Light Pollution and Public Health
Reducing Light Pollution on a Regional Scale

National Summit for Gateway Communities
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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 applying 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.
Bortle Scale

9  Inner City sky
7  Suburban/urban transition
5  Suburban sky
3  Rural sky
1  Excellent dark sky site
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
COLOR TEMPERATURE - KELVIN SCALE

Colour Temperatures in the Kelvin Scale

North Light (Blue Sky)
Overcast Daylight
Noon Daylight, Direct Sun, Electronic Flash Bulbs
Household Light Bulbs, Early Sunrise, Tungsten Light, Candlelight
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

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

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

**ipRGC**
Pineal - Melatonin
Day/Night signal
Blue-light sensitive
Human Experience of Light
How the human eye works

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

Campfire. - Martin Cathrae
Human Experience of Light
How the human eye works
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

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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
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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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/


Night pollinators impaired or eradicated by light pollution
• Ragged fringed orchid, native to Minnesota, polinated only at night

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

Light Pollution + Public Helath - Everyone Needs the Dark

Waterfowl Migration Flyways
Birds migrate by the stars

Pacific
Central
Mississippi
Atlantic

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Light Pollution + Public Health - Everyone Needs the Dark
Aquatic light pollution - Stress Index

Great Lakes Environmental Assessment Mapping website, Dec. 15 2012 screen capture
Light Pollution + Public Health - neighborhoods
continuous light, glare and extreme contrast can increase crime rates

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Light Pollution + Public Health - neighborhoods
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GUIDANCE NOTES FOR THE REDUCTION OF OBTRUSIVE LIGHT

All living things adjust their behaviour according to natural light. Man's invention of artificial light has done much to enhance our night-time environment but, if not properly controlled, obtrusive light (commonly referred to as light pollution) can present serious physiological and ecological problems.

Obtrusive Light, whether it keeps you awake through a bedroom window or impedes your view of the night sky, is a form of pollution and can be substantially reduced without detriment to the lighting task.

Sky glow, the brightening of the night sky above our towns, cities and countryside, glare the uncomfortable brightness of a light source when viewed against a dark background, and light trespass, the spilling of light beyond the boundary of the property or area being lit, are all forms of obtrusive light which may cause nuisance to others, waste money and electricity and result in the unnecessary emissions of greenhouse gases. Think before you light. Is it necessary? What effect will it have on others? Will it cause a nuisance?

How can I minimise the problem?

Do not "over" light. This is a major cause of obtrusive light and is a waste of energy. There are published standards for most lighting tasks, adherence to which will help minimise upward reflected light. Organisations from which full details of these standards can be obtained are given on the last page of this leaflet.

Dim or switch off lights when the task is finished. Generally a lower level of lighting will suffice to enhance the night-time scene than that required for safety and security.

Temple Report (see "Resources")

Institute of Lighting Professionals (see "Resources")

However, if possible use a separate detector that can be sited in a more ideal position where it is most likely to detect intruders into your property, rather than neighbours taking the dog for a walk or small animals roaming around the garden causing the light to switch on and off throughout the night.

Movement detectors can be useful if they are correctly installed and aimed. Unfortunately, many systems do not allow the detector to be separately aimed from the luminaire.

Remember, when buying such equipment check to see if the detector can be separately aimed, or better still purchase a separate detector, which can be installed in the best position and correctly aimed to minimise unnecessary switching.

Luminaires and detectors should be aimed to only detect and light people on your property. They should not detect a person or animals walking down the street. If the detector is fitted with a timer, this should be adjusted to the minimum to reduce the operation of the light. When aiming floodlights...
thank you!