



Pollution knows no borders

- air pollution
- water pollution
- light pollution

97% of all Canadians live under light pollution

Workshop - Why is this this a problem?

What Is Light Pollution?

LP is too much of a good thing!

To Astronomers → Sky Glow

To Other Citizens:
 Glare, Light Trespass,
 Over Illumination, Visual Clutter,
 Distracting Signage

Astronomers: the “canaries” for the night environment

- Light Pollution has regional impact
- action *MUST* be local

R. Borba, P. Cinzano, MapQuest

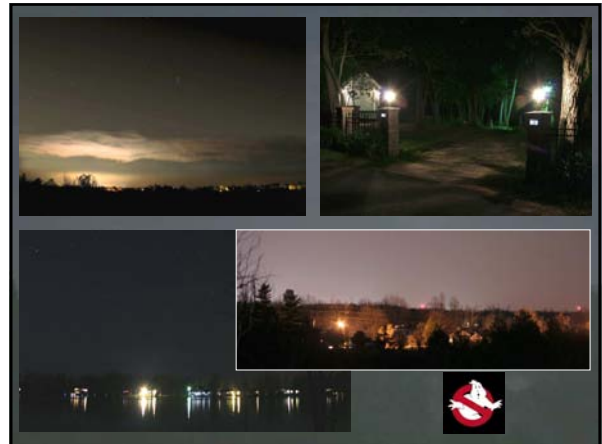
Energy Lost to Space

City	Mwh/km ²
Calgary	32.1
Edmonton	28.5
Ottawa	14.8*
Montreal	25.2*
Seattle	7.3
Toronto	23.1*
Vancouver	4.6
Victoria	2.3

* adjusted from Dr. Isobe's data

Sources of Light Pollution

- Municipal lighting
 - street lights, sports fields
- Commercial lighting
 - signage, parking lots, indoor light
- Residential lighting
 - curb-side light, door and yard lights



Luminaires - Not all Alike



Light Trespass more than a Nuisance

- Humans evolved with day and night
- | | |
|----------------------|---------------------|
| Day - activity | Night - rest |
| - fatigue, damage | - repair of tissue |
| - cluttered memories | - file and compress |
- Light and dark cycle → circadian rhythm
- becoming increasingly confused
 - cycle of hormone release corrupted
 - health compromised

How We (and Animals) See



Biology of Night - Scotobiology

- Ebb and flow of hormones follow cycle
→ Circadian Rhythm
- Rhythm > approximately 24 hours
 - Kept synchronized by day/night contrast
 - Melatonin prepares body for rest
 - Other hormones rejuvenate body during rest

Light / Dark and Biology

Pineal Gland

- perceives seasonal changes in day length
- secretes melatonin

Melatonin

- Melatonin chemistry present in many species (animal and plant)
- provides diurnal and seasonal cues for
 - reproduction
 - metabolism cycle of foetus
 - pollen release, leafing of trees, etc.

Animal Behaviour

- Foraging patterns
- "Common sense" behaviour
- Predator and Prey balance

- Matting patterns
- Preparation for winter

Length of
Night

Shoreline Glare

- Navigation hazard
- Nuisance
- Affects land / aquatic environment



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- Feeding / foraging
- Diurnal (vertical) migration
- Predation
- Seasonal preparation (matting, migration, hibernation)

Typical Studies of Light on Fish

- Light intensity (brightness)
- Spectra (colour)
- Comparison of behaviour between species

Conclusions

- results vary between species
- results applicable to efficient harvesting (aquaculture)

Photopic - Scotopic Behaviour

After Dark

- day-active fish become quiescent, and
- nocturnal fish (scotopic) become active

(Chech and Moyle 1982)

- reef fish respond VERY rapidly to changes in light levels (solar eclipse)

(Journal of Fish Biology, (1998) 53, 683-686, Article No. jfb980720)

What is Known?

- Commercial fishery (aquaculture)
- Sport fishery (visibility of lures)
- Temperature variations over seasons
- Research of opportunity ("clinical studies")
- Physics of light penetration
- Physiology of fish eyes

Aquatic Life

- Signs of healthy stable ecosystem
- successful indigenous species
 - healthy food chain
 - stable water quality

Unstable ecosystem - Disruption of habitat

Leprieur F. 2008
Nikolsky 1963

"Invasion" related to Gross Domestic Product, not to natural processes! **Why?**

PLoS Biol 6(2): e28. doi:10.1371/journal.pbio.0060028

Fish - Reproduction, Metabolism and Maturation

- Most studies based on the effect of light (photobiology)
- Only recent studies address effect of darkness (scotobiology)
- Species optimized for their historical natural environment
- Altered lighting affects health and reproduction of species

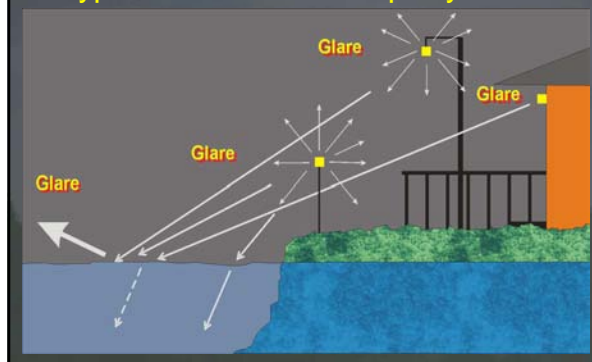
Nikolsky 1963

Fish - Predation

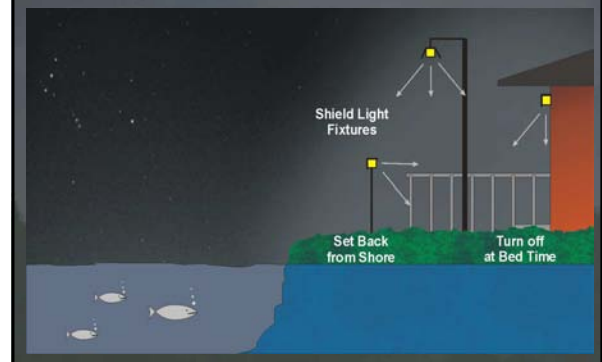
Sky Glow and Shoreline Lighting

- extends advantage to vision oriented predators
- extends zone depth of vision oriented predators
- shaded zone under docks creates "blind" similar to aquatic vegetation

Typical Lake Front Property



Much Better!



Some Solutions

See Handout



15 watt incandescent bulb



8 watt incandescent bulb



12 watt bulb incandescent



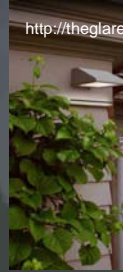
Some More Solutions

<http://theglarebuster.com/>

The good and Bad Cobras



<http://store.starrynightlights.com/hub-skycap.htm>



www.pappilighting.com/

www.darksky.org - Best Choice Lighting → Fixture Seal of Approval