



Special AAS Splinter Session
Sponsored by the AAS Committee on Light Pollution,
Radio Interference and Space Debris; NOAO;
IAU Commission 50 on Light Pollution; and
the International Dark-Sky Association.

Light Pollution at Campus & University Observatories

**Orange Blossom Ballroom at the
Gaylord Palms Resort
on Friday, 8 January 2016
from 9:30-11:30am**

Invited Speaker

Doug Arion, *Carthage Institute of Astronomy*



- Prof. of Physics & Astronomy
- Donald Hedberg Distinguished Professor of Entrepreneurship
- President of Galileoscope LLC
- Public science & nature education and outreach
- Working in partnerships with the Appalachian Mountain Club and Dartmouth College.



Dark Skies Education

Astronomy and Nature Education Public Outreach

Presented by

Dr. Douglas Arion

Carthage College Institute of Astronomy

Galileoscope, LLC



A Great Partnership



Activities

- Public Lectures and Observing Programs
- Table Talks
- Workshops
- Training Programs
- Ongoing Displays and Demonstrations

Dark Skies Awareness:

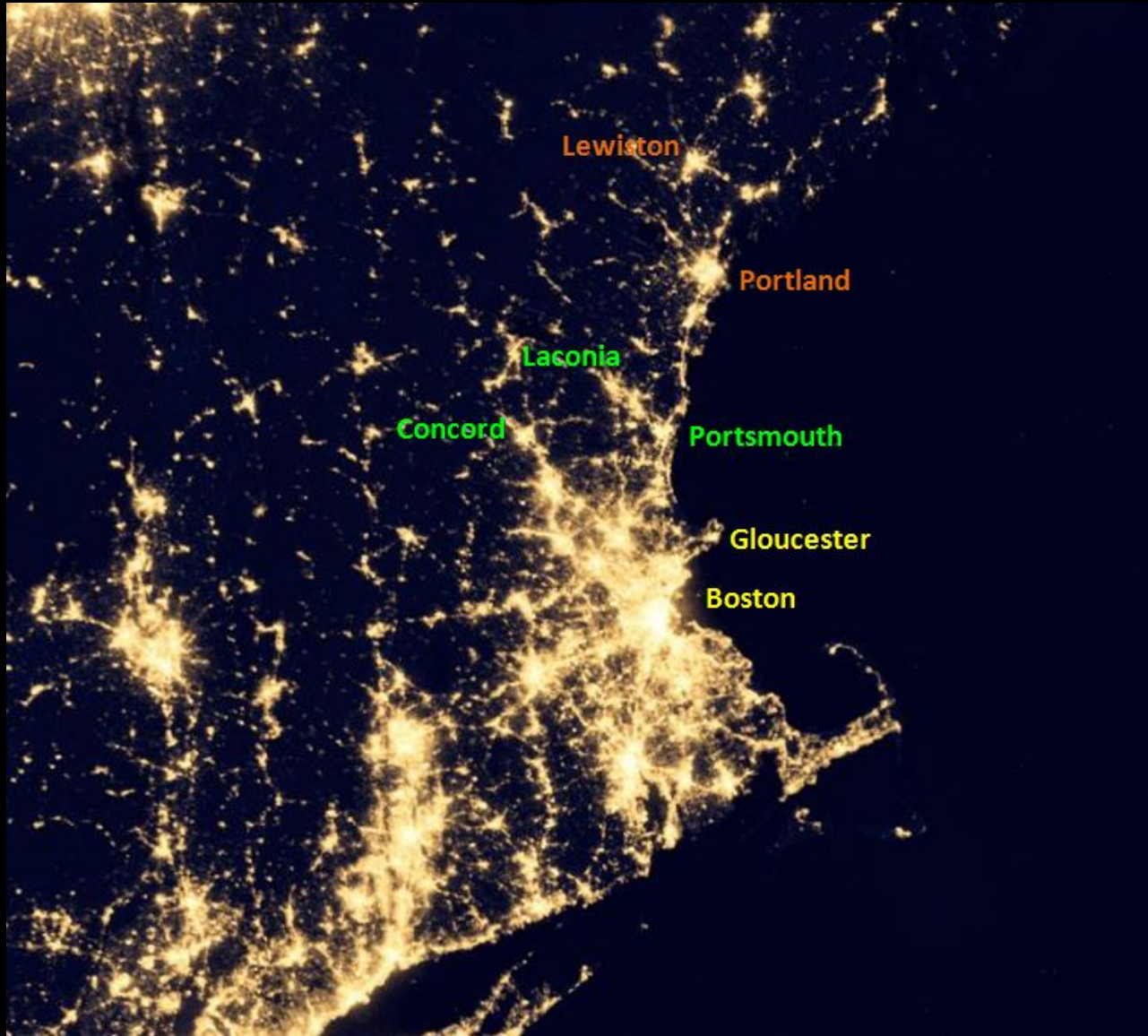
Leave No Trace for the Stars

- The sky is a *resource* – just like the forest
- It must be protected
 - The International Dark Sky Association (darksky.org) is the Sky's AMC
- Light pollution kills
 - People
 - Plants
 - Animals
 - The night sky



A Terrible Waste of Energy in the US



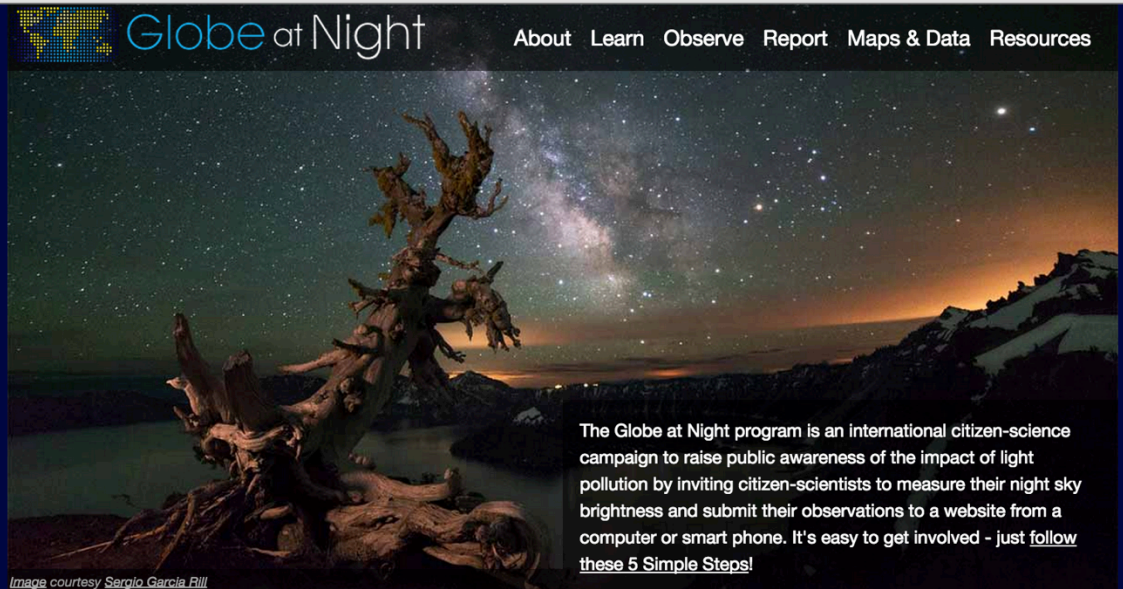


Globe at Night x

www.globeatnight.org

Apps Apple Yahoo! Google Maps YouTube Wikipedia News Popular The Amateur Telescope image: Astronomy Other Bookmarks

http://www.globeatnight.org wants to use your computer's location. Deny Allow x



Join us now for the January, 2015 campaign!

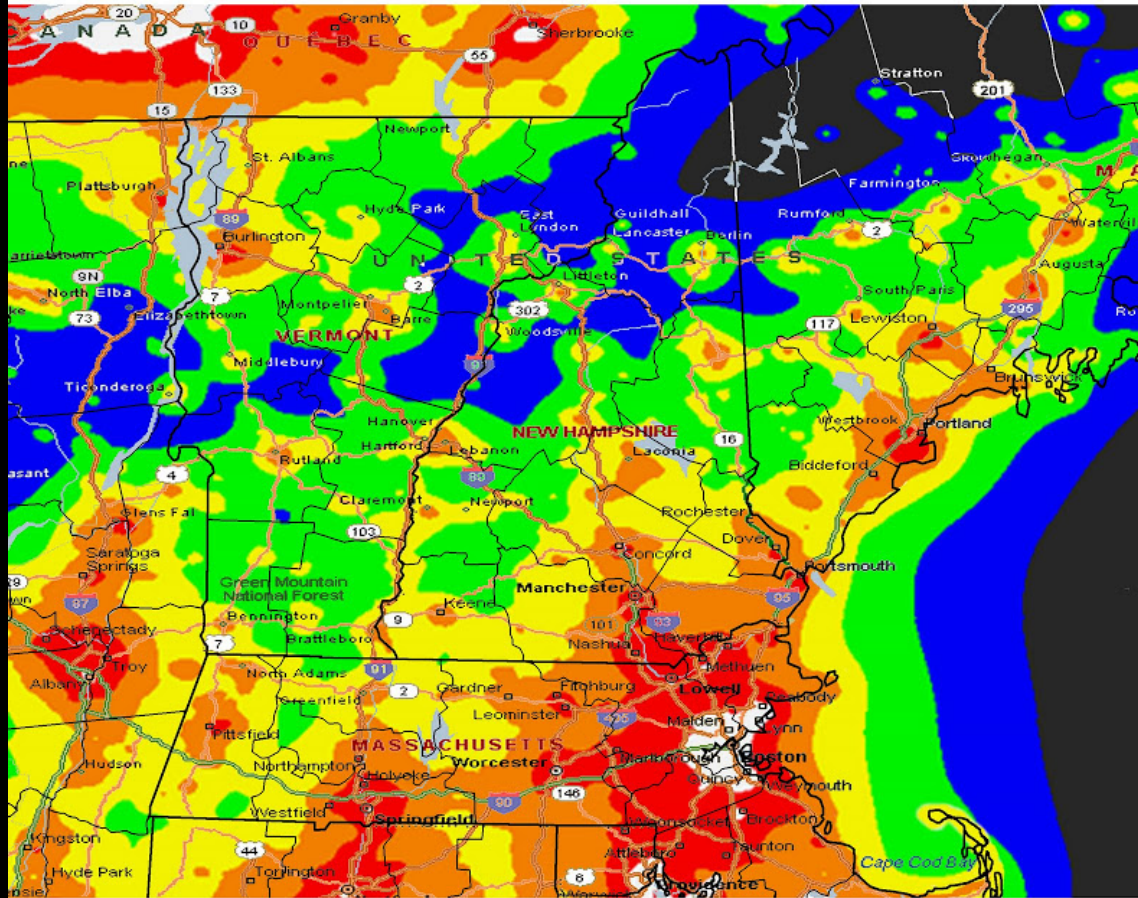
Citizen scientists from around the world have [contributed](#) 489 data points so far this year - thank you! Read more in our [Globe at Night Newsletter](#).



Globe at Night webapp

The final campaign of 2014 is over! Whether you use a smartphone, tablet or computer, you can [submit your data](#) in real time with our webapp - [available in 28 languages](#) for 2015! Help us get 2015 off to a great start!

THE ARTIFICIAL NIGHT SKY BRIGHTNESS OF NEW HAMPSHIRE AND SURROUNDING AREAS



	<0.01	0.01 - 0.11	0.11 - 0.33	0.33 - 1.0	1.0 - 3.0	3.0 - 9.0	9.0 - 27.0	>27
Bortle Scale	1	2	3	4	4.5	5	6,7	8,9

Colors correspond to ratios between the artificial sky brightness and the natural sky brightness

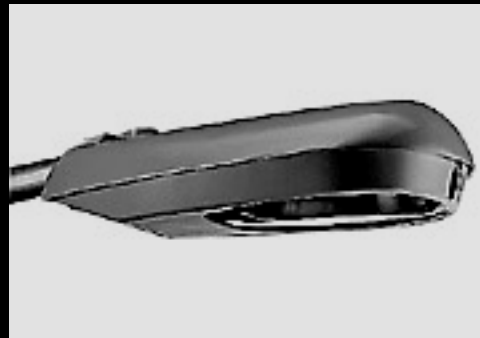
Light pollution gradient map layer ©2000, P. Cinzano, Thiene, Italy All rights reserved

Credit: P. Cinzano, F. Falchi (University of Padova), C. D. Elvidge (NOAA National Geophysical Data Center, Boulder).

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For more information, go to <http://www.lightpollution.it/dmsp/>

Map overlay by Matthew Ota





Workshops, Demonstrations, and Training



Table Toppers



The Many Benefits of Dark Skies

Bright, unshielded lighting can cause disability glare—the same effect one gets from an oncoming car's headlights at night.



How well can you see the pedestrians?

Go to www.darksky.org for more information.



The Many Benefits of Dark Skies

Light pollution kills migratory birds. Many migrate at night, and they often crash into brightly lit buildings. Nocturnal migrants include threatened species like the Bicknell's Thrush—an iconic bird of the White Mountains—and the Cerulean Warbler.



Cerulean Warbler

Source: my.nature.org
Image: my.nature.org

Go to www.darksky.org for more information.



The Many Benefits of Dark Skies

Light pollution wastes money. If we used more appropriate lighting—such as fixtures that only direct light downward, rather than upward into the sky—then we would save \$3.3 billion in energy costs each year.



The U.S. at night. All this light energy is wasted, as it never reaches human eyes.

Go to www.darksky.org for more information.



The Many Benefits of Dark Skies



Photograph by Thierry Cohen

This is how the New York City skyline would look without light pollution.

Go to www.darksky.org for more information.



The Many Benefits of Dark Skies

Light pollution increases cancer rates. With less darkness, people produce less melatonin, a hormone that controls circadian rhythms and also fights tumors. Greater exposure to light at night has been linked with higher breast and prostate cancer rates, according to the National Library of Medicine.

Image: dpchallenge.com



Severe light pollution in New York City has negative health effects.

Go to www.darksky.org for more information.



REACH

- Training
 - 200 AMC Volunteers and Naturalists
 - 100+ Seasonal staff
 - All permanent nature and education staff
 - Undergraduate astronomy interns
- The Public
 - 12,200 formal participants in 2015
 - Over 25,000 since program initiation

www.outdoors.org

www.carthage.edu/astronomy

Invited Speaker

James Lowenthal, *Smith College*

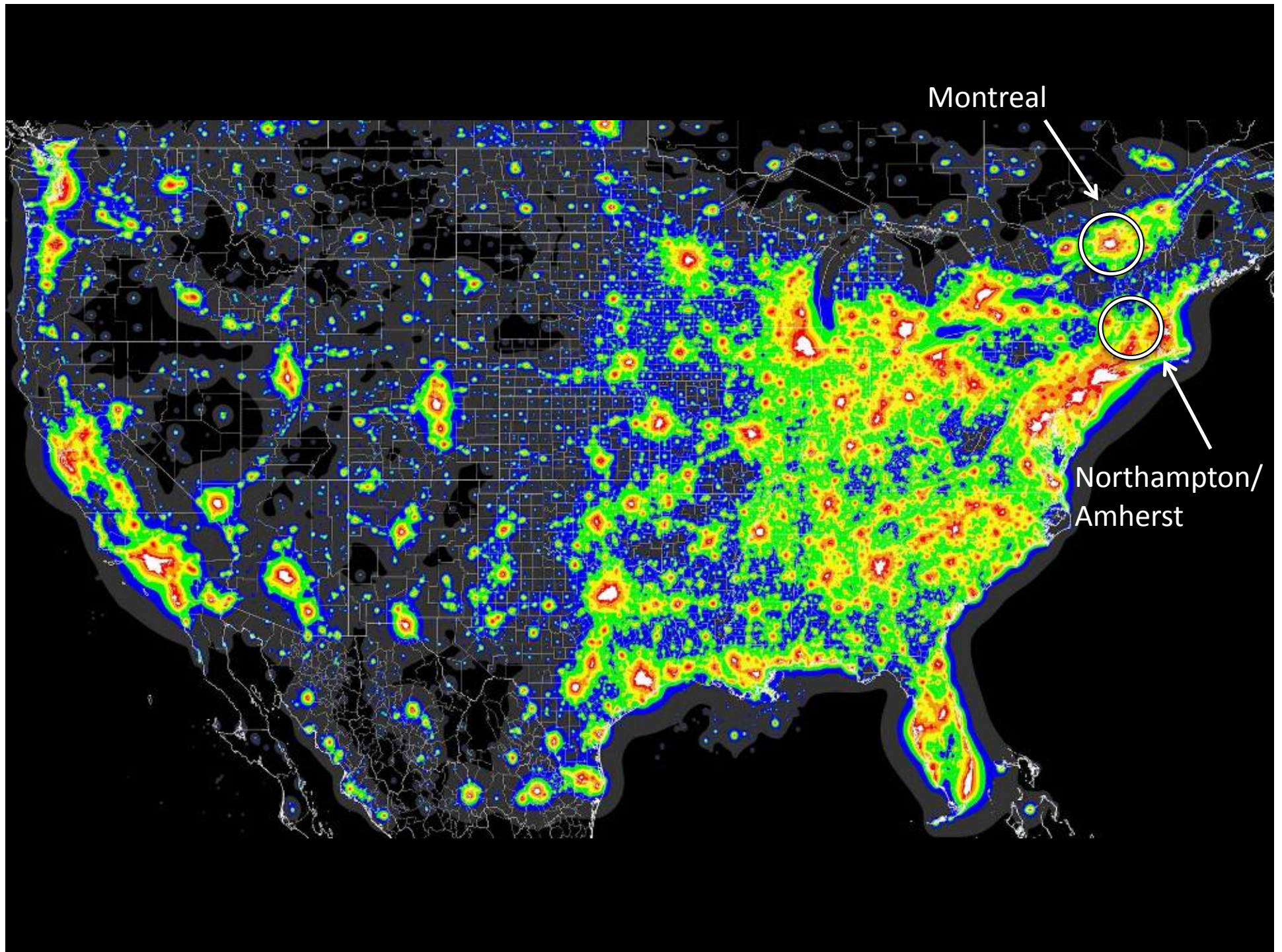


- PhD in 1991 from U. Arizona
- Postdocs at John Hopkins U., STScI, & UC Santa Cruz
- Joined faculty at UMass Amherst and Smith College in 2002.
- Active in light pollution control
- Teaches observational astronomy to undergrads in the Five College system in Massachusetts
- Is an avid backyard astrophotographer & environmental activist

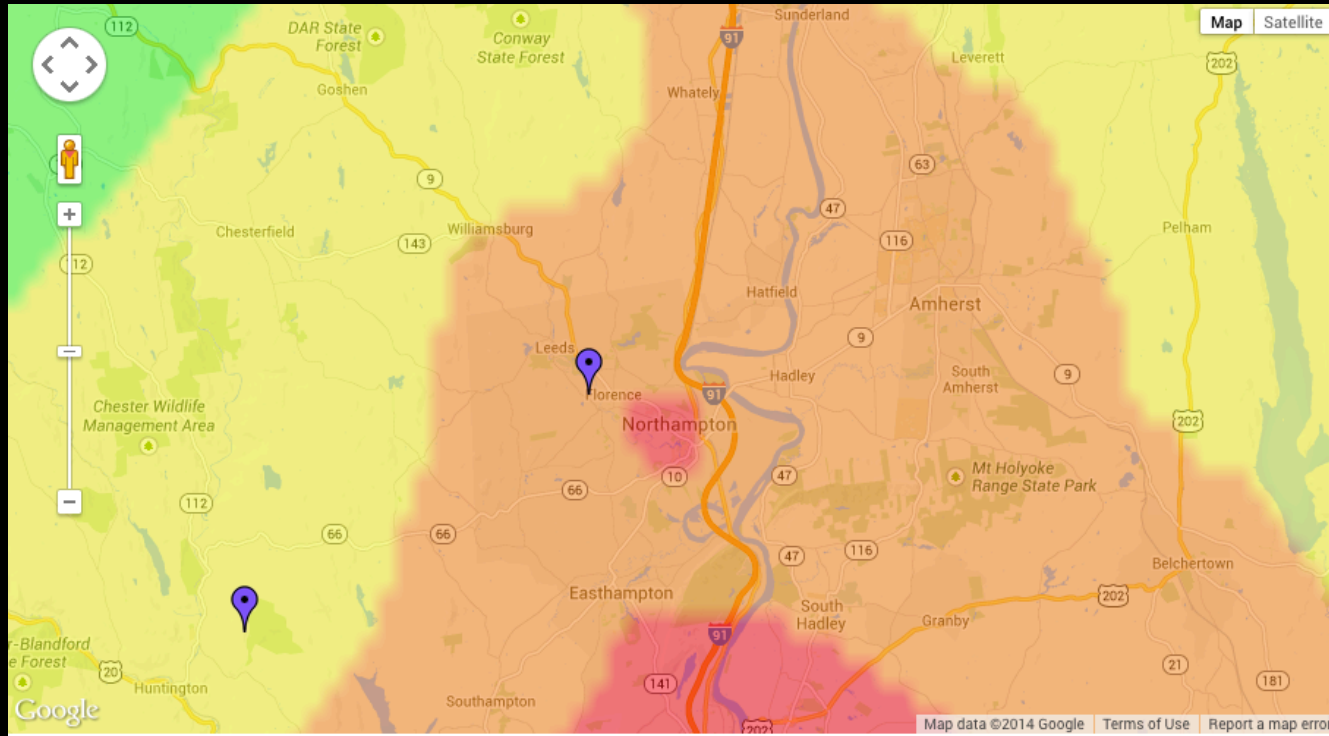
Light Pollution Control at Smith College, UMass Amherst, and McGill U.

James Lowenthal
Smith College





Northampton, MA: population 30,000



Color Magnitude	Bortle Class	Sky Brightness	
		mag/arcsec ²	Artifi./Natural
7.6 - 8.0	1	>21.90	<0.01
7.1 - 7.5	2	21.90 - 21.50	0.01 - 0.11
6.6 - 7.0	3	21.50 - 21.30	0.11 - 0.33
6.3 - 6.5	4	21.30 - 20.80	0.33 - 1.00
6.1 - 6.3	4.5	20.80 - 20.10	1.00 - 3.00
5.6 - 6.0	5	21.1 - 19.10	3.00 - 9.00
5.0 - 5.5	6,7	19.1 - 18.00	9.00 - 27.0
<4.5	8,9	<18.00	>27.0

Map shows brightness of night sky

Northampton's night sky (Bortle scale 5)
is **10x brighter** than natural dark sky conditions

Northampton Outdoor Lighting Code

§ 350-12.2. Lighting (March 2006)

- Overall, this was a good site lighting ordinance in 2006; needs updating now.
- Consistent with ca. 2006 best practices for preventing glare, uplighting, light pollution, and excessive lighting
- Consistent with ca. 2006 recommendations of International Dark Sky Association (IDA)
- Full cutoff lighting
- Shielding; no direct glare or light trespass
- Max. 5 foot candles = 500x brighter than full moon (too bright?)

✓ Fully shielded
 ✗ Unshielded

Fixtures with Adequate Cutoffs – ALLOWED	Light Fixtures with No Cutoff – PROHIBITED
	<p>(Other than Mass Electric for public ways)</p>
Fixtures with Adequate Cutoffs – ALLOWED	Light Fixtures with No Cutoff – PROHIBITED
Wall Packs:	
<p>Shielded</p>	<p>un shielded</p>
Residential Fixtures	
	<p>Flood light</p>

Northampton light pollution control ordinance NOT well enforced



New police station



New development

BCRP Series

OK CPM
9/24/08

38A-116

Catalog No.	Type:
Job Name:	

Features & Specifications

Materials

Post top fitter is heavy die-cast aluminum housing. Acorn globe is clear polycarbonate or acrylic acorn with a built-in Type III or V Refractor.

Finish

Thermoset polyester TGIC powder coat paint.

Ballast

HID - Magnetic core and coil, 120 or 277V, NPF.

Installation

Mounts to a standard 3" O.D. pole.

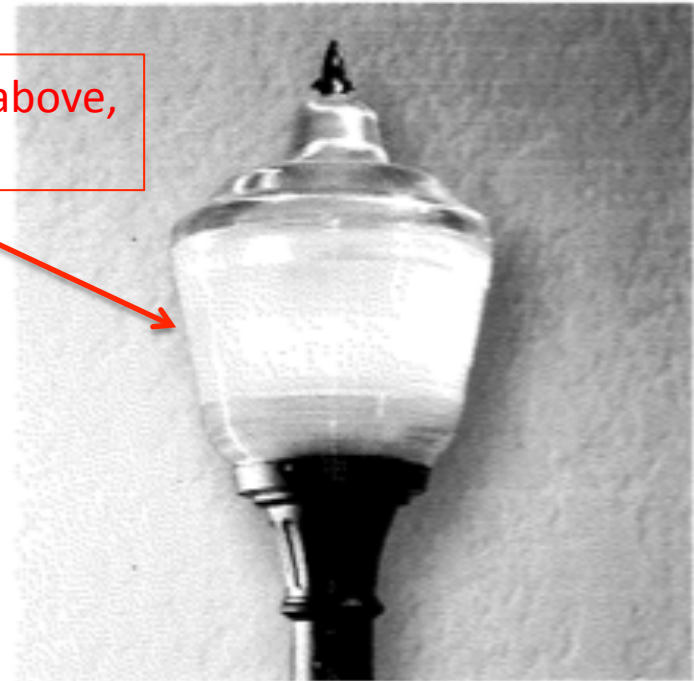
Warranty

Two years product warranty, exclusive of lamps.

Features

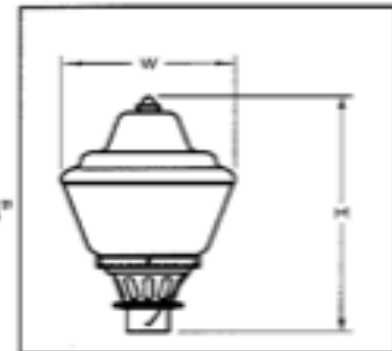
- UL listed **wet** location
- DarkSky rated
(with optional non perforated LiteLid)
- Built-in Refractor Type III or Type V distribution pattern
- Acrylic or Polycarbonate Globe

Light visible from above,
even with shield



BCRP -30
*Height - 28"
Width - 14"
Depth - 14"

BCRP -34
*Height - 32 1/4"
Width - 16"
Depth - 16"
*Finial adds 2"



Example: BCRP-34-8-M175-T-B99-CTP-T3-LLN

Model	Voltage	Lamping	Kelvin	Finish	Diffuser	Options
BCRP-30	1 120V/60Hz	M100 100w MH	T Clear	B99 Black	CTA Clear Textured	NR Neck Ring

Northampton Planning Office does understand need to control light pollution

L3 KEO Parking lot, Village Hill:
lights are **shielded** or **off** at midnight.

(Moon for comparison)



Presentations to City of Northampton

- Planning Board (advises Planning Office, approves/denies projects): one-hour talk
- City Council: proposed lighting curfew (vs. police chief)
- Transportation and Parking Commission: street and parking lot lighting
- Energy and Resources Commission: upcoming LED streetlight retrofits
- Petition to Mayor: “In support of Northampton Starry Skies”
- Plus: resident/homeowner/business owner info brochure and lighting audit

Fixing Light Pollution in the Pioneer Valley

Dear Homeowner, Manager, or Business Owner,

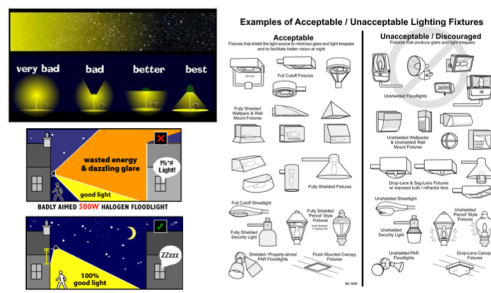
Your property has a light or lights that are:

unshielded poorly aimed excessively bright excessively blue _____

Not all outdoor lighting is the same. Good lighting should be (1) fully shielded, with the light going down only, not out or up; (2) not too blue; and (3) no brighter than necessary. Bad lighting causes glare and light pollution, which benefits no one but wastes energy, is dangerous and unsightly, is linked to health effects ranging from sleep disruption to cancer, is responsible for millions of bird and mammal deaths yearly, and ruins the dark, starry sky. Rule of thumb: *light bulbs should not be directly visible except from directly underneath the fixture.*

Would you please consider fixing the problem light(s)? Here are some suggested solutions:

- Re-aim floodlight so that it shines down only, and not beyond your property line
- Replace unshielded incandescent/compact fluorescent light (CFL) bulb with shielded light
- Sample shielded LED replacement light (CCT<3500K, <10 watts) provided free of charge*
- Replace unshielded fixture with fully shielded fixture, or add shield to existing fixture
- Replace uplighting with downlighting
- Turn lights off when not needed, e.g. 1 hour after close of business, after midnight, etc.
- Other: _____



* If you don't like the free replacement bulb, just call us and we'll put the old one back.

This handout delivered by: _____

Outdoor Lighting FAQ

Can I still keep my outdoor lighting?

Of course! But please keep the light on your own property, not your neighbor's. Properly shielded lights provide *better* visibility. And please turn them off when not needed. Thank you!

What's the big deal about glare?

Glare (unwanted light shining sideways) makes it harder to see the things you want to see. Glare is especially dangerous when it blinds drivers, bicyclists, and pedestrians. Glare also leads to high contrast and deep shadows that can hide intruders. The elderly are especially sensitive to glare.

What's especially bad about blue-rich white light?

Blue light disrupts sleep, ruins night vision and causes more glare in the human eye, making it harder to see what you want to see. Blue light also scatters more in the atmosphere: LED lights with correlated color temperature CCT = 5000K ("cool white") make 7 times more light pollution than LEDs with CCT = 3000K ("warm white"). Most people prefer "warm white" to "white" or "cool white".

Doesn't more lighting protect my property from criminals?

No. Scientific studies have found no confirmed link between outdoor lighting and reduced crime. In fact, bad lighting causes glare (see above), which is more dangerous. Safety is enhanced by better lighting, not more lighting.

Is outdoor lighting regulated by law?

Usually. For example, Northampton code Section 350-12.2 requires that all light fixtures shine downward only, with no light escaping above horizontal and no glare (unwanted, sideways-shining light) directed off the property, and specifies maximum permitted illumination levels.

How much will it cost to fix?

Since bad lighting is wasted energy, most fixes that reduce glare and uplighting will *save* you money. There may be upfront costs for new bulbs or fixtures, but they will usually pay for themselves within a few years. Example: changing a 25W unshielded CFL to a 5W shielded LED (\$16) saves \$8/year, so it pays for itself in just 2 years (assumes 4000 hrs/yr, 10 cents/KWH).

What are some good, shielded porch light bulbs (for down-facing fixtures only)?

- GE 4.5w PAR16 LED Bulb Dimmable Narrow Flood 180Lm Soft White (\$21, Foster Farrar)
- Satco S8997 6w 120v PAR16 3000k E26 FL40 (\$21; try <http://www.BulbAmerica.com>)
- TCP 7W (35W equiv) Warm White LED PAR16 (\$14; try www.bulbs.com)

Where can I find good outdoor light fixtures?

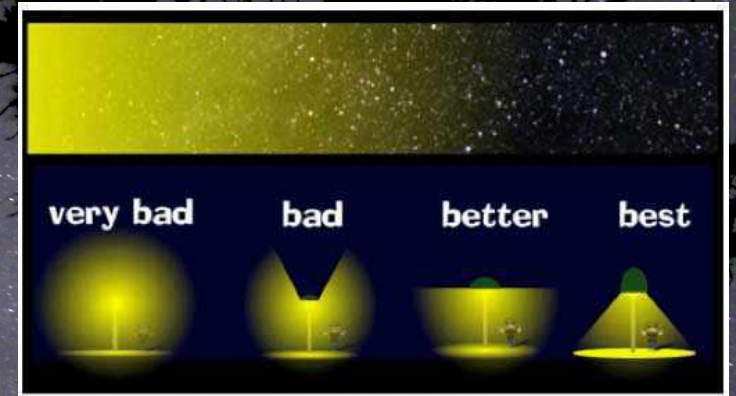
Whether you're shopping online or in a store, look for the *Fixture Seal of Approval* by the International Dark Sky Association.

Where can I find out more info?

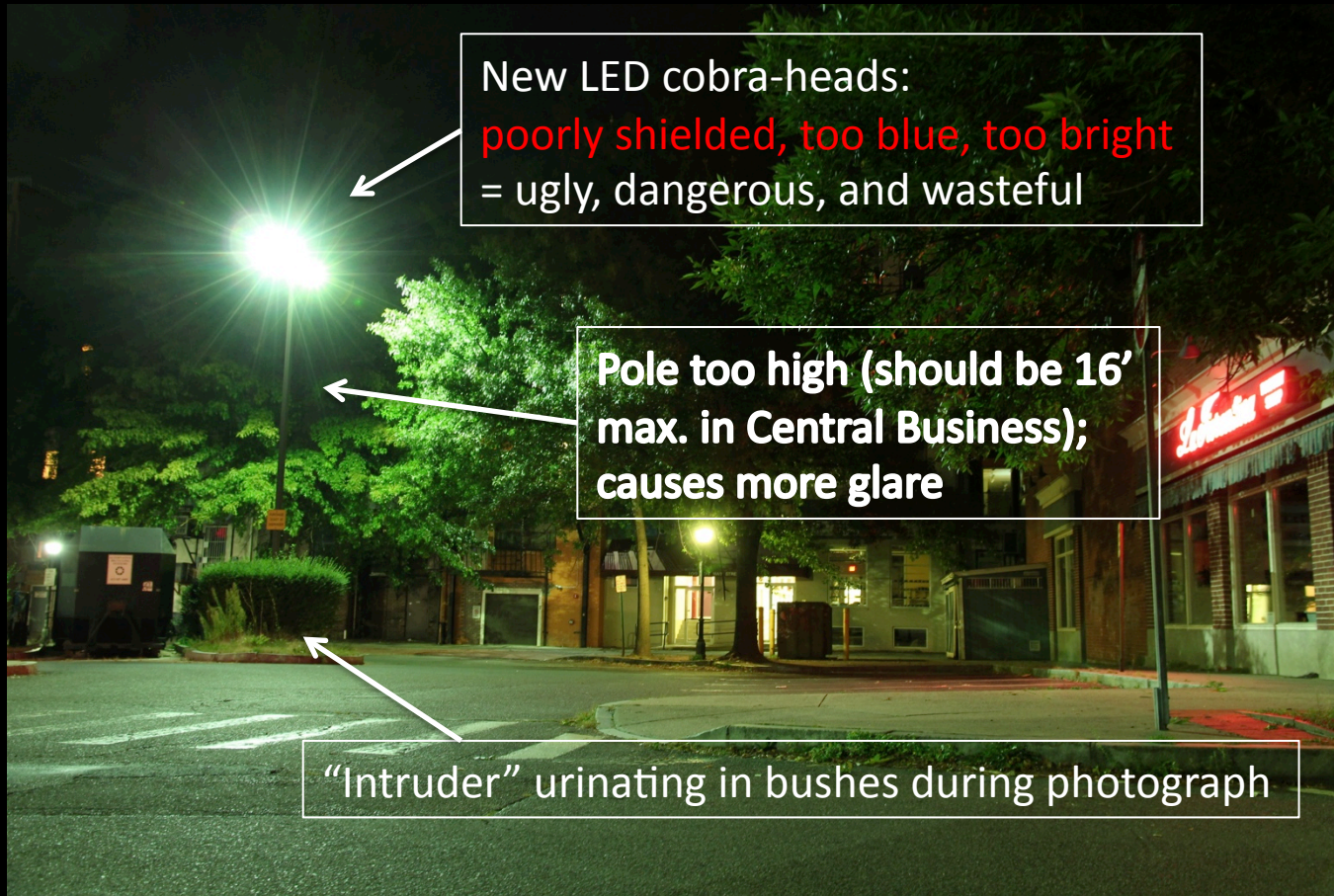
International Dark Sky Association: <http://www.darksky.org>
 Smith College Astronomy Dept.: <http://smith.edu/astrology/>
 Illuminating Engineering Society of North America: <http://www.ies.org>

Outdoor Lighting Concepts

1. Light should go down only, not out or up
2. “Warm” colors (<3000K) are better than “cool” colors
3. Lighting should not be brighter or on longer than necessary



Need to address fear and crime



Smith College: thanks to astronomer Dick White for setting standards (1980s)



Old standard



Current standard

Smith College, Capen House parking lot:
fully shielded luminaire; no glare; even, diffuse illumination; CCT=2700K .
Perfect!



Thanks to Gary Hartwell (project manager) for on-the-ground fixes



Fixed!



McConnell Hall entrance: fully shielded, CCT<3000K, not too bright.

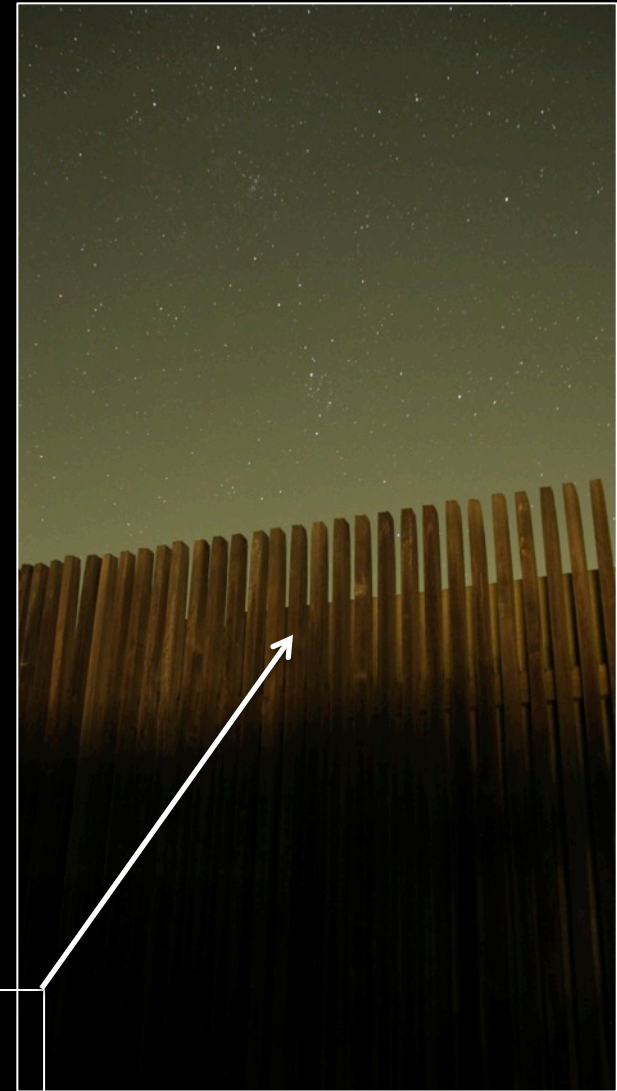


But: roof of McConnell not great...



View from McConnell Rooftop Observatory

Light cast on McConnell telescope shed
from Conference Center



Athletic field lights: visible from *above*





Park Annex

Light Pollution activities at Smith



- Liberal Arts lunch series: 45-min talk
- Facilities Management: lunch talk
- Student government: 10-min talk/Q&A
- 2-day visit by Paul Bogard (“The End of Night”)
- “Lighting Walks” organized by Dean of Students (pro-safety) 2x/year
- Regular star parties
- Board of Trustees: VIP stargazing
- Upcoming Kahn Institute project: “Fear”

Light pollution in Smith observational astronomy classes

Light Pollution Log

Name(s) _____ Date: _____ Time: _____

Exact Location: _____

Temperature: _____ Cloud cover (%): _____

Other weather conditions: _____

I. Sky Quality Meter with Lens (SQML)

Instructions:

1. Point the lens of the SQML straight up.
2. Press the Start button once. Wait for red numbers to appear. These show the sky brightness overhead in units of magnitudes per square arcsecond.
3. Press and hold button to see temperature (F and C).
4. Record three readings below, and take the average.



Reading 1: _____ Reading 2: _____ Reading 3: _____

Average: _____

II. Naked-Eye Limiting Magnitude (NELM)

Observe one or more of the three constellations shown on the *Light Pollution Star Charts* to estimate the magnitude of the faintest star you can just barely see using averted vision. Make sure to wait at least 10 minutes so your eyes are fully dark adapted, and if you need glasses, wear them for this measurement.

1. Ursa Minor

2. Pegasus

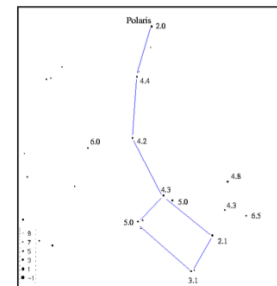
3. Cygnus

Light Pollution Star Charts

Record observations on separate *Light Pollution Log*

1. Ursa Minor (any season)

Compare your view of the Little Dipper (Ursa Minor) to the diagram below to estimate the limiting magnitude.

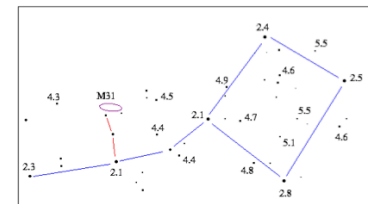


2. Pegasus (Fall, Winter)

a. Count the number of stars you can see *inside* the Great Square. Consult the table below to estimate the limiting magnitude.

Number of stars visible inside Great Square	Naked Eye Limiting Magnitude (NELM)
2	4.6
8	5.5
13	6.0

b. Compare your view of Pegasus and Andromeda to the diagram below to determine the limiting magnitude.



Light Pollution at Umass Amherst



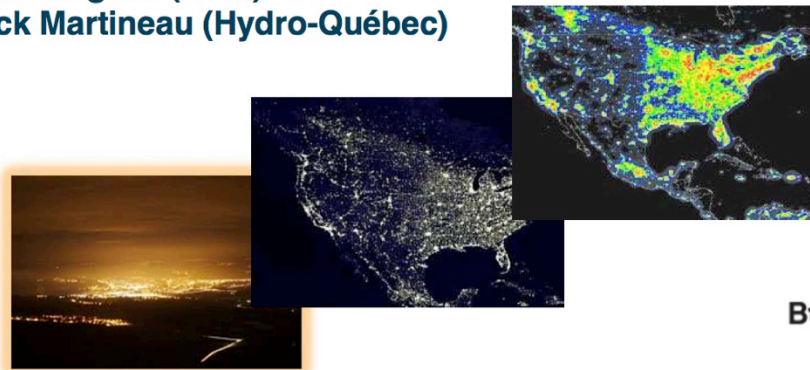
- Many years of negotiations with administration, so far fruitless
- Chair of Astronomy Dept. involved
- Promises to copy U. of Arizona specs in master plan, then forgotten
- Office of Sustainability, Dept. of Landscape Arch./ Regional Planning supportive
- Assoc. VC for Facilities: promised to shield future lights; no meeting with us
- Planning Office: no replies to emails
- No major grassroots effort (students, public, petitions...) yet

McGill U.: subject to Québec, Montréal regulations

Lunch-éclair IES Montréal
20 octobre 2015

Projet de norme BNQ P-4930-100 *Éclairage extérieur – Contrôle de la pollution lumineuse*

Daniel Langlais (BNQ)
Patrick Martineau (Hydro-Québec)



BNQ
Bureau de normalisation
du Québec

New provincial outdoor lighting norms now pending

Montreal about to move to LEDs



Total lunar eclipse from Mont Royal



Opposition letter by City Councilor Sylvain Ouellet

Currently on hold, pending input from IDA-Québec, FAAQ, CAAS, ASTROLab, MMO

Light Pollution at McGill U. (Montreal)



- Many over-bright, unshielded lights
- Light trespass on abutting property
- No existing policy on outdoor lights
- Director of Sustainability is receptive
- New Master Plan in the works, includes input from lighting designer; not (yet) dark-sky oriented



Interview on CTV

CTV MONTREAL... A PART OF THE CTV NEWS VIDEO NETWORK



Clip link: <http://montreal.ctvnews.ca/video?clipId=760934&binId=1.1332485&play>

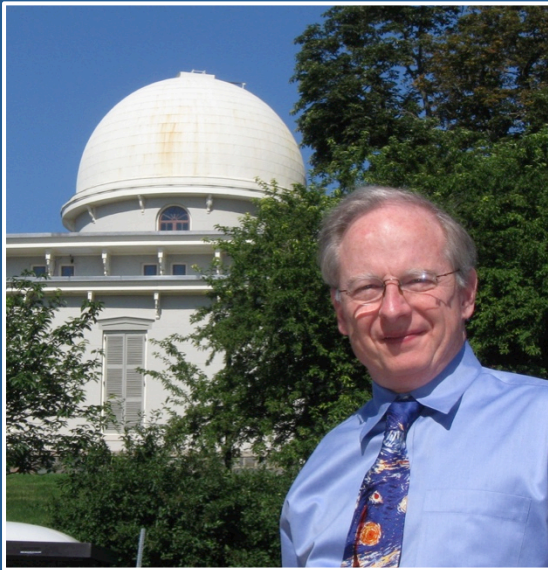
Summary: campus light pollution

- Find allies, preferably high up in institution
- Pick easy, winnable, high-profile first project(s)
- Focus on getting policy right
- Then play watchdog to see that policy is enforced
- Involve students in measuring sky brightness
- Discuss fear, safety, and crime openly, but respectfully
- Mention health impacts of light pollution
- Emphasize the positive: “We can make campus more beautiful, safer, healthier”



Invited Speaker

Pat Seitzer, *Lowell Observatory.*



- A Research professor in the Dept of Astronomy at the University of Michigan in Ann Arbor.
- His research specialty is applied astronomy
- Specifically, studying the distribution of orbital debris in Earth orbit from the breakup of artificial satellites.

Observing from an Urban University Observatory

Patrick Seitzer

Department of Astronomy

University of Michigan

Ann Arbor, Michigan

pseitzer@umich.edu

1854 Detroit Observatory, Ann Arbor, Michigan
named for donors from city of Detroit



1854 Detroit Observatory, Ann Arbor, Michigan
named for donors from city of Detroit



Angell Hall Student Observatory
University of Michigan, Ann Arbor, Michigan



Angell Hall Student Observatory
University of Michigan, Ann Arbor, Michigan



Angell Hall Student Observatory 0.4-m DFM RC
University of Michigan, Ann Arbor, Michigan



Angell Hall Student Observatory HVAC systems – earthquake simulator



Angell Hall Student Observatory
University of Michigan, Ann Arbor, Michigan



Angell Hall Student Observatory
University of Michigan, Ann Arbor, Michigan



Angell Hall Student Observatory
University of Michigan, Ann Arbor, Michigan



University of Michigan Observatories Ann Arbor, Michigan

Detroit Observatory



View from Student Observatory



Invited Speaker

Jeff Hall, *Lowell Observatory.*



- Director at Lowell Observatory.
- Received his BA from Johns Hopkins and his PhD Penn State
- For the Ph.D., specialized in optical spectroscopy of the Sun and Sun-like stars.
- Worked fervently on many dark-sky preservation issues in Flagstaff and in Arizona.

DISCUSSION QUESTIONS