Plant seasonal timing (phytochrome)

Plant growth

Daily cycle in mammals and birds (melatonin suppression)

Bumblebee vision

Human vision

Ultra-violet   Visible light   Far-red
The ecological impacts of nighttime light pollution: a mechanistic appraisal

Kevin J. Gaston1,*, Jonathan Bennie1, Thomas W. Davies1 and John Hopkins2

doi: 10.1111/brv.12036
Behavior of Loggerhead Sea Turtles on an Urban Beach. II. Hatchling Orientation
Salmon et al.
Dacke et al., (2013) Dung beetles use the milky way for orientation
Current Biology 23 (4) 298-300
Small ermine moths (*Yponomeuta cagnagella*) adapt to urban areas by reducing their “flight to light” behaviour.

Altermatt & Ebert Reduced flight-to-light behaviour of moth populations exposed to long-term urban light pollution

Ecological effects or artificial light

- Artificial light can have profound effects on the **physiology** and **behaviour** of species
- Mediated through the effects on **rhythms**, **spectra** and **intensity** of natural light
- How does this affect **populations** and structure of ecological **communities**?
- How **widespread** are these effects in ecosystems?
Search for evidence for:

- Species **population**-level effects of artificial light?
- Species **community**-level effects of artificial light?
- **Regional effects** of artificial light (sky-glow)?
- **Landscape effects** of networks of artificial light?
- Opportunities to minimise ecological effects.

-> **ECOLIGHT project**
Ecological effects of artificial light at night on wild plants

Jonathan Bennie*, Thomas W. Davies, David Cruse and Kevin J. Gaston

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Common Redshank *Tringa totanus* by Andreas Trepte - Own work. CC BY-SA 2.5 via Wikimedia Commons

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![Graph showing light levels](chart.png)

- **Daylight**
- **Twilight**
- **Moonlight**
- **Starlight**
- **Car headlights**
- **Street lighting (tree canopy)**
- **Street lighting (grass verge)**
- **Skyglow**

**Illuminance (lx)**

- 0.00001
- 0.0001
- 0.001
- 0.01
- 0.1
- 1
- 10
- 100
- 1000
- 10,000
- 100,000
Ecological effects of artificial light at night on wild plants

Jonathan Bennie*, Thomas W. Davies, David Cruse and Kevin J. Gaston

*Correspondence: Jonathan.Bennie@exeter.ac.uk

Light measured in hedgerow beside roadway from sunset to sunrise
THE EFFECT OF STREET LIGHTS IN DELAYING LEAF-FALL IN CERTAIN TREES

Edwin B. Matzke

American Journal of Botany, Vol. 23, No. 6 (Jun., 1936), pp. 446-452
Empirical measurement of the time of budburst on trees near path lighting on Exeter University campus
Effectiveness of Five Vision-Lighting Sources on Photo-Regulation of 22 Species of Ornamental Plants

Henry M. Cathey and Lowell E. Campbell

Agricultural Research Service U.S. Department of Agriculture, Beltsville Agricultural Research Center, Beltsville, MD

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Environment and Sustainability Institute

www.exeter.ac.uk/esi
High pressure sodium street lights affect crops in Ghana

World Crops, November/December 1981
Bird song occurs earlier in some birds.
Does light pollution alter daylength? A test using light loggers on free-ranging European blackbirds (*Turdus merula*)
Dominoni & Partecke 2015 Phil Trans B Volume: 370 Issue: 1667
Blackbirds exposed to streetlight mature earlier in first year

Blackbirds exposed to streetlight do not mature in second year

**Long-Term Effects of Chronic Light Pollution on Seasonal Functions of European Blackbirds (Turdus merula)**

Davide M. Dominoni¹,²,³, Michael Quetting¹, Jesko Partecke¹,³

PLOS ONE | www.plosone.org | December 2013 | Volume 8 | Issue 12 | e85069
Artificial light alters natural regimes of night-time sky brightness

Thomas W. Davies, Jonathan Bennie, Richard Inger & Kevin J. Gaston

SCIENTIFIC REPORTS | 3 : 1722 | DOI: 10.1038/srep01722

20 km from city

9 km from city

City Centre

Natural lunar cycle
Barn owl sensitive to light

Redshank have two modes of feeding. Birds attracted to oil refinery use daytime mode (eyesight) which is more efficient than nocturnal mode of feeding by probing.
Larger bats avoid lit areas
Changes in Irish bat population and diversity with time

http://www.batconservationireland.org/
3D high resolution light modelling

How do organisms respond to:

- fine-scale patchiness of light
- variation in spectral composition
- temporal changes
Potential landscape-scale effects of direct light in restricting movement
Innovative mapping of bat transit routes using electrical resistance analogy

Modelling movement paths
Modelling movement paths
Street lighting changes the composition of invertebrate communities

Thomas W. Davies, Jonathan Bennie and Kevin J. Gaston
Community and population-level effects – potential for light at night to locally restructure communities
Exeter field experiment
Exeter field experiment site
Mesocosm experiment
**Blackbird tree** by John Arundel - [http://commons.wikimedia.org/wiki/File:Blackbird_tree.jpg#mediaviewer/File:Blackbird_tree.jpg](http://commons.wikimedia.org/wiki/File:Blackbird_tree.jpg#mediaviewer/File:Blackbird_tree.jpg)
Cascading effects of artificial light at night: resource-mediated control of herbivores in a grassland ecosystem

Jonathan Bennie, Thomas W. Davies, David Cruse, Richard Inger and Kevin J. Gaston
Effects of artificial light on wildlife

Light as information:

• Interferes with detection of seasonal changes in daylength (tree budburst and leaf-fall; flowering in plants; breeding in birds)
• Alters detection of day and night (melatonin production in mammals and birds)
• Obscures natural cues for navigation (seabirds, night-flying insects)
Effects of artificial light on wildlife

Light as a resource:

• Increased activity of diurnal species (eg. songbirds) and some predators and foragers (owls, spiders, waders, pipistrelles around streetlamps)
• Reduced activity of light-shy species (eg. lesser horseshoe bat, rodents)

Light as a barrier:

• Fragments landscapes by repelling or trapping animals (eg. bats, moths)
Effects of artificial light on wildlife

Ecosystem effects:

• Effects of artificial light on seasonal timing may lead to mismatches between species
• Light may disrupt predator-prey interactions (top-down effects)
• Light may alter the availability of food resources (bottom-up effects)
• Light may alter other interactions between species (eg. nocturnal pollination)
Effects of artificial light on wildlife

Ecosystem effects:

• Artificial light may have unexpected consequences
• Acting together with other pressures – climate change, land-use changes, habitat loss
Thanks for listening.

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