cost
EUROPEAN COOPERATION
IN SCIENCE AND TECHNOLOGY

The Loss of the Night Network (LoNNe)

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IGB
Leibniz-Institute of
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and Inland Fisheries

SCIENCE STORIES

The Loss of the Night Network LoNNe (EU-COST ES1204)

WHY LIGHT MATTERS

Knowledge of the multifaceted aspects of artificial light at night (ALAN)

LEARN ABOUT LIGHT

How can we use this knowledge?

HANDS ON INVOLVEMENT

Measures to reduce light pollution

COSMIC LIGHT

There is not such thing as a dark night

SCIENCE STORIES

What is COST?

EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

- oldest and widest European intergovernmental framework for transnational Cooperation in Science and Technology
- for 40 years COST supported networking of research activities across all its Member countries (36 today) and beyond
- open to all disciplines, to all novel and ground-breaking S&T ideas, to all categories of partners
- supported by the EU RTD Framework Programme, European Science Foundation, and the Council of the European Union, now under Horizon 2020
- Loss of the Night Network (LoNNe) COST Action ES 1204, 2012-2016

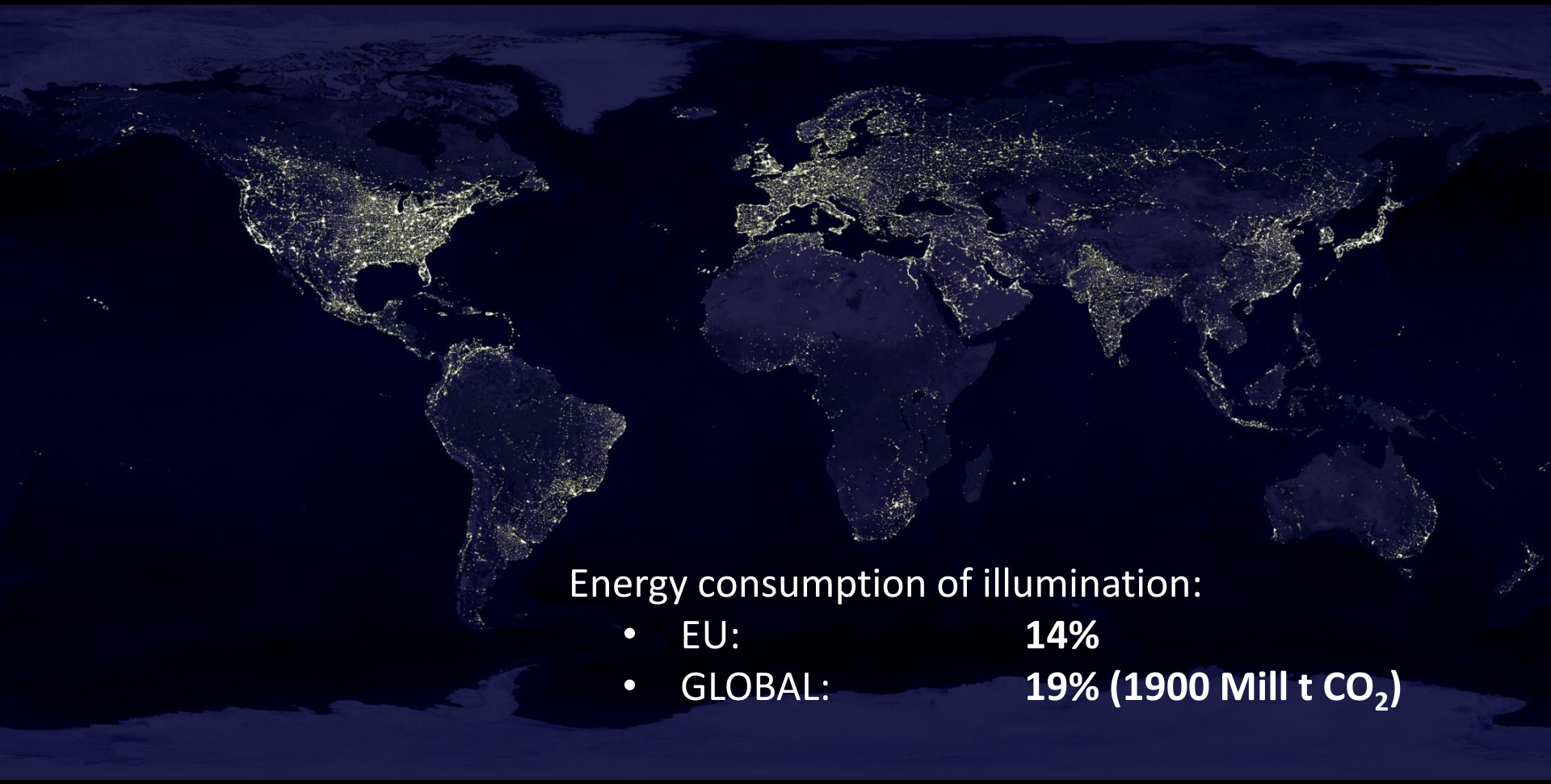
LoNNe
ES1204
Loss of the Night Network

SCIENCE STORIES

Network of institutions from 18 countries

- Transfer of existing knowledge between the fragmented national research projects
- Studying the multifaceted aspects of artificial light at night
- Stimulating future transdisciplinary research
- Initiating dialogue regarding light pollution with the whole range of concerned and involved stakeholders, in particular the general public

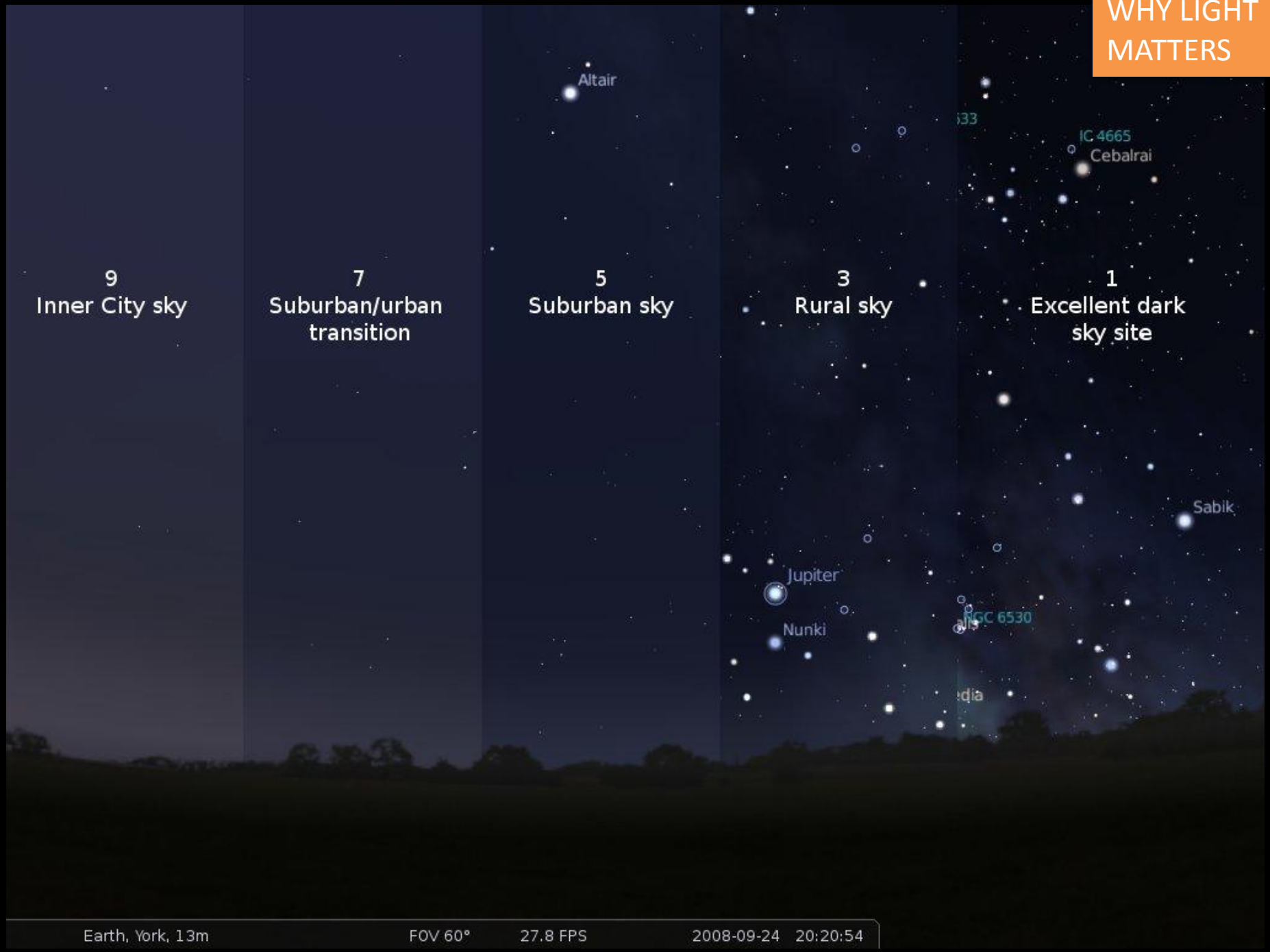
Increase in artificial illumination
6% (0–20%) per year 1993 – 2002*



Energy consumption of illumination:

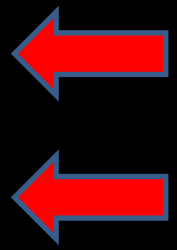
- EU: **14%**
- GLOBAL: **19% (1900 Mill t CO_2)**

Photo: NASA Earth Observatory/NOAA NGDC
*Hölker et al. 2010


WHY LIGHT MATTERS
Altair
IC 4665
Cebalrai
9
Inner City sky
7
Suburban/urban transition
5
Suburban sky
3
Rural sky
1
Excellent dark sky site
Sabik
Jupiter
Nunki
NGC 6530
Earth, York, 13m
FOV 60°
27.8 FPS
2008-09-24 20:20:54

Night as living space

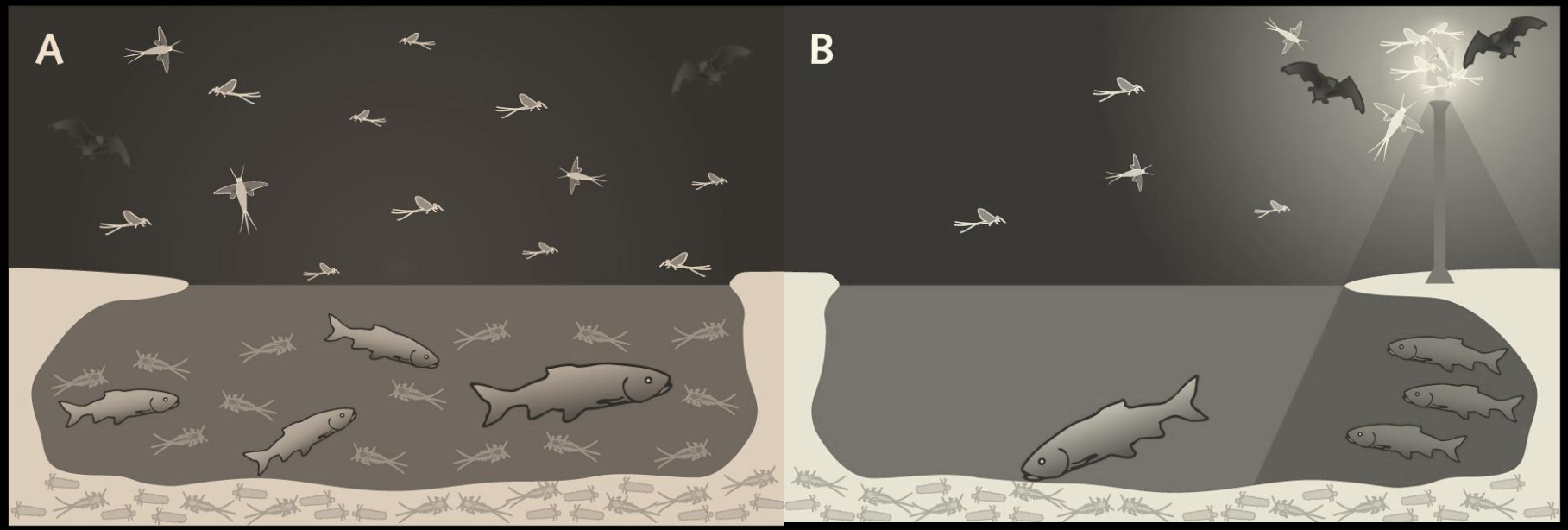
	Estimated number of described species	Thereof nocturnal [%]
Vertebrates		
Mammals	5 488	63,8
primates (incl. *H. sapiens*)	432	31
bats	1100	100
birds	9 990	19,6
reptiles	8 969	16,6
amphibians	6 433	93,3
Fishes	30 700	14,1
Total	**61 580**	**28,0**
Invertebrates		
Insects	950 000	49,4
Lepidoptera	180 000	77,8
Colleoptera	500 000	60
Crustacean	40 000	50
Arachnidae	98 000	5
Molluscs	81 000	?
Coral	2 175	?
others	61 209	?
Total	**1 232 384**	**64,4**



Hölker et al. 2010, TREE

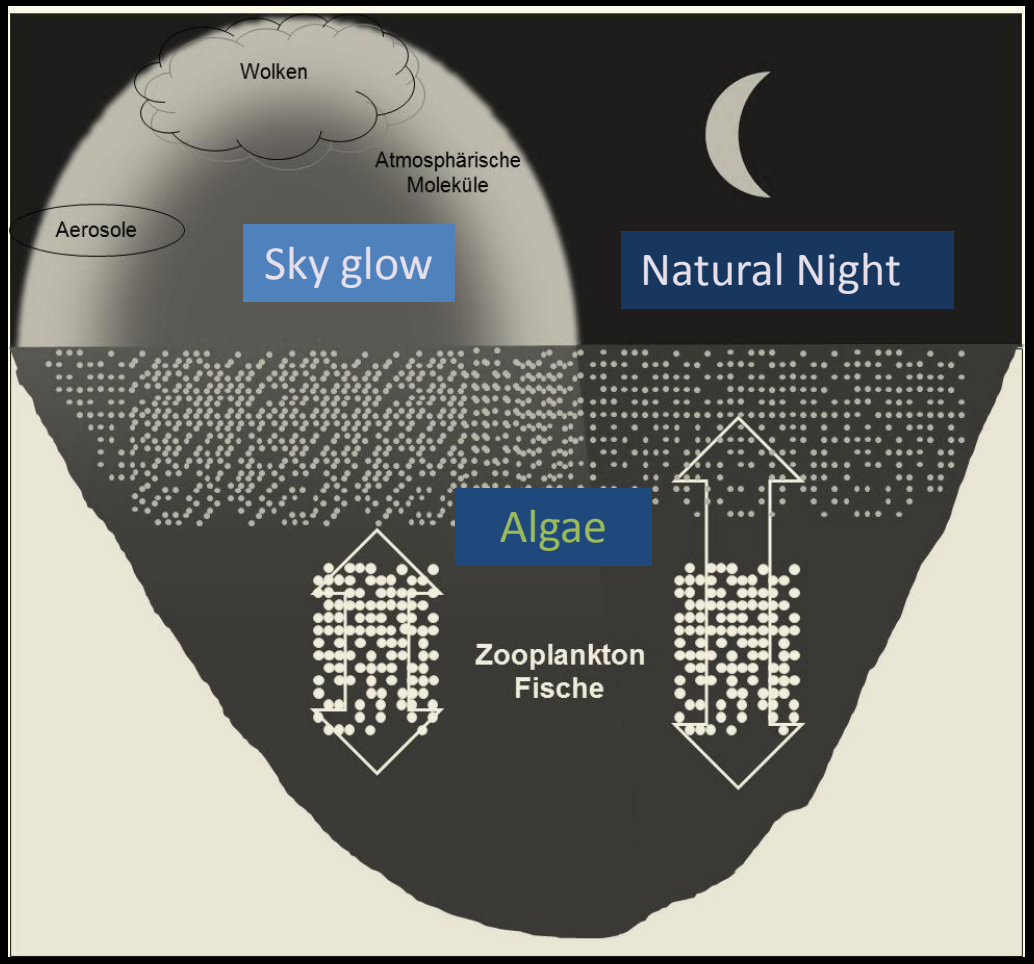
The Nile and the Mediterranean Sea at Night As Seen From Space

Changes in spatial species distribution and distortions in food webs



Perkin et al. 2011 / 2014

Decline in night time ecosystem services e.g. water clarification



Moore et al. 2000 (image by Hölker)

Migrating species get disoriented by ALAN

Photo: E. Richter

Photo: DAVID ILIFF. License: CC-BY-SA 3.0

Photo: Jay Smooth, flap.org

ALAN causes decline in biodiversity

„There is more mechanistic evidence for caterpillar-booms than for baby booms following power outage“ Koert van Geffen

- Moth reproduction activity declines, quantity and quality of female pheromone blend decreases (Van Geffen et al. 2015. Insect Conservation and Diversity)
- Frogs (*Rana clamitans melanota*) produce fewer advertisement calls and move more frequently (Baker & Richardson 2006. Canadian Journal of Zoology)
- Fireflies rapidly decrease with increasing light pollution, at light intensities above moonlight levels (0.5 lux) (Hagen et al. 2015. Advances in Entomology)
- Altered Darwinism for song birds, male song birds sing earlier, the lamp type might become crucial for reproduction success (Nordt & Klenke 2013. Environmental Research)
- Atlantic salmon (*Salmo salar*) fry dispersal is delayed by up to two days. The delay is critical for salmonid population development, it may increase predation and reduce fitness (Riley et a. 2015. Freshwater Biology)

Health risk due to disturbed wake-sleep rhythms

Suppression of melatonin synthesis

sleep disorder

cardiovascular disease

weakening of the immune system

increased risk of common public disease

“So what? “

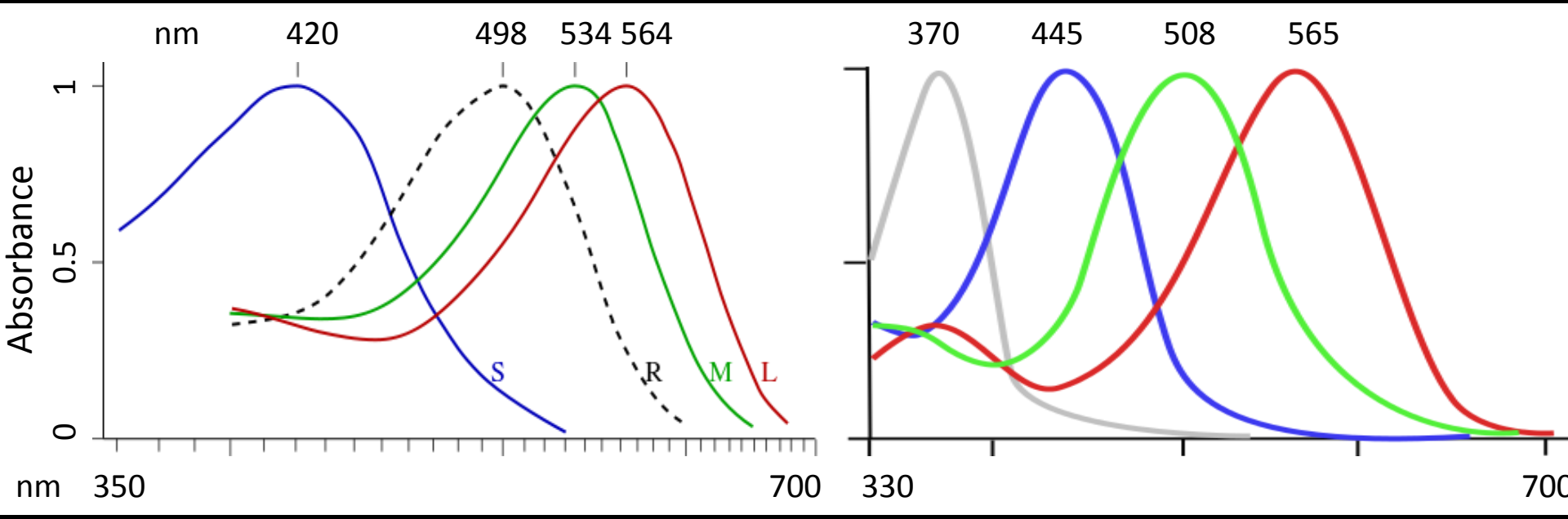
“There are much higher risks out there!”

“Where are the thresholds?”

LoNNe participants responses to the question ‘why light matters‘:

- “The increase in ALAN is the most visible but also the most neglected aspect of global change”
- “ALAN increases risk from other pollutants, by weakening the immune system“
- “We knew that insects were attracted to light but were unaware that ALAN disrupts the behaviour and reproduction of animals, increases stress, compromises their immune system, disrupts seasonal timing and changes community composition”
- “We have no knowledge on how light pollution will modify animal vision and ecosystem structure - although we are sure it will happen”

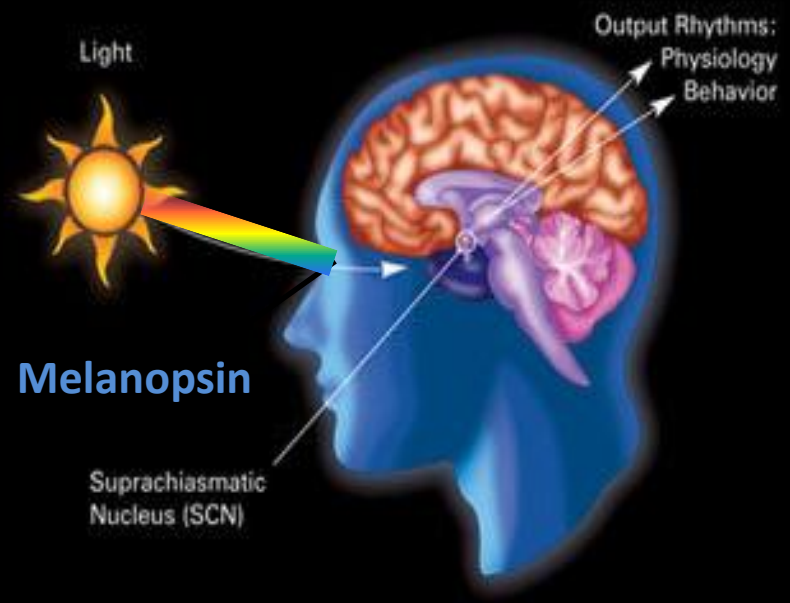
Differences of light perception human and birds



- The visual perception is highly species dependent
- Often it is associated with the habitat of the organism

LEARN ABOUT LIGHT

Circadian signal reception in human and mammals



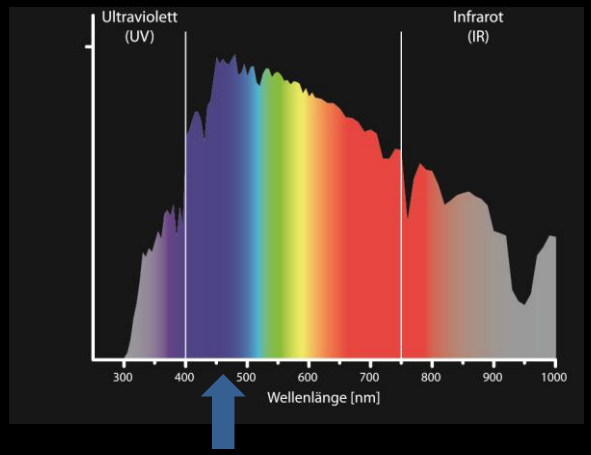
Human melanopsin forms a pigment maximally sensitive to blue light
= **λmax 479 nm**.
This maximal sensitivity is comparable to studies on monkeys and rodents.

Bailes & Lucas 2013, Proceedings of the Royal Society B

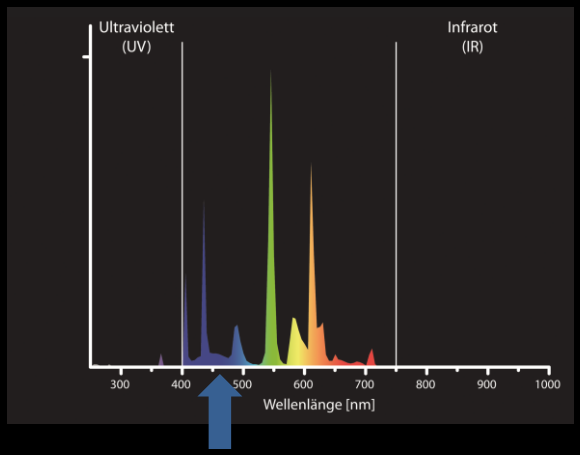
LEARN ABOUT LIGHT

The choice of the illumination is important!

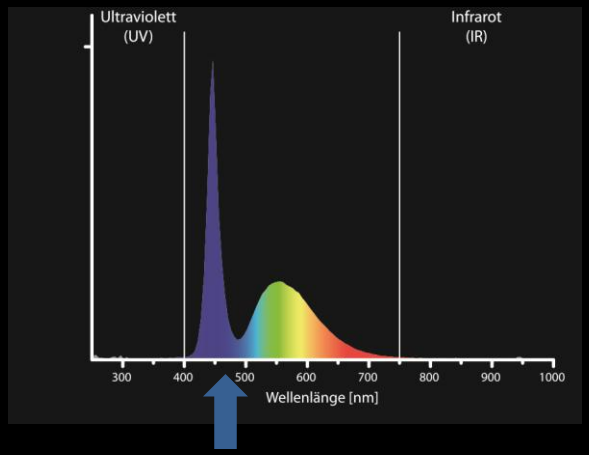
Sun light

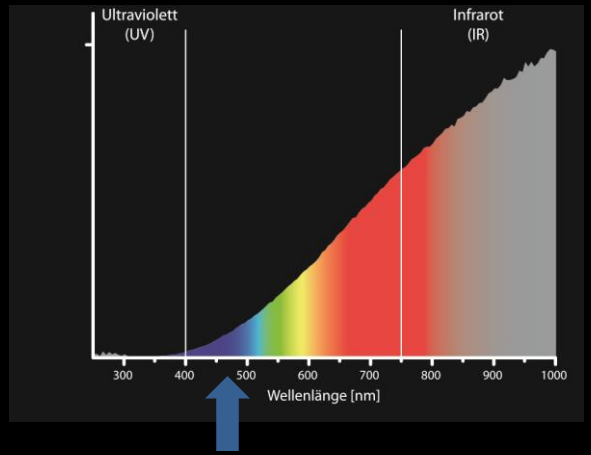


fluorescent

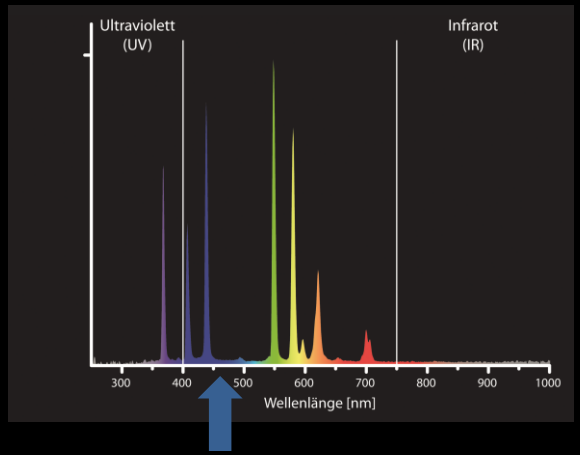


LED

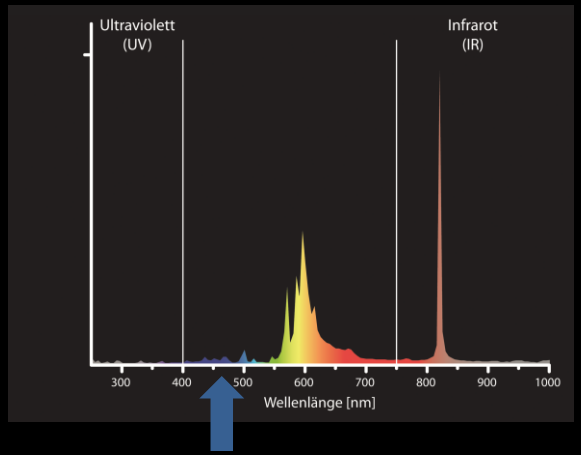




Incandescent



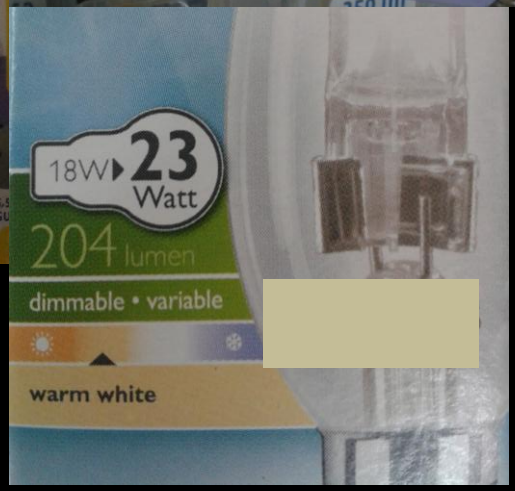
Mercury vapour



Sodium vapour

LEARN ABOUT LIGHT

Consumers choice:



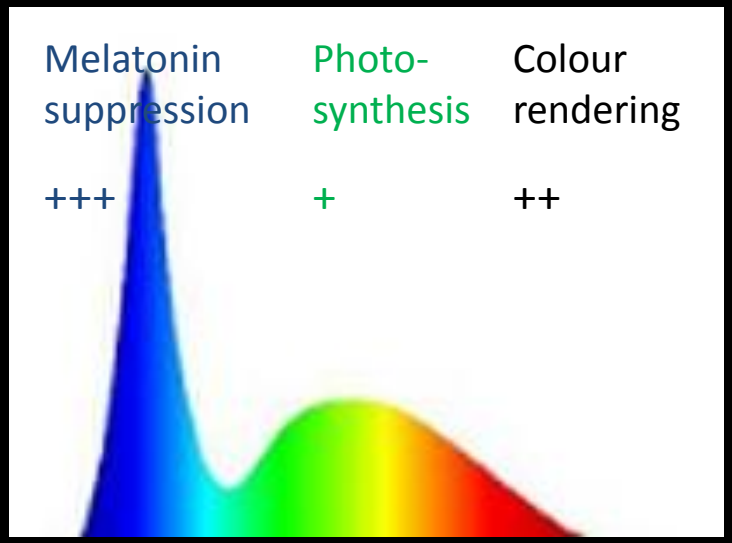
Indices for level of impact of some commercial lamps

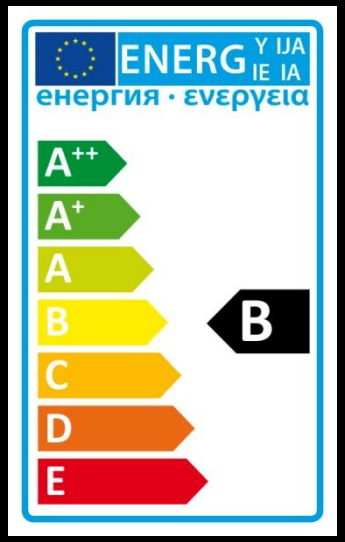
Lamp type	Melatonin suppression	Photosynthesis	Scotopic Vision
LED 5000 K - filtered	+	++	+
LED 5000 K	++	++	++
LED 4000 K	++	++	++
LED 2700 K -filtered	-	++	+
LED 2700 K	+	++	++
HPS	+	++	-
LPS	-	+	+
Incandescent (3000 K)	+	+++	++
Metal Halide	++	++	++
Halogen	+	+++	++

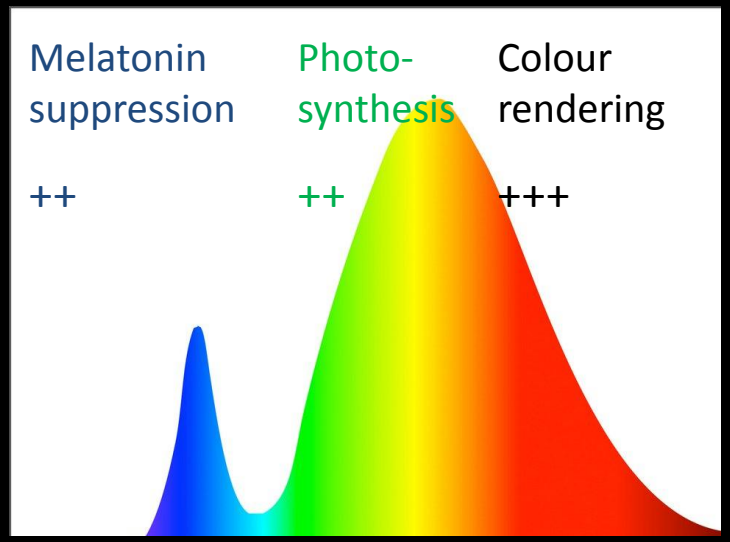
Values – low impact (indices <0.1), + medium impact (indices >0.1<0.4) and ++ high impact (indices >0.4<0.7) and +++ highest measured impact (>0.7)

Aubé et al. 2013 PloS ONE 8(7) e67798

Ideas for labelling







LEARN ABOUT LIGHT

Where are the thresholds?

- Arthropods ≥ moonlight, about **0.3 lux** (multiple authors)
- Perch (*Perca fluviatilis*) **< 1 lux** (Brüning et al. 2015 and 2016. Science of The Total Environment)
- Salmon (*Salmo salar*) **= 1 lux** (Riley et al. 2015. Freshwater Biology*)*
- Amphibians **= 0.001 lux** (Perry et al. 2008. Urban Herpetology)
- Nocturnal mammals **= 0.03 lux** (Reiter 1988. ISI Atlas of Science: Animal and Plant Sciences)

⟶ thresholds are below skyglow levels

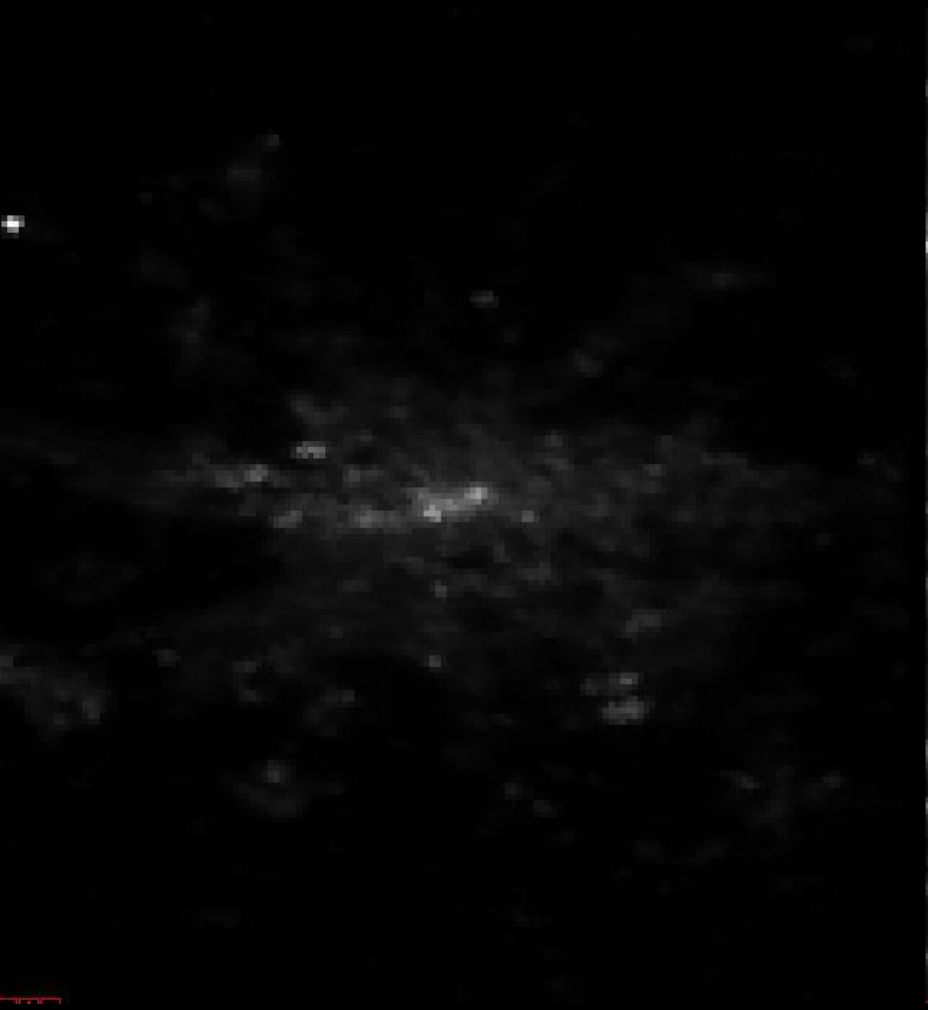
LEARN ABOUT LIGHT

Skyglow in Europe

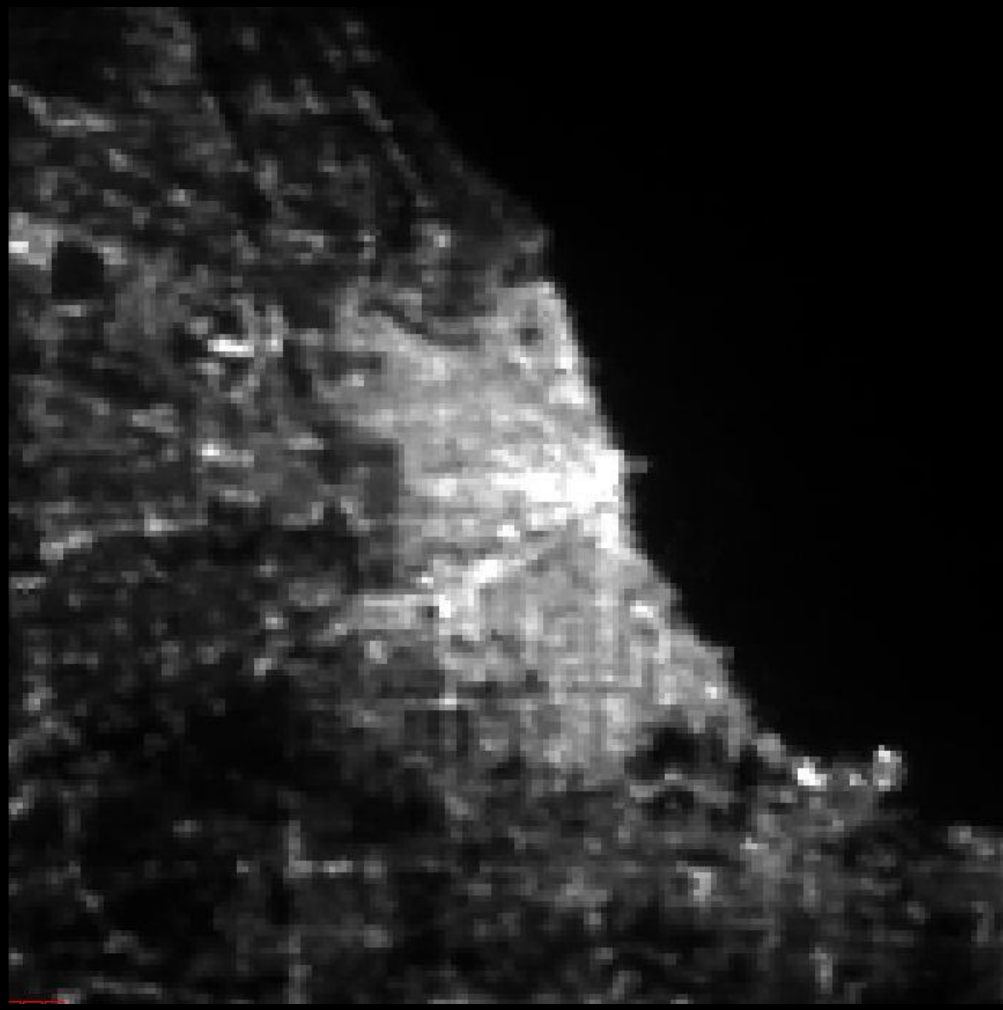
White areas are at least 35% brighter than is natural

(Cinzano et al. 2001. Monthly Notices of the Royal Astronomical Society)

Empirical comparison of lighting regimes between different cities show that there are great differences in the lighting intensity

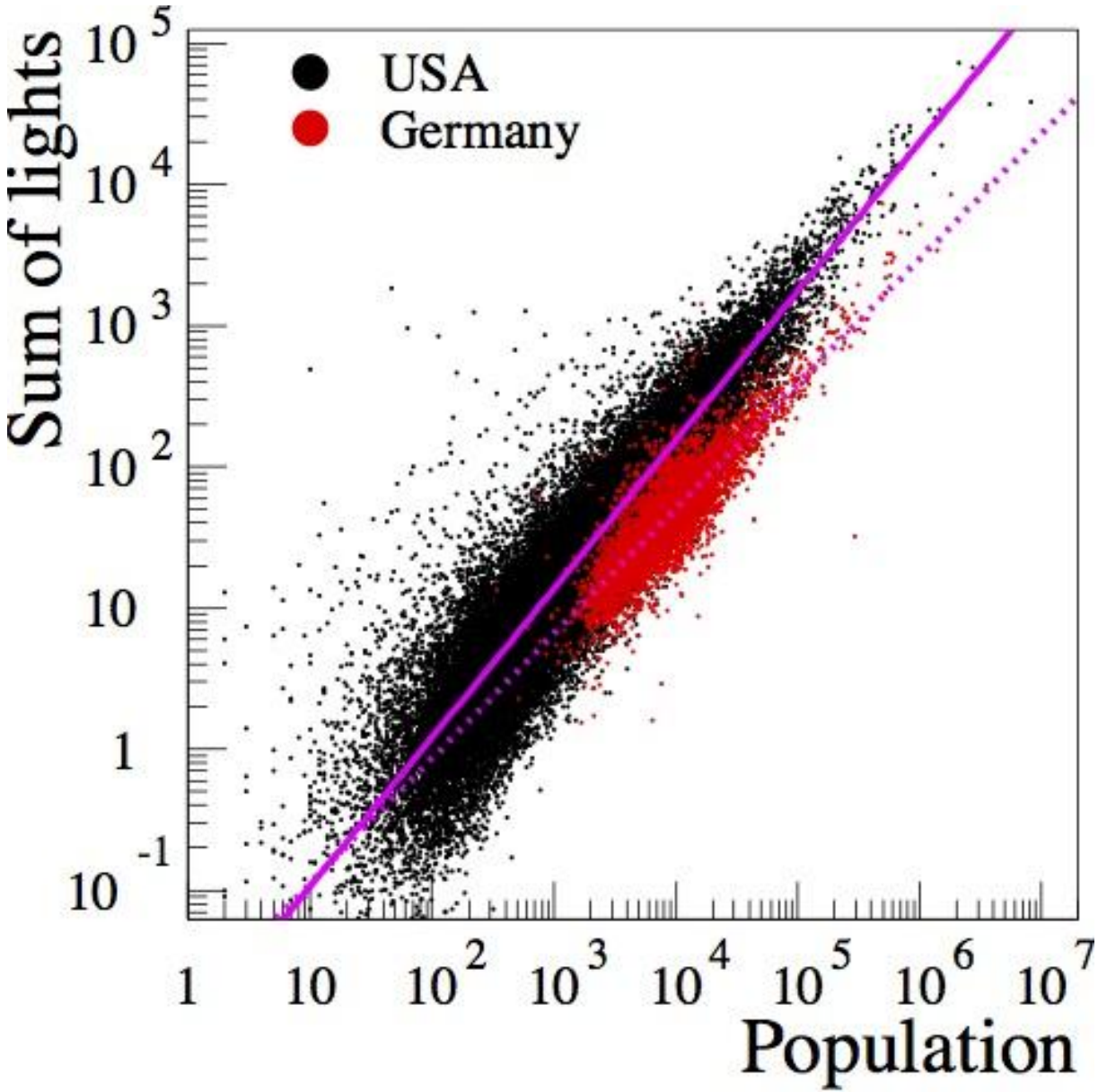


Berlin, DE: 3.5 Million people



Chicago, USA: 2.7 Million people (9.5M metro)

Comparison of USA and DE



Kyba et al. 2015. Remote Sensing

Lighting concepts mostly do not consider to lower lighting levels

before reconstruction in 2013

after reconstruction in 2014

Malta, Madonna ta' Pinu in Gozo

Photos: Michael Nolle

Lighting planning considering the light intensity and the upward directed light ratio (ULR)

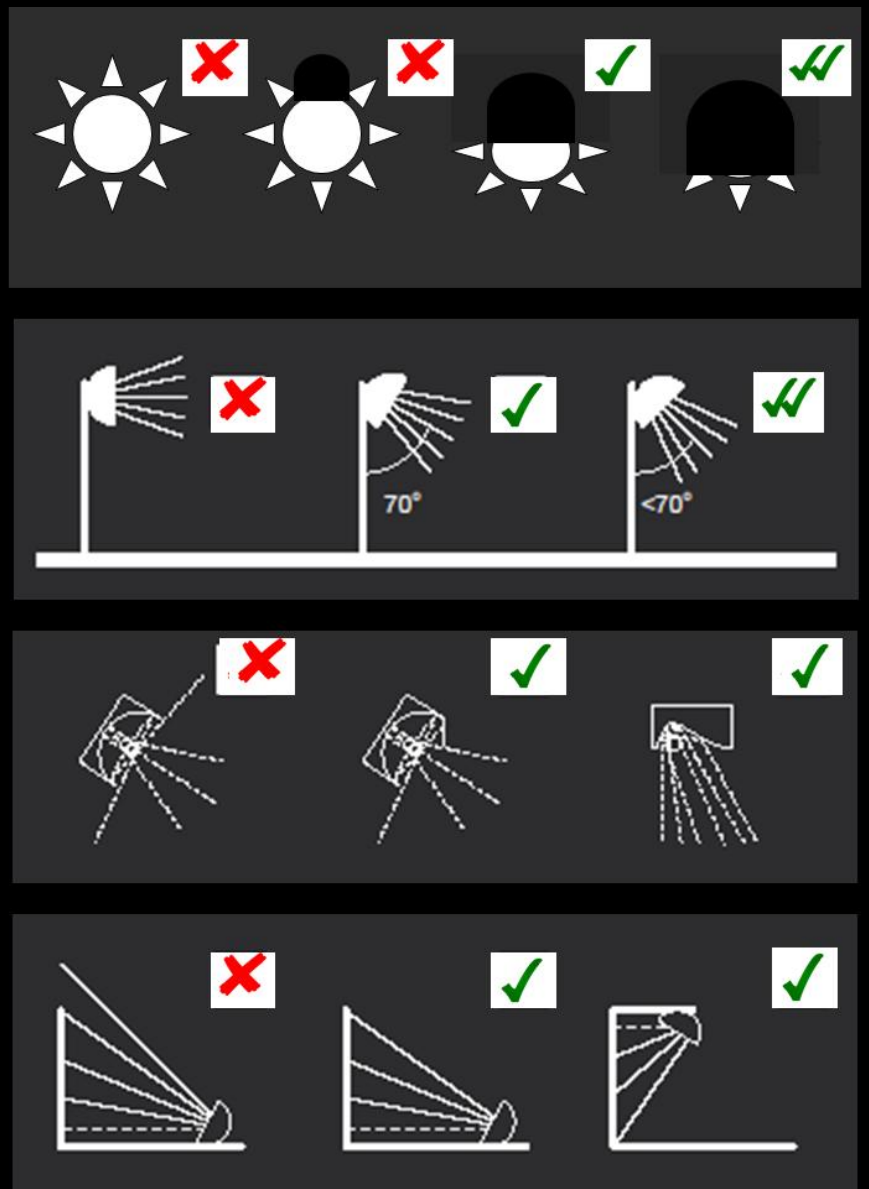
before reconstruction
in 09/2011

after reconstruction
in 08/2012

Croatia, Lastovo village

Photos: Andrej Mohar

Decrease Upward directed light



Measures to reduce light pollution

1. Direct the light to where it is needed
2. Reduce the light intensity to the minimum needed
3. Use light spectra adapted to the environment
4. When using white light, then in ‚warm‘ colour temperature (>3000 Kelvin)
5. Limit the use of light to when it is needed

Raise Awareness

Stars4ALL **www.stars4all.eu**

***A Collective Awareness Platform for Promoting Dark Skies in Europe* - H2020-ICT-2015**

- **Generate citizen awareness** about the problem of light pollution.
- **Allow anybody to contribute** in the detection, documentation, verification and solution of specific local light pollution problems.
- **Generate recommendations** oriented towards consumers, industry, governments and public institutions to take care and protect dark skies.

Create **Light Pollution Initiatives (LPI)**

LoNNe participants call for action:

- “Unlike other forms of environmental pollution, light pollution is one that we can imagine solving within our lifetimes.”
- “True quantification of the effects of light on organisms requires the knowledge of internal circadian time.”
- “The growing body of knowledge regarding the effects of ALAN shows the need of sustainable lighting planning and the protection of natural night reserves. These decisions are ultimately political.”
- **“The negative aspects of ALAN are on the agenda, amongst others because of IYL 2015!”**

COSMIC LIGHT

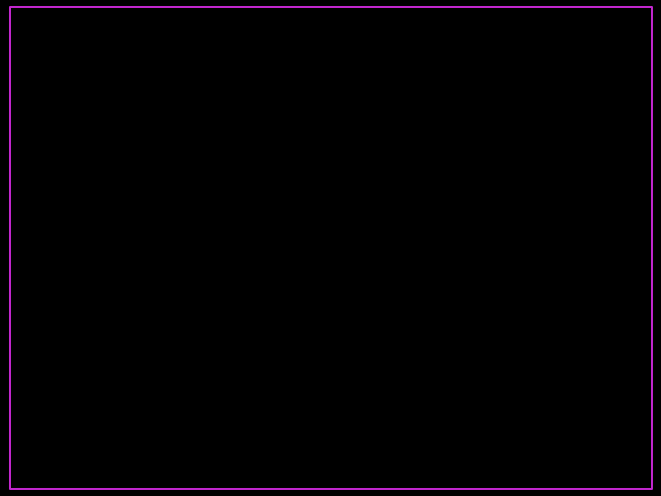
Thank you!

Photo: Andreas Hänel, Westhavelland Germany

COSMIC LIGHT

There is not such thing as a dark night

Christopher Kyba GFZ



COSMIC LIGHT

Contact us: cost-lonne.eu

More literature: http://darksky.org/resources/research/alan-database/