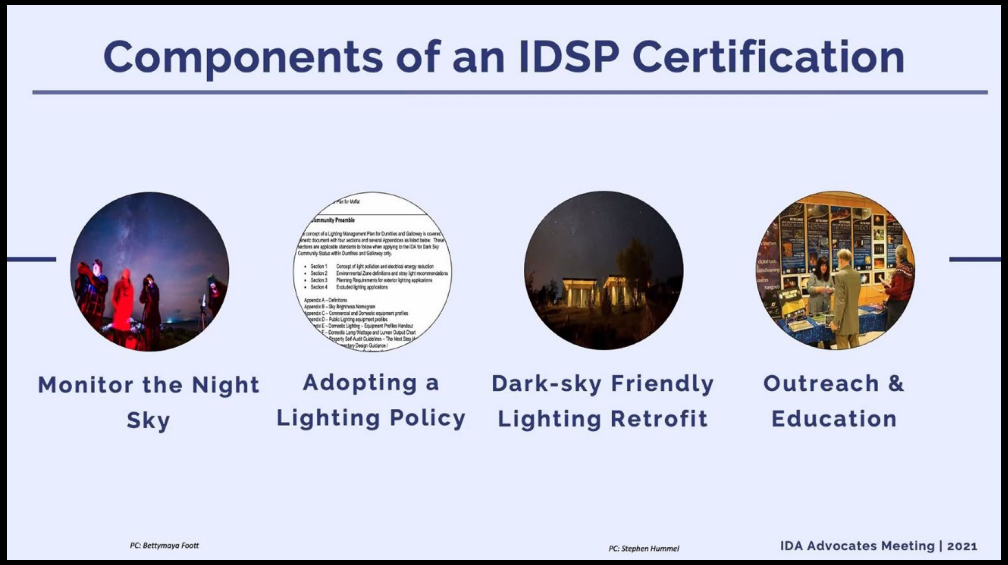
We can bring the Starry Skies back

What Can You Do?

Get your NWR Certified as an Int'l Dark Sky Place

Benefits

- Brings attention to the light pollution problem
- Connects people to nature
- Economic driver of local tourism economy



FAQ – Dark Sky Places

We can bring the Starry Skies back

What else can you do?

- Join DarkSky International (darksky.org)
  - Become a Dark Sky Advocate
  - Meet the Global Community

- Become educated on the issues of Light Pollution
  - Artificial Light at Night: State of the Science 2025

YouTube Video

Published Article

  - An Up-To-Date Library of Scientific Articles on Light Pollution

https://www.zotero.org/groups/2913367/alan_db/library

Summary

- Use outdoor lights Responsibly – the human and wild ecosystems will benefit
- Avoid using white light at night – it contains blue wavelengths – choose amber lights
- Inventory your outdoor lights – at home, in your NWR – and fix them to be Responsible
- Together, we can bring back the Starry Night Skies

Prineville Reservoir State Park
Photo Credit: Dawn Davis

DarkSky
OREGON

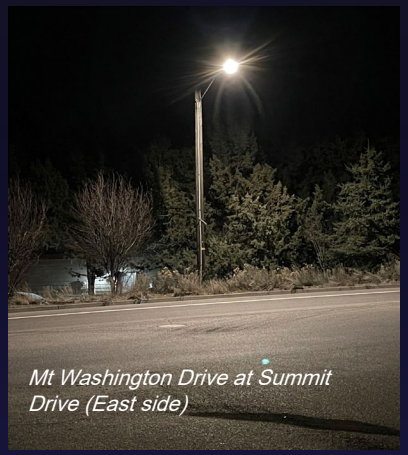
darkskyoregon.org

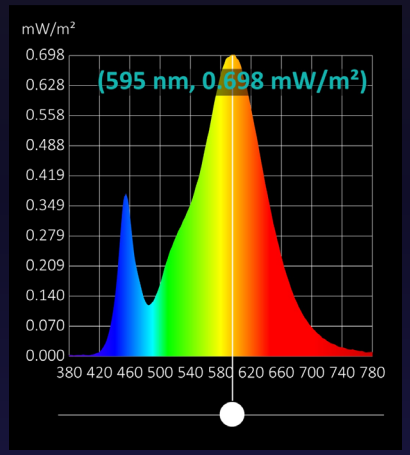
Prineville Reservoir State Park
Photo Credit: Dawn Davis

Purple Street Lamps in Bend

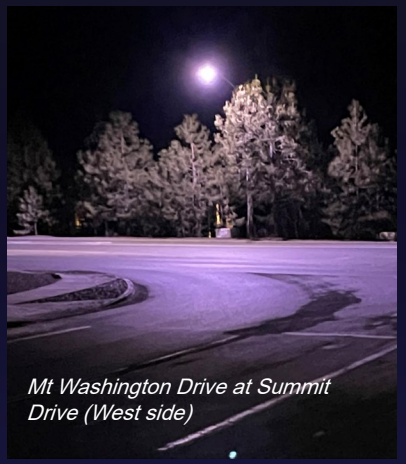
Increased Blue

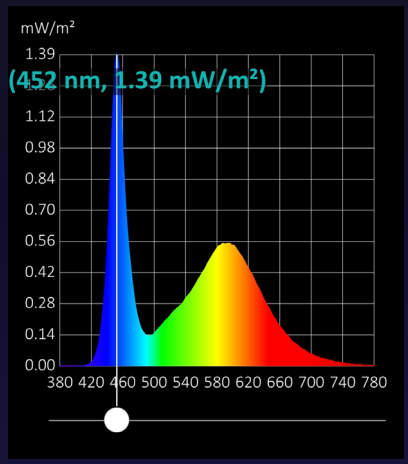
Normal Street Lamp
Appears white to our eyes





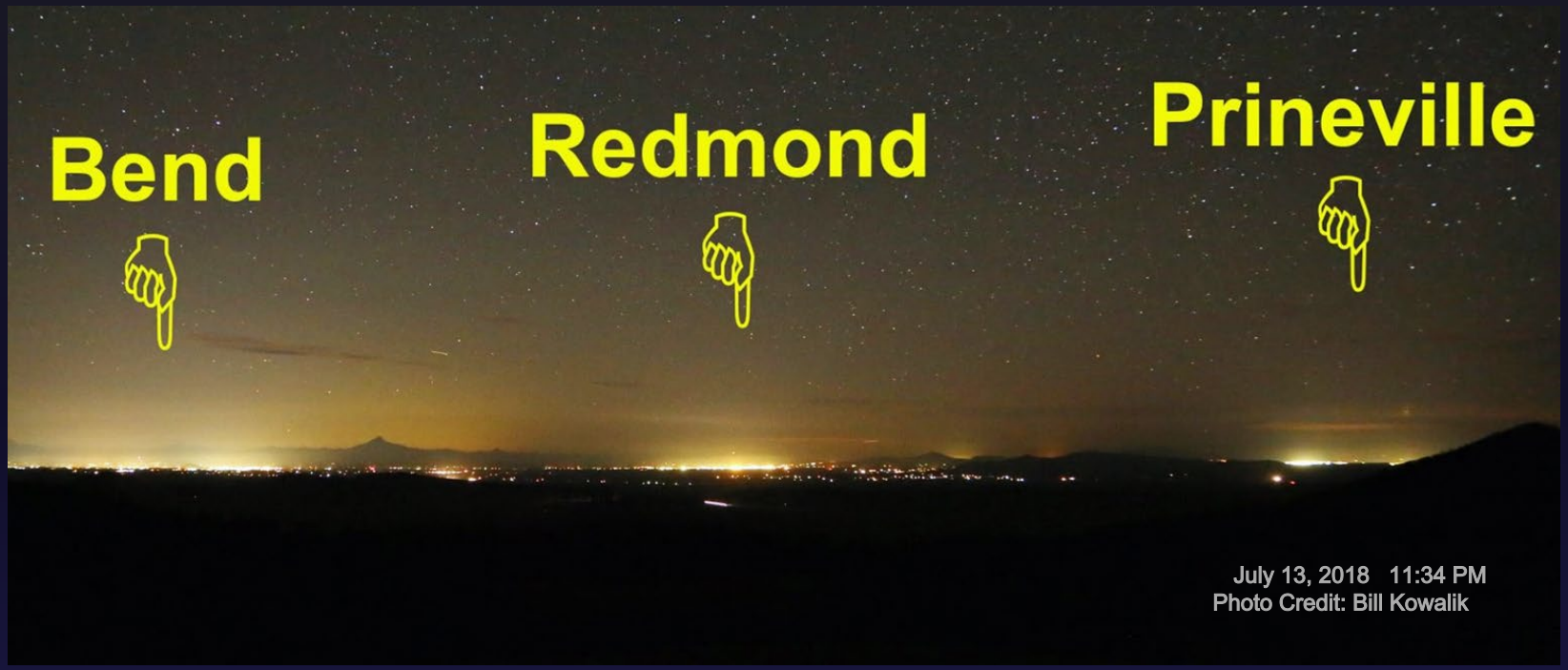
Defective Street Lamp
Appears purple to our eyes





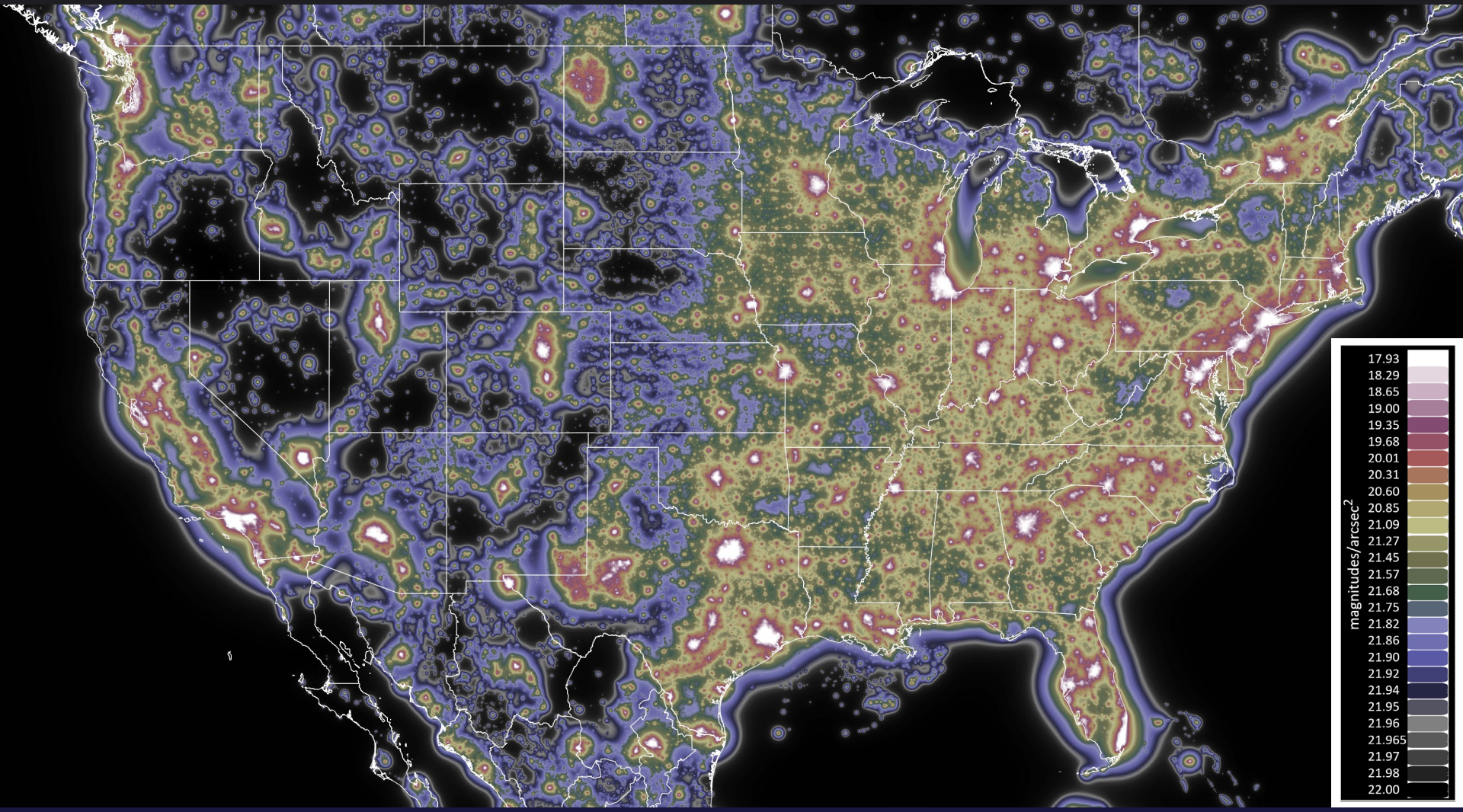
Credit: Bill Kowalik, Cathie Flanigan, DarkSky Oregon

Central Oregon Skyglow



Up Light Scattered Back Down by the Atmosphere - View from Pine Mountain Observatory 12 second exposure

80% of US residents can’t see the Milky Way at home (2023)



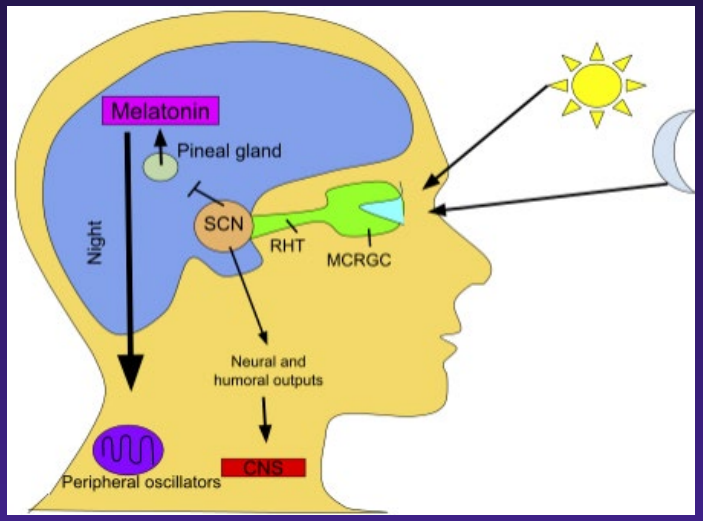
Credit: Dave Lorenz, University of Wisconsin

Light Clutter

Image source: assa.org.au

Clutter light pollution is common in urban areas -- multiple lights may overlap, resulting in an overly bright and confusing light environment

Impact on Human Sleep- Melatonin – Blue light at nightt



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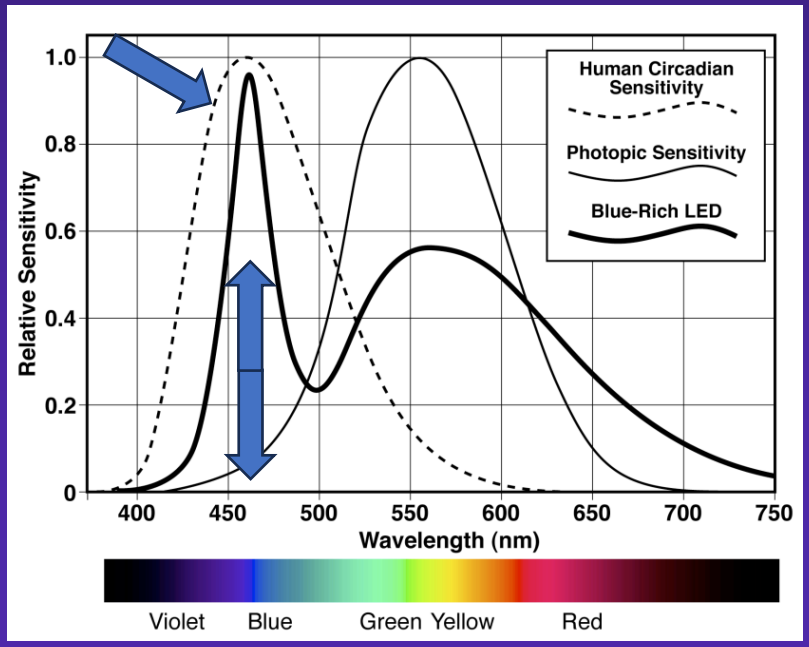
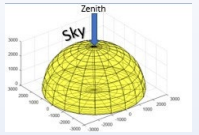
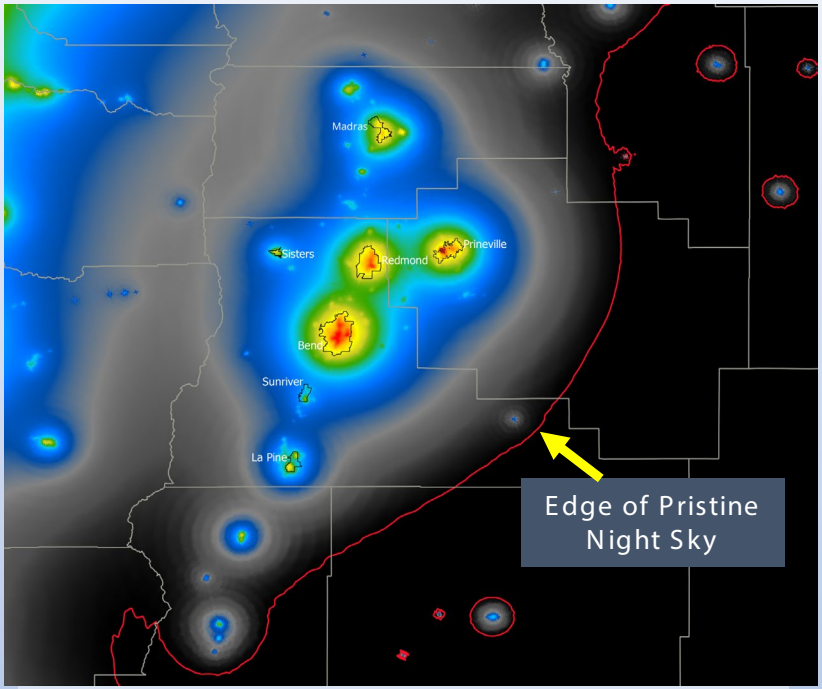
See NIH, National Library of Medicine.



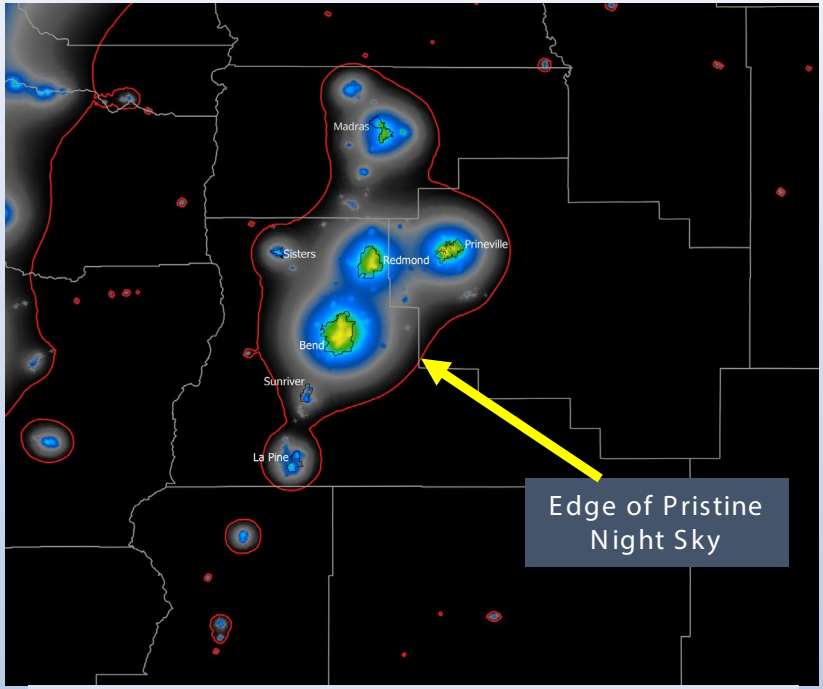
IDA White Paper, 2010



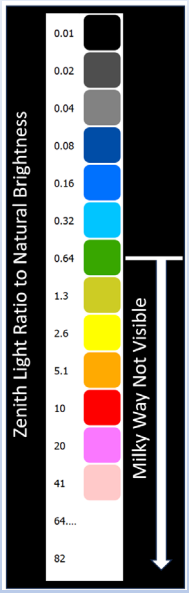
Modeled Impact of Converting to Warm Lights with Full Shielding



Skyglow Model Approximates
Current Conditions



Skyglow Model Assumes
Warm Lights (80% Amber & 20% 2700K) and Full Shielding



The absence of blue light in the spectrum of the amber outdoor lights makes a huge difference in reducing skyglow, brings the pristine night sky closer to us and reduces the various negative other impacts of outdoor lights.

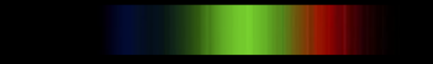
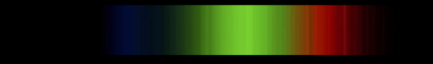
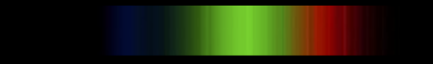
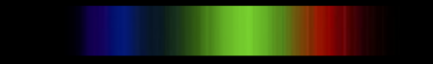
Preliminary Results
Courtesy of Christian Luginbuhl
Flagstaff Dark Skies Coalition

DarkSky OREGON

Modern Lamps & Skyglow

Flagstaffdarkskies.org

Luginbuhl et al. 2014

Type	Description	S/P Ratio	Sky Glow[1] (relative to LPS)	Sky Glow[1] (relative to HPS)
			FDSC Grade[2]	
LPS	Low-pressure sodium – a nearly monochromatic yellow-orange light source used mostly in areas near astronomical observatories and sea turtle nesting beaches.	0.23	1.0	0.4
			AAA	
NBA LED[3]	Narrow-band amber LED – a narrow-spectrum yellow-orange LED nearly equivalent to LPS in light pollution impacts.	0.23-0.30	1.0	0.4
			AAA	
HPS	High-pressure sodium – A golden-yellow light source, widely used throughout the world.	0.64	2.4	1.0
			A	
PCA LED[4]	Phosphor-converted amber LED – Similar to HPS though products vary.	0.45-1.0	1.8-4.1	0.7-1.6
			AA-B	
FLED[5]	Filtered warm-white light-emitting diode – a straw-yellow LED lamp with a filter that removes most emission with wavelength shorter than 500 nanometers.	0.9	3.6	1.5
			B	
LED 2200K	Light-emitting diode with "correlated color temperature" (CCT) of 2200K – a "warm-white" LED. This type of LED has not seen wide use.	0.84-0.90[6]	3.6-3.8	1.4-1.5
			C	
LED 2700K	Light-emitting diode with "correlated color temperature" (CCT) of 2700K – a "warm-white" LED.	1.0-1.1[6]	4.4-4.9	1.7-1.9
			C	
LED 3000K	Light-emitting diode with "correlated color temperature" (CCT) of 3000K – a "warm-white" LED.	1.3[6]	5.4	2.0-2.2
			C	
LED 4100K	Light-emitting diode with CCT of 4100K – a "cool-white" LED. This is a common LED type in recent LED area lighting installations.	1.6[6]	6.4	~2.7
			D	
LED 5100K	Light-emitting diode with CCT of 5100K – a "cool-white" LED. This also is a common LED type in recent LED area lighting installations.	2.0[6]	7.9	~3.3
			E	

Low Pressure Sodium
0.4x

Narrow Band Amber
0.4x

High Pressure Sodium
1x

Phosphor -converted amber LED
~1x

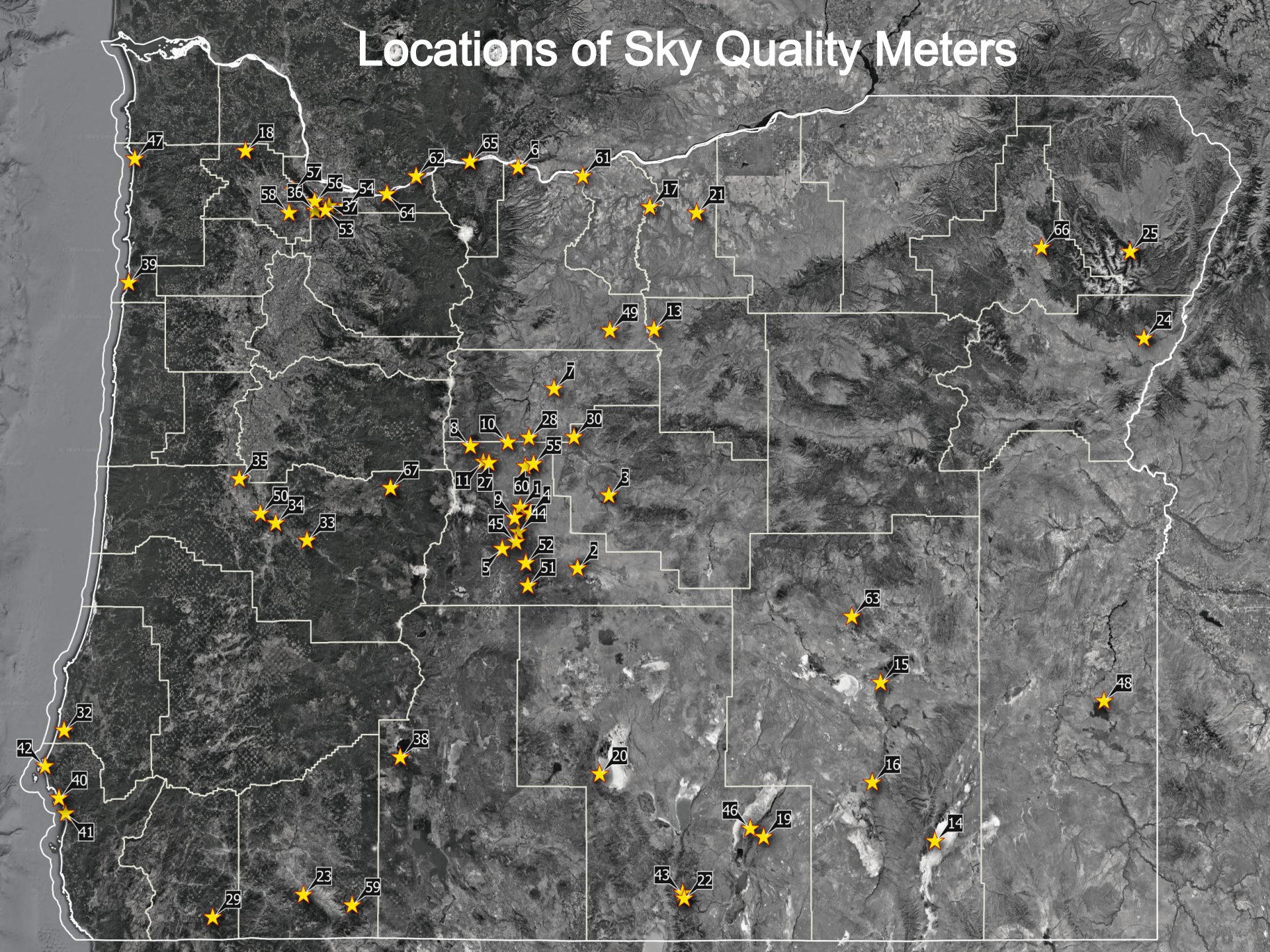
White LED Lights
Create a lot of Skyglow

Warm -white LED
2200K
~1.4x

Warm -white LED
3000K
~2.1x

Warm -white LED
4100K
~2.7x

Cool-white LED
5100K
~3.3x


Locations of Sky Quality Meters
47
18
65
62
6
61
57
56
54
58
36
37
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17
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66
25
39
49
13
24
7
8
10
28
30
55
35
67
11
27
60
1
4
3
50
34
9
44
33
45
52
2
5
51
63
15
48
32
38
42
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16
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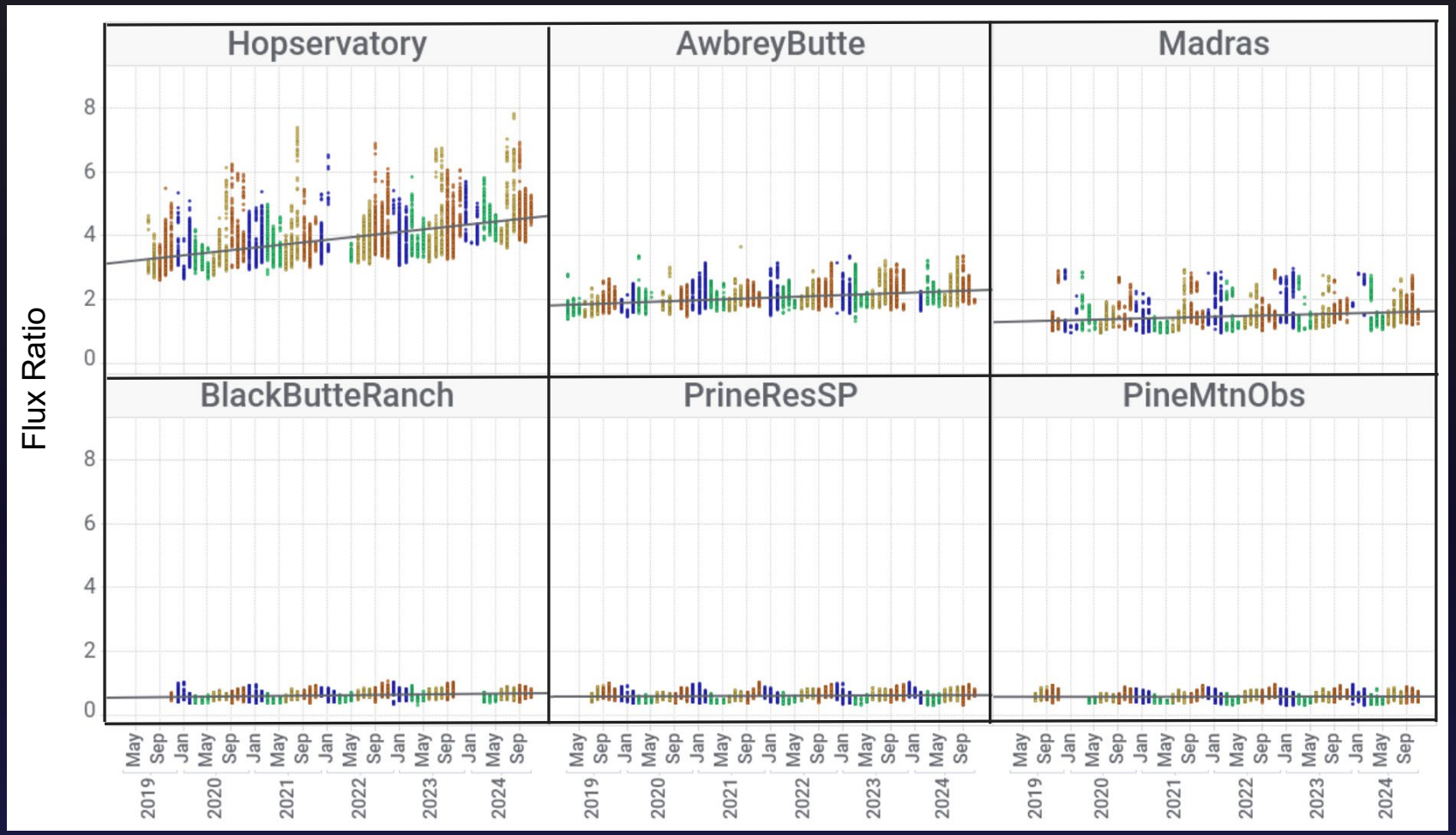
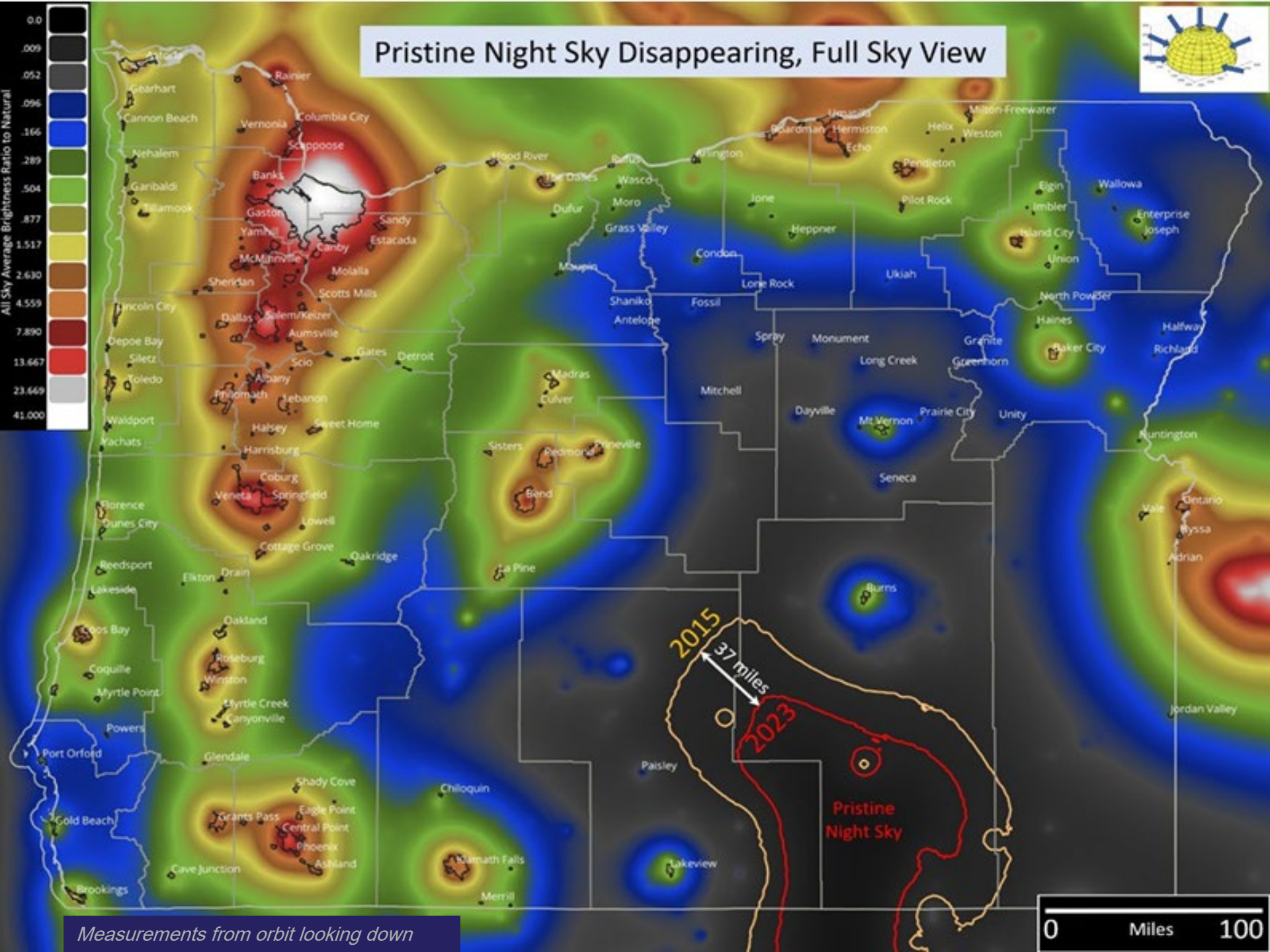
29

Skyglow is increasing over Oregon Cities

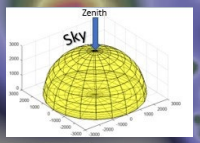
SIX SITES IN CENTRAL OREGON



Measurements from the ground looking up (zenith)
Hopservatory is increasing at 7% per year


Pristine Night Sky Disappearing, Full Sky View
All Sky Average Brightness Ratio to Natural
0.0
.009
.052
.096
.166
.289
.504
.877
1.517
2.630
4.559
7.890
13.667
23.669
41.000
2015
37 miles
2023
Pristine Night Sky
0
Miles
100
Measurements from orbit looking down

Status of Oregon's Dark Sky Places



magnitudes/arcsec^2
17.93
18.29
18.65
19.00
19.35
19.68
20.01
20.31
20.60
20.85
21.09
21.27
21.45
21.57
21.68
21.75
21.82
21.86
21.90
21.92
21.94
21.95
21.96
21.965
21.97
21.98
22.00

Cannon Beach
LL Stubb Stewart SP
Hood River
Mosier
Cottonwood Canyon SP
Wallowa Lake SP
Lincoln City
Antelope
Halfway
Black Butte Ranch
Eagle Crest
Sisters
Blue River
Prineville Reservoir SP
Tetherow
Sunriver
Newberry NVM
Crater Lake NP
Oregon Outback (Phase 1)
Oregon Outback (Phase 2)
Cape Blanco SP
Humbug Mtn SP
Provolt Rec Area, BLM
Cave Junction
Oregon Caves NM
Cascade Siskiyou NM

Certified 7
Application 1
Discussions 18

Background Image: "D Lorenz Skyglow 2024"

Economics of Dark Skies

Astronomy -based recreation and tourism

Quebec, Canada Study

- Mont Megantic National Park Dark Sky Reserve
- US $10 Million/year increased economic benefit
- Divided over the 34 small towns (population 225,000)

Credit: The Milky Way rises over Mont -Mégantic Observatory, Québec. Photo by Guillaume Poulin.

Light pollution worsens climate change

- ★ ALAN disrupts ecosystem metabolism and should be included in studies
- ★ Shielded, dimmable and amber lighting at night is beneficial
- ★ Lighting accounts for 20% of global electricity consumption and 6% of CO_2 emissions; exacerbates poor air quality.

Widespread influence of artificial light at night on ecosystem metabolism; Alice S. A. Johnston, Jiyoung Kim & Jim A. Harris; Nature Climate Change, November 2025
https://www.nature.com/articles/s41558-025-02481-0

Image: Mel Bartels, Sisters

Dark Skies are key for ecological health

- Wildlife - insects, birds, bats, nocturnal animals
- Vegetation growth - timing of seasonal changes

Photo of Great horned owl by Sevilla Rhoads

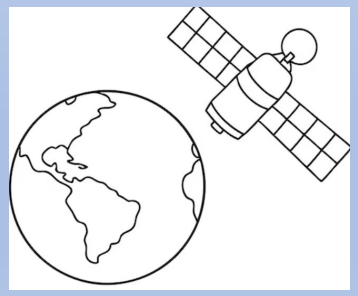
Photo of night sky over the Cascades with Andromeda Galaxy by Tom Spies
From Rima Givot and Scott Woodford, City of Sisters

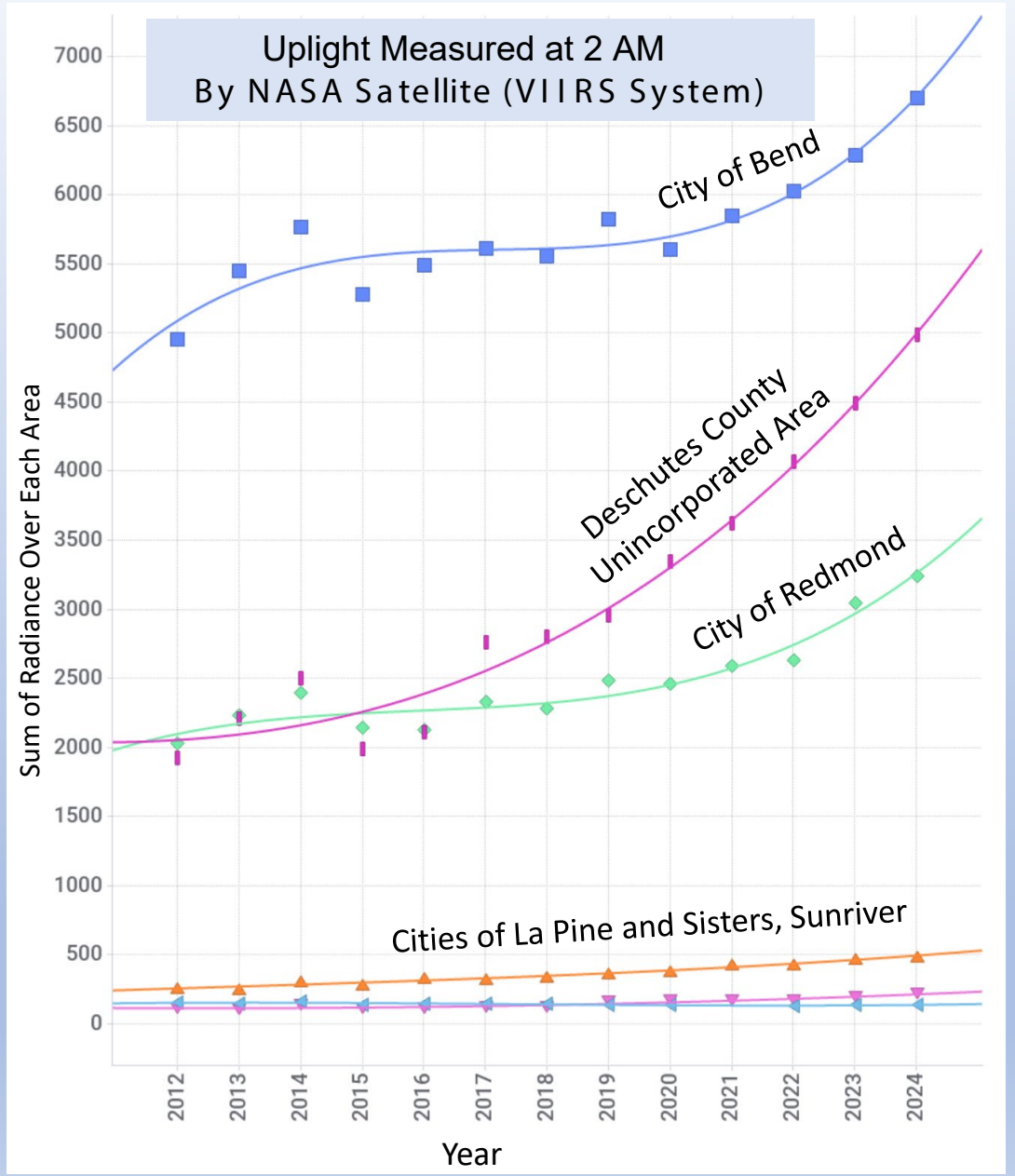
Scientific data show that light pollution from Deschutes County and our incorporated cities is increasing year-by-year

The amount of uplight detected by the NASA satellite VIIRS system over Central Oregon is increasing dramatically. Uplight is proportional to the light pollution that we see from the ground looking up.

While the City of Bend is the currently the largest contributor of uplight, the unincorporated part of Deschutes County may overtake Bend in a few years.

This uplight causes skyglow which is extending progressively outward, westward into the Cascades and southeastward toward the Oregon Outback.





Annual Measurement Data

DarkSky OREGON