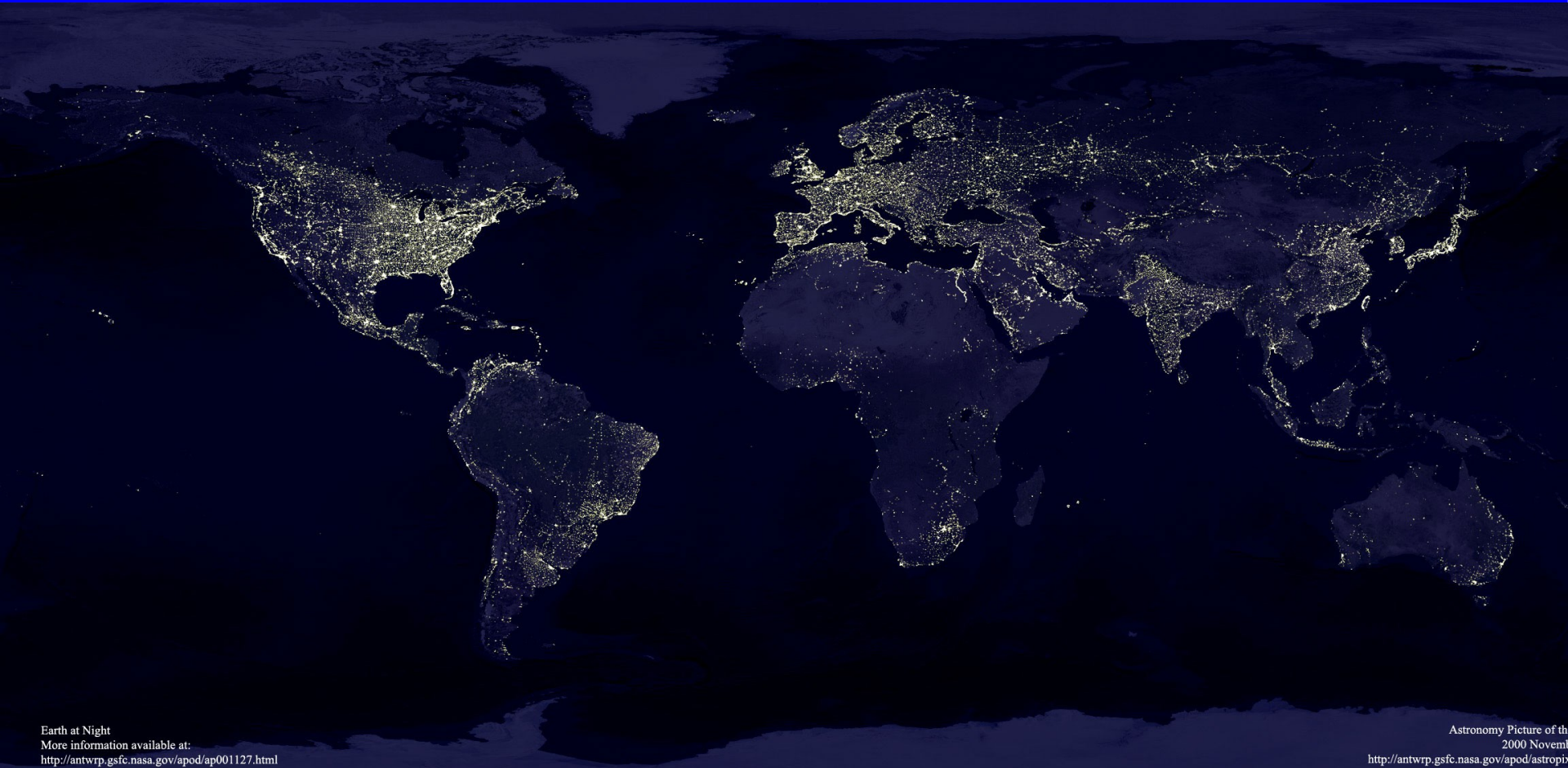


Gloucester Lighting

The Good, the Bad, and the Ugly

By Mario Motta

What threatens the night? Light pollution!





What's light pollution?

- Light pollution
- Any adverse effect of artificial light
 - * Sky glow
 - * Glare
 - * Light trespass
 - * Light clutter
 - * Decreased visibility at night

What else is light pollution?

- Light pollution
- Any adverse effect of artificial light
 - * Loss of community
 - * Loss of safety & security
 - * Damage to human health
 - * Energy waste
 - * Air & water pollution
 - * Disruption of nature (e.g. birds, turtles)

Where would you really want to live

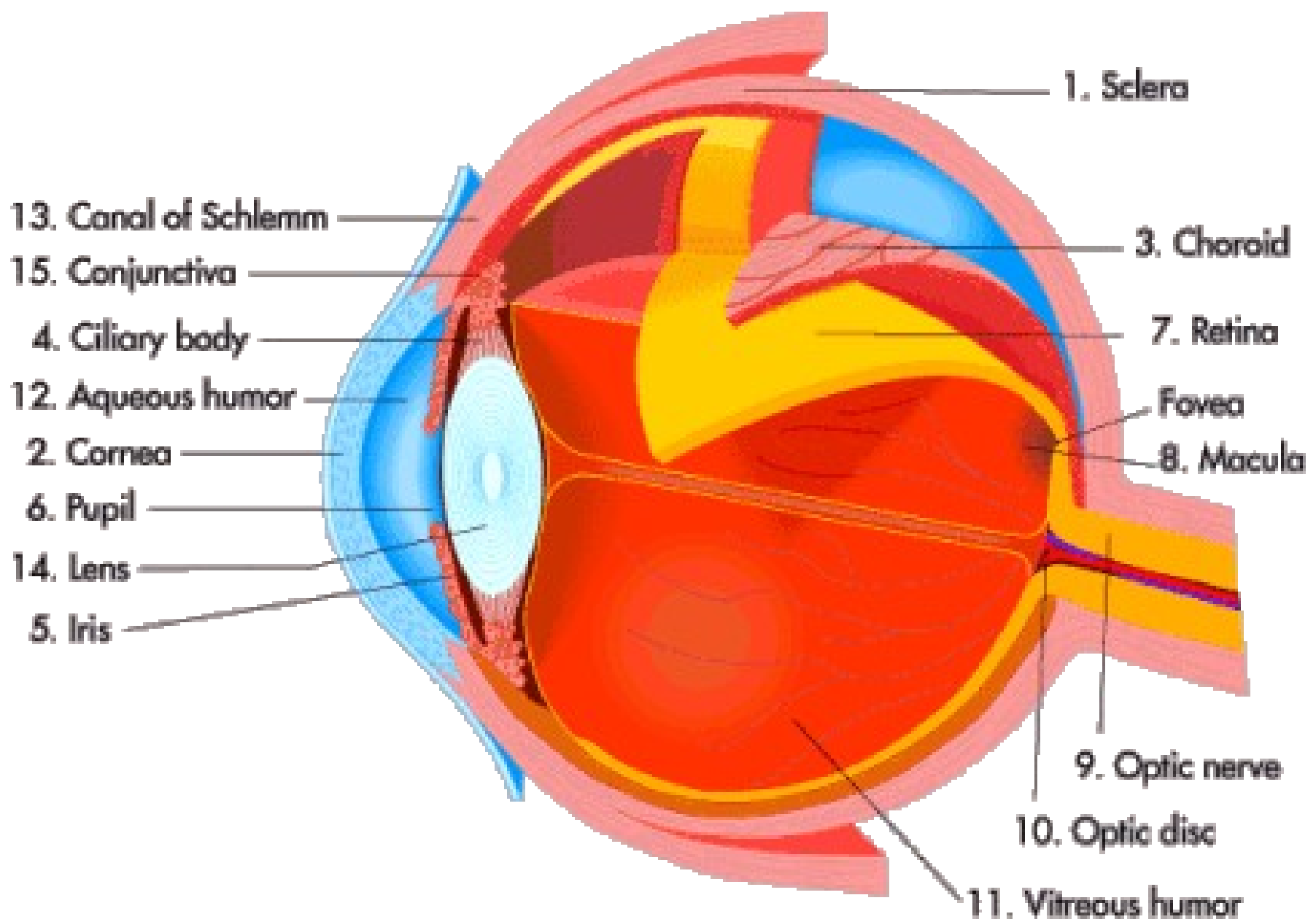


Why so much bad lighting?

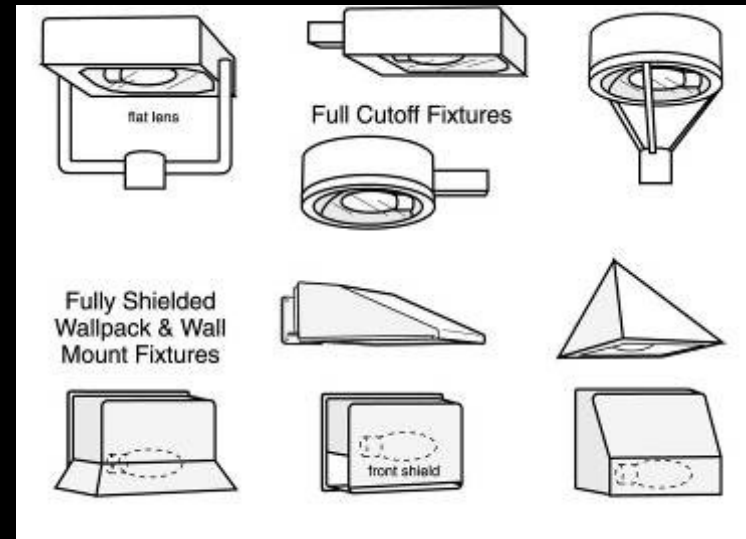
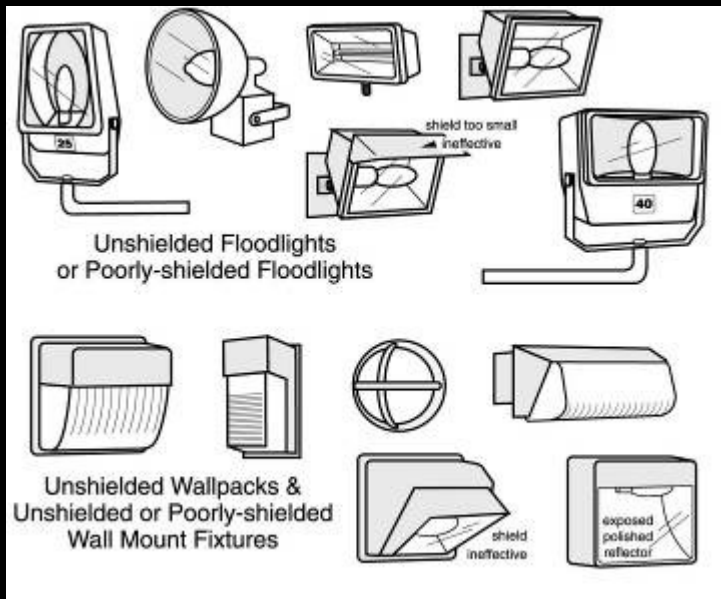
- * Lack of awareness
 - * The public
 - * Government
 - * Builders, contractors, owners, operators
 - * Even the lighting community!
 - * Apathy, inertia

- Why protect the night environment?
 - * For the night around us
 - For people
 - For wildlife
 - For plants
 - * For the night above us
 - For its beauty
 - For world cultures
 - For astronomers & stargazers
- Dark skies are natural skies





Unshielded vs. Shielded



Problem: “old” fixtures were originally designed for flame light sources



500 LUMENS
---40 WATTS
incandescent and
9 watts compact
fluorescent) WILL
ILLUMINATE A
DOORWAY



“Brightness” and greater lumens emitted per watt
increasing with technological advances

Candle, gas, and oil “flame” light sources

= less than 200 lumens

100 watt incandescent / 23 watt compact fluorescent

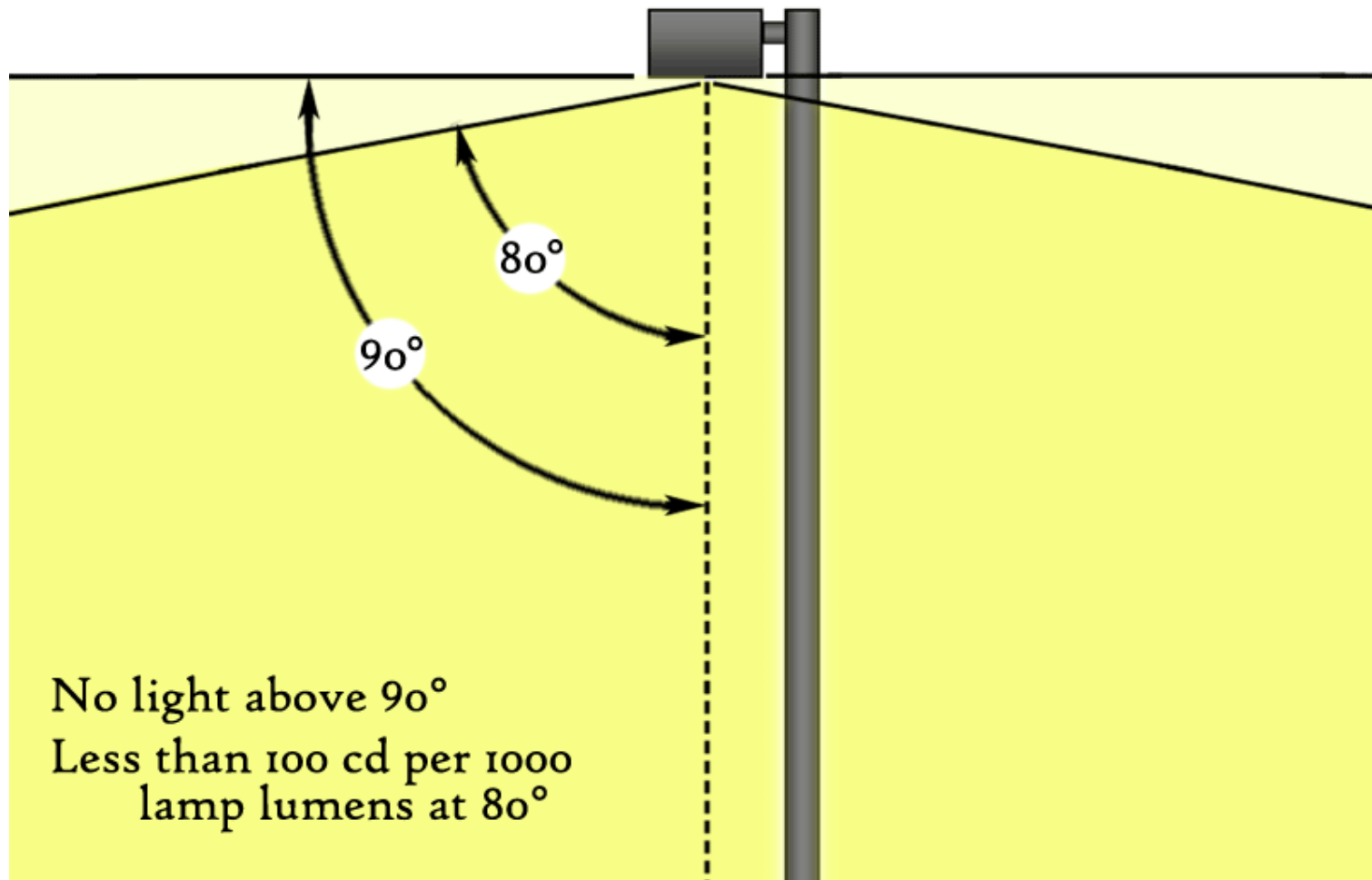
= 1,800 lumens

High Intensity Discharge bulbs

= 8,000 to 124,000 lumens

FULL CUTOFF FIXTURES: The “Gold Standard”: No light at or above the fixture and restricted light output in the “Glare Zone”

Full cutoff fixture



Glare interferes with good vision

Unshielded lighting-veiling luminance



It's hard to see in the presence of glare caused by unshielded lighting.

Can you see the pedestrians walking in front of your car?

Glare interferes with good vision

Unshielded lighting-veiling illuminance



It's hard to see in the presence of glare caused by unshielded lighting.

Can you see the pedestrians walking in front of your car?

Shielded lighting



With shielded lighting the glare is reduced significantly.

Safety is improved.

Glare inhibits good vision, reduces security



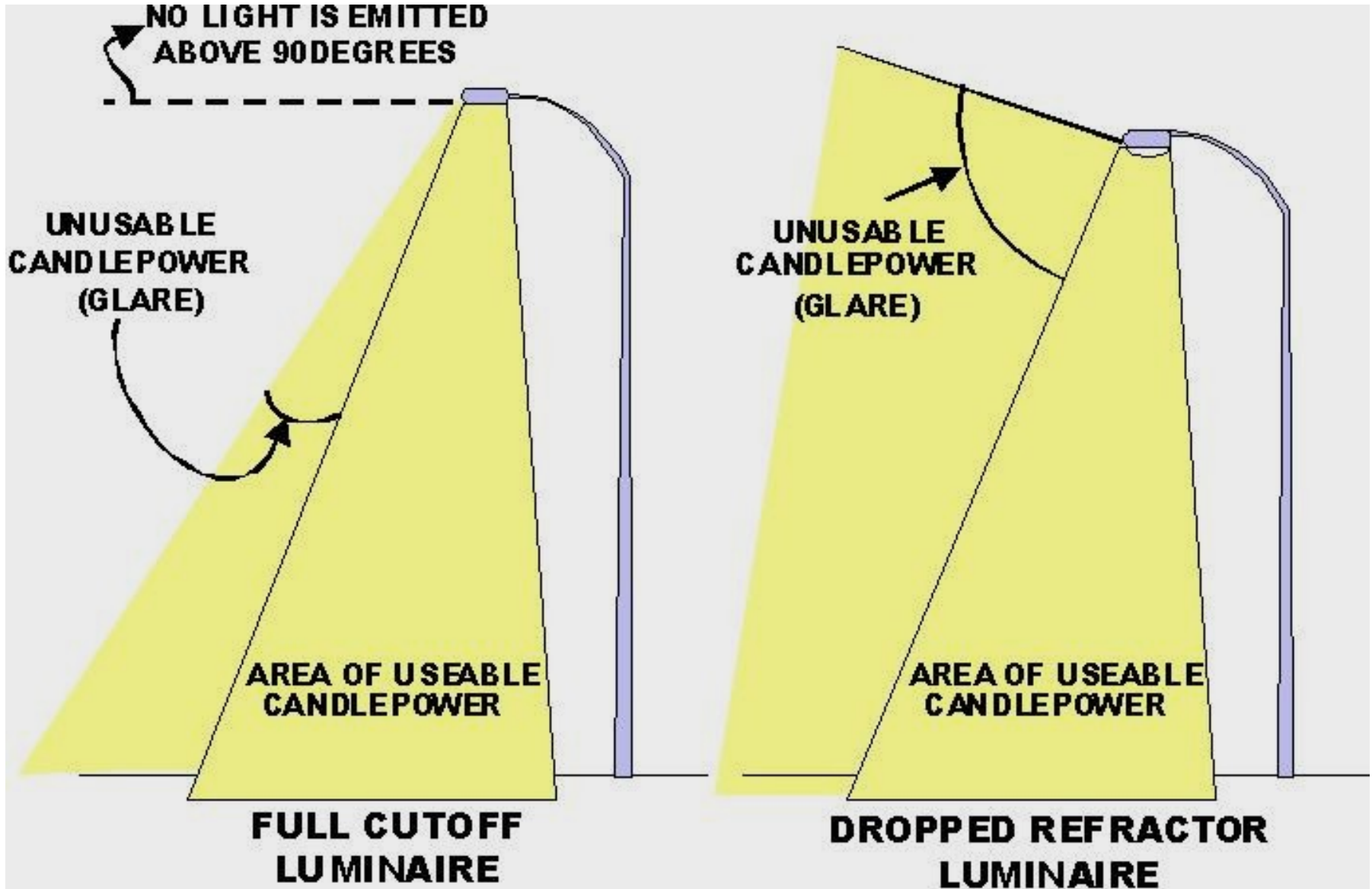
What is wrong with these lights? Try to follow where this person goes...

Glare inhibits good vision, reduces security

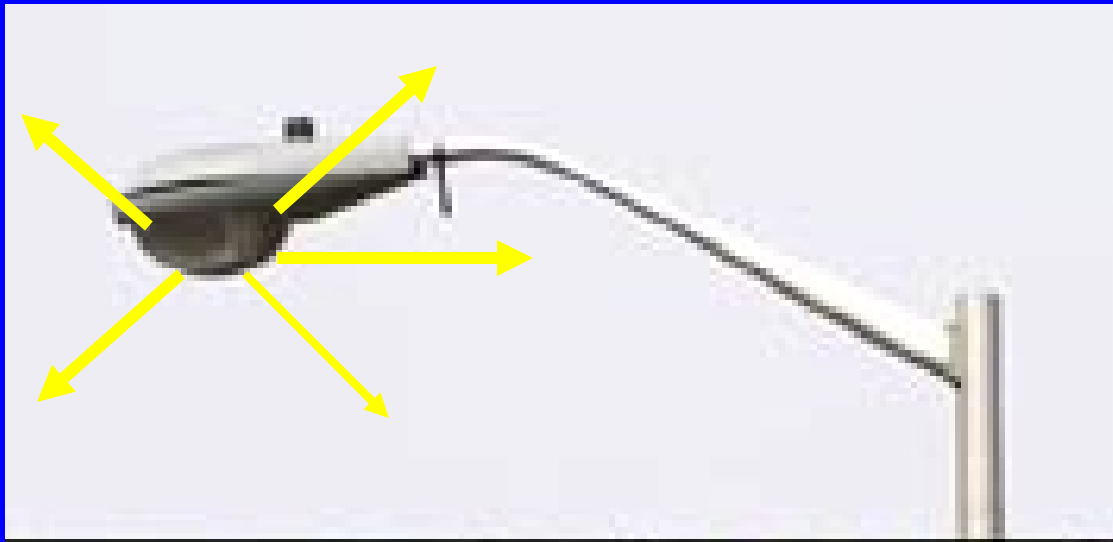


She is still in the picture- can you find her?

30 to 50% of all light pollution is produced by roadway lighting that shines wasted light upwards and outwards.



Cobrahead Streetlight innovation: Drop lens vs. Flat lens



Retrofits underway in New York Communities in advance of NY State Legislation:

East Hampton Town, East Hampton Village, Riverhead, Southampton, Brookhaven, and other municipalities

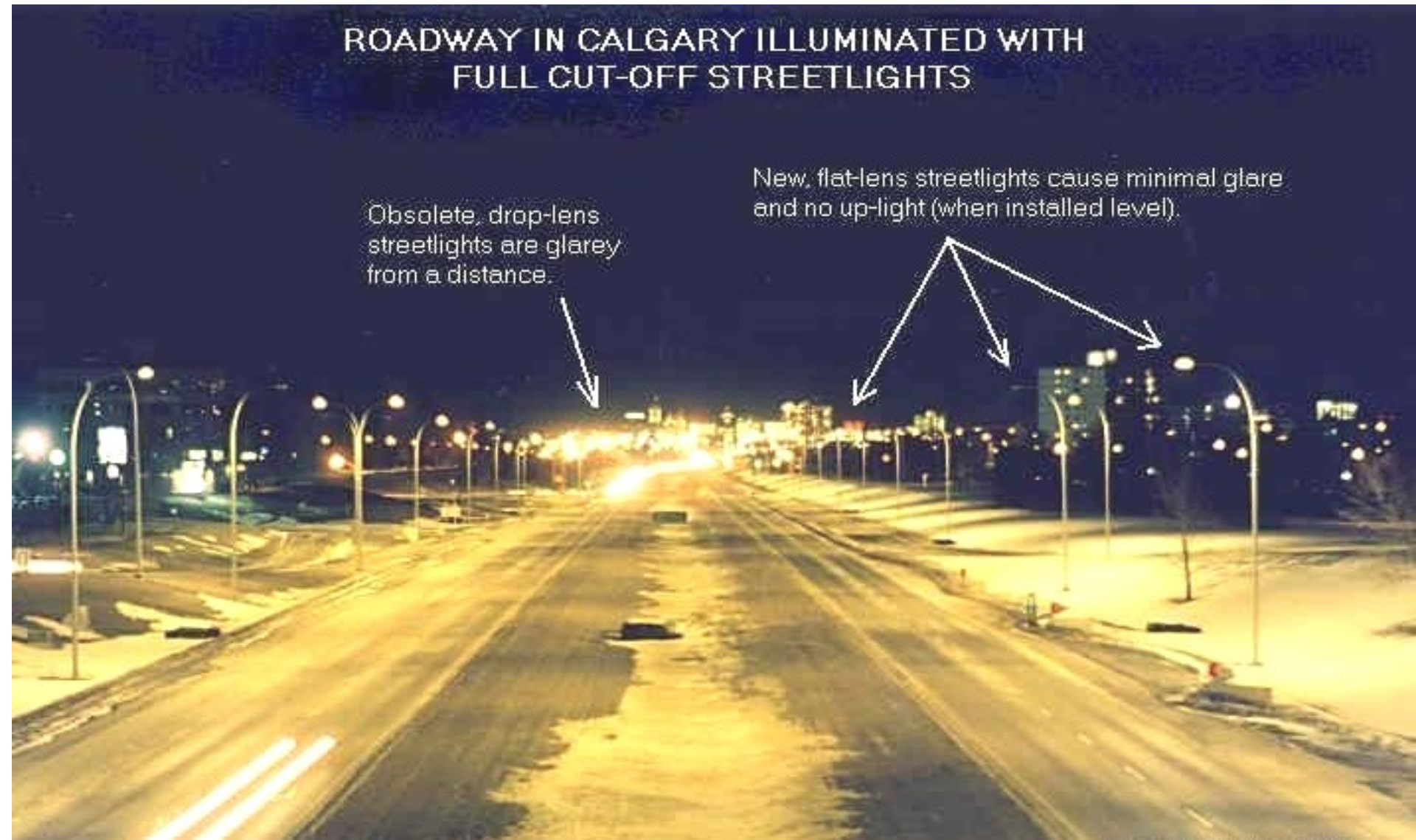
As well as entire states of Washington, Texas, New Mexico, Arizona, California.

“In Process” streetlighting conversion in Calgary, Canada to Full Cutoff fixtures, and with a reduction in wattage, saving \$1.7 million tax dollars every year. (ROI 4 yr)

ROADWAY IN CALGARY ILLUMINATED WITH FULL CUT-OFF STREETLIGHTS

Obsolete, drop-lens streetlights are glarey from a distance.

New, flat-lens streetlights cause minimal glare and no up-light (when installed level).



Night Vision Impaired by Glare

Humans can see in a broad range of lighted environments,
but not at the same time:

- sunny beach: 12,000.00 footcandles
- bright moonlight: 0.02 footcandles

Glare interferes with night vision “adaptation”
from dark to light to dark (E.g. Gas stations at 100 fc)

The Adaptation period takes longer as we age,
because the membranes in the eye are not as elastic.

GLARE: when a visible light source is brighter than the surroundings, reducing our ability to see well at night.

---Technically called “Veiling Luminance”.

The eye cannot adjust when the ratio of bright to dark is greater than 20:1.

In a dark environment, “glare” can occur with a bare light bulb over 500 lumens (40 watts incandescent).

Types of GLARE:

Disability, Distracting, and Nuisance

(Lighting Research Center, Dr. Peter Boyce)

Glare and Light Trespass

- **Glare**
 - Direct view of light source by the eye
 - Cause: light fixtures aimed horizontally, not down
 - Recognized as issue by professional lighting organizations
- **Light trespass**
 - Light spilling off originating property
 - Generally not welcomed by neighbor
- **Effect of glare and light trespass**
 - Annoyance, vision disturbance
 - In severe cases, can be a safety hazard
 - Accidental deaths documented
 - Poor lighting leads to more poor lighting
 - Effect on character of community



Church, Prospect and Pleasant St

Is this light burned out?



No!, it never sees night to turn on.



Unshielded light examples



Pole-mounted 400-W floods



Drop-lens 175-W mercury road light



Light pattern from floods

Unshielded lights---

- **Generally poor control over light direction**
- **Light spill and glare unavoidable**

GE Powerflood Turnpike fixtures: NO MORE new utility pole installations !!!



16,000 of these fixtures currently installed all over Long Island will be phased out.



How much is enough light?

- * The more, the better is a myth
 - Use IESNA or CIE recommended levels
- * Consider location
 - Use environmental lighting zones
- * Consider task
 - Use good transition lighting
- See the effect, not the source

More glare and turned off streetlight, Main Street



Glare and light trespass

Prospect Street



Examples of fully shielded lights



Fully shielded road light




Fully shielded box-type parking light

Fully shielded lights

- No light emitted above horizontal plane thru lowest light-emitting part
- Provide good lighting with reduced glare, light trespass and sky glow
- Recognize by their flat, horizontal, clear lens



Shielded Lights, no glare



Glare from utility pole mounted floodlights into
right-of-way disables vision of drivers and
obscures pedestrians

Bass Ave., Glare Bomb, and public safety hazard



Little light falls on Parking lot. Most hits drivers. Is this Safe?

Parking lot light not creating Hazard



Bass Ave, Shielded light has no glare, Drive safely

Shielded lighting examples



Fully shielded streetlights along road

Streetlight bulbs not visible- no glare

Compare to unshielded business lights

How differently this scene would look if all lights were shielded!



Fully shielded lighting pattern

Light directed down, not horizontally



Salem



Haunted
Happenings

Salem



Haunted
Happenings



Salem. All glare light, street dark. Cannot even read sign under light





Street dark. Lights point upward, look good in daylight only

Bad transition lighting





Main St. lights go in windows, not the street.



All glare and shadows, poor for pedestrians, tacky



Main St, Glare and poor public safety. Worse with rain or snow

East Hampton, NY, Main Street “Before” post top fixtures changed



Glare was debilitating to drivers and pedestrians, causing accidents

85 Montauk “Carriage Light” Conversions



Bulb
moved
up
under
opaque
cap

The Long Island
Manufacturer,
Magniflood,
re-designed their
own fixture



- Reduction of 100 watts each fixture gives better illumination
- Light bulb recessed into cap conceals glare
- Headlights able to light pedestrians in the center of the road
- Reduction of glare, light trespass, and skyglow



Light points up and sideways, not on street



Bank. Can you see the car right under the light?

“Bright lighting sells” ?

Customer reaction to improved lighting

Original fixtures



Full cutoff fixtures



“The percentage of drivers turning in to the station and the mean number of gallons of gasoline sold daily increased immediately following the change of lighting from the drop-lens, non-cutoff luminaires to the flat-lens, full-cutoff luminaires”

An Evaluation of Three Types of Gas Station Canopy Lighting

P.R. Boyce, C.M. Hunter, and S.L. Vasquez, Lighting Research Center

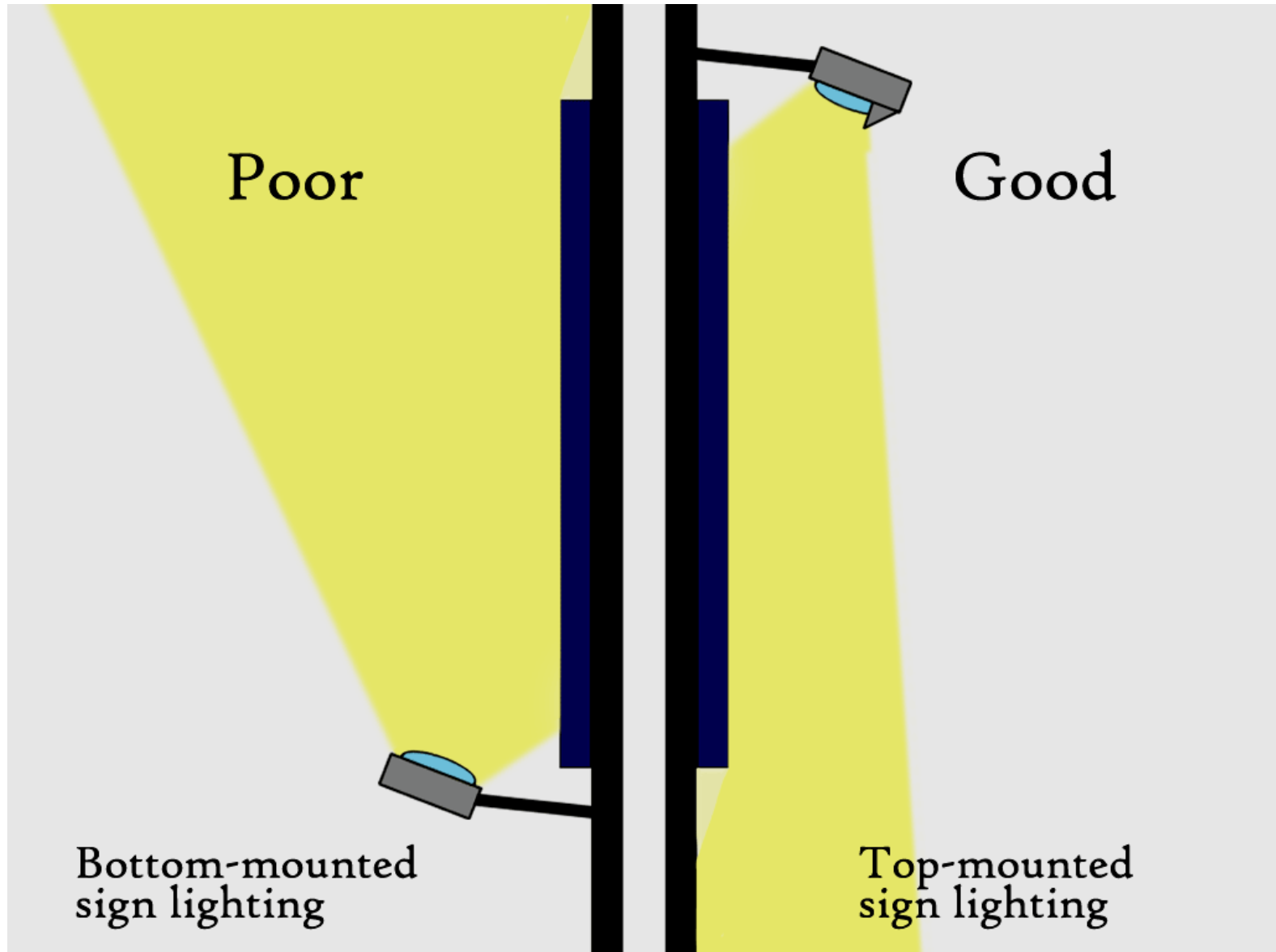
Rensselaer Polytechnic Institute

Good Business lighting!

**c.a.p. / Discount
Auto Parts**



Billboard and Sign Lighting





Over 300 watts does not increase visibility;
wasted energy lighting the night sky.

Advertising searchlights rotate 72,250 lumen beams that can be seen for over 5 miles



Photograph taken in Oklahoma

McDonald's franchises are being offered leased searchlights.



How Much Light is Enough?

- **Many installations use much higher light levels than...**
 - Needed for good vision
 - IESNA-recommended minimums
- **What are some reasons for higher-than-needed light levels?**
 - Don't know what's needed (didn't hire professional help)
 - **Common Belief: “better security”**
 - Contrast safety vs. security needs
 - **Common Belief: “bright lighting sells”**
 - Outdoor sales areas need brighter light for the task
 - Bright lights get attention (but will not be pleasant)
 - RPI study; uniformity is the key

Why use recommended minimum levels?

- **Prevent light level ratcheting**
 - Protect existing responsible businesses from new adjacent development
- **Reduce sky glow**
- **Save money, energy costs**
 - Typical lot of 20 lights, 4x over IESNA recommendations, => \$7500/10 years in excess electricity cost
- **Visually effective**
 - Uniformity, not total level, more important for good vision.
 - Recommended levels have really been shown to provide good vision
- **Treat customers considerately**
 - Provide safe, adequately lighted area that feels secure
 - More pleasant shopping experience.
 - RPI study of customer preference
 - Attract customers and provide better business?

Bad Business lighting! All glare, poor visibility



Great lighting, pleasant, good visibility





Not the worst, but still glare, and poor. Building lights upward



Good lighting!, all shielded, point down. Pleasant



The correct way to light, safe and efficient

Business rewards of good outdoor lighting

- **Improve your business attractiveness to customers**
 - Eliminate annoying glare
 - Use recommended light levels
 - Treat customers like adults- don't shine lights in their eyes
- **Save money and improve profit margins**
 - Lower operating costs for lighting energy
- **Improve relations with residential neighbors**
- **Reduce your potential liability claims**
 - Customers can see better, avoid injury

Good parking lot lighting



Fully shielded lighting greatly reduces glare

Glare poor lot lighting



Good lot lighting



Does this parking lot make you feel secure?



Walking toward your car against strong glare.....feel secure?

Does this parking lot make you feel secure?



Extra light reveals a person hidden by glare, non-uniformity!

Enhance security by eliminating glare and improving uniformity

Can anyone see the steps?



Garage floodlights





Anyone want this house as a neighbor?

A private home with six sets of 150 watt high pressure sodium "*Floodzillas*" on each corner, projecting intense glare for miles, dusk-to-dawn



36 West Pond Drive, Southampton, NY

Security Lighting:

Is bright Lighting effective in reducing crime?

- Recent survey of inmates convicted of property crimes
 - Question: what were deterrents to you carrying out crime?

- Results:

Top deterrents were; (percentage of respondents)

- | | |
|-----------------------|--------------|
| – Dog | 15.8% |
| – Alarm System | 15.1% |
| – Move to safer area | 10.2% |
| – Someone at home | 9.7% |
| – Owner buy/use a gun | 7.3% |
| – Security lighting | not on chart |

Lighting and crime

- Many school systems have discovered shutting off lights actually reduced vandalism.
- Teenagers congregate at well lit places, not in the dark
- Over lit homes advertise: “I own valuable things”, do not deter crime in any study

And Timers and Sensors save even more money and pay for their cost and installation



For “security” when you are away:

Give your home the illusion of being occupied by setting interior lights on independent timers.

Leaving on exterior lights “on” when you are away helps vandals and criminals to see their way while not “protecting” your property.

It is more **cost effective** to use a real security system.

Security Lighting:

Is bright Lighting effective in reducing crime?

- **Studies of effectiveness of lighting on reducing crime**
 - “Sometimes makes an improvement, sometimes doesn’t matter, sometimes makes situation worse” –(*NIJ report to Congress [1995]*)
 - Improvement in roadway lighting reduces crime [2000]
 - But daylight crime reduced too- other factors?
 - Dark campus experiments
 - Turning off lights actually reduced vandalism.
- Survey studies show: (*Clanton et. al. [2002], private comm.*)
 - More glare leads to feeling of less security
 - Poor or no correlation between lighting levels and feeling of security

Light Pollution Consequences:

- Stars obscured by **SKY GLOW** from “up” light
- Visibility decreased due to **GLARE** from bright light sources, interfering with night vision
- **LIGHT TRESPASS** crossing private property boundaries, disturbing peaceful enjoyment
- **WASTED ELECTRICAL ENERGY**
- **ECOLOGICAL** Disturbances
- **HUMAN HEALTH** Affected
- **LOSS OF CONNECTION** to the stars in “Night Sky”

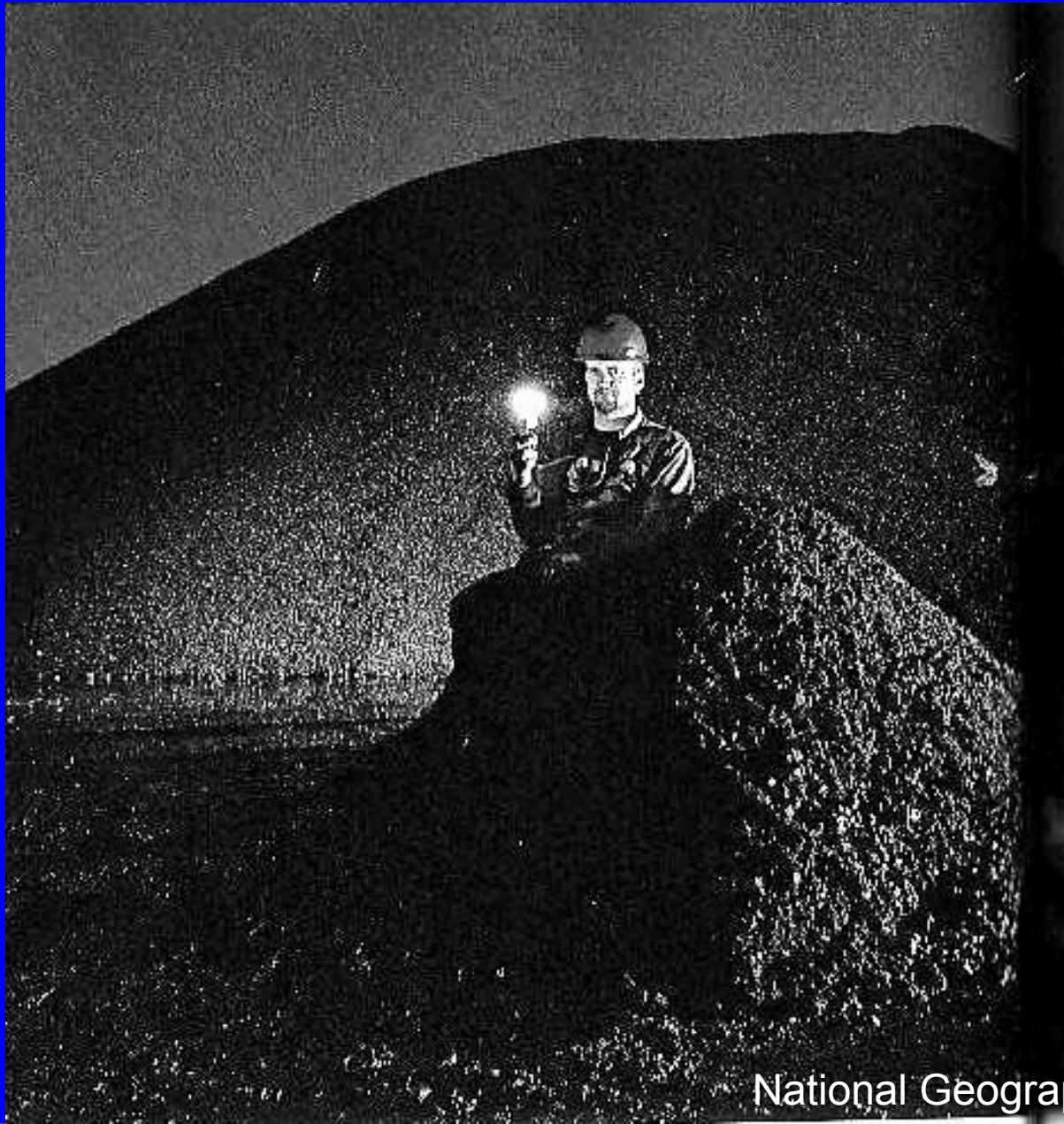
- 30% of night lighting estimated to be expended upward by unshielded or excessive lighting.
- ESTIMATE:= \$4,500,000,000+ per year in the U.S. wasted
* International Dark Sky Association, Tucson Arizona
- Consuming (electricity is primarily generated by burning finite fossil fuels):

6 million tons of coal

23 million barrels of oil per year

Light Pollution causes economic waste, manifested in additional and unnecessary municipal expenses which increase our taxes and higher consumer product prices.

One Half Ton of coal is burned to produce 100 watts of incandescent dusk-to-dawn lighting



National Geographic Magazine

Light Pollution = Air Pollution

- Every kilowatt causes release of:
 - 1.3 pounds carbon dioxide
 - 2 grams sulfur dioxide
 - 1.6 grams nitric oxide

Yearly:

- 62 billion kWh = 40 million tons of CO₂
= 1.4 million tons SO₂
= 1.1 million tons NO



What are they thinking? Prison atmosphere

Overall better lighting

Glare bomb ruins it



Light Pollution affects Human Health*

- Interferes with circadian rhythms
- Air and water pollution related health problems
- Melatonin suppression
- Sleep disturbances
- Suspected in rise in childhood leukemia
- Glare into roadways creates dangerous conditions for drivers and pedestrians
- Loss of our natural nocturnal environment contributes to loss of connection to nature and the inspiration of a star filled night sky

* Researchers: Blask, Pauley, Brainard, Rea, Schernhammer, Crain

LIGHT AT NIGHT

suppresses the production of Melatonin:

“... the evidence is accumulating, that light at night, and the consequent decrease in melatonin, may be a major driver of breast cancer.”

--- Cancer Epidemiologist Dr. Richard Stevens

Melatonin is now being studied as a way to prevent and treat breast and other cancers.

Flora and fauna have evolved over hundreds of millions of years in a bright day - dark night cycle, with moon phase stimulated behaviors.

Light Pollution dramatically disrupts habitats and behaviors of:

- Birds (more than 100 million song birds die every year due to upwardly directed night lighting)
- Amphibians
- Fish
- Insects
- Mammals

Night lighting results in ecological disturbances and mortality of individuals and entire species in ways that being discovered in every study conducted.

"Ecological Consequences of Artificial Night Lighting", UCLA, 2002

"Ecology of the Night Symposium", Muskoka Heritage Institute, September, 2003

“All of the things we do for nature preservation are necessary, but they might not be sufficient if we don't address this.”

-- Travis Longcore, Research Assistant Professor of Geography at the USC Center for Sustainable Cities,
and author (with Catherine Rich) of [Ecological Consequences of Artificial Night Lighting](#), Island Press, 2005.

Professor Longcore is also Science Director of The Urban Wildlands Group, a Los Angeles based conservation nonprofit.

Birds

Hundreds of millions of song birds die every year*

during migrations when they are thrown off course by bright, upwardly directed night lighting, and when they die in collisions with lit structures or from exhaustion when circling them.

“Lights distract migratory birds from the visual cues they receive from the stars and the moon”, -- Douglas Stotz, a conservation ecologist at the Field Museum in Chicago.

Predator-Prey relationships are altered: Crow and pigeons have been found to be greater in number in all-night lighted areas because owls and predators will not thrive there.

--National Audubon Society and Fatal Light Awareness Program

* U.S. Fish and Wildlife Survey

Light Pollution—Plants affected

Alteration of growth patterns, flowering, dormancy and pollination (“Security Lighting and Its Impact on the Landscape”, *Journal of Arboriculture*, 1975)

TREES: are stressed and die prematurely when dormancy delayed and growth altered. (Purdue University)

WATER quality: increases in algae bloom when lighted water inhibits movement of zooplankton (Moore, *American Scientist*, 2001)

Amagansett, NY tree holding leaves longer in the same pattern as the semi cutoff fixture, not achieving full dormancy before winter weather sets in, shortening tree life.



Shoreline Glare reflecting on water interferes with maritime navigation

“Lights from boats can often be obscured from lights on nearby land”,
said Homicide Squad Detective Lt. Jack Fitzpatrick after a fatal boat accident on Long Island. —
Newsday 8/05

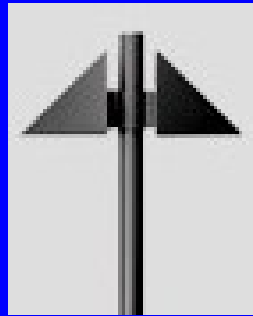
Water acts like a mirror



Photo:

Citizens for Responsible Lighting

1 Most effective Solution for Light Pollution: use shielded Fixtures



Simple & Cost effective Conversions to “dark sky friendly” lighting:

- one-for-one replacement to shielded version of fixture and reduce wattage
- bulb replacement to lower output
- bulb type replacement to reduce impacts
- re-aiming floodlights (and reduce watts)
- add switching control
- add retrofit shield
- add motion sensor
- remove unnecessary or redundant lights

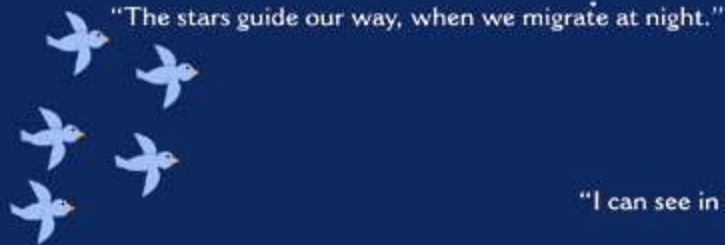
Community rewards of good outdoor lighting

- **Community nightscapes are more attractive**
 - Enhances potential commerce and quality of life
 - Improves property values
- **Visual acuity is enhanced**
 - Roads safer for drivers and pedestrians
 - Increased security- police have improved vision
- **Reduction of glare and light trespass**
 - Reduces undue eye stress and annoyance
- **Cost of energy for public lighting reduced**
 - Efficient, low-wattage, well shielded public lighting

Guide to good outdoor lighting

- **Use only as much light as needed**
 - Light intensity compatible with surroundings
 - Turn off lights when nobody is present to benefit
 - Encourage motion detection lighting for security
- **Use shielded outdoor lighting fixtures**
 - Direct light below the horizontal plane
 - Keep your light on your property
- **Glaring lights have a deleterious effect**
 - On safety
 - On quality of our environment

The night is full of plants and animals that depend on darkness for a healthy habitat.



"I can see in the dark, thank you"



"The blight of urban sky glow stops children from wishing on stars, and lovers from counting them. Light pollution severs our human connection to the beautiful celestial creatures of the night."

—Dava Sobel, author of *Galileo's Daughter*



In your local library for kids:
There Once Was A Sky Full of Stars

Illustrations: Karen Fredericks
Design: JV Advertising & Design 4/04

Summary

- **Glare, Light trespass**
 - Intrudes on others
 - Easy fix: use shielded light fixtures aimed vertically down at pavement
- **Light levels- how much light to use?**
 - Many installations use much higher light levels than needed/recommended
 - Security lighting: Uniformity most important; more is NOT better.
 - Sales lighting: Bright lighting does NOT improve sales
 - Why light unused parking lots at night??
- **Good lighting provides rewards for**
 - Community
 - Businesses
 - Residents