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Fotos: C.C.M Kyba & A. Hänel

Light Pollution and regulations in Germany

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Regulations against adverse effects of light emission in Germany

Nature and Landscape Protection under German Law

- Legal obligations if an alteration or impact of an area occurs.
- Alteration or impact are changes affecting the shape or use of areas, significantly impairing the performance and functioning of the natural balance or landscape appearance.
  - ➢ e.g. new street lighting installations.
- Impairment is determined by the number or quality of affected species or habitats.
- Legal obligations cascade:
  1. Avoidance
  2. Compensation or offset
  3. Offset payments if authorities approve

German Immission Control Act

- Outdoor lighting is in most cases not subject to approval procedures.
- Nevertheless, harmful environmental effects caused by light emissions need to be minimized or avoided.
- The protection includes humans, animals and plants, soil, water, atmosphere as well as culture and other material assets.
- However, excluded are exterior lighting system that serve non-commercial purposes, such as garden illuminations and public street lighting.

DIN EN 13201

- Municipal street lighting are highly influenced by the technical standard EN 13201.
- Recommendations for minimum requirements for public lighting and specification of the technical prerequisites to meet existing legal requirements.
- The German DIN Standards Committee Lighting Technology is composed of about 66% industry delegates representing the interests of lighting stakeholders. It is a private association, it lacks democratic legitimacy and therefore has no legislative power.

The broad and unspecific scopes of the Immission Control Act and the nature and landscape protection laws fade behind a detailed technical standard.

Environmental protection gaps

Schroer et al. (2019) Sustainability, 12(6), 2551.

- The protection of habitat is spatially limited and would require an individual impact assessment for lighting systems.
- The protection of specially protected species requires an adverse effect such as the injury, death, or avoidance behaviour, excluding most of the adverse effects of ALAN.
- Most provisions require either a significant increase in killing risks or a significant decline of a local population. Both criteria are in ALAN-related situations difficult to assess.
- Species and landscapes without special protection status are often not affected by the protection.

The night as a living space

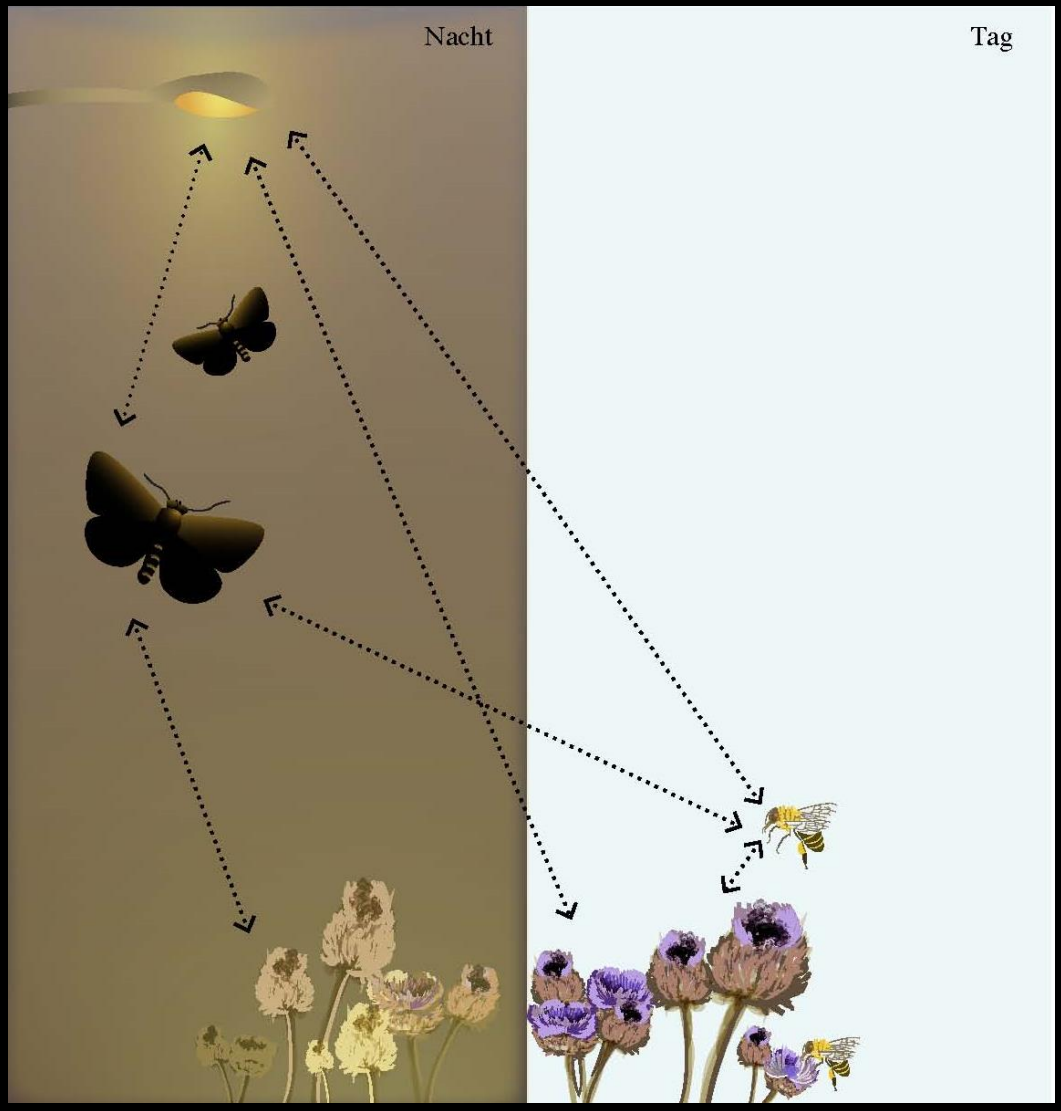
Nocturnal animals

	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. .
Trends Ecol. Evol. 12, 681–682 (2010)

Foto: Sven Haustein

Providing food for bees



Knop et al. *Nature* (2017) Illustration: Catherine Perez Vega

Loss of biodiversity – only a matter of the day?

PLOS ONE

RESEARCH ARTICLE

More than 75 percent decline over 27 years in total flying insect biomass in protected areas

Caspar A. Hallmann[1]*, Martin Sorg[2], Eelke Jongejans[1], Henk Siepel[1], Nick Hofland[1], Heinz Schwan[2], Werner Stenmans[2], Andreas Müller[2], Hubert Sumser[2], Thomas Hörren[2], Dave Goulson[3], Hans de Kroon[1]

ALAN adverse impact on bats

Hale et al. (2015) Global Change Biology, 21(7), 2467-2478 :

- Movement is an important ecological process that can be disrupted by artificial lighting. - Connectivity in urban areas is being disrupted.

Azam et al. (2018) Landscape and Urban Planning, 175, 123-135

- Streetlights negatively impacted light-sensitive bats up to 50 m at illuminance below 1 lx.

Russo et al. (2017) Animal Conservation, 20(6), 492-501

- The effects of ALAN on drinking: Forest species never drank when the light was on and edge-foraging species reduced drinking activity.

ALAN adverse impact on birds

Cabrera-Cruz et al. (2018) Scientific Reports 8: 3261.

- Migratory birds may be subject to the effects of light pollution particularly during migration, the most critical stage in their annual cycle.

Ouyang et al. (2015) Biology Letters, 11(8).

- Artificial light can induce changes in individual hormonal phenotype.

Ouyang et al. (2017) Global Change Biology 23(11), 4987-4994.

- White ALAN increases nighttime activity levels, sleep debt and affects disease dynamics in a free-living songbird.

ALAN effects on landscapes and ecosystems

Garrett et al. (2019) Animal Conservation.

- About a half of the world's Key Biodiversity Areas are affected by artificial night-sky brightening and only about a fifth contain no light polluted area.

Grubisic et al. (2017) Limnology and Oceanography, 62(6), 2799-2810.

- ALAN effects on periphyton as a fundamental component of stream ecosystems, might propagate to higher trophic levels and/or affect critical ecosystem functions.

Manfrin et al. (2017) Frontiers in Environmental Science, 5, 61.

- The effects of ALAN on the composition of riparian predator and scavenger communities …may cascade through the riparian food web … and …affect … adjacent ecosystems.

ALAN parameters can mitigate adverse effects

van Grunsven et al. (2017) Amphibia-Reptilia, 38(1), 49-55.

- Common toads avoided sections of roads that were illuminated with white or green light - but not red light

Grubisic et al. (2018) Annals of Applied Biology, 173(2), 180-189.

- Understanding the contribution of ALAN … to the decline of insects is an important step towards mitigation and the recovery of the insect fauna in our landscapes.

Donners et al. (2018) Journal of Experimental Zoology Part A, 329 (8-9), 434-440

- Insight in potential insect attraction of light sources can be the key to mitigate and minimize ecological impact of nocturnal illumination.

The solutions

Illustration: Rainer Stock, Loss of the Night Network 2016

Guide the light to where it is needed

Illustration: Rainer Stock, Loss of the Night Network 2016

Use warm light colours (< 3000 K)

Illustration: Rainer Stock, Loss of the Night Network 2016

Apply the lowest light intensity necessary

Illustration: Rainer Stock, Loss of the Night Network 2016

Implement requirement profiles

- Justifying the need of lighting requirements e.g. by traffic or visitor numbers (in the dark phase).

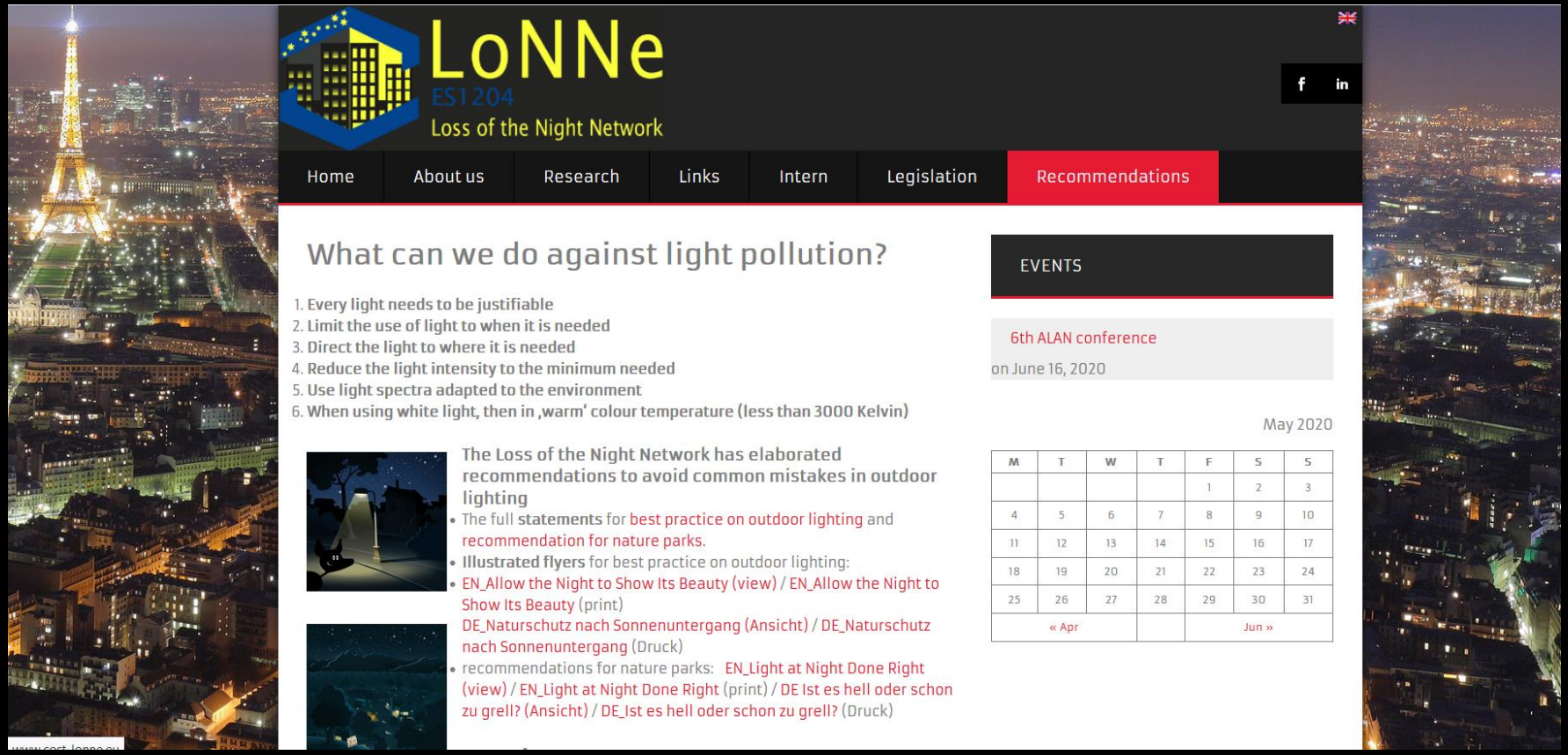
Measure night sky brightness

- Set regional limits and targets comparable to climate protection regulations.

Foto: Andreas Jechow

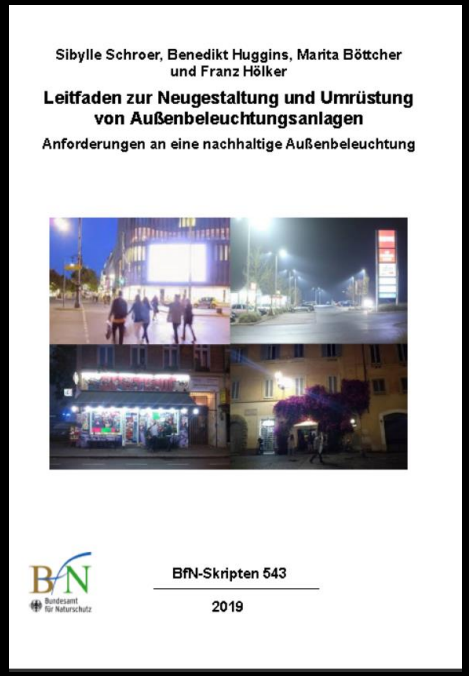
Illustration: Rainer Stock / COST Aktion LoNNe ES1203 (2016)

Recommendations at the Loss of the Night Network Website: cost-lonne.eu



Guide for new installation and modernisation of outdoor lighting systems (German)

http://bit.ly/bfn-543



English Publication: Schroer et al. (2019) Working with inadequate tools: Legislative shortcomings in protection against adverse effects of artificial light. Sustainability, 12(6), 2551.

Foto: Andreas Hänel, Westhavelland

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