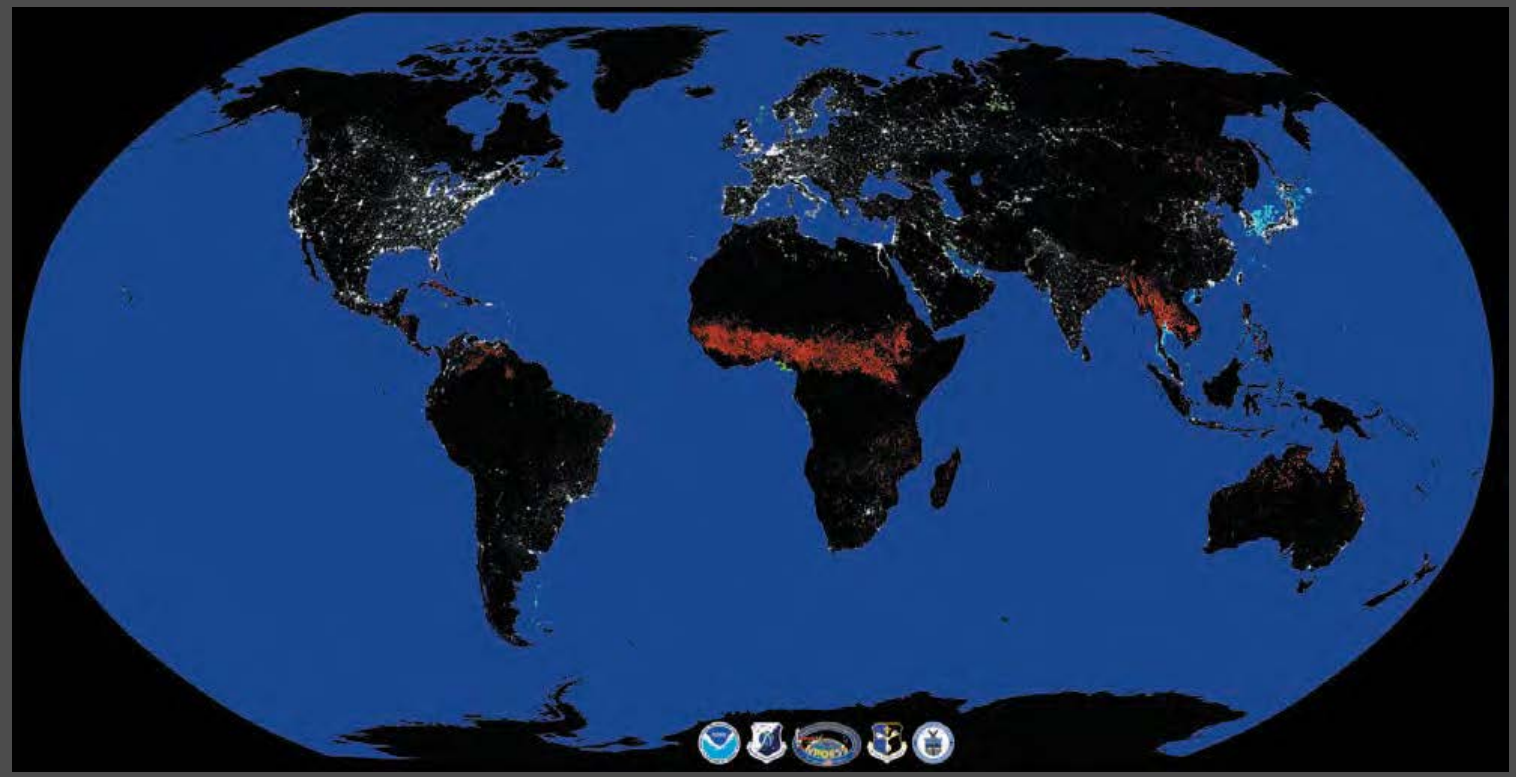
Society of Light and Lighting Conference 2025

Illuminating the future: Balancing light and dark nightscapes

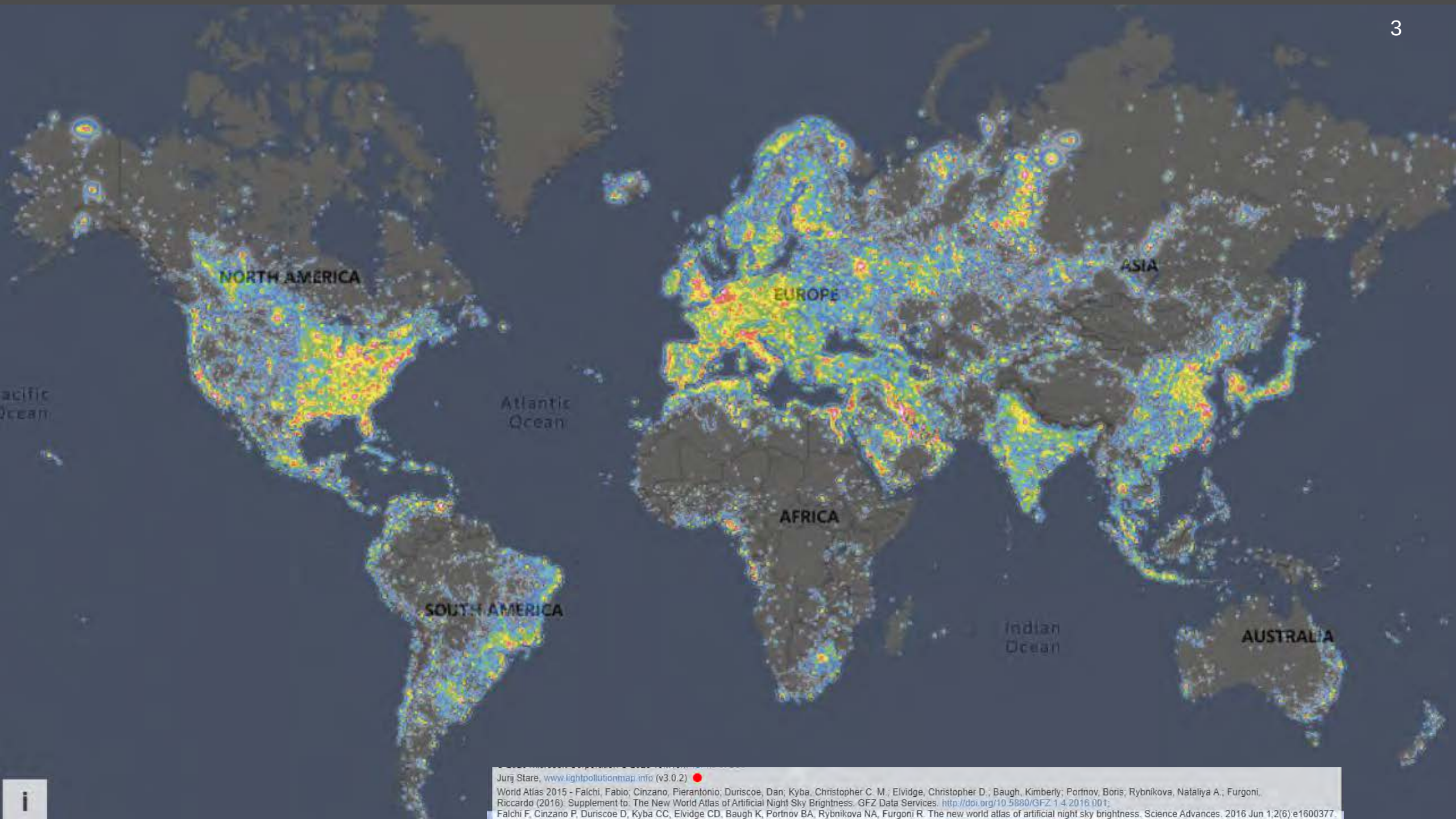
27th March 2025, Senate House, University of London

Addressing the biological and ecological impacts of Artificial Light at Night

Dr Mike Wells RDI FRSA FCIEEM



Source: www.freepik.com/


NORTH AMERICA
EUROPE
ASIA
Atlantic Ocean
AFRICA
SOUTH AMERICA
Indian Ocean
AUSTRALIA
Jurij Stare, www.lightpollutionmap.info (v3.0.2)
World Atlas 2015 - Falchi, Fabio; Cinzano, Pierantonio; Duriscoe, Dan; Kyba, Christopher C. M.; Elvidge, Christopher D.; Baugh, Kimberly; Portnov, Boris; Rybnikova, Nataliya A.; Furgoni, Riccardo (2016): Supplement to: The New World Atlas of Artificial Night Sky Brightness. GFZ Data Services. http://doi.org/10.5880/GFZ.1.4.2016.001;
Falchi F, Cinzano P, Duriscoe D, Kyba CC, Elvidge CD, Baugh K, Portnov BA, Rybnikova NA, Furgoni R. The new world atlas of artificial night sky brightness. Science Advances. 2016 Jun 1;2(6):e1600377.

Source: Medium.com

IT’S ALL ABOUT ALAN

(ARTIFICIAL LIGHT AT NIGHT)

https://universemagazine.com/en/light-pollution-deprives-people-of-the-opportunity-to-observe-the-s

https://darksky.org/

Problems when ALAN meets nature

ALAN is the introduction of light at night into places where it does not occur naturally, and has never occurred, naturally

ALAN is the introduction of light of a different spectrum from those of sunlight, moonlight or starlight; so, at wavelengths unfamiliar to nature

ALAN as a phenomenon is unprecedented. There are no natural analogues at any point in the past that mimic the nature, extent, distribution, timing or rate of spread of ALAN

Source: frenchriviera-services.com/en/our-tours-on-the-dazur-coast/lumieres-dans-les-yeux-monaco-by-night/

A VERY BRIEF HISTORY OF RESEARCH INTEREST IN THE EFFECTS OF ALAN

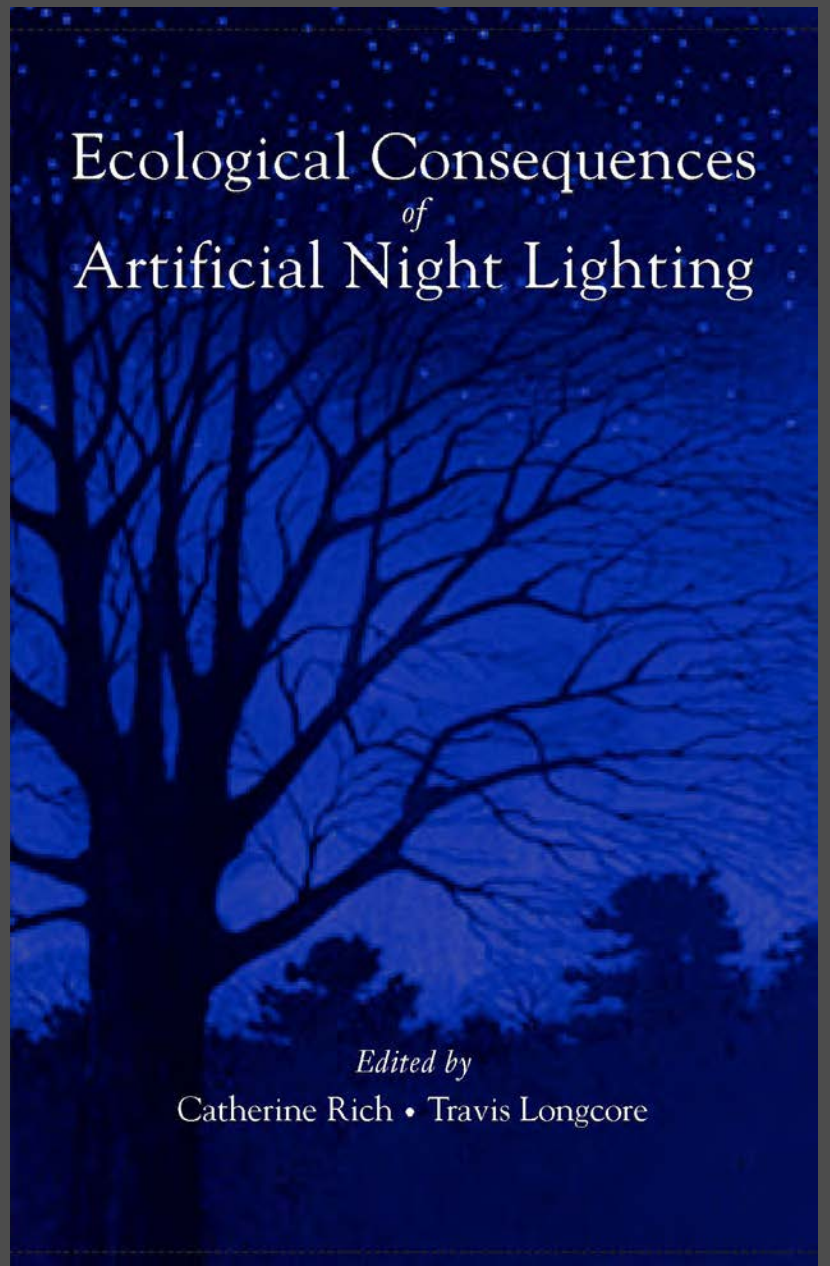
In July 2023, the journal *Science* for the first time featured light pollution on its cover, precisely 50 years after the first mention in its pages.

2004

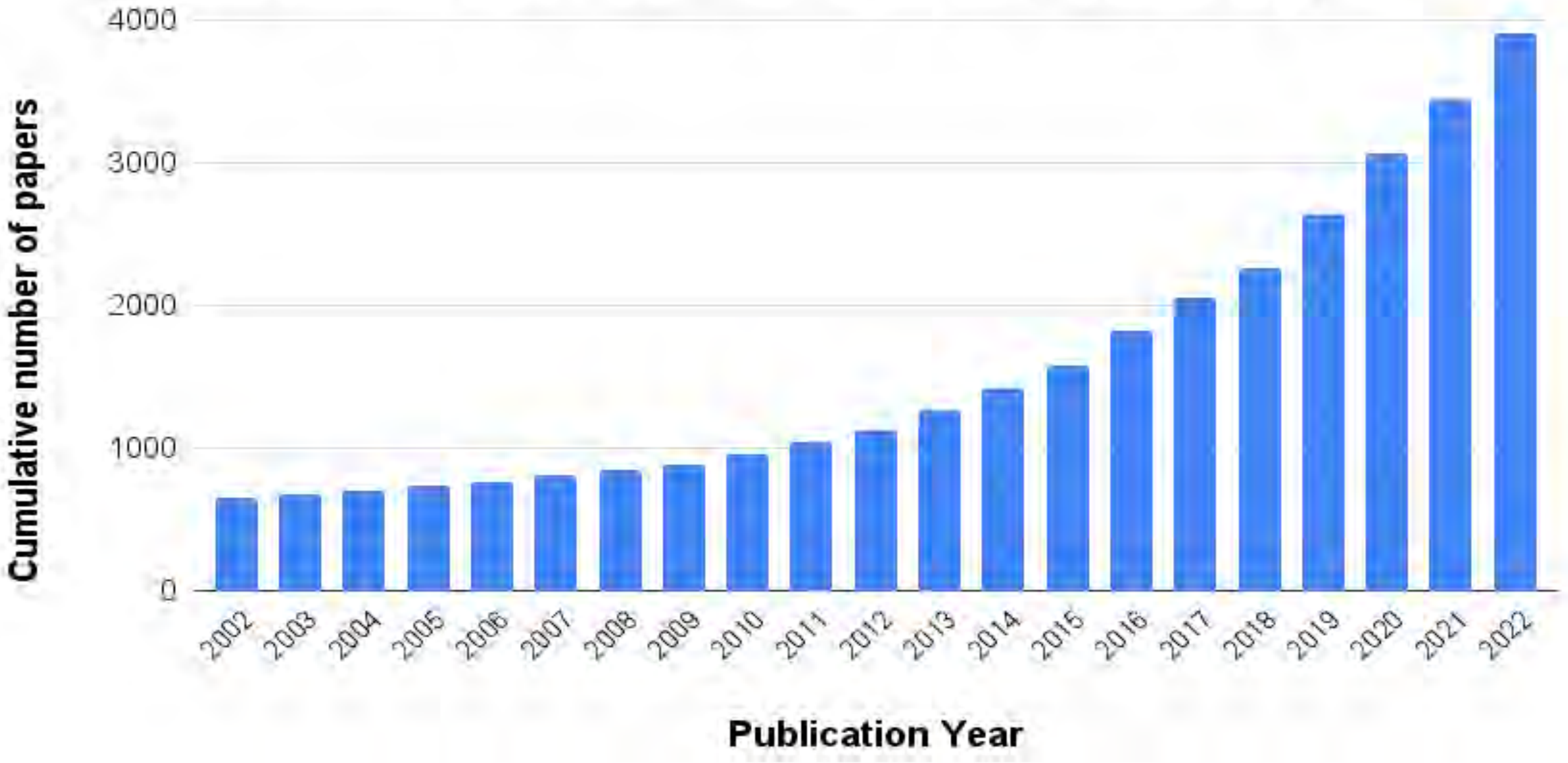
“Ecologists have long studied the critical role of natural light in regulating species interactions, but, with limited exceptions, have not investigated the consequences of artificial night lighting.”

Longcore, T. & Rich, C. (2004)
Front Ecol Environ 2(4): 191–198

2006



Total number of ALAN Database papers by year



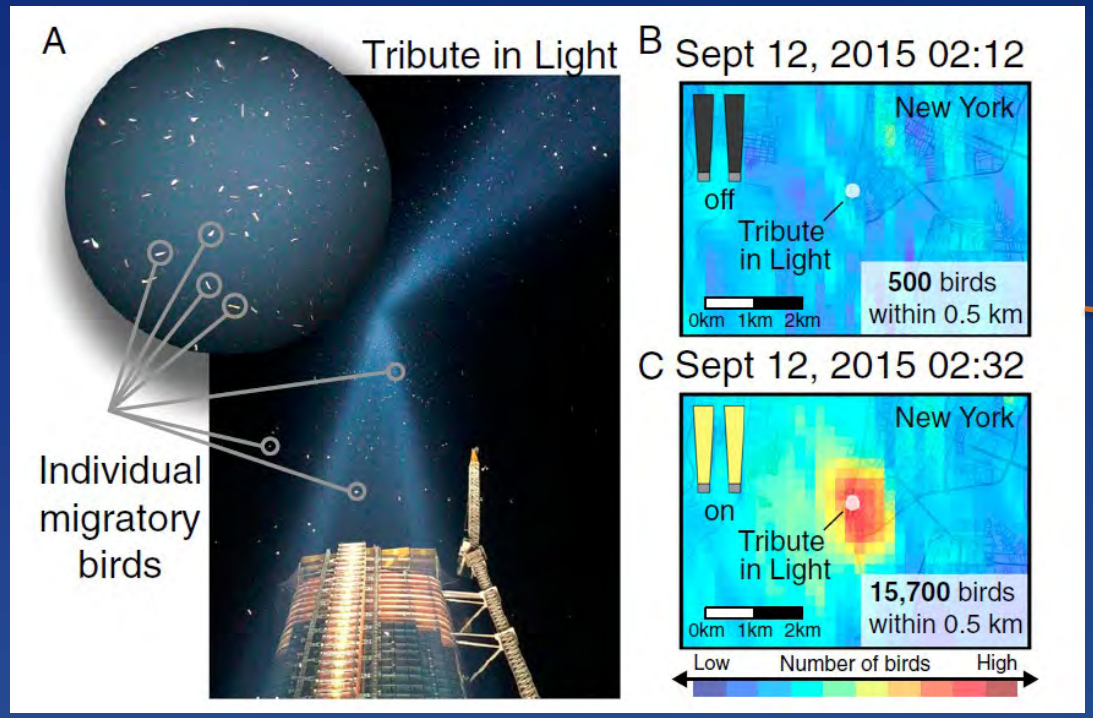
Source: darksky.org/news/artificial-light-at-night-state-of-the-science-2023-report/

2004

‘Some of the catastrophic consequences of light for certain taxonomic groups are well known, such as the deaths of migratory birds around tall lighted structures, and those of hatchling sea turtles disoriented by lights on their natal beaches.’

Longcore, T. & Rich, C. (2004)
Front Ecol Environ 2(4): 191–198

Tribute in Light, NYC



Source: Doren *et al.* (2017) High-intensity urban light installation dramatically alters nocturnal bird migration www.pnas.org/cgi/doi/10.1073/pnas.1708574114

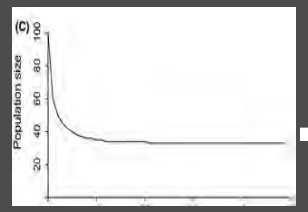
Source: www.terrain.org/articles/15/kousky.htm

Source: www.wildlondon.org.uk/campaigns/record-your-sightings/glow

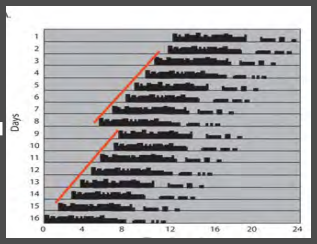
‘The more subtle influences of artificial night lighting on the behavior and community ecology of species are less well recognized

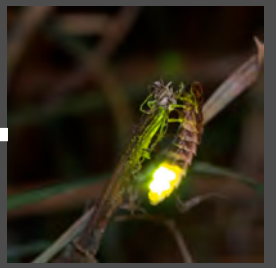
Source: Longcore, T. & Rich, C. (2004) *Front Ecol Environ* 2(4): 191–198

Artificial light's potential ecological impacts on wildlife

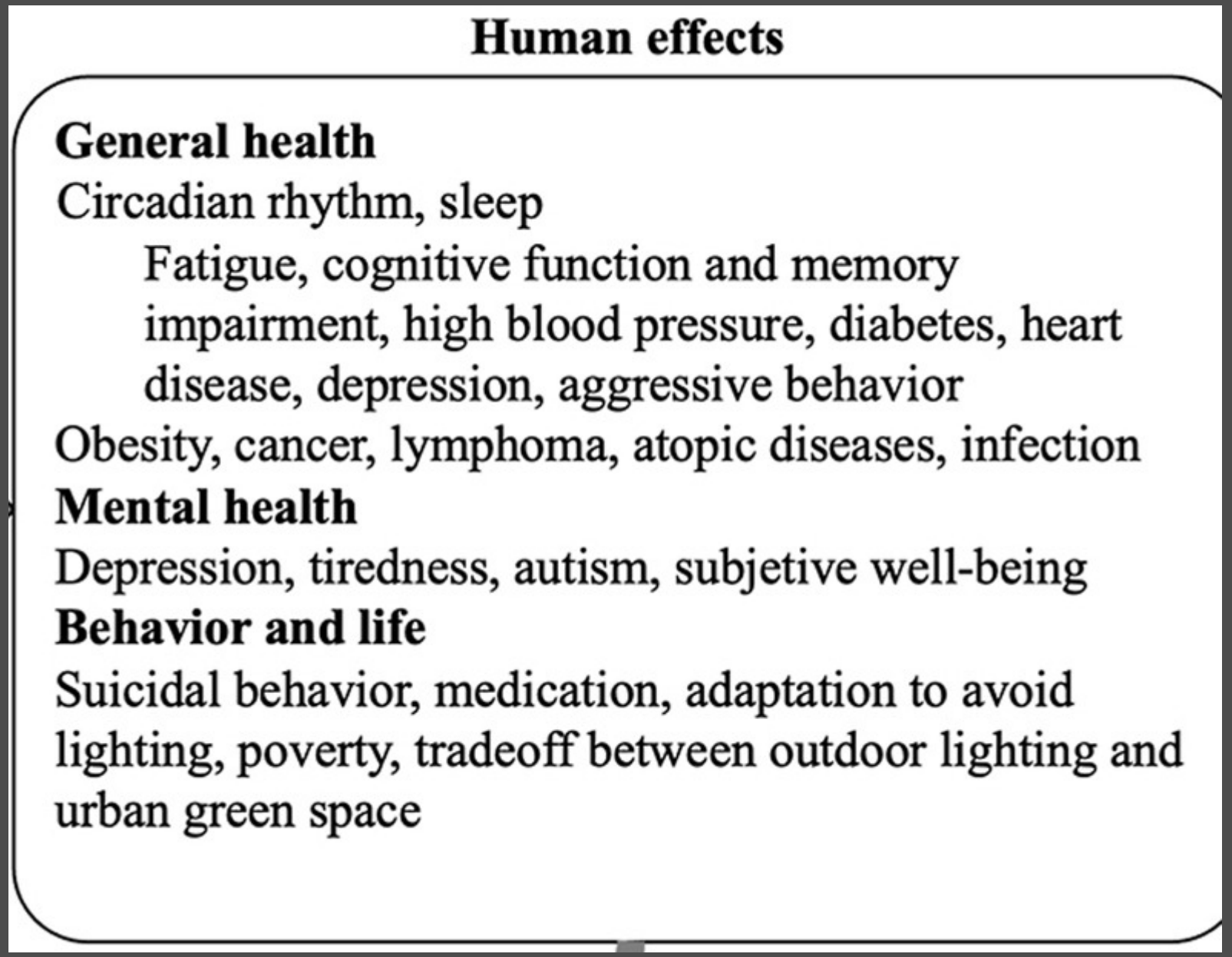


ECOLOGICAL AND BIOLOGICAL IMPACTS	DESCRIPTION
Mortality	Species attracted to light may be killed
Health and circadian rhythms	Light can influence various physiological processes that can impact health and circadian rhythms
Migration	Artificial light disturbs natural movement patterns, migration and orientation
Foraging	Reduced or increased foraging because of presence of light
Indirect competition	Light can benefit certain species at the expense of others
Communication	Light can interfere notably with species communication
Population size	Reduced or increased foraging because of presence of light





Source: Jägerbrand, A.K.; Bouroussis, C.A. Ecological Impact of Artificial Light at Night: Effective Strategies and Measures to Deal with Protected Species and Habitats. Sustainability **2021**, 13, 5991.



We still know relatively little about the extent is outdoor ALAN specifically harming human health and well-being though are learning steadily

Source: Reagan D.**(2024).** ***Artificial Light at Night: State of the Science***

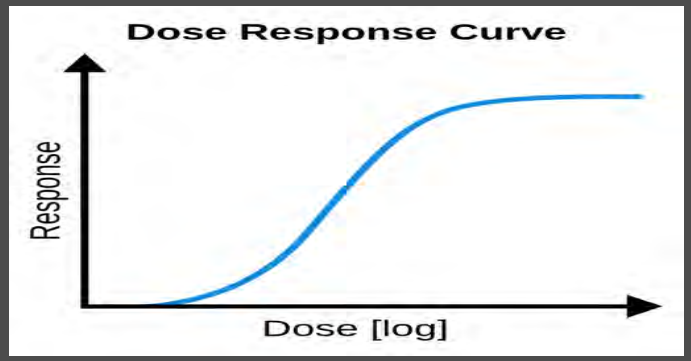
Source: Wang *et al*. (2023) Effects of outdoor artificial light at night on human health and behavior: A literature review. Environmental Pollution Volume 323, 15 April 2023, 121321

We still know relatively little about how effects of ALAN vary with age and sex of a species; or

with the amount of ALAN to which it is expose and over how long (Dose-Response characteristics); or

about effects of ALAN affect the fitness /survival chances of individual animals

Source: sfw.furaffinity.net/view/18218455/



Source: theconversation.com/

Source: Gaston et al/ (2015) The Biological Effects of Artificial Light at Night: The Research Challenge. Phil. Trans. Roy. Soc. B 370: 21040133

We know relatively little about how ALAN contributes to species population decline or extinction...

Source: Reagan (**2024**). ***Artificial Light at Night: State of the Science***

Is light pollution driving moth population declines?

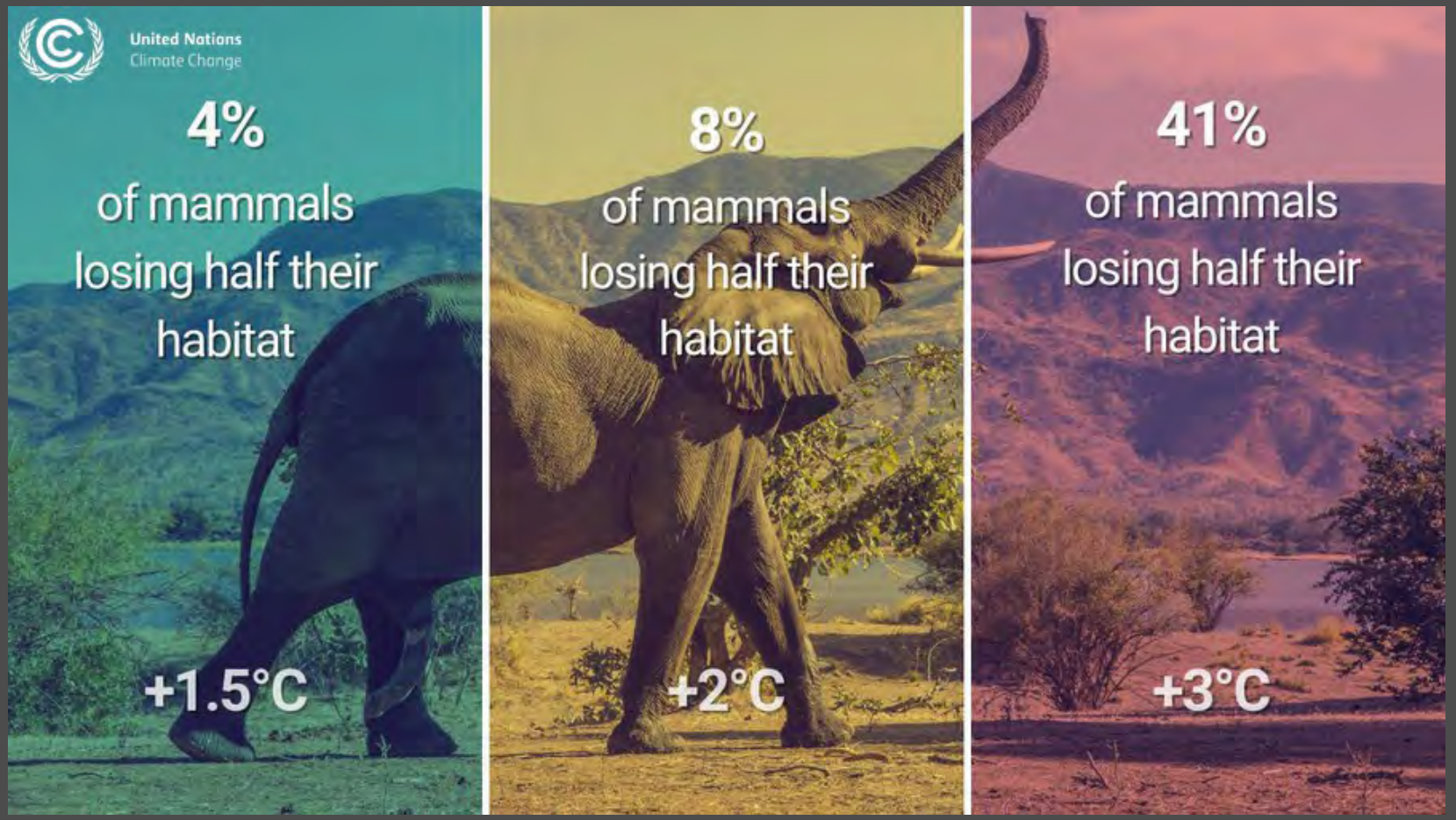
Overall, we found strong evidence for effects of artificial light on moth behaviour and physiology, but little rigorous, direct evidence that this scales up to impacts on populations...

...we recommend precautionary strategies to mitigate possible negative effects of ALAN on insect populations

Source: Boyes *et al.* **(2021). *MAJOR REVIEWI Is light pollution driving moth population declines? A review of causal mechanisms across the life cycle. Insect Conservation and Diversity (2021) 14, 167–187***

Indirect harm via accelerating climate change

- In 2015 - indoor and outdoor lighting accounted for **5 percent** of worldwide greenhouse gas emissions.
- Since then, there has been a significant investment in LED lighting to reduce energy savings
- However, there is growing evidence of a classic "rebound effect" whereby as light becomes cheaper, we use more of it



(US Department of Energy)

Source: www.un.org/en/climatechange/science/climate-issues/biodiversity

CURRENT APPROACHES TO MITIGATION

2024

...poor evidence base on which types of light pollution mitigation, whether physical or especially policy solutions, are most effective..

Source; Reagan (**2024**). ***Artificial Light at Night: State of the Science***

Five Lighting Principles for Responsible Outdoor Lighting

DarkSky

IES Illuminating Engineering Society

Responsible outdoor lighting is

1 Useful and Careful

Use light only if it is needed

All light should have a clear purpose. Consider how the use of light will impact the area, including wildlife and their habitats.

2 Targeted

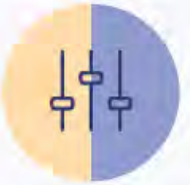
Direct light so it falls only where it is needed

Use shielding and careful aiming to target the direction of the light beam so that it points downward and does not spill beyond where it is needed.

3 Low Level

Light should be no brighter than necessary

Use the lowest light level required. Be mindful of surface conditions, as some surfaces may reflect more light into the night sky than intended.



4 Controlled

Use light only when it is needed

Use controls such as timers or motion detectors to ensure that light is available when it is needed, dimmed when possible, and turned off when not needed.

5 Warm-colored

Use warmer color lights where possible

Limit the amount of shorter wavelength (blue-violet) light to the least amount needed.

Source: www.darksky.org/resources/guides-and-how-tos/lighting-principles/

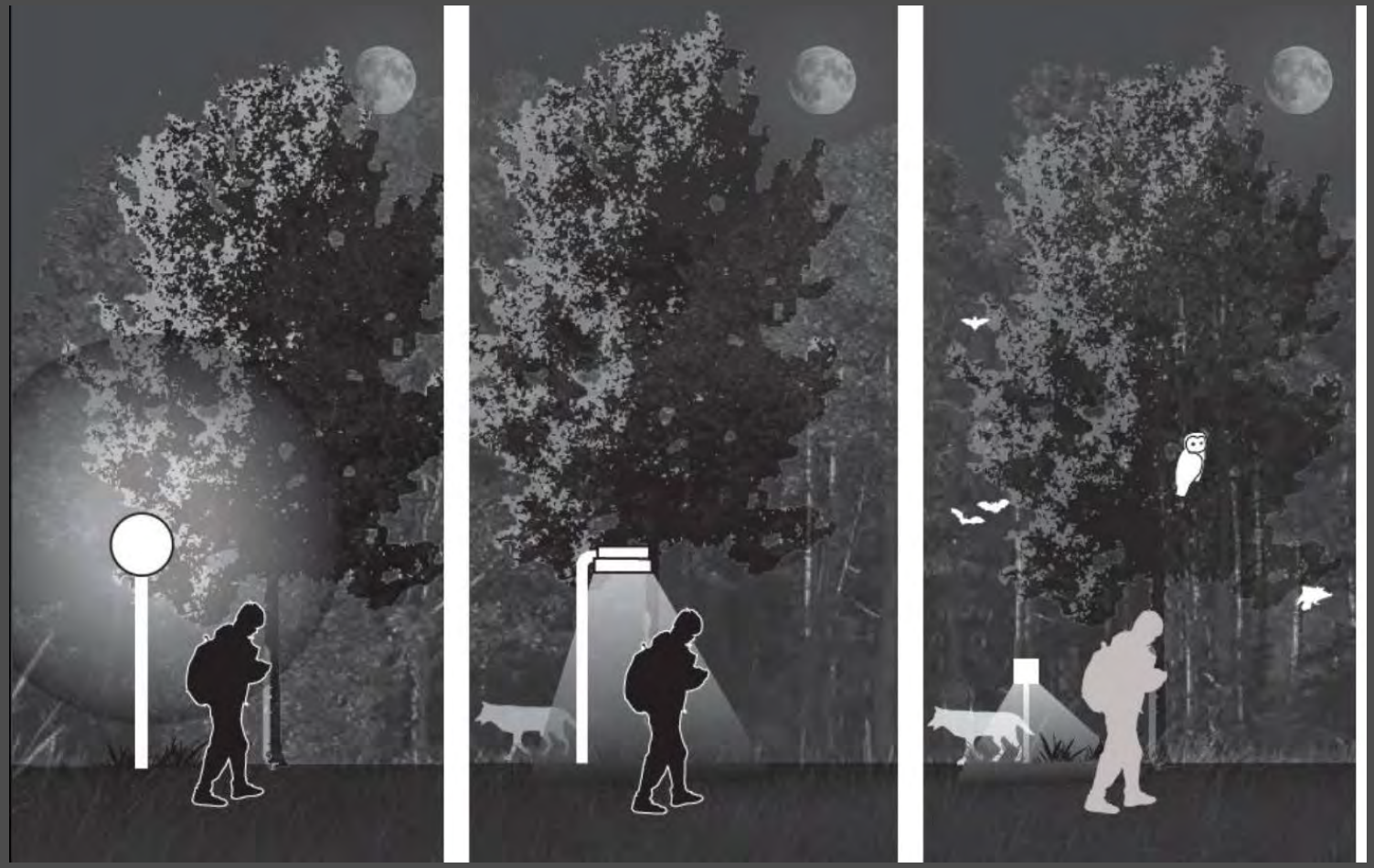
Rev. 08-2023

USEFUL (AND CAREFUL)

Artificial Night Lighting and Protected Lands

Ecological Effects and Management Approaches
(Revised August 2017)

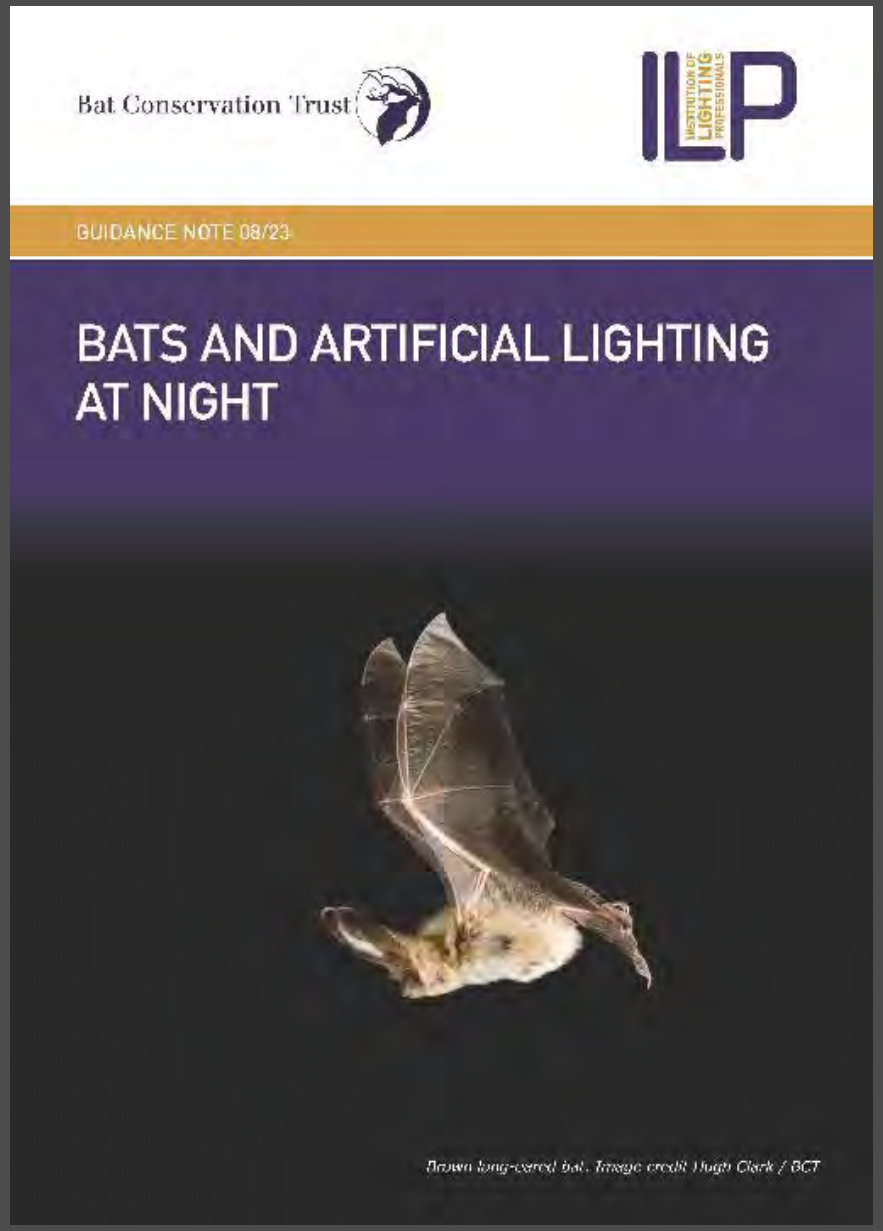
Natural Resource Report NPS/NRSS/NSNS/NRR—2017/1493



USEFUL AND CAREFUL

Special care is needed next to special sites for nature

National Park Services: US Department of the Interior



USEFUL AND CAREFUL

Special care is needed where valued and particularly light-sensitive species are active

WaterSpace
Design Guidance

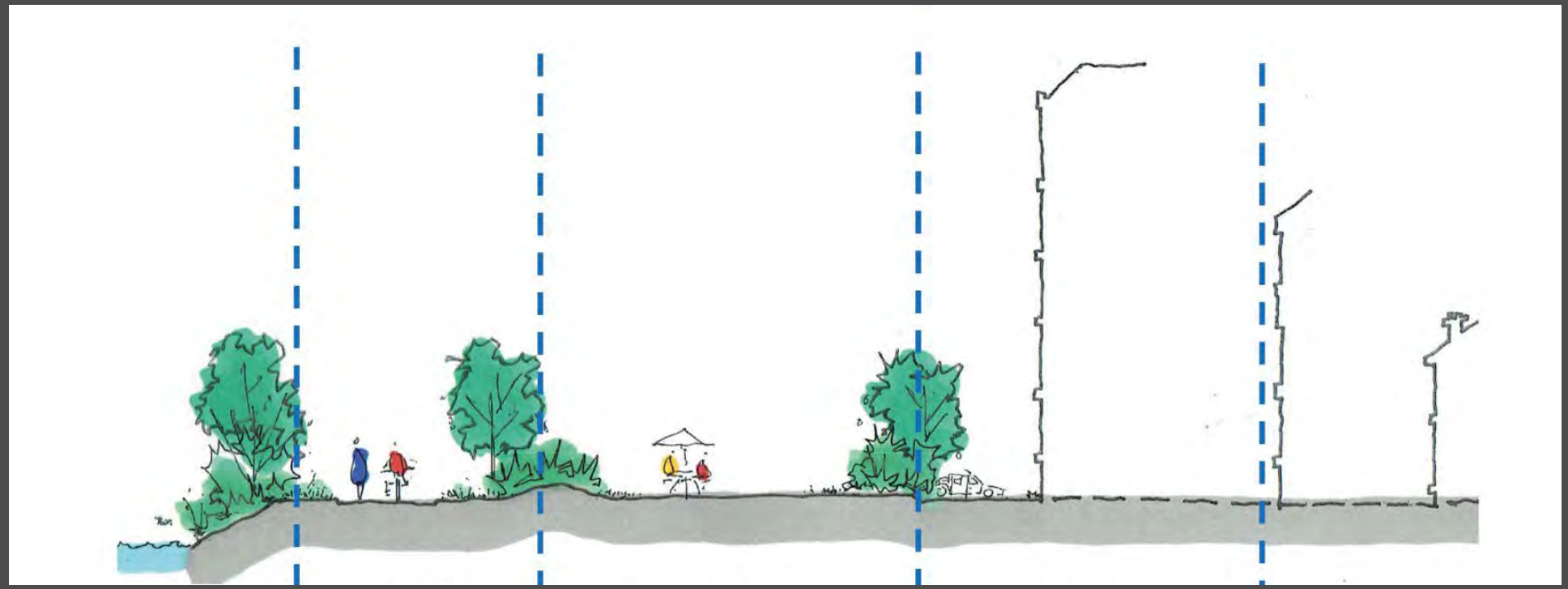
Protecting bats in waterside development

June 2018

WaterSpace
DUNDAS
BATH
HANHAM
REVITALISING OUR WATERWAYS

Bath & North East Somerset Council

Bath Waterspace Design Guidance 2018



River and Banks
< 0.2 lux

Banktop and Footpaths
< 0.5 lux

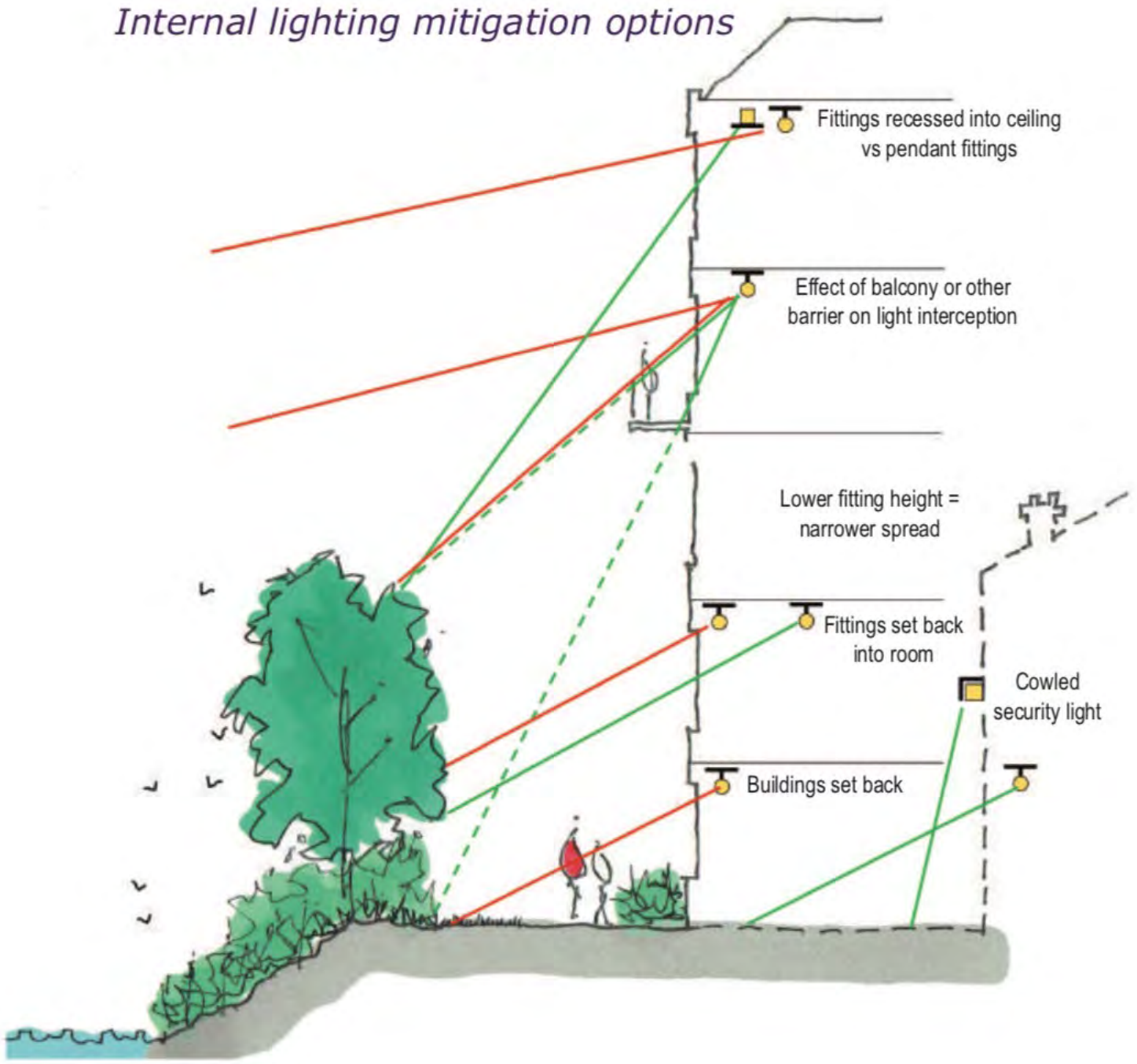
Development Edge
< 0.35 lux

Development Zones: No lux limits?? (But CCT/ILL 2023 says – lowest illumination limits and ‘sensitive lighting design to achieve targets in adjacent zones’)

Moonlight (full moon) is approximately 0.5 lux.

Source: B&NES 2018 Waterspace Design Guidance and BCT/ILL (2023)

TARGETED



TARGETED

Luminaire positioning inside buildings

Setting back, recessing, intercepting

Source: BCT/ILL (2023)

Source: Ecological Lighting Solutions

TARGETED

Using luminaires only when they have upward light ratio of 0%

and with good optical control

and above a relatively unreflective ground plane

South Downs National Park: Lightscape Management Policy)

SOLUTION: ELECTROCHROMIC GLASS

"... the spill of lights from large open glass windows and sky lights often present a greater source of light pollution than externally mounted lights. Consequently, it is important to control the lighting coming from these types of developments. The design of buildings should reduce the impact of light spill from internal lighting or suitable mitigation measures should be put in place." (SDNPA Local Plan: 5.64 – South Downs Lightscape Management Policy)

Source; www.architecturelive.co.uk/2018/10/sdnps-dark-night-skies-policy-requires-innovative-design/

LOW-LEVEL

Source: Ecological Lighting Solutions

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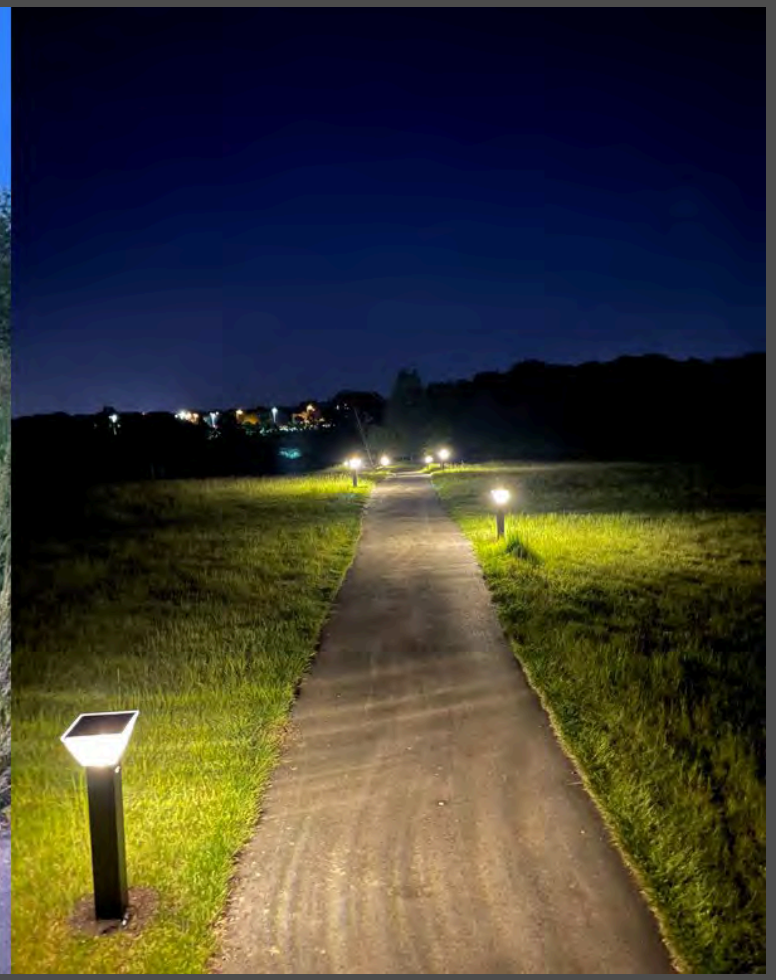
Floor washer lights provide light very locally to the working plane

Can remove the requirement for bollards or columns

Are lighting bollards environmentally benign?



Source: nightsearcher.co.uk/products/nexsun-bollard-c

Source; www.lumenalights.com/outdoor-lighting/pro-solar-eccentrica-angled-solar-path-lights/

Lighting of Lesser Horseshoe Bat flyway at junction between GI and River Severn flight corridors in Worcester

Source: BCT/ILL (2023)

WARM

Generic mitigation with universal applicability

All luminaires should lack ultraviolet elements.
Metal halide, fluorescent sources should not be used.

ANCPEN (FRANCE) 2015

Lighting for the 21st century

Towards a better understanding of the side effects of outdoor lighting on our environment

Tableau 6 : Lampes pouvant être recommandées lorsque la présence d'un éclairage artificiel demeure nécessaire

	UV							IR		
Longueurs d'ondes (nm)	*<400*	*400 - 420*	*420 - 500*	*500 - 575*	*575 - 585*	*585 - 605*	*605 - 700*	*>700*	*Lampes les « moins néfastes »*	*Lampes néfastes mais aux impacts plus « modérés »*
Poissons d'eau douce	x	x	x	x	x	x	x		*- Sodium Basse Pression - LEDs Ambrées à spectre étroit*	*- Sodium Haute Pression*
Poissons marins	x	x	x	x					*- Sodium Basse Pression - Sodium Haute Pression - LEDs Ambrées à spectre étroit -LEDs Rouges*	*- Fluo compacte (Blanc le plus chaud < 2700°K) - Tube Fluorescent (Blanc le plus chaud < 2700°K)*
Crustacés (zooplancton)	x	x*	x*							
Amphibiens et reptiles	x	x	x	< à 500 et > à 550	x	x	x	x		*- Sodium Basse Pression*
Oiseaux	x	x	x	x		x	x	x	*- Sodium Basse Pression - LEDs Ambrées à spectre étroit*	*- Sodium Haute Pression - Tube Fluorescent (Blanc le plus chaud < 2700°K)*
Mammifères (hors chiroptères)	x	x	x	x			x		*- Sodium Basse Pression - LEDs Ambrées à spectre étroit*	*- Sodium Haute Pression - Fluo compacte (Blanc le plus chaud < 2700°K) - Tube Fluorescent (Blanc le plus chaud < 2700°K)*
Chiroptères	x	x	x	x					*- Sodium Basse Pression - Sodium Haute Pression - LEDs Ambrées à spectre étroit -LEDs Rouges*	*- Fluo compacte (Blanc le plus chaud < 2700°K) - Tube Fluorescent (Blanc le plus chaud < 2700°K)*
Insectes	x	x	x	x						

x* : Probable mais non identifié dans la littérature scientifi

Recent research indicates some adverse effects

Red can affect migrating bat species

Generic mitigation with universal applicability

Specifying a colour temperature of 2700K, or less, reduces the harmful effect of artificial lighting on wildlife.

Source: https://lightingdesignstudio.co.uk/colour-temperature/

Red LED

Worcestershire, UK

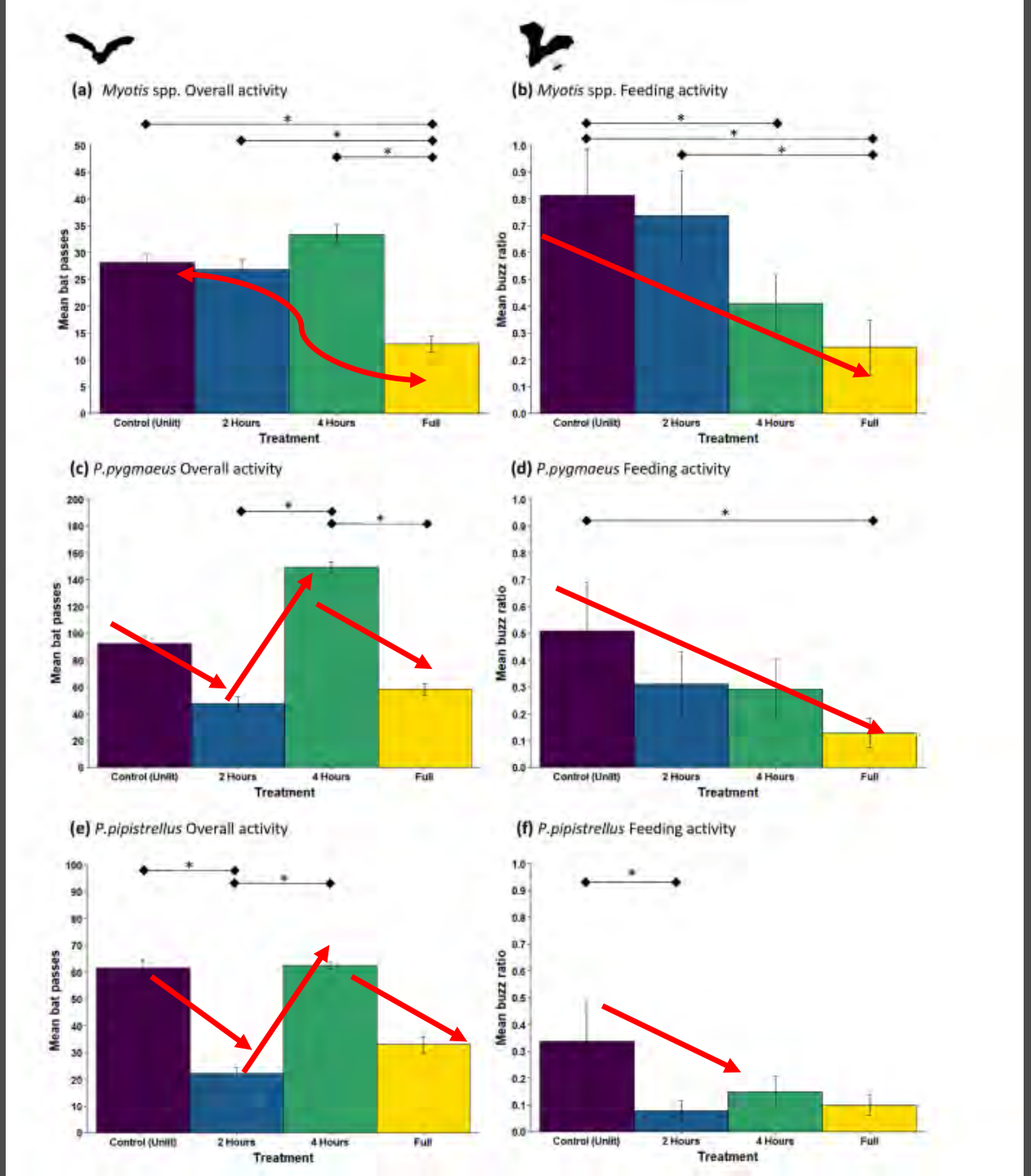
Source: wildlife.org/uk-county-puts-on-red-light-for-bats/

Gladsaxe, Denmark

Source: afry.com/en/newsroom/news/gladsaxe-municipality-in-denmark-switches-bat-friendly-lighting

CONTROLLED

PARTIAL NIGHT LIGHTING



Source: Hooker *et al.* (2022) Lighting up our waterways: Impacts of a current mitigation strategy on riparian bats . *Environmental Pollution* 307 (2022) 119552

MOTION SENSITIVE LIGHTING

WARREN PATH LONDON BOROUGH OF RICHMOND UPON THAMES

The dimmable LED luminaire uses warm white light and highly controlled optics to focus the light distribution.

A motion sensor is attached to each column, increasing the lumen output of the three adjacent columns each time a person passes.

The whole scheme is switched off at 11pm to allow a substantial period of natural darkness.

Needs a Central Management System (CMS) with capacity for smart metering

Source: Wandle Trail Lighting Design Feasibility and Concept Report For Sustrans and London Borough of Merton.13th June 2016

sustainability

MDPI

Article

Rethinking Sustainable Cities at Night: Paradigm Shifts in Urban Design and City Lighting

Karolina M. Zielinska-Dabkowska [1,*] and Katarzyna Bobkowska [2]

SDG *11* *Sustainable Cities and Communities: Make Cites and human settlements inclusive, safe, resilient and sustainable*

should be updated to include mitigation of the effects of ALAN to consider all factors from ecological and human health to social benefit, technology and the nighttime economy.

Source: singletrackworld.com/

I would like to issue a call

for interdisciplinary endeavour

to find win-win solutions

to the impacts of ALAN