



Light Pollution and Public Health

Reducing Light Pollution on a Regional Scale

National Summit for Gateway Communities

Shepherdstown, WV USA

December 13, 2018

Cynthia Lapp

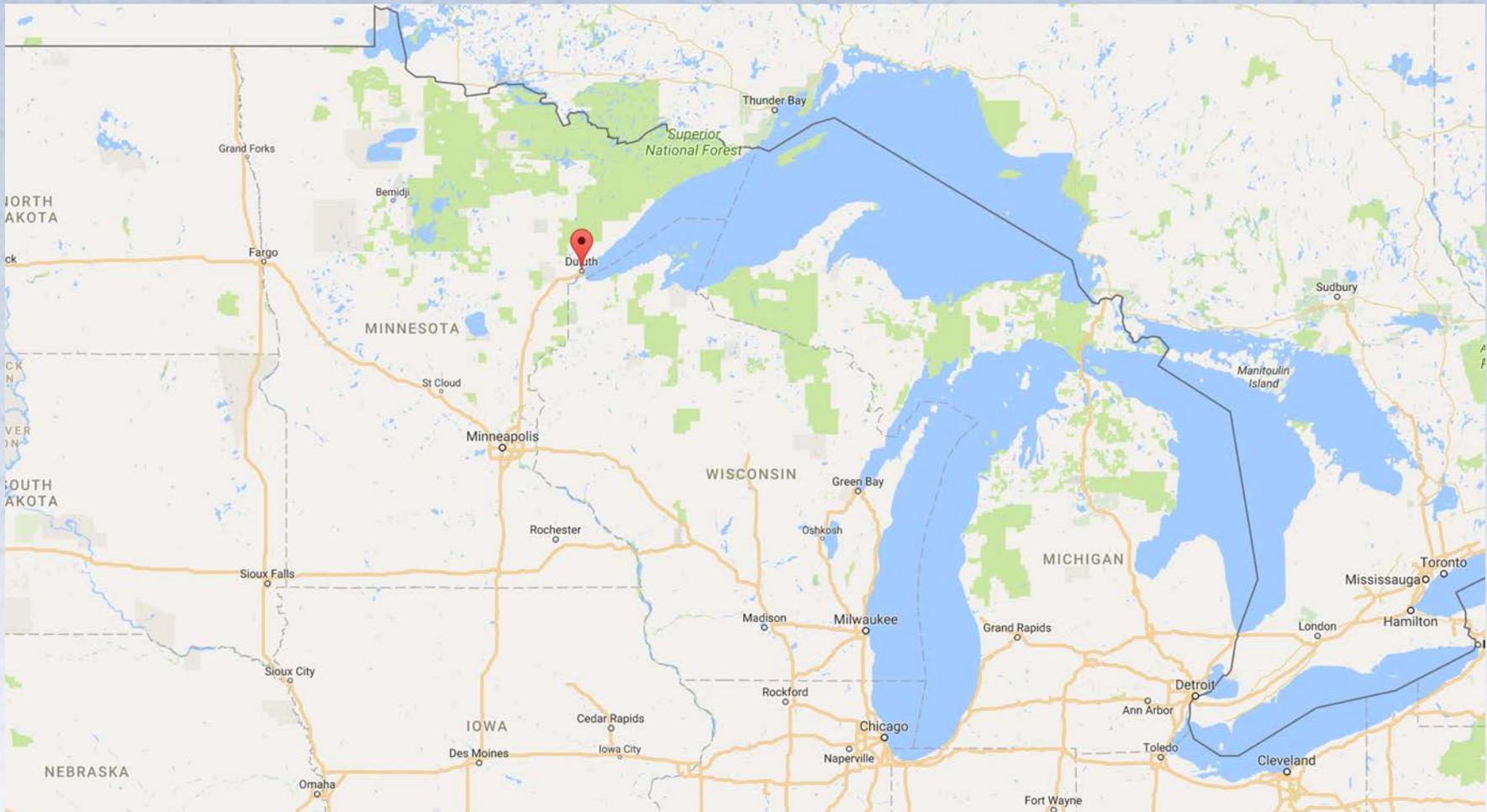
Starry Skies Lake Superior IDA

introduction

what is light pollution?

human experience of light

how is light pollution a public health issue?



introduction...

Cynthia Lapp

- background in Human Ecology, Natural Resources, Community Facilitation
- Master of Landscape Architecture 2009; ecological corridors
- teaching, design and project management
- interested in Night Skies from environmental and human experience perspective (Northern Lights and meteor showers!)



Starry Skies Lake Superior IDA

- Duluth, MN based chapter of the International Dark Sky Association
- working in the Lake Superior region towards eliminating light pollution
- partnering with municipalities, agencies, tourism, neighborhoods professional organizations, etc.



Regional Solutions Starry Skies Lake Superior IDA

Working with Stakeholders -

- municipalities, universities, counties, townships
- architects, designers, planners, lighting and code professionals
- tourism groups, utilities, DOTs
- State and National public lands managers
- schools, neighborhoods, general public

Heart of the Continent Partnership

- 5 million acres public lands, US / Canada border west of Lake Superior
- most public lands units now applyig for Dark Sky status with the IDA; we are working with cities, counties, townships on integrating light pollution mitigation with area identity for residents and visitors



Current Barriers to Mitigating Light Pollution

- Lack of understanding - how light effects humans and our environment
- Current lighting standards / lighting manufacturers / designers, suppliers, contractors / planners, engineers, municipal codes, code enforcement, etc.!

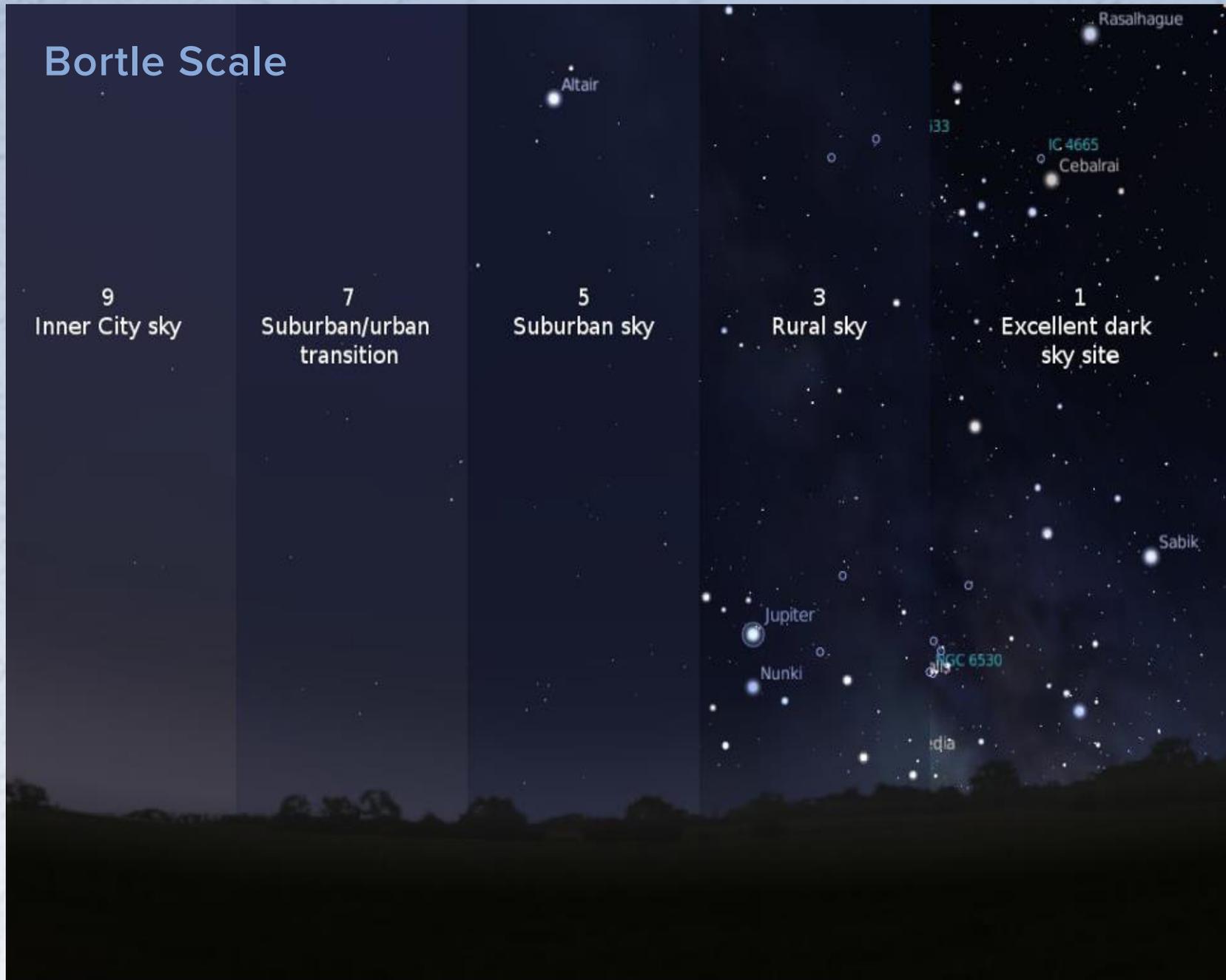
what is Light Pollution?

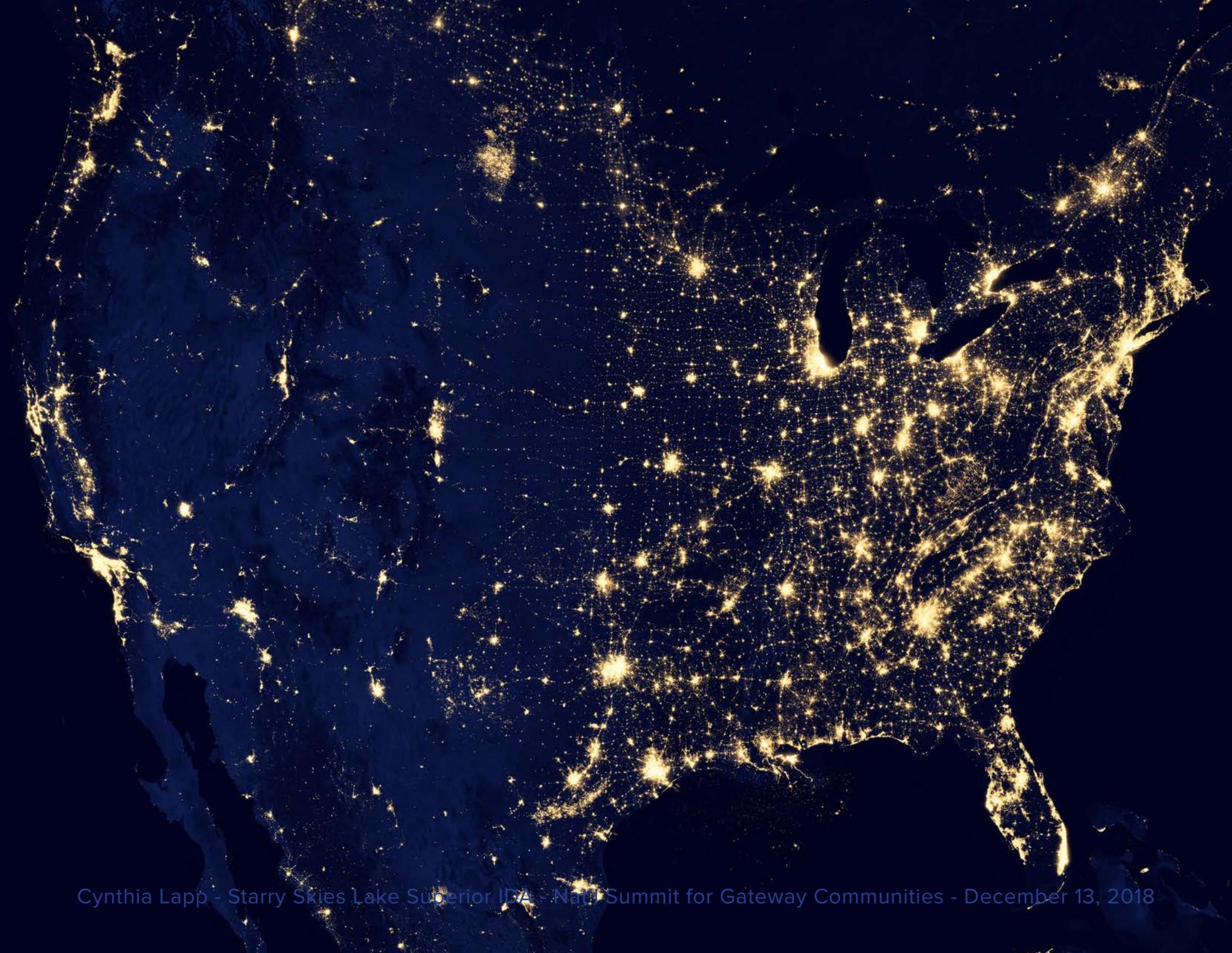
human-sourced light in the night environment that is excessive, misdirected or obtrusive, having a disruptive effect on natural cycles, and inhibiting the observation of night sky phenomena



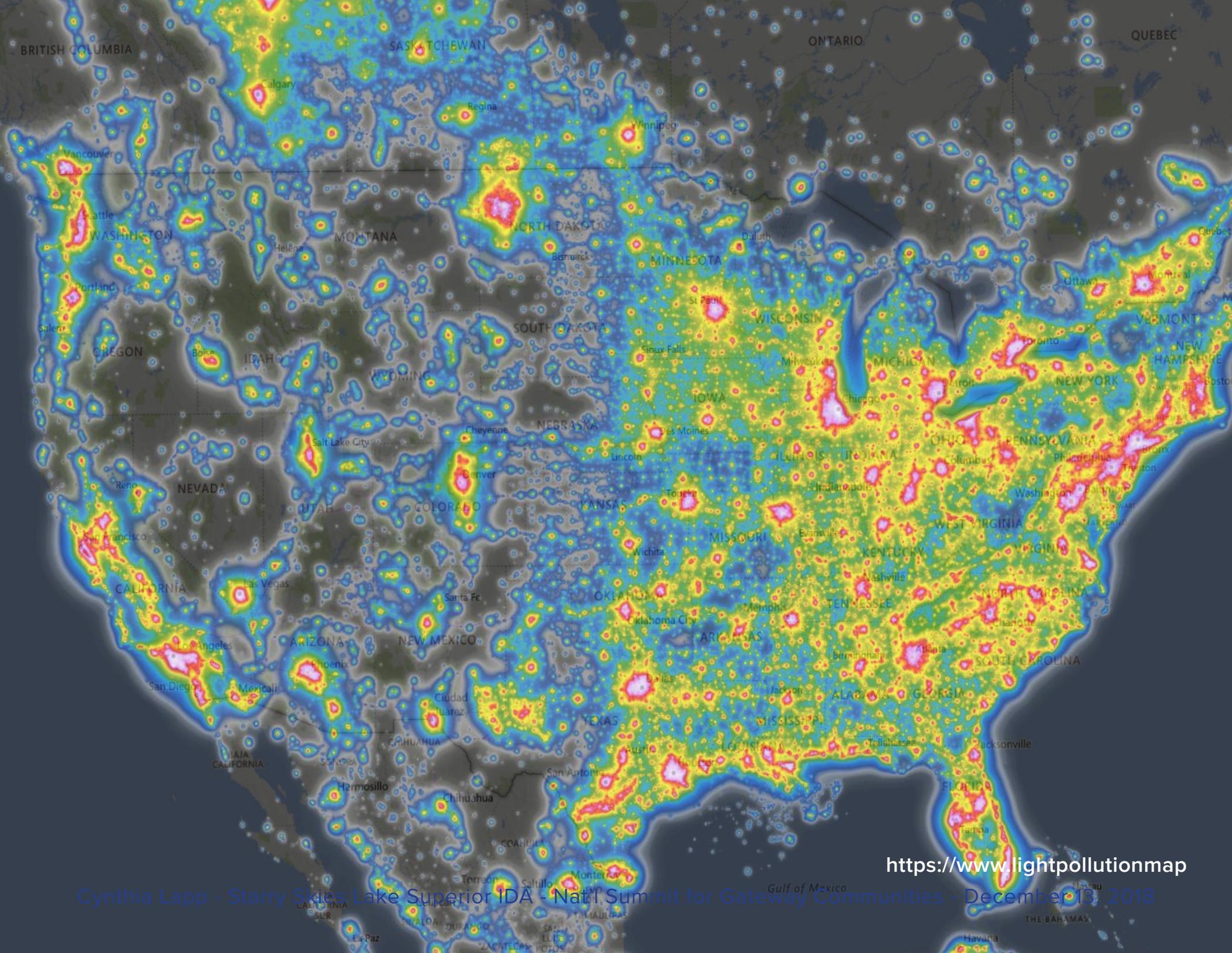
PHOTO Matthew Moses

Bortle Scale



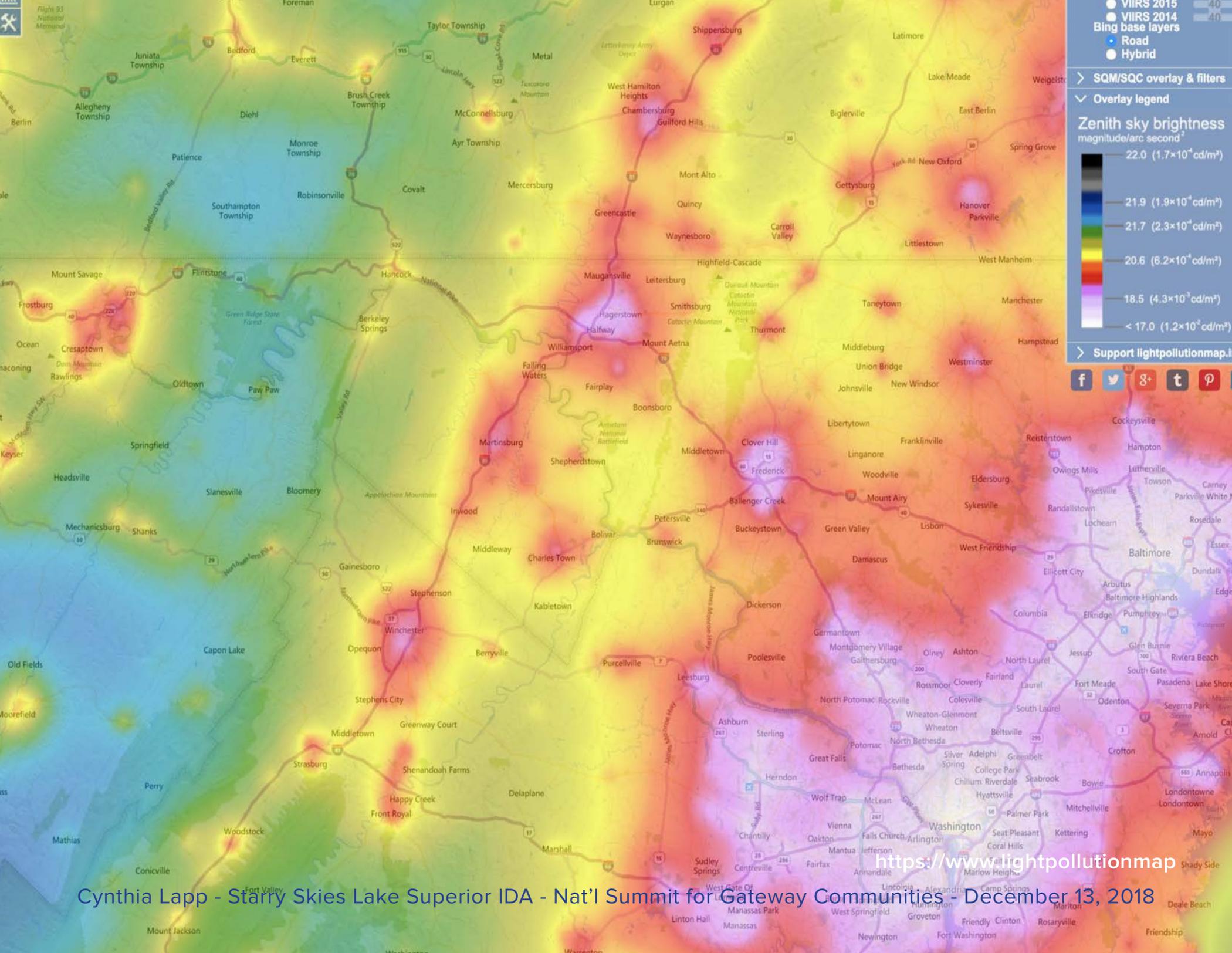


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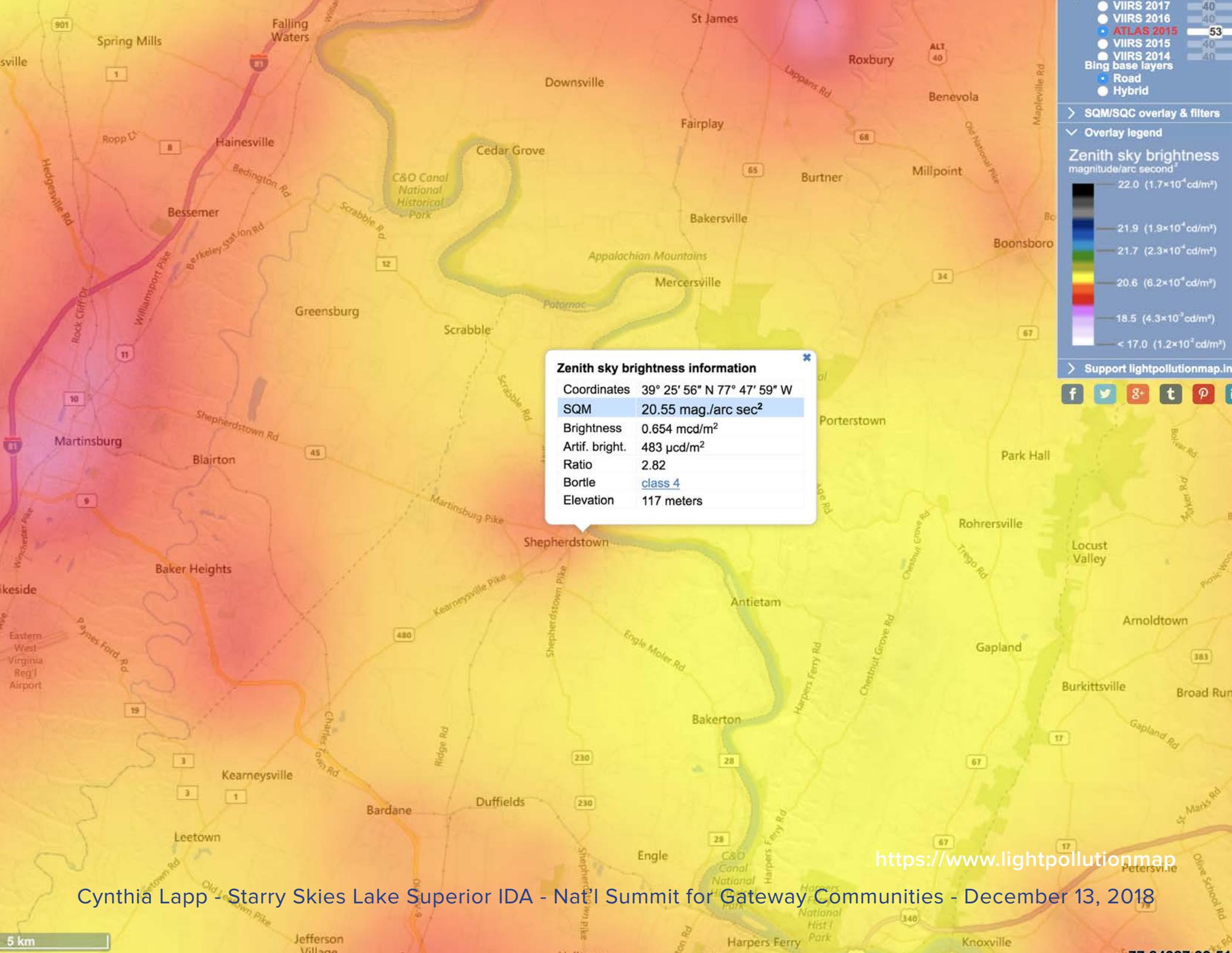


<https://www.lightpollutionmap>

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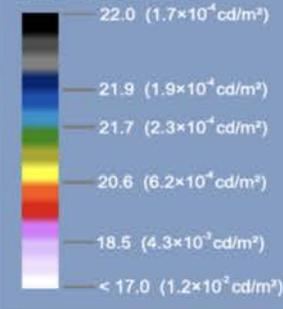


- VIIRS 2017 40
- VIIRS 2016 40
- ATLAS 2015 53
- VIIRS 2015 40
- VIIRS 2014 40
- Bing base layers
- Road
- Hybrid

> SQM/SQC overlay & filters

∨ Overlay legend

Zenith sky brightness
magnitude/arc second²



> Support lightpollutionmap.in



Zenith sky brightness information

Coordinates 39° 25' 56" N 77° 47' 59" W

SQM 20.55 mag./arc sec²

Brightness 0.654 mcd/m²

Artif. bright. 483 μcd/m²

Ratio 2.82

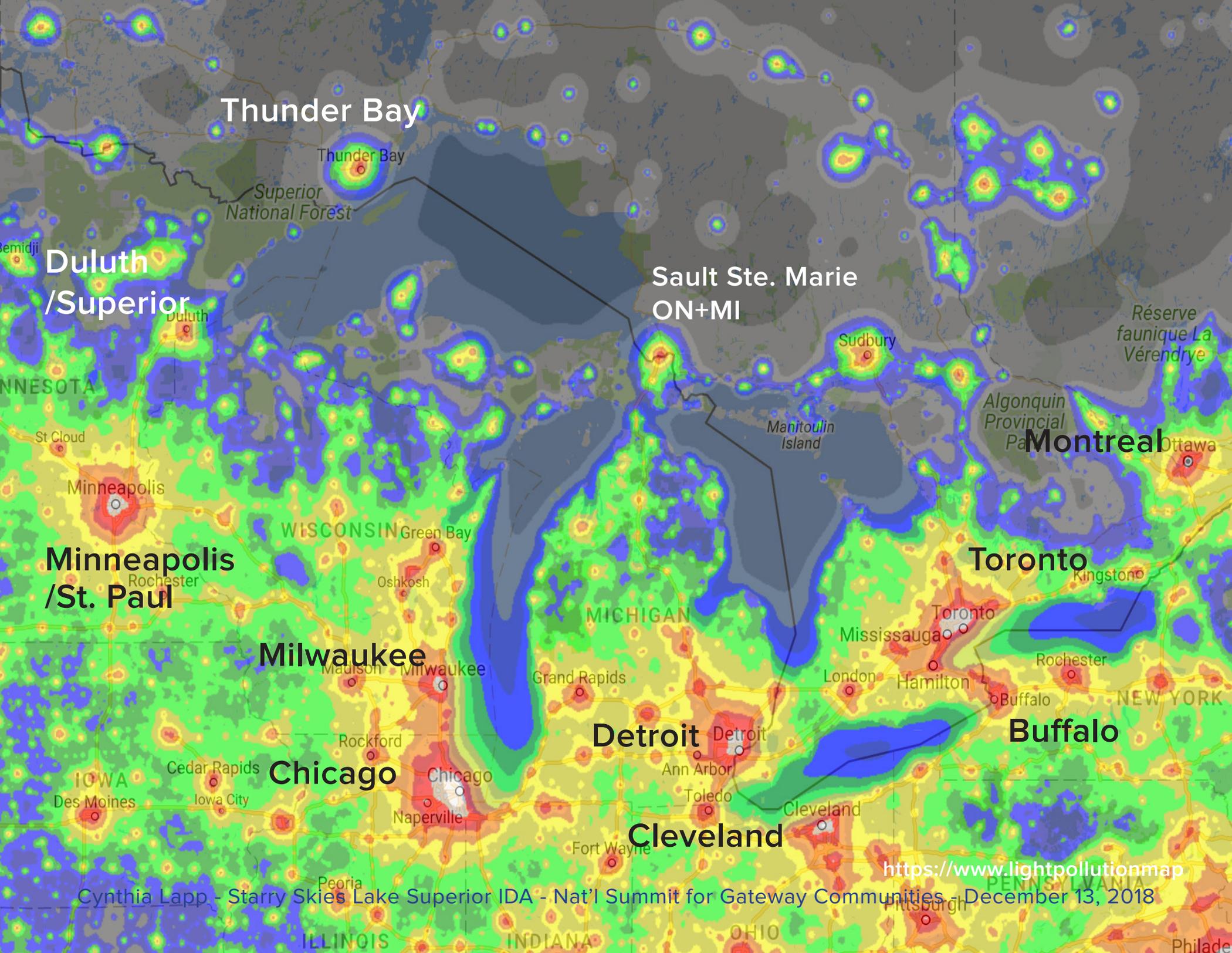
Bortle [class 4](#)

Elevation 117 meters

<https://www.lightpollutionmap>

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5 km



Thunder Bay

Thunder Bay

Superior
National Forest

**Duluth
/Superior**

Duluth

**Sault Ste. Marie
ON+MI**

Sudbury

Réserve
faunique La
Vérendrye

Algonquin
Provincial
Park
Montreal
Ottawa

**Minneapolis
/St. Paul**

WISCONSIN
Green Bay

Milwaukee

MICHIGAN

Toronto

Chicago

Detroit

Buffalo

Cleveland

<https://www.lightpollutionmap>

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ILLINOIS

INDIANA

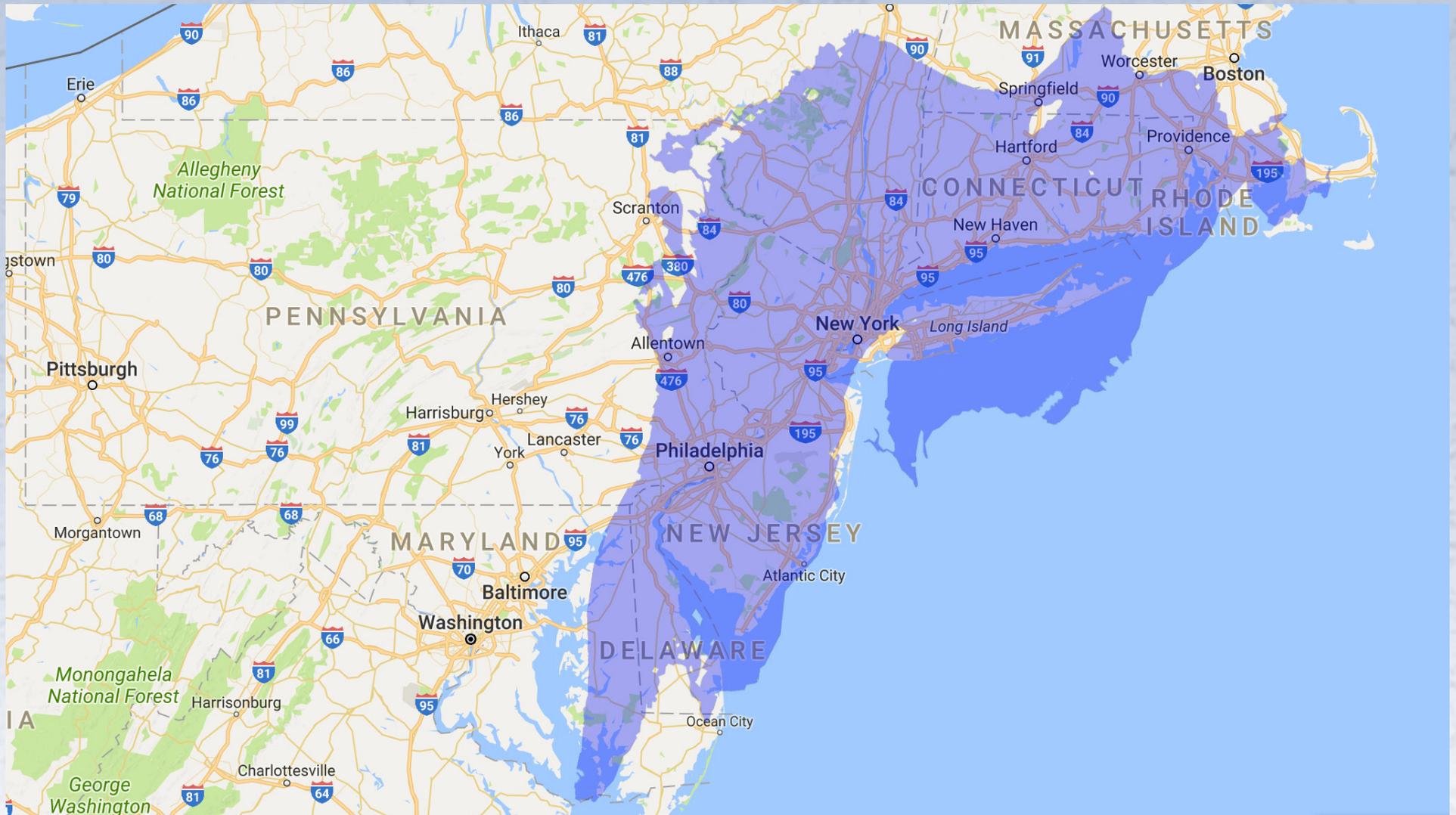
OHIO

PENNSYLVANIA

Philad

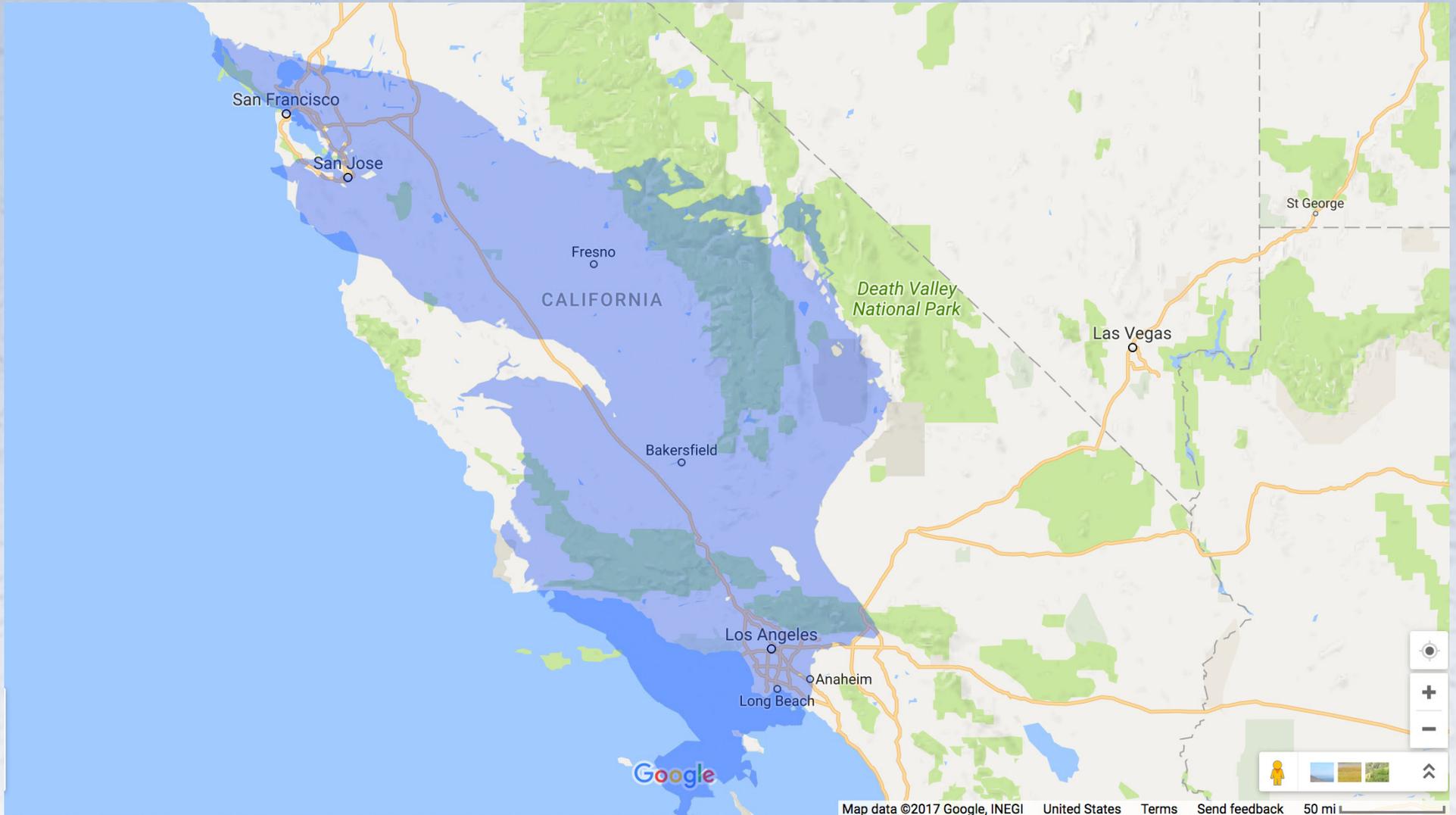
Scale of Lake Superior -

-pop. 630,000 - about 350 mi. long - 10% world's fresh water



Scale of Lake Superior -

- 30,000 cu. mi. of water - Duluth to Atlantic 2,343 mi.



Human Experience of Light

DAY

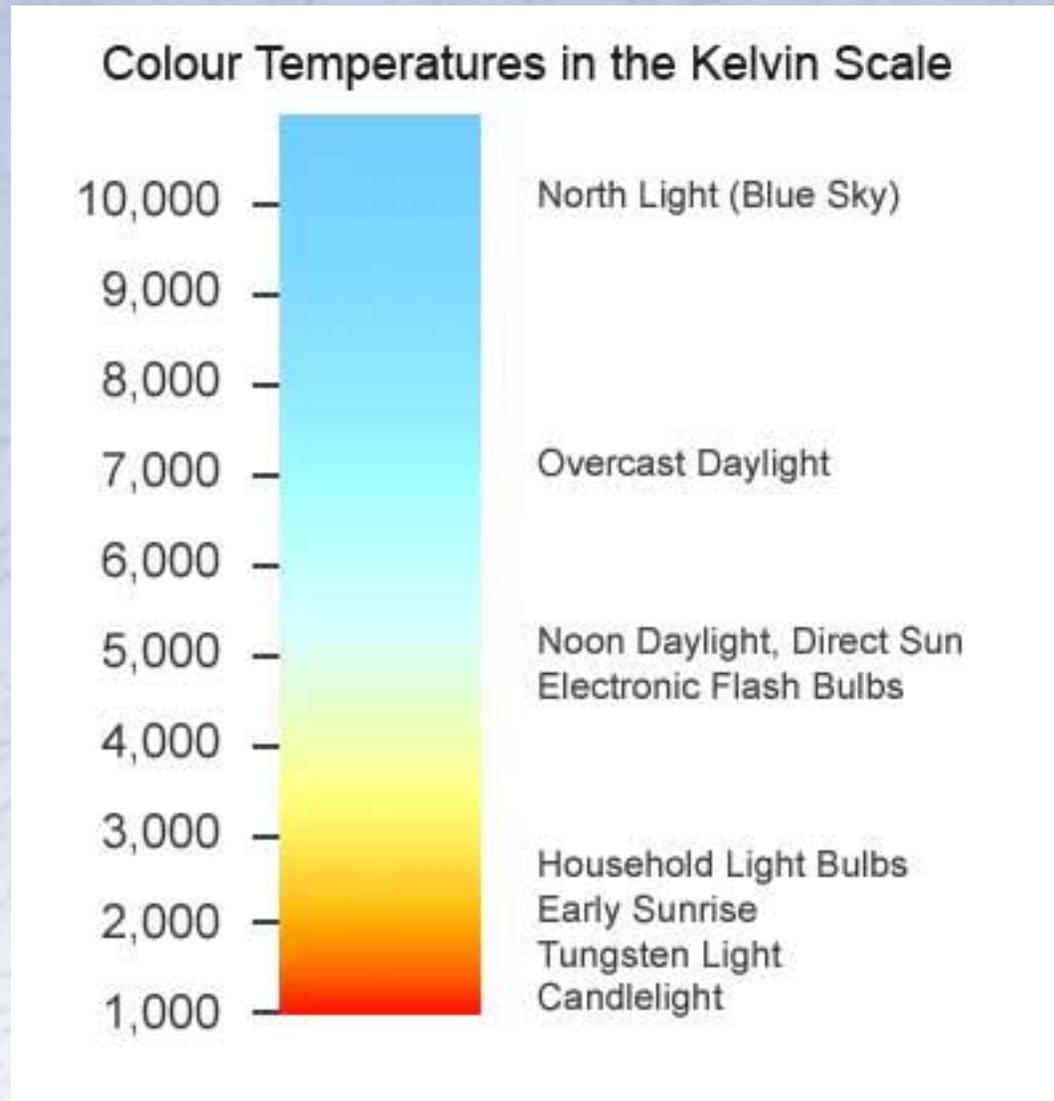


NIGHT



Human Experience of Light

COLOR TEMPERATURE - KELVIN SCALE



Human Experience of Light

How the human eye works

Color temperature
around 2000 Kelvin

Lake Superior Sunset - Chris Swenson, Jan 2017

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Human Experience of Light

How the human eye works

Color temperature
around 10,000 Kelvin

Snowy Road at Evening - Jaime Vedres Jan 2017

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Human Experience of Light

How the human eye works

VISUAL CORTEX



CONE



ROD

SCN - non-visual parts of the brain (suprachiasmatic nucleus)



ipRGC

Intrinsically photosensitive Retinal Ganglion Cells

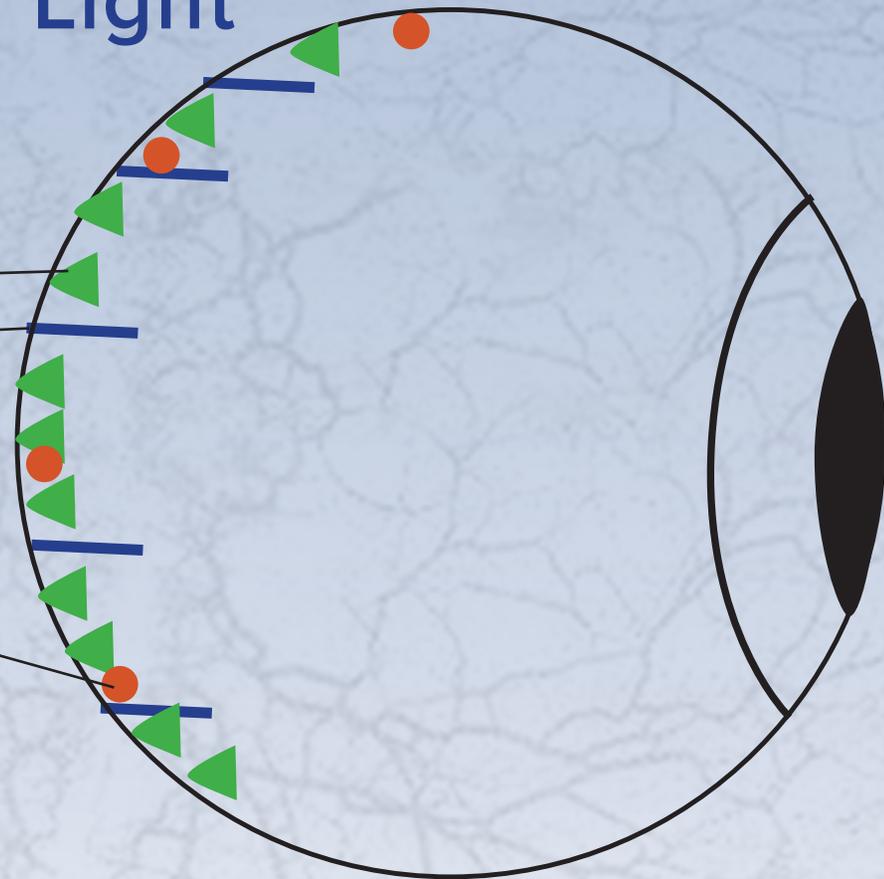


diagram of the eye



CONE



“Photopic” - Daylight
Color - Fast-adjusting
Bright Light



ROD



“Scotopic” - Night
Greyscale - Slow-adjusting
Dim Light



ipRGC

Pineal - governs Melatonin
Day/Night sensor
Blue-light sensitive

Human Experience of Light

How the human eye works



CONE

“Photopic” - Day

Color - Fast-adjusting

Bright Light

- activates under bright light
- processes color
- adapted to continuous, “daytime” lighting
- adapted to very bright light, not much “glare”



ROD

“Scotopic” - Night

Greyscale

Slow-adjusting

Dim Light

- very sensitive to low-light conditions
- processes greyscale contrast, hierarchy of shadows
- adapted to uneven, intermittent lighting
- adapted to dim light (bright light perceived as “glare”)
- adjusts slowly



ipRGC

Pineal - Melatonin

Day/Night signal

Blue-light sensitive

- evolved with 12-hour Day / Night cycle
- all light affects it, **ESPECIALLY BLUE LIGHT**
- signals the body, day / night

Human Experience of Light

How the human eye works

Fire 1,000-2,000 Kelvin
Sky around 10,000 Kelvin

Campfire. - Martin Cathrae

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Human Experience of Light

How the human eye works



Woodland Ave., Duluth MN - Nov 2015

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Human Experience of Light

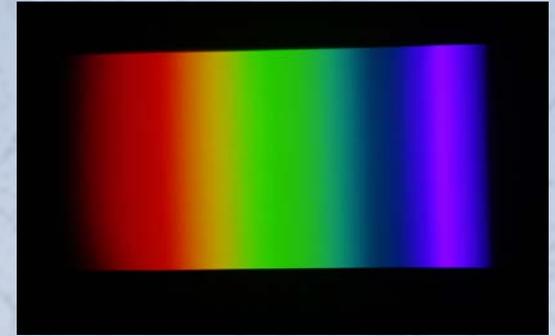
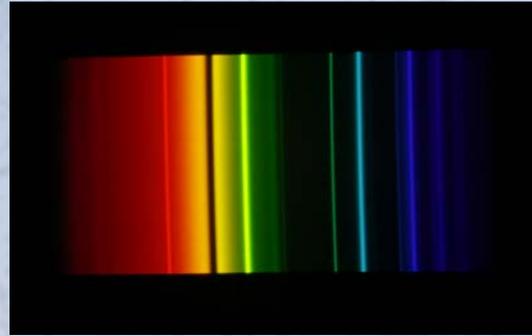
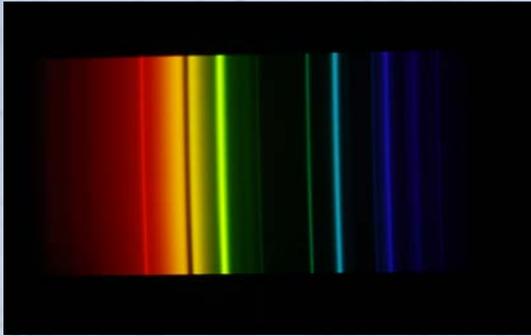
Human circadian rhythm

The human system is organized around day / night cycles of roughly 12 hours each - “circadian rhythm”

- **we produce serotonin during the “blue” light of day** - we need bright light during the day
- **we produce melatonin during the dark, or very dim light, of night** - we need darkness or very dim light to support melatonin production
- **our melatonin production is most easily suppressed by blue light** - blue light is the most effective wavelength in shutting down our melatonin production

Human Experience of Light

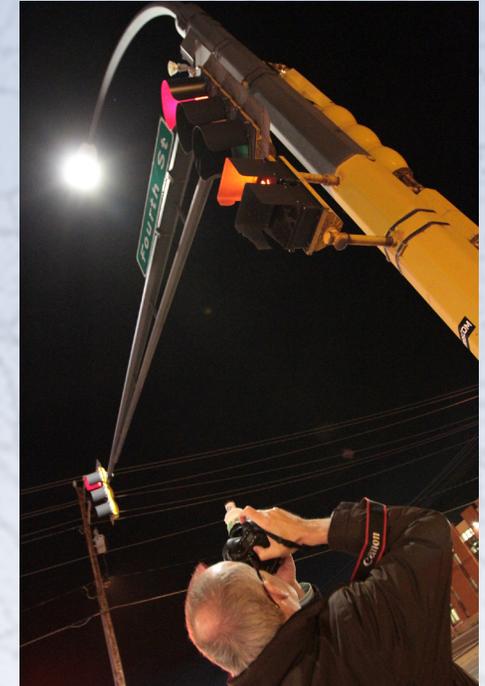
COLOR TEMPERATURE / “blue” light more effectively shuts down melatonin



Pendant Lamp - 2015
High Pressure Sodium
4th St. across from Co- Op



High Pressure Sodium - 2015
7th. Ave and 4th St.
“cobra head”



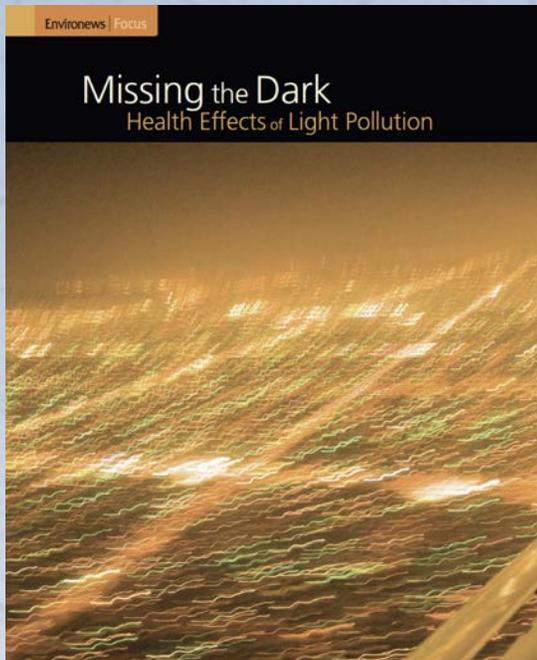
New Intersection LED - 2015
6th Ave. and 4th St. E.

Human Experience of Light

Human circadian rhythm

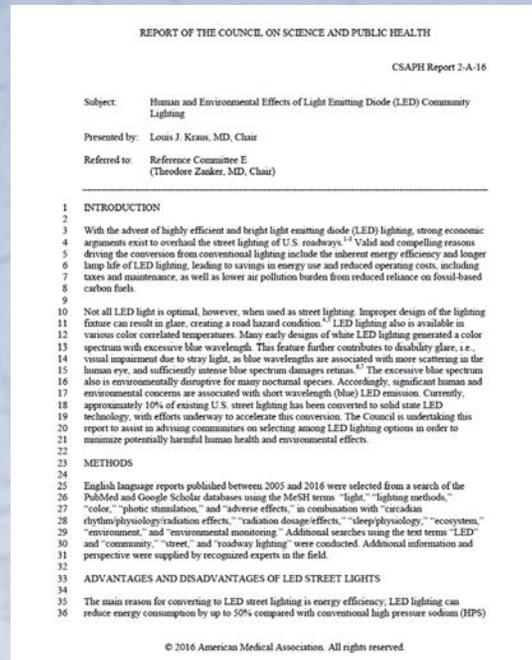
- **DISRUPTING OUR CIRCADIAN RHYTHM STRESSES OUR BODY'S REGULATORY FUNCTIONS**
- the ipRGC signals the endocrine system of the presence of blue-rich light - **IS IT NIGHT OR DAY?**
- the longer our body “delays” night functions, the less time the body has for night-time cellular regeneration and regrowth
STUDIES LINK LIGHT-BASED MELATONIN SUPPRESSION TO AN INCREASED RISK FOR OBESITY, DIABETES, CARDIOVASCULAR DISEASE, AND OTHER CHRONIC CONDITIONS
- blue-rich light starts before sunrise and extends past sunset
VISUAL ACCESS TO THESE LIGHT SHIFTS ARE CRUCIAL
- **study** : phase timing of inducing labor
(Phasing of labor induction - labor duration in daytime vs. nighttime inductions at Brigham and Women's Hospital)
Shadab Rahman, PhD, MPH, et. al., currently in peer review

Light Pollution + Public Health - Everyone Needs the Dark



Missing the Dark: Health Effects of Light Pollution
Ron Chepesiuk, 2009

Environ Health Perspect. Jan; 117(1): A20–A27. doi: [10.1289/ehp.117-a20]
PMCID: PMC2627884 PMID: 19165374



AMA Report on LED Lighting and Public Health
June 2016

CSAPH Report 2-A-16 resulting in Policy H-135.927



Bright Lights, Big Problems
Diana Kwon, 2018

Scientist Magazine, October 2018

includes citations of most studies through 2015:

Electric light, particularly at night, disrupts human circadian rhythmicity: is that a problem?

Richard G. Stevens, Yong Zhu

Published 16 March 2015. DOI: 10.1098/rstb.2014.0120
PubMed 25780233 Published By The Royal Society
Print ISSN 0962-8436 Online ISSN 1471-2970

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Light Pollution + Public Helath - Everyone Needs the Dark

INSECTS TREES OWLS TURTLES BATS WOLVES

every plant and animal has day/night adapted behavior...

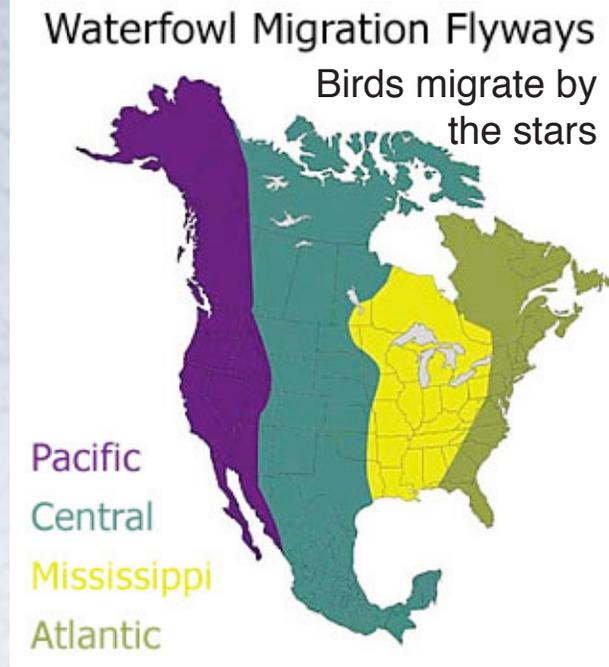
Germany - 75% drop in flying insect populations since 1980

- C.A. Hallman et al, PLOS One, 12:e0185809, 2017

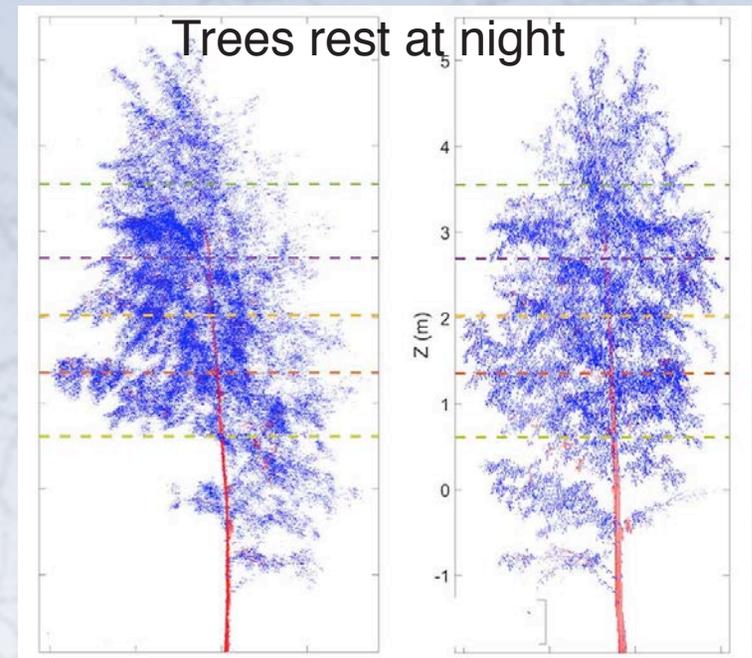


Night pollinators impaired or eradicated by light pollution

- Ragged fringed orchid, native to Minnesota, polinated only at night



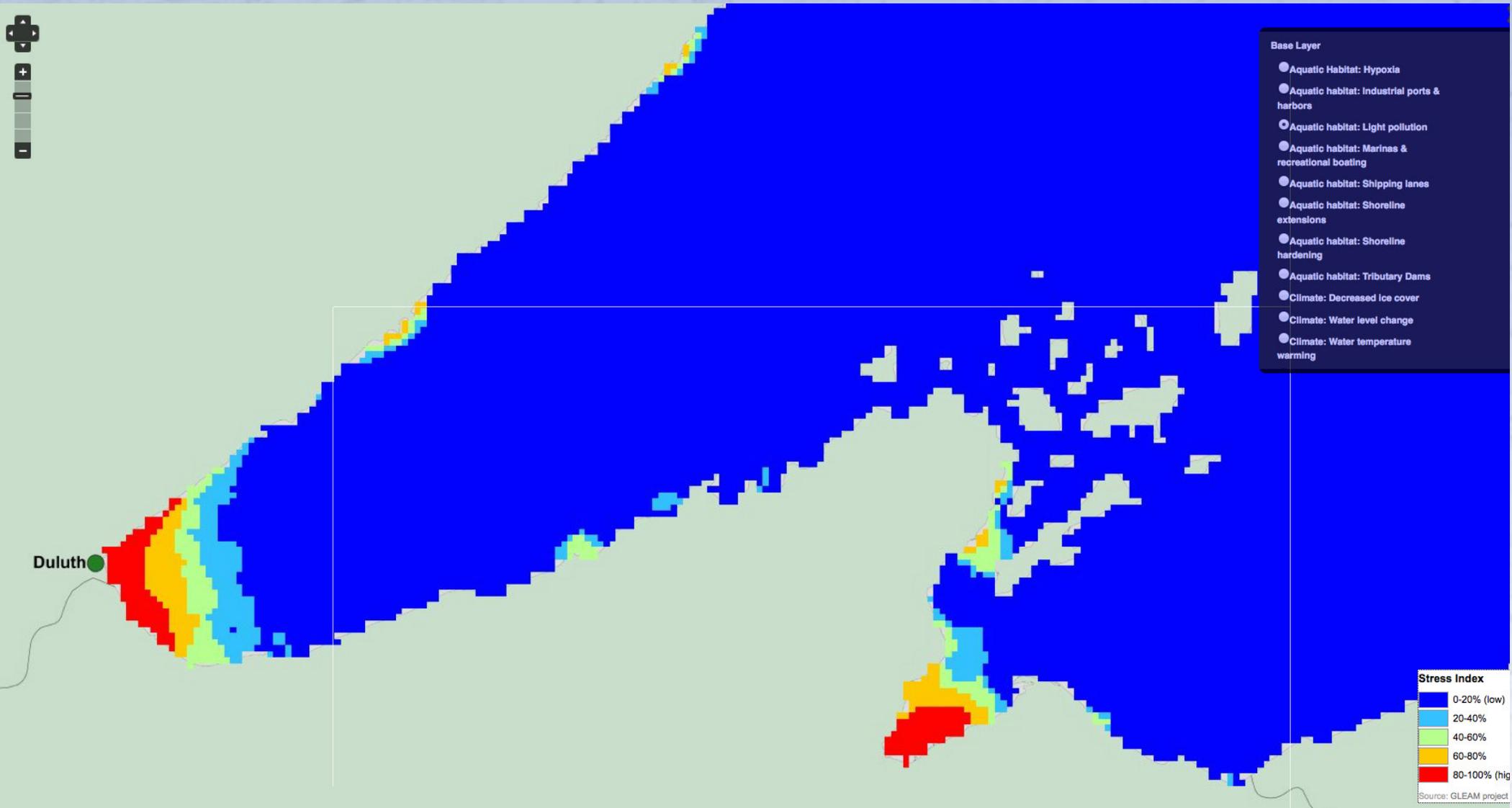
Ducks Unlimited
<http://www.ducks.org/Conservation/Where-Ducks-Unlimited-Works/Waterfowl-Migration-Flyways>



At night (left) tree branches droop more than during the day (right) Image courtesy of Vienna University of Technology, TU Vienna
<https://www.newscientist.com/article/2088833-trees-seen-resting-branches-while-asleep-for-the-first-time/>

Light Pollution + Public Helath - Everyone Needs the Dark

Aquatic light pollution - Stress Index



Great Lakes Environmental Assessment Mapping website, Dec. 15 2012 screen capture

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Light Pollution + Public Helath - neighborhoods

continuous light, glare and extreme contrast can increase crime rates



International Dark Sky Ass'n "Light Pollution and Safety" brochure

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Light Pollution + Public Helath - neighborhoods

continuous light, glare and extreme contrast can increase crime rates

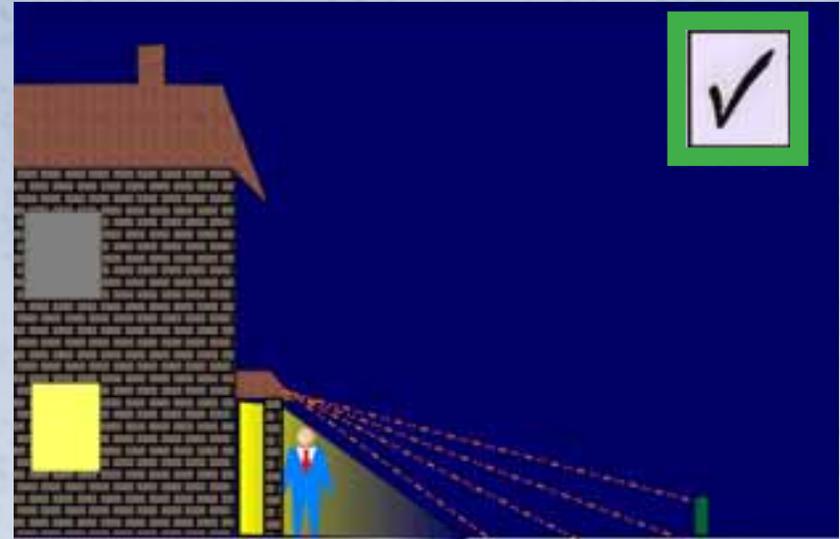
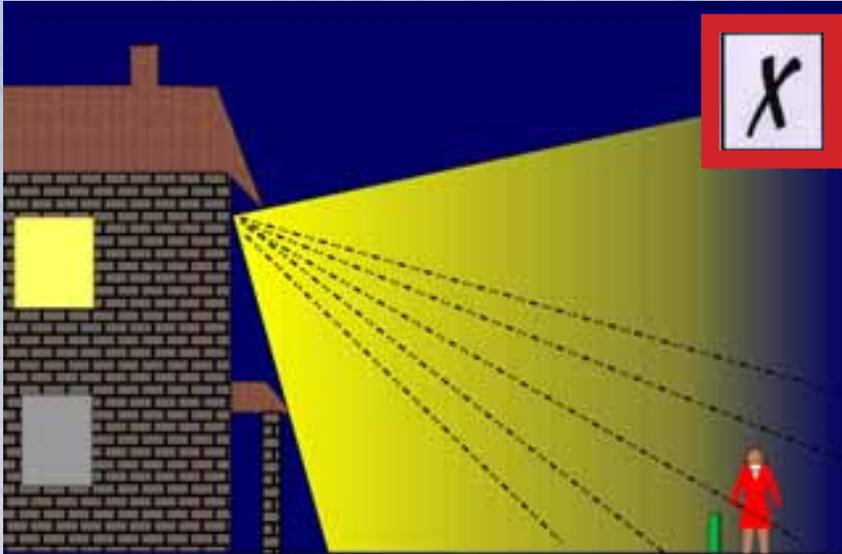


International Dark Sky Ass'n "Light Pollution and Safety" brochure

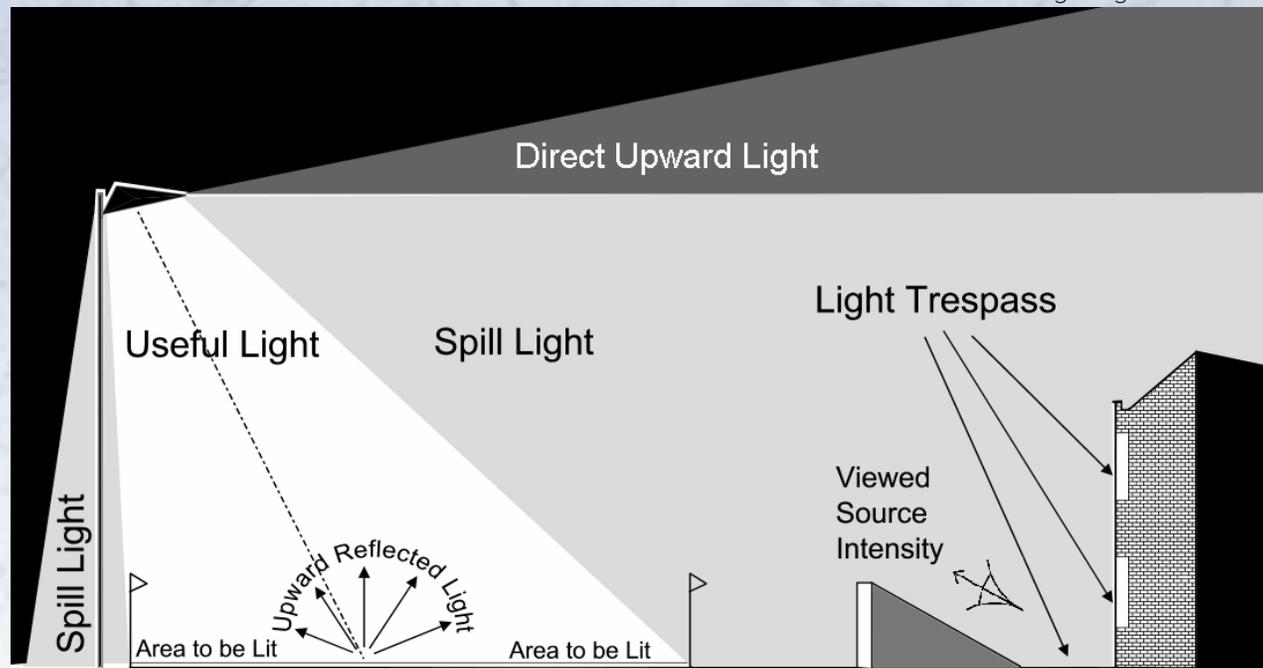
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Light Pollution + Public Health - neighborhoods

minimizing light trespass, shields beyond “horizontal cutoff”



Institute of Lighting Professionals (see “Resources”)



Temple Report (see “Resources”)

thank you!

PHOTO Matthew Moses

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