Artificial Light at Night: State of the Science 2025

DarkSky International

DOI: 10.5281/zenodo.15492393

This briefing summarizes the current state of knowledge about how the widespread and growing use of artificial light at night interacts with six key topics: the night sky (Section 1); wildlife and ecology (Section 2); human health (Section 3); public safety (Section 4); energy security and climate change (Section 5); and social justice (Section 6). It also includes a discussion of the emerging threat from light pollution caused by objects orbiting the Earth (Section 7). Finally, it concludes with a discussion of the knowledge gaps that exist within these topics and the research questions whose answers can fill the gaps (Section 8). It is intended to be useful to those seeking to broaden their understanding of research on the causes and consequences of artificial light at night.

Introduction

Artificial light at night (henceforth, 'ALAN') in the outdoor context is surging in both its presence and reach across our planet (1–4). It is the source of both known and suspected harm to the nighttime environment (5–8). ALAN is generally recognized as the cause of light pollution, a form of environmental pollution (9, 10).[1] Scientific studies suggest that overuse of ALAN is the main source of light pollution (11, 12), yet the functional efficacy of outdoor lighting remains extremely low (13). The main challenge identified by scientific research is how to maximize the human benefits of ALAN while limiting its potentially negative social and environmental impacts (14–17).

1 The Night Sky

Light emitted into the night sky makes it difficult to see the stars. On the ground, ALAN makes the nighttime environment brighter. Weather changes like clouds and snow on the ground can make this impact worse. New and inexpensive light sources like white light-emitting diodes (LEDs) have a growing impact on both the night sky and outdoor spaces at night.

[1] Although there is no single definition of "light pollution" on which all researchers agree, there are some definitions in wide circulation. DarkSky International defines it as "the human-made alteration of outdoor light levels from those occurring naturally." (https://darksky.org/resources/glossary/) The International Commission on Illumination definition ("the sum total of all adverse effects of artificial light"; CIE S 017:2020 ILV: International Lighting Vocabulary, 2nd edition) focuses on the negative consequences of ALAN.

The most immediate symptom of light pollution is the phenomenon of "skyglow". It brightens the night sky in and near cities where large installations of outdoor lighting exist. The lower layers of the Earth's atmosphere scatter light emitted near the ground. Some of that light escapes the atmosphere, either directly or after reflecting from ground surfaces (18, 19). Some of the escaping light is detected by instruments aboard Earth-orbiting satellites (20, 21), but many light rays encounter molecules and small particles in the atmosphere. These interactions redirect the paths of some of the light rays back down to the ground. Observers there see light appearing to come from the night sky itself; see Figure 1. Skyglow competes with the faint light of astronomical objects in the night sky. It lowers the contrast between those objects and the background sky, making it difficult to observe them (22). This is a significant threat to ground-based astronomical observations and research (23, 24). It can also alter the polarization state of light in the night sky (25, 26). There are currently no absolute metrics to characterize light pollution in wide use among researchers and practitioners (27, 28).

Measurement and monitoring of light pollution provides important information about its extent, severity and rate of change (29). A slow but steady rise in skyglow in much of the world leads to gradually degraded visibility of the natural night sky and a transformation of outdoor spaces. Such a situation, changing slowly over decades, may go unnoticed due to a psychological effect known as a "shifting baseline" (30). This applies to various aspects of artificial light on a 'normal' night: the number of visible stars, the amount of artificial light associated with perceptions of safety, and the experience of using non-visual senses such as hearing and balance. Along with other effects, the loss of the night sky is barely noticed.

Researchers have also studied both the sources of light pollution and the means of reducing its influence. In many places, publicly owned sources of light contribute most to the brightness of the night sky, especially in the earlier hours of night (31–34). Certain approaches, such as shielding light fixtures and reducing their intensity, seem to have the greatest benefit in terms of decreasing skyglow (35, 36).

Remote sensing of light pollution

"Remote sensing" is a method of measuring the properties of something at a distance without directly sampling it. It is often applied to measurements of light pollution made

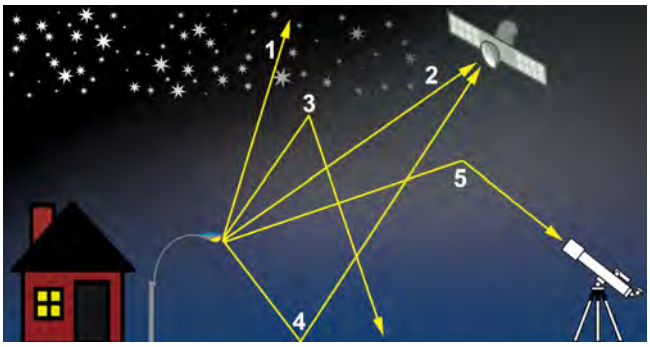


Figure 1. The streetlight at left emits light in many different directions. Some of the light rays (1) travel upward into the sky and pass completely through Earth's atmosphere. Satellites detect some of these rays (2) as they pass over the nighttime side of our planet. In other cases (3), the atmosphere scatters rays back to the ground. This light becomes the familiar "skyglow" seen over cities. Some of the rays traveling downward (4) reflect off the ground into the sky where they are seen by satellites. Lastly, some rays scatter into astronomers' telescopes (5), blocking their view of the universe. Credit: DarkSky International.

by stratospheric sounding balloons (37–40), low-flying aircraft (41), unmanned aerial vehicles (or 'drones') (42–44), Earth-orbiting satellites (20, 45, 46) and even the International Space Station (47). In particular, satellites provide our only view of the global scale of the problem of light pollution (1, 2). Remote sensing platforms closer to the Earth's surface, mentioned above, offer more detailed information at finer spatial scales and over longer time periods.

Figure 2 shows a global map of night lights made from satellite remote sensing observations (48). This is a composite image composed of observations of Earth made over many nights in one year. It gives the appearance of our planet as if it were simultaneously night everywhere at once. It also ensures that the result does not include clouds or light from the aurora near the Earth's poles. The camera used to make this map uses a sensitive detector that records faint light in the visible spectrum. It can resolve features on Earth smaller than one kilometer in size. This is smaller than the size of most cities, so the images give detailed information about the number and characteristics of various light sources on the ground. Images like these dating from as early as the 1970s are available to the public and for scientific study (49).

In recent years, researchers have learned much about the spread of light pollution across the globe by studying remote sensing data. They found that skyglow fouls the night sky for more than 80% of all people and more than 99% of the U.S. and European populations (1). ALAN now reaches even into remote parts of the world such as the Arctic (50, 51).

Both the amount of artificial light seen on Earth at night and the land area that light covers grew by about two percent each year on average during the first half of the 2010s. (Figure 3). Yet, both numbers vary significantly across our planet (52). There are only a few countries in which they seem to be either stable or decreasing (2, 53).

Satellite remote sensing used to make studies like these is not perfect. For example, scattered light (54) and varying atmospheric conditions (55) can adversely affect their measurements. Also, insufficient color information on outdoor lighting is identified as a problem (56). The best available satellite cameras are not sensitive to some colors of light. In particular, some do not see the blue light emitted by white LED lighting. This means that key light pollution indicators are probably underestimated. Ground-based visual estimates of night sky brightness support this hypothesis. These indicators increased on a global average basis by about 10% per year between 2011-2022 (Figure 4) (4). There are also other concerns related to the accuracy of satellite data used in these studies. These include the angle at which satellites sense lights (57) and the time of night satellites pass over cities (58).

Combining satellite data with ground-based observations can improve the reliability of results (59, 60). But the need for new, dedicated orbital facilities to address important research questions is urgent (61, 62). This is especially true given that some Earth-observing satellite missions, such as NASA's Terra, are slated to end in coming years.

Environmental conditions change night sky quality

Cloudy conditions tend to make skyglow more intense in urban and suburban areas. This is because overcast nights can increase the intensity of light reflected back down to ground level by up to ten times (63, 64). However, in rural areas with few light sources, cloud cover tends to darken the night sky (65). This is because clouds efficiently absorb and scatter light from both natural and artificial sources, decreasing the amount reaching the ground. Skyglow is also sensitive to very small particles in the air (66), and it can be increased by air pollution (67, 68). ALAN itself may also interact or interfere with the chemistry of gasses in the lower atmosphere, potentially degrading air quality (69–72).

Ice and snow make skyglow worse because they reflect much more light than darker ground covers. This enhances the apparent nighttime light emissions from cities (73). Snow cover on the ground under clear-sky conditions can increase night sky brightness by up to three times (74). When clouds cover the sky in the winter months, light reflected from both snow and clouds "amplifies" skyglow. The result can raise night sky brightness by over 3500 times compared to overcast conditions with no artificial light (75). Even in clear weather, the tendency of ground covers like asphalt and concrete to reflect light can raise night sky brightness (76, 77).

The rise of solid-state lighting may threaten dark skies

Global light pollution has increased in recent years in part because of the introduction of solid-state lighting (SSL). This kind of lighting uses semiconductor materials to generate light. It differs from earlier technologies that used electric currents in tubes of gasses like high pressure sodium, mercury vapor or metal halide. Those earlier light sources once dominated the global outdoor lighting market.



Figure 2. A cloud-free composite image of the Earth at night made using Earth-orbiting satellite data for the year 2016. Credit: NASA Earth Observatory/Goddard Space Flight Center/J. Stevens/M. Román (public domain).

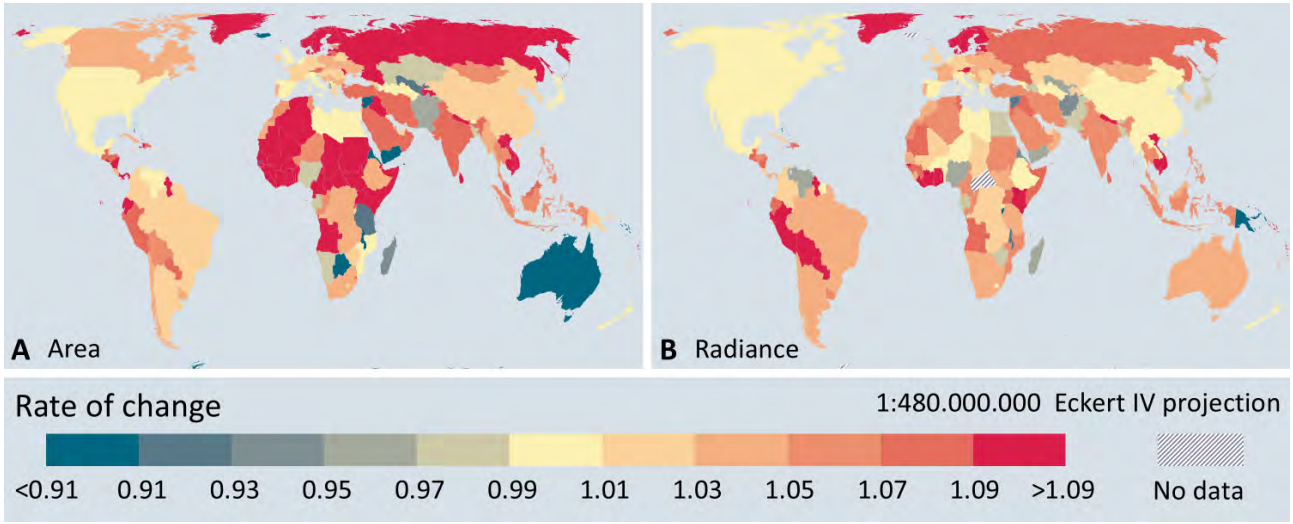


Figure 3. This figure from reference (2) shows how nighttime lights on Earth changed during 2012-2016. The map on the left shows the change in the land area showing indications of artificial light as seen from space, and the map on the right shows how much the brightness of the light changed. Red colors mean increases in lit area and/or brightness during the study period and blue colors mean decreases. Yellow areas were unchanged. This image is reproduced under a Creative Commons Attribution-NonCommercial 2.0 Generic license.

The most familiar kind of SSL technology is the white light-emitting diode, or LED. This technology now accounts for almost 50% of global lighting sales (78). The lighting market's explosive growth in recent years is due in part to the exceptional energy efficiency of SSL, which is up to ten times higher than earlier technologies like incandescent filament lamps. While one-for-one SSL replacements save energy compared to earlier technologies (with beneficial impacts; see Section 5), the energy efficiency and low cost of SSL can encourage over-lighting (with negative impacts; see Sections 2, 3, and 5). In order to achieve the full promise of SSL, factors such as the spectrum and distribution of the light source should be carefully designed (79).

The rapid rush to adopt and install SSL has changed the color of artificial light emitted into the nighttime environment (80, 81). White LED lighting generally emits much more short-wavelength (i.e., blue) light than other technologies. This causes a shift in the color of cities as they transition to SSL (82). It may also make skyglow over cities worse even when the number of lumens – that is, the amount of light to

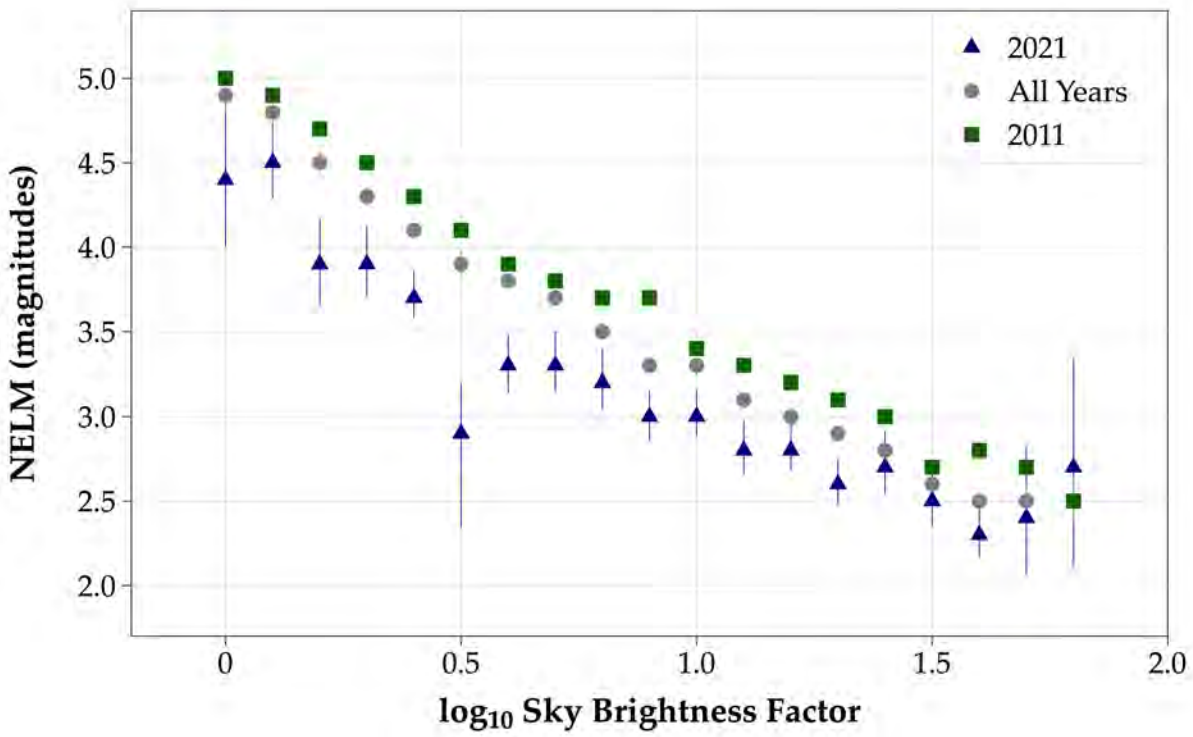


Figure 4. The relationship between naked-eye limiting magnitude (NELM), a measure of the number of visible stars in the night sky, and the brightness of the night sky ('Sky Brightness Factor') from citizen science observations obtained between 2011 and 2021. Larger NELM values mean that more stars are visible. Points are observations in the years 2011 (green squares) and 2021 (blue triangles) as well as the average of all years (gray circles). Adapted from Figure 1 in (4) and reproduced with the permission of the authors.

which the human eye is sensitive – used is the same (83–86). This may extend the impact of city lights much farther into adjacent, ecologically sensitive areas (87, 88). It also specifically threatens the productivity of ground-based astronomical observatories (23, 89, 90), which rely on sites with dark night skies in order to produce new knowledge about our universe. However, the characteristics of LED lighting can enable its more efficient use, often requiring less light for the same applications than previous technologies (91). When cities plan LED retrofits carefully, they can hold light pollution steady or even reduce it (92–94).

Dark-sky conservation and astrotourism

Meanwhile, the ongoing conversion of world outdoor lighting to SSL, and its potential to increase skyglow, may work against dark-sky landscape conservation goals. Public interest in visiting naturally dark places is increasing (95, 96). This has created a new kind of "astrotourism" (97, 98) with significant revenue-generating potential (99). This may (or may not) in turn encourage lighting practices and public policies that protect night skies (100–102). It also calls into question what defines a "dark sky" (103) and how it should be quantified (104, 105). It also requires understanding how to measure or describe nighttime darkness to best preserve it (22, 106). Limited evidence suggests that efforts that recognize the value of dark skies and support their conservation may have positive benefits in reducing skyglow on regional scales (107).

2 Ecological Impacts

ALAN exposure affects almost every species studied by scientists. It interferes with their biology and changes how they interact with the environment. This harms ecosystems and can make plants and animals less resilient in the face of environmental change.

Organisms at or near the surface of the Earth experience natural levels of light that vary by a factor of over one billion (Figure 5). The rising and setting of the Sun and Moon set light levels and the timing and duration of light exposure. They are the most important sources of light in the natural environment, and they establish cues that species look for around them. This tells them when to engage in certain behaviors like finding food and mates.

Some species rely on very dim sources of natural light, such as starlight, for orientation and navigation (109, 110). Artificial light can disrupt the activities of these species (111). Their behaviors evolved over billions of years in the presence of only natural sources of light at night.

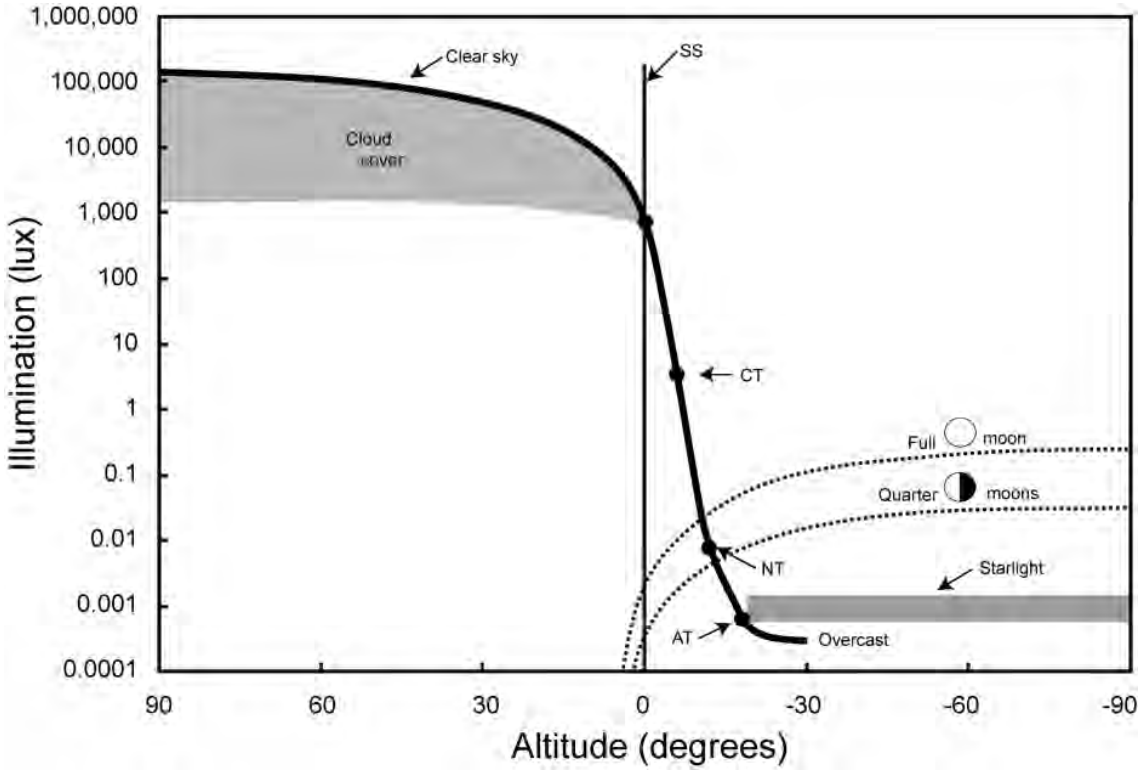


Figure 5. Natural illumination during the day and at night. The solid black line is the amount of light falling on surfaces near the ground. Certain times are indicated: SS = sunset (when the Sun's angle above the horizon reaches 0°); CT = end of civil twilight (Sun angle = −6°); NT = end of nautical twilight (Sun angle = −12°); AT = end of astronomical twilight (Sun angle = −18°). Note that the increments on the vertical axis increase in factors of ten. The horizontal axis shows the Sun's angle above or below the horizon. Dotted lines show the illumination by the Moon for its full and quarter phases. Cloud cover decreases the ground brightness by the amount in the shaded region at upper left. The shaded region at lower right is the contribution from starlight under clear skies. Adapted from (108); figure courtesy of T. Longcore.

The scale of ALAN impacts on wildlife

Scientists have studied at least 160 species for effects due to ALAN exposure. They have observed harms at levels from individual plants and animals all the way up to entire populations (112–115). Nearly all living things react to artificial light. Effects have been seen among birds (116–119); fishes (120); mammals (121–123); reptiles (124–126); amphibians (127–129); insects and other invertebrates (130–133); mollusks (134, 135); plankton (136, 137); microorganisms (138, 139) and plants (140–143). Effects are seen particularly in aquatic environments (144, 145) including the world's oceans (146–150) to depths of hundreds of meters (151).

The presence of ALAN disrupts natural light intensity, its timing and color characteristics (152). It increases total light intensity relative to natural levels and tends to shift the spectrum of ambient light away from its natural condition (153). Poorly timed light exposure interrupts various biological activities in plants and animals (154). These activities rely on the daily and seasonal rhythms of exposure to light in the environment. Examples include finding food (155–158); the time at which certain animals first emerge from their hiding places (159, 160); plant and animal reproduction (121, 161–163); sequencing of seasonal events in plants (164); and animal migration (165, 166) and communication (167–169). All these effects can make it difficult for organisms to survive and reproduce (170). It may even influence how species adapt and evolve (171–174). This adds to other environmental pressures many species face like habitat loss and climate change (175–177).

Artificial light exposure seems to weaken the immune systems of some organisms (178–180). It can make them less resilient in the face of environmental stress (181, 182). Parents may pass that weakness to their offspring (183, 184). ALAN exposure may thus leave some species more vulnerable to both predators (185, 186) and parasites (187, 188). Researchers also find that light exposure often occurs alongside noise caused by human activity (189). The combination of artificial light and noise can further harm some species (190–193).

How light affects biology

Light has two kinds of effects on plants and animals: internal (through physiology) and external (through interactions with the environment and with other species). Physiological effects of ALAN exposure include disruption of normal chemical signaling in organisms (195, 196). This signaling relates to the circadian rhythm, a roughly 24-hour cycle of

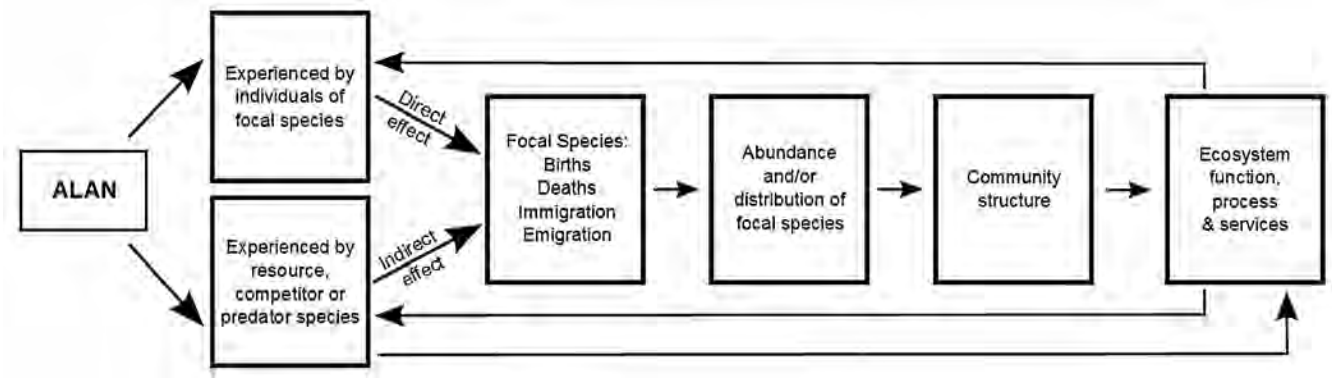


Figure 6. Routes by which ALAN exposure can influence interactions between different species. The figure shows some of the ecological consequences of those interactions. Figure 7 in (194), reproduced under a Creative Commons Attribution 3.0 Unported license.

activity tied to the length of the day. Exposure to sunlight, followed by many hours of darkness, establishes an environmental cue. This helps 'entrain' the circadian rhythm when the period of the rhythm differs from the day length. Artificial light exposure at times that conflict with these natural cues can interfere with this entrainment.

In addition, some species show sensitivity to the polarization of light (197–199). Polarization refers to the plane in which light waves travel. Light can become polarized by reflection from surfaces such as water, which presents a special challenge to aquatic species near sources of ALAN (200–202). ALAN can pollute the polarization signal of natural light sources (203), which may confuse some animals. The example of polarization effects shows that when evaluating the impact of ALAN on wildlife, we must look at factors in addition to the intensity, spectrum, duration and timing of light exposure (204, 205).

Modifying outdoor spaces at night by exposing species to artificial light causes environmental effects (6). There are few sources of natural light in the nocturnal environment besides the Moon and stars (22). This light dominated the landscape for billions of years until the invention of electric light. ALAN can therefore be a disadvantage to species that evolved in a world without it. It thus represents an emergent pressure on populations and communities of species (206–208).

The sweeping changes brought about by ALAN have many observed effects on ecosystems (Figure 6) (194, 210). For instance, ALAN exposure can change the interaction between predatory species and their prey (Figure 7) (211–214). This weakens food webs (215, 216) and can make wildlife susceptible to other environmental harms (217–219). Other ways ALAN harms species are by reducing options for finding food (155, 156, 220) and altering how individuals find mates and reproduce (221–224).

ALAN can create an effective barrier in the environment to the movement of organisms. It interferes with organisms' abilities to orient themselves and move about (118, 225, 226). ALAN also alters the competition for resources

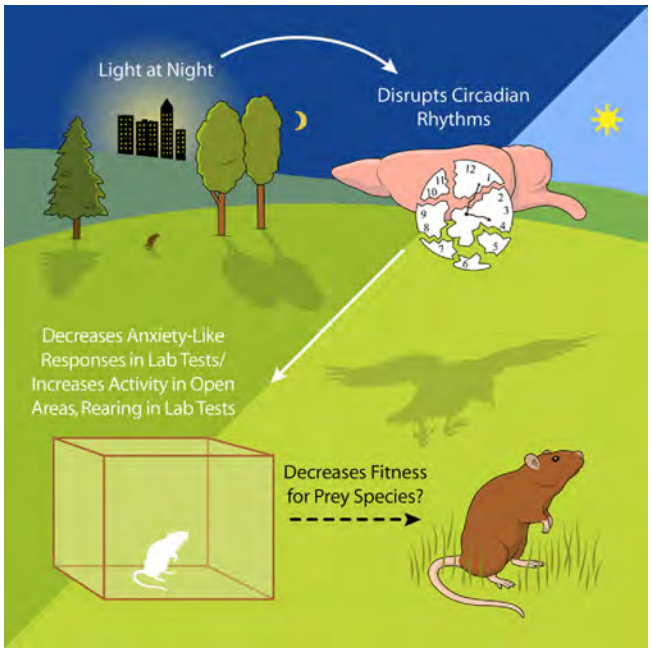


Figure 7. A cartoon representation showing how ALAN exposure can make prey species more vulnerable to predators in the wild. In lab tests of rodents, ALAN interferes with signaling processes beginning in the brain's pineal gland. This interference apparently decreases anxiety responses, such as activity in open areas and behaviors like standing up on the hind legs, that could increase their visibility to predators. Figure 1 from (209), reproduced with permission of the authors.

between species by either including species in, or excluding them from, their habitats based on their exposure tolerance (227–229). Animals sometimes avoid lit areas in preference to darker ones (230), and ALAN can disguise barriers that can injure or kill individuals (231, 232). It can also cause *phototaxis*, a condition in which organisms tend to move either toward light (positive phototaxis) (219, 233, 234) or away from light (negative phototaxis) (235, 236). Phototaxis is a cause of injury and death among both birds and insects (237–239).

ALAN is one of the most pressing and imminent threats to global biodiversity (240–242). Studies suggest

clear impacts on wildlife populations due to artificial light, even from indirect exposures (243). In particular, certain types of outdoor lighting adversely affect wildlife biology (244). In some cases lighting may convey advantages to invasive species (245, 246), helping them out-compete native species. In others, light pollution combines with other kinds of environmental changes to yield greater harm to species (247).

Yet biological impacts of artificial light sources are still mainly referenced to human vision. Our understanding of the impact of artificial light on species beyond our own is therefore hindered by the convention of measuring light in reference to human vision. Scientists stress the need to take into account the different visual systems of animals in comparison to humans (153, 248). Researchers have further called for ecology considerations in outdoor lighting design (249) and a "dark infrastructure" to preserve species diversity (250). Early experiments with improved outdoor lighting design to increase the ecological availability of darkness show promising results (251). Such experiments can also suggest improvements to outdoor lighting design and operation intended to reduce the impact of ALAN on species. (252) But it remains the case that there is no source of ALAN that is entirely safe for wildlife (253). And we do not know if 'sustainable' lighting practices actually reduce harm to wildlife (254).

ALAN is likely responsible for the death of millions of birds and insects each year. In the following subsections, we focus on these two classes of animals.

Migratory birds

Although most migrating birds navigate by sensing the Earth's magnetic field (255), many species also rely on light cues in the environment. Some use these cues to 'calibrate' their magnetic sensitivity (256, 257). Artificial light exposure interferes with this behavior, with red light potentially disrupting their magnetic orientation more than blue light (258, 259).

Positive phototaxis is of particular concern for the conservation of migrating birds. Bright lighting in cities can become a beacon to some species, drawing them away from their migratory routes (260, 261). Fixtures emitting light vertically seem to have the strongest effect (262), but even 'dark sky friendly' lighting attracts birds at night (263). The attraction to light can become lethal as it promotes collisions between birds and windows (264). And birds drawn off their migratory routes and into cities by ALAN suffer higher exposure to harmful air pollution (265, 266).

ALAN can negatively affect the distribution of birds at points along migratory routes where birds stop to rest and feed (267). The presence of lit cities along those routes causes birds to fly higher than in more rural areas (268). Very bright lighting can attract so many birds that weather radar installations can detect them (261). This fact is now used to measure the extent of attraction of birds to bright light sources on landscape scales. Researchers find that periodically switching powerful light sources off during the night can reduce this effect by providing opportunities for birds trapped by positive phototaxis to escape (269).

Pollinating insects

Ecologists have studied the role that various species play in providing what are now called 'ecosystem services'. These are benefits that humans receive from the natural environment. An example of an ecosystem service that is critical to human wellbeing is the pollination of food crops by insects. Many of these insects are only active at night (270). Some species seem to pollinate only under conditions of dim, natural light such as moonlight (271). ALAN can cause changes in insect movement and make species more vulnerable to predators (272). ALAN can therefore diminish the economic value of their ecosystem services (273).

ALAN appears to harm at least some nocturnal pollinator species (274–278), leading to a possible loss of species diversity (279). This in turn could reduce crop yields (280) and threaten food supplies in some instances (281). It may even contribute to significant population declines among pollinators that some have called the 'insect apocalypse' (282–284).

Researchers find effects from many types of outdoor lighting, including common applications such as street lighting (285, 286). In at least some cases, light color may disrupt nocturnal pollination (287). While some pollinators may simply seek out darker places, they may find conditions there less suitable (288). Further work is needed to firmly establish the importance of the threat and which lighting changes make the greatest improvements for pollinators.

3 Human Health

Scientific evidence establishes a link between ALAN exposure and adverse human health consequences. These include disruptions in chemical signaling in the body, certain kinds of changes at the genetic level, and shifts in sleep/wake cycles set by natural light sources. These effects may contribute to the incidence of certain chronic diseases in some people. These conclusions are largely drawn from controlled studies of exposures to indoor lighting, suggesting caution in interpreting the influence of outdoor lighting on health.

The light-melatonin connection

The precise relationship between outdoor ALAN exposure and human health and wellbeing is controversial. Replicating urban environments and using human participants is difficult to achieve in practice. This leads researchers to rely on lab studies carried out on certain animals, such as mice and rats, which serve as well-understood models of biology in mammals generally. In these studies, ALAN exposure has effects

on the entire life cycle, from childhood (289–291) and adolescence (292–294) to old age (295–297).

In particular, these effects seem to result from short-wavelength ("blue") light. While exposure to blue light during the day is important for healthy circadian functioning (298), exposure to this light at night can disrupt the circadian rhythm. This can affect everything from the timing of hormone release in the body (299) to the duration and quality of our sleep (300, 301), increasing systemic inflammation (302, 303) and potentially resulting in adverse health outcomes (304, 305). The significance of these effects depends on the intensity of light, the proportion of blue light, and the timing and duration of the exposure. Research now points to lighting approaches that can reduce the impact of ALAN on circadian rhythms (306).

Exposure to light at inappropriate times during the 24-hour day delays or prevents the secretion of melatonin (307). This powerful antioxidant is a hormone that interacts with the immune system (180, 308). Low-intensity artificial light can suppress melatonin production (309). As little as 5 lux of light can yield this effect in some particularly sensitive people (310, 311) 5 lux is about 50 times brighter than full moonlight and 100 times less intense than the amount of light in a bright indoor office environment. In another study performed under various recommended roadway lighting exposures the spectrum of the light source yielded no apparent impact on melatonin levels in the saliva of healthy subjects (312). Other studies looking at the effect of ALAN exposure from viewing electronic screens at night have found that delayed melatonin secretion has only minor influence on sleep onset latency, with a more significant effect attributed to an emotional need for connection through device "screen time" (313). More research is required to determine quantitative exposures to ALAN that might result in negative health outcomes.

The production of melatonin varies over the 24-hour day. Researchers guessed that there must be some way by which the body senses light in the environment. They suspected that it might not relate to our image-forming sense of sight. In 2001, Professor George Brainard and his co-workers discovered the missing piece of the puzzle. They found evidence for chemical machinery in light-sensitive cells in the retina of the eye that couples light exposure to the system regulating the circadian rhythm (314). This machinery involves a substance called melanopsin that is very sensitive to blue light (315).

Melanopsin is produced in specialized cells called intrinsically photosensitive retinal ganglion cells (316). These cells are particularly sensitive to blue light and send signals to the master circadian "clock" in the brain. This establishes a timing reference for other such 'clocks' in various organs and systems of the body (Figure 8). Those clocks in turn govern various biological activities (317, 318). Exposure to ALAN can cause the master clock to go out of sync with the natural light pattern of the 24-hour day (319). The consequences of such resets are still not fully understood. And some of the peripheral clocks seem to be sensitive to light on their own, independent of the brain (320).

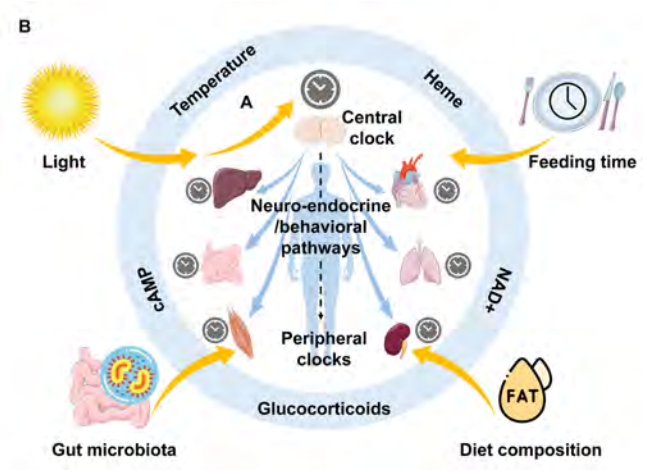


Figure 8. A cartoon representation of how the human body regulates the circadian rhythm. The system of internal "clocks" (inside the blue ring) is designated "A", and external influences that affect the clocks are labeled "B". In A, the master clock in the brain is set by exposure to light. The brain in turn sets peripheral clocks in various organs through nervous and endocrine signals. External factors (B), which include metabolic signals, can further manipulate the peripheral clocks. Figure 2 in (305), reproduced under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 license.

Further, it is now recognized that light exposure makes changes at the level of our genetic code. While it is not known to alter our DNA, the molecule that spells out that code, light can cause "epigenetic" changes in humans (321, 322). These changes switch genes "on" or "off", altering their normal roles. Some of those genes relate to the function of our circadian clocks. Epigenetic changes to those genes appear to increase the risks of certain cancers (323), particularly breast cancer (324, 325).

The consequences of frequent ALAN exposure

Exposure to ALAN plays an important and complex role in human biology and behavior (326). Even relatively brief exposures during certain phases of sleep can produce measurable effects (327). Frequent exposure to excessive light at night may be an emerging lifestyle risk along with other factors associated with shift work, contributing to various health problems (328). These include obesity (329–331); diabetes (332–334); cardiovascular disease (335, 336); eyesight deterioration (337, 338); impaired fertility (339–341); endocrine disorders (342); allegic diseases (343); and certain cancers (344–347) such as those of the breast (348–350), lung (351), thyroid (352), prostate (353–355) and skin (356).

ALAN exposure also seems to promote the more aggressive spread of some types of cancer (357). It can make cancer resistant to even the best available drug therapies (358) and weaken the body's self-repair mechanisms (359). ALAN can

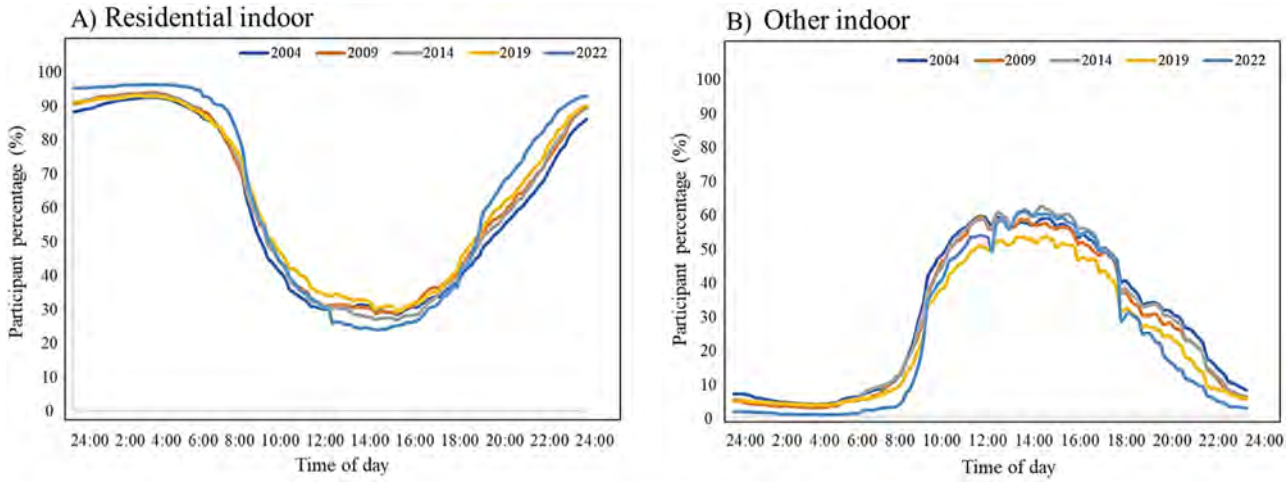


Figure 9. Time-location profiles of 12,776 adult survey respondents in Seoul, South Korea, from 2004 to 2022. The curves show the percentage of respondents reporting being indoors in residential (A) and non-residential (B) settings at the indicated times. During the overnight hours, occupation of indoor spaces nears 100%. Figure 1 in (414), reproduced under a Creative Commons Attribution 4.0 International license.

also combine with other environmental influences such as air pollution to increase the incidence of disease (360).

Some studies find strong correlations between indications of ALAN from satellite data and the incidence of cancer (361–363) and diabetes (364), suggesting outdoor light exposure as an influence. Yet critics point out the reliance on the use of satellite data to predict disease-related ALAN exposures (365). This may make study results less reliable because satellite measurements are only crude estimates of the actual doses of ALAN from outdoor sources. Other studies find little or no evidence for a connection between outdoor ALAN exposure and cancer (366–368). In some cases, apparent effects may be coincidental (369).

A more common way that ALAN exposure triggers effects in humans is by causing insomnia (370, 371). Melatonin production and cycles of sleep and wakefulness follow each other. Chronic ALAN exposure associated with shift work can cause these two cycles to decouple (372). The result is often poor quality sleep and low sleep duration (373). Many social and health consequences are associated with frequent insomnia (374, 375), posing a threat to both public health and worker safety and productivity (376, 377). Appropriate management of nighttime light exposure in workplace environments may reduce these effects (378).

Influences on health outcomes

Health practitioners now recognize the roles that light and darkness play in healing. ALAN exposure is a predictor of mortality from all causes (379). It can delay or prevent recovery from stroke (380, 381), hardening of the arteries (382), skin wounds (383), and whole-body inflammation (384, 385). Controlling ALAN exposures in places like hospitals results in better health outcomes (386–388), suggesting a need for more focused lighting design in healthcare facilities (389). The growth of outdoor lighting may be encouraging the spread of communicable diseases (390, 391). It may also create conditions for new and devastating diseases, such as COVID-19, to emerge (392, 393).

Other studies identify ALAN as an influence on the process of normal aging (394). Nighttime light exposure and frequent disruption of the circadian rhythm relate to mental illness (395–400), improper signaling between nerves (401), and the onset of both dementia (402–404) and Alzheimer's disease (405, 406). It may also play a role in the incidence of autism (407, 408). Babies born to some pregnant women exposed to ALAN suffer from certain developmental defects (409, 410). On the other hand, limiting nighttime light exposure helps maintain a normal circadian rhythm. It can ward off some abnormalities that may lead to disease (411).

While we understand much about how ALAN interacts with our health, our knowledge is incomplete. It is not possible now to directly connect *outdoor* light at night exposure to the incidence of disease in individual people. Many of the above-referenced studies were performed under *indoor* lighting conditions. Most people in industrialized economies spend the majority of their nighttime hours indoors (Figure 9) (412–414), where ALAN exposure is much higher than in outdoor settings. For this reason it is recommended that indoor light exposure at night be minimized.

4 Public Safety

The belief that outdoor lighting improves traffic safety and discourages or prevents crime is common. It may explain in part the rapid growth in the use of outdoor light at night in recent years and decades. There are cases where the careful application of outdoor lighting may improve nighttime safety, but there is no general benefit supported by scientific evidence.

Traffic and pedestrian safety

There are many conflicting research results on this topic. Some studies find that adding lighting to outdoor spaces reduces road collisions (415, 416) and even recommend particular illumination levels based on the results of field experiments (417). Others find no effect at all (418, 419), or unclear results (420, 421). Some researchers ask whether reducing outdoor lighting in areas prone to traffic accidents leads to poorer outcomes. Little evidence has emerged to support this hypothesis (422).

Traffic studies are challenging to design and are therefore subject to criticism (423). In particular, it is difficult to properly account for all the variables that might alter the results. For example, a road safety study about lighting might fail to account for changing traffic volume throughout the night. Some variables may have a stronger influence on the observations than lighting changes. Sometimes subtle effects that add up to important results. It can be easy to assign responsibility to lighting even though it actually contributed very little. As a result, many of the claims about outdoor lighting and its impact on traffic safety – for better or worse – may be fundamentally wrong (424, 425).

Researchers have not been able to predictively model the way outdoor lighting might affect safety and security. This is one reason why it is difficult to establish the significance of lighting in studies. There is no clearly known "dose-response" relationship that may predict appropriate lighting levels (426). In other words, even if lighting influences outcomes, scientists can't determine how much light is required.

International lighting standards often do not clearly establish benchmarks for the amount of light at night that drivers and pedestrians need on the basis of scientific evidence (427). There are only a few instances in which the issue has been rigorously studied, e.g., (91), and it is unclear whether the results are universally applicable. Decision makers, from elected officials to lighting designers, often substitute their intuition when guidance is lacking. In a belief that more of something is always better, they often specify too much light relative to actual needs.

Automotive lighting

No one doubts that automotive lighting has clear public safety benefits, but this kind of lighting may itself be the source of objectionable light pollution. There is little evidence to date on the contribution of automobile lights to light pollution. Some early work suggests that the impact is not small (31, 428, 429). Many expect autonomous (self-driving) vehicles to become common in coming decades. Researchers are only beginning to study what this means in terms of reducing the need for roadway lighting in the future (430).

Crime deterrence

As with road safety, the influence of outdoor light at night on crime is mixed. Some of the same studies that looked at lighting and traffic/pedestrian safety also considered nighttime crime incidence. Certain studies reported crime reduction when lighting is added to outdoor spaces (431, 432). Others find either a negative effect (433, 434), no effect (435, 436), or mixed results (437).

Along the same lines as whether reducing roadway lighting leads to unsafe conditions, some studies ask if reducing street lighting increases crime. Limited research in the U.K. found no evident connection between part-night dimming of street lighting and any uptick in crime in the study areas (422). Like traffic and lighting studies, designing and conducting well-controlled experiments having to do with crime is difficult.

The amount of light used in outdoor spaces at night may not reflect public expectations for feelings of safety and comfort (438, 439) (Figure 10), and artificial light itself may influence the human perception of fear (440). In some cases, over-lighting can itself become the source of safety hazards (441). Some studies find diminishing returns in terms of the public perception of the safety of outdoor spaces at night as light levels increase (Figure 10) (438). However, properly designed lighting can reduce light pollution and save energy without compromising public feelings of safety in outdoor spaces at night (442, 443). Comprehensive strategies that do not focus solely on illumination levels may in fact yield the best results (444).

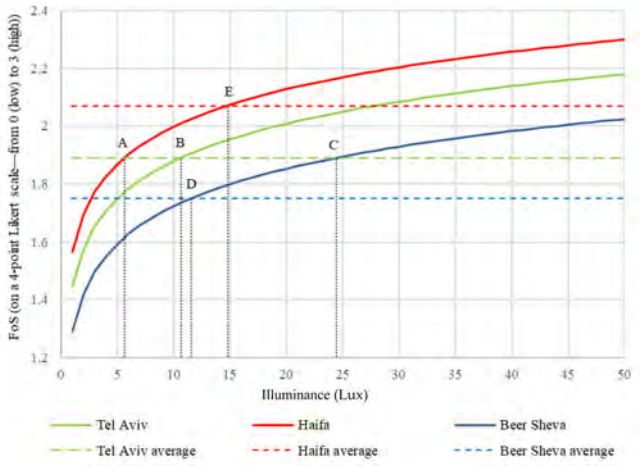


Figure 10. Perceived "feelings of safety" (FoS) at various brightness levels of neighborhood outdoor spaces in three Israeli cities. These results suggest that the most effective application of light in improving FoS is adding small amounts to previously dark places. Increasing light levels beyond this threshold may result only in a minor improvement in FoS levels. Figure 7 in (438), reproduced with permission of the authors.

The hazards of glare

Glare from bright artificial light sources is a particular concern for nighttime safety. It results from intense light rays entering the eye directly from a source. Some of that light scatters inside the observer's eye, reducing the contrast between foreground and background. This effect makes it difficult to

see objects as distinct from what surrounds them.

Glare reduces the visibility of objects at night for motorists, pedestrians and bicyclists. Although some older observers report stronger sensations of glare from certain sources, it seems to affect people of all ages (445). Some modern lighting sources like LED can make glare worse by emitting considerable light at very shallow downward angles (30) and also by using non-uniform light sources with insufficient optical diffusion (446).

The perception of glare seems to vary with the wavelength of light involved. In general, short-wavelength ('cool') light causes stronger glare than long-wavelength ('warm') light (447). Observers report that it takes about the same amount of time to recover from glare exposure no matter the color of light (448). The severity of glare appears to relate more to the 'dose' (light intensity times exposure duration) rather than to the color (447). If the background surrounding a glare source is higher in luminance, its perceived intensity is lower; for instance, car headlights are often seen as glare sources at night but not during the day. Warmer light backgrounds reduce perceived glare more than cooler backgrounds (449).

5 Energy Use and Climate Change

Wasted outdoor light at night is wasted energy. The world remains highly dependent on fossil fuels to generate electricity. Since light pollution represents a waste of energy, it also contributes directly to climate change.

Light and global energy demand

Electricity used to power outdoor lighting once accounted for about 1.5% of global power consumption (450–452). Researchers hypothesized that the introduction of energy-efficient solid-state lighting would reduce this consumption. Many governments rushed to deploy the new technology in the past 15 years. As the price of SSL products declined, the adoption rate increased. The motivations for this included reduced cost of operation and meeting the requirements of "green" policies.

At first glance, the high energy efficiency of SSL seems to be good for the environment. For example, the United Nations Environment Programme estimates that a transition to energy efficient lighting would reduce global electricity demand for lighting by 30–40% by 2030 (453). The rapid adoption of SSL may, however, unintentionally worsen the problem of light pollution. SSL makes outdoor light less expensive and more convenient to consume. In turn, cheaper light may cause the use of more and brighter light at night where it is not needed.

The "greenwashing" of solid-state lighting

As ALAN has become cheaper to produce, the world has consumed more of it. In fact, humans now consume thousands of times more lumens of light than they did in the historic past (454). There are signs of what economists call a "rebound effect" in lighting. This is thought to result from the improved energy efficiency and long lifetime of SSL products. In such conditions, increased consumption of light at night erodes away the expected savings in energy use and reduction of greenhouse gas emissions. Some researchers now question whether SSL is truly "sustainable" lighting (455).

By the mid-2010s, the average country's annual economic output was changing at a rate that matched that country's increase in light at night consumption (2), although large variations among countries existed. That observation suggests that the cost savings from the switch to SSL went into deploying new outdoor lighting. If true, it means that SSL has not to date brought a reduction in world energy use. The authors of the landmark 2017 study that made these findings wrote that their results are "inconsistent with the hypothesis of large reductions in global energy consumption for outdoor lighting because of the introduction of solid-state lighting."

Claims about the environmental benefits of SSL may be, at best, overstated. Some researchers conclude from this that a new definition of 'efficiency' is needed (30). It would consider the total cost of outdoor light at night over the full life cycle of outdoor lighting products and include factors beyond just the cost of electricity, such as harm to the environment. Redefining efficiency in this way may help governments make better decisions about outdoor lighting in the future. It is furthermore unclear whether the root of the problem is in the technology itself or how it is applied, and hence whether a shift in the ways in which SSL is deployed might result in a different outcome.

The total cost of outdoor lighting

Solid-state lighting may not provide any meaningful environmental benefits in terms of reducing carbon emissions. Realizing the promise of SSL requires rethinking how governments regulate outdoor lighting. Otherwise, SSL may well make the problem of light pollution worse. Its impacts have costs to the environment that cannot be measured in currency alone.

The social and financial benefits of SSL seems to fade if one considers the total environmental cost of lighting. For example, one study of a SSL retrofit program in the United States found a ten-year rate of return of +118.2% based solely on savings due to reduced electricity consumption. Researchers then adjusted the return for externalities such as the social costs of poor health outcomes that may be related to ALAN exposure and the benefit of avoided carbon emissions. The resulting rate of return dropped to –146.2% (456).

SSL programs become less attractive when the negative consequences of ALAN are included in return-on-investment calculations. The jury remains out on the question of whether SSL can deliver its promised environmental benefits without a reduction in outdoor light consumption.

6 Light and Social Justice

We know very little about how ALAN affects people in social contexts. Light at night may be used in ways that affect neighborhoods according to the race of the people who live in them. That may make light at night use a matter of social and environmental justice.

We know little about the social implications of using outdoor light at night. Remote sensing of light at night from space can show certain patterns of light use. These observations may reveal social inequities in other variables otherwise unnoticed (457). Poor social outcomes may follow from the application of outdoor light. Considerations include equity, health outcomes, climate vulnerability, human rights, mobility barriers, and community cohesion (458, 459). These may in part be the legacies of racist policies and practices in historical times (460, 461). Past histories can even create environmental "memory effects" (462), but observed disparities in nighttime light exposure do not always affect underprivileged or marginalized groups in particular (463). At the same time, there is evidence that access to natural nighttime darkness contributes positively to people's sense of happiness and wellbeing (464, 465).

Limited research to date on this topic looked at the social aspects of lighting in the U.S. only (466, 467). In one study, researchers found that Americans of Asian, Hispanic and Black descent tend to live in brighter neighborhoods (Figure 11). In these areas, skyglow is about twice as high as in predominantly white neighborhoods. They further note that lower socioeconomic status is also associated with higher nighttime light exposures. These conditions can add to other social and environmental stressors such as poverty and exposure to air and water pollution, affecting quality of life.

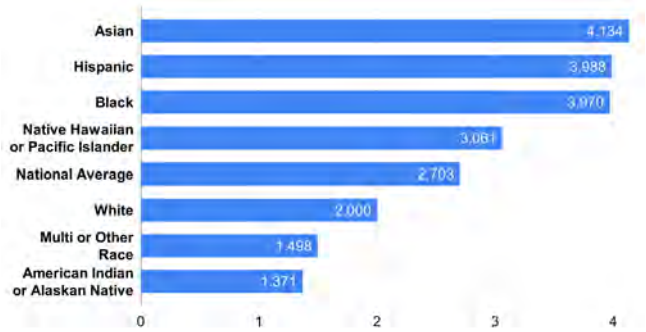


Figure 11. Average exposure to light pollution in the continental United States by racial/ethnic group. The bars show population-weighted average zenith night sky brightness levels in units of millicandelas per square meter. Adapted from Figure 4 in (466) and reproduced under the Fair Use doctrine.

Other approaches link light at night exposure to specific health outcomes that may harm certain groups more than others (468, 469). There are also limited results from established fields such as environmental psychology (470–472). For instance, "feelings of safety" can lead people to accept lower lighting levels (473). Biased perceptions may drive the punitive installation of lighting in certain neighborhoods. Furthermore, poorly designed outdoor lighting installations can disadvantage visually impaired pedestrians (474). These considerations, and the health implications discussed in Section 3, call for proactive attention to mitigating light pollution in urban environments (475).

Lastly, some scholars have criticized framing the idea of "darkness" in terms of how outdoor light at night use can affect marginalized people (476, 477). They argue that failing to learn from the lessons of environmental history may result in simply repeating mistakes of the past. Closely related to this is the idea that light pollution is harmful to people whose religious or cultural practices rely on access to the night sky. The erasure of the stars from view due to skyglow separates people from this resource (478). Some argue that, in particular, it threatens Indigenous traditions and knowledge systems based on accessibility of the natural night sky (479).

7 Space Light Pollution

The number of artificial satellites surrounding the Earth is increasing rapidly. Satellites reflect sunlight to the ground and change the appearance of the night sky. Because they raise night sky brightness, they are a new kind of light pollution threat.

Artificial satellites have orbited the Earth since the late 1950s. Until recently, they were not considered a source of light pollution. That perception changed in May 2019, when the launch of 60 satellites in the SpaceX "Starlink" project ushered in a new era in the use of outer space (480). Private commercial space companies have since announced plans to launch about 100,000 new satellites. They intend the satellites to expand broadband internet access around the world. Yet, some researchers question whether satellites are necessary to achieve this goal (481).

Satellites are increasingly considered an emerging form of light pollution (482–484) that can diminish the value of dark night skies (485–487). They impact the night sky in two key ways. First, they reflect sunlight to the night side of Earth. Illuminated satellites appear as bright, moving points of light in the night sky (488). They can affect activities of both amateur and professional astronomers alike (489–492). Under certain conditions, transient "flares" from satellites can surpass the brightest stars in the night sky (493). By the late 2020s, hundreds of satellites may be visible to the unaided eye at any moment from a given location (494). There are also reasons for concern over the broader impacts of the full life cycle of space objects on both the Earth and space environments (495–497).

Second, satellites can make the night sky itself brighter (499) (Figure 12). This may be true even when observers do not see the individual satellites. As a form of

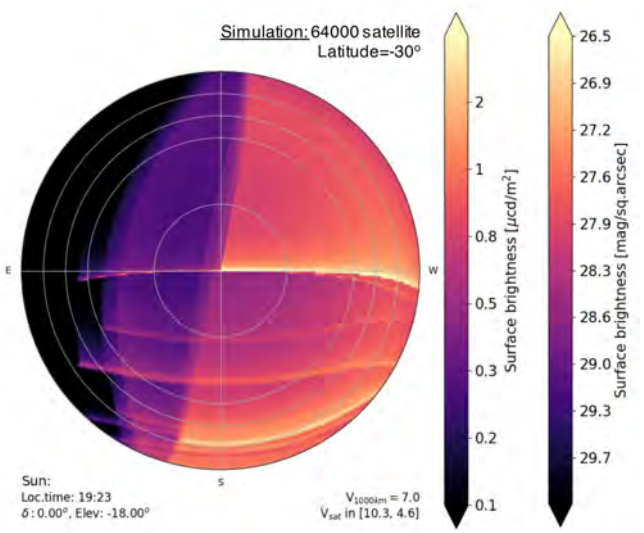


Figure 12. A simulated view of the night sky showing the brightness attributable to a population of 64,000 Earth-orbiting satellites. The view is centered on the zenith, with the horizon running around the outer edge; circles centered on the zenith mark lines of constant elevation above the horizon at 10°, 20°, 30° and 60°. Warmer colors indicate brighter parts of the sky. Unpublished results adapted from (498) and reproduced with permission of the creators.

light pollution, it adds to the observed brightness of the night sky along with skyglow caused by cities. Researchers estimate that space objects may already raise night sky brightness above natural light sources by as much as ten percent (500). It may rival the influence of "terrestrial" light pollution by 2030. Observers at high latitudes are thought to be affected more than those in the tropics (501). Concerns are now emerging about the effects of a new generation of very large satellites used to relay radio signals to individual mobile devices on the ground (502).

Astronomers and space industry officials began consultations soon after the first Starlink launch. Scientists suggested reducing satellite brightnesses and limiting orbital altitudes to reduce harm to their observations (503–505). Design changes dimmed the Starlink satellites, but they still exceeded the target (506–510). Recent efforts emphasized the need to engage industry and regulators with stakeholders beyond astronomy (511–513). They also called for activism to halt further damage to the night sky (514) and funding to study the problem more and to create a central clearinghouse for information (515).

Legal scholars increasingly view large satellite constellations as a disrupting influence on the global space law order (516, 517). Policy remedies proposed to date include the reclassification of outer space as an 'ecosystem' subject to environmental protections (518–521). Ensuring reasonable access to space for commercial development is important, but we do not yet understand how to do so while protecting the night sky from the effects of satellites.

8 Knowledge Gaps and Research Needs

While we have learned much about the effects and costs of ALAN, there is also much we still do not know. Here we summarize key research questions in the coming decade.

Interest in ALAN among researchers in all fields has grown by leaps and bounds (522). The average number of scientific papers published each year has increased by over 1000% since 2000. Methods required to answer particular questions increasingly span many different disciplines (523, 524), and the emergence of 'night studies' as its own research field prove that the subject is rapidly maturing (525).

The state of the science summarized in this report leads to identifying important topics for future research:

The Night Sky

- What drives increasing ALAN emissions around the world?
- How is night sky brightness around the world changing on regional scales?
- How bright is the night sky worldwide on cloudy nights?
- Which lighting interventions are most effective in reducing skyglow?
- Does the rising popularity of astrotourism help or harm efforts to protect dark skies?

Ecological Impacts

- What are the sensitivity thresholds and spectral contents at which different ALAN impacts occur for different species?
- Does skyglow in particular affect many or most plant and animal species? Does it impact entire ecosystems?
- What are the long-term ecological consequences of light pollution?
- How does ALAN contribute to species population decline or extinction?
- To what extent is ALAN responsible for observed declines in insect populations?

Human Health

- Does exposure to ALAN in specifically outdoor spaces affect human health in any way?
- Does outdoor light at night entering indoor spaces affect sleep and health?

- Are the observed relationships between remotely sensed outdoor light at night and health the result of cause and effect?
- Is ALAN exposure from outdoor lighting undercutting the efficacy of newer pharmaceutical therapies, e.g., 'biologics' that target the immune system to fight cancer?
- Are ALAN studies in model organisms broadly replicable in human subjects?

Public Safety

- How does outdoor light at night relate to traffic safety?
- How does it relate to both violent crime and property crime?
- Can we design better experiments to answer these questions definitively?
- Which systematic effects and confounding factors contribute most to uncertainties in ALAN/public safety research?
- What are the characteristics of lights, such as intensity, color, glare, and other design features, that achieve desired safety results?
- How can the directionality, uniformity, controllability and spectral tuning of LED lighting support actual and perceived safety with minimally disruptive light levels?
- By how much can roadway, street and area lighting be dimmed during low-traffic times in a safe and legally defensible manner?

Energy Use and Climate Change

- Has the ongoing global transition to solid-state lighting had a net positive effect in terms of reducing electricity consumption and the emission of greenhouse gases?
- What social, financial and environmental tradeoffs have resulted from the LED lighting revolution?
- By how much does good lighting design lower electric power consumption?
- As solid-state lighting approaches market saturation, how effective are adaptive controls at reducing light at night use?
- Given certain practical limitations, can we better quantify the amount of carbon emissions associated with outdoor lighting?
- Which lighting technologies, design practices and policies can reduce light pollution and electricity usage to minimum safe levels?

Light and Social Justice

- How well does ALAN use match with indicators of public health along racial and economic lines?
- If consistent disparities in the application of ALAN are found, why do they exist?
- Which public policies are effective in reducing ALAN exposures across different communities?

Space Light Pollution

- Are predictions about the contribution of satellites to diffuse night sky brightness correct?
- How do night sky impacts vary according to the numbers of satellites, their orbital heights, and spatial distributions?
- Do large satellites providing Supplemental Coverage from Space (SCS) service present special concerns?
- Is there a particular "carrying capacity" of satellites in Low Earth Orbit?
- Are any satellite designs effective at reducing or eliminating their impacts on the visibility of the night sky?
- Which national and international legal mechanisms may be brought to bear on the problem?

We also consider questions and topics that span more than one field of ALAN research as well as the application of that research itself:

Synthetic Research

- Can something like an environmental "safe exposure threshold" to ALAN be defined?
- Can luminaire design improvements increase the overall efficacy of outdoor lighting?
- How are various lighting metrics related? For example, can we model skyglow based on broad collections of luminance?
- How does air pollution interface with ALAN?
- How are some measures of ALAN such as skyglow specifically related to a suite of undesired outcomes (e.g., adverse ecological, health, or astronomical outcomes)?

Applications of ALAN Research

- Are lighting practices implemented at the landscape scale effective in rehabilitating ecologically sensitive areas?
- Are they (also) effective in measurably reducing night-sky brightness?
- Which interventions besides public policy are available to mitigate the undesired consequences of ALAN?

- Are social or financial incentives to reduce light pollution effective?
- What specific economic benefits does astrotourism bring to communities?
- What measurable benefits do dark sky places receive? What costs do they incur in managing their dark-sky status?
- Which communities seek and obtain dark-sky designations and why?

Methodology

This report was compiled using as its main source the Artificial Light at Night Research Literature Database (ALANDB; https://alandb.darksky.org/), a database of scientific literature citations curated by experts in different fields of ALAN research. We supplemented ALANDB with other online resources such as Google Scholar (https://scholar.google.com/) and PubMed (https://pubmed.ncbi.nlm.nih.gov/).

We defined "scientific literature" as results subjected to at least single-blind, external peer review and published in what we believed to be reputable outlets. Both open-access and non-open-access papers were considered. Where available, we considered post-publication metrics like citations in deciding which sources to use. We state caveats and shortcomings about sources where we know of them.

Generally we did not consider technical reports, white papers, theses and other sources that are sometimes collectively referred to as "gray literature". Future editions of the report may be extended to include gray literature when there is sufficient evidence of rigorous review, especially in cases where there is very little or no information on a topic otherwise available.

The original version of this report was prepared in 2022 by John Barentine, Ph.D. (Dark Sky Consulting, LLC). It was externally reviewed by subject matter experts, whom we thank for their comments that helped improve the result. As a "living document", it was updated in 2023-25 and will be similarly updated in the future.

References

1. Falchi, F., Cinzano, P., Duriscoe, D., Kyba, C.C.M., Elvidge, C.D., Baugh, K., Portnov, B.A., Rybnikova, N.A. and Furgoni, R. The new world atlas of artificial night sky brightness. *Science Advances*, 2(6):e1600377, jun 2016. doi: 10.1126/sciadv.1600377.
2. Kyba, C.C.M., Kuester, T., de Miguel, A.S., Baugh, K., Jechow, A., Hölker, F., Bennie, J., Elvidge, C.D., Gaston, K.J. and Guanter, L. Artificially lit surface of earth at night increasing in radiance and extent. *Science Advances*, 3(11):e1701528, nov 2017. doi: 10.1126/sciadv.1701528.
3. Azman, M.I., Dalimin, M.N., Mohamed, M. and Bakar, M.F.A. A brief overview on light pollution. *IOP Conference Series: Earth and Environmental Science*, 269(1):012014, Jul 2019. doi: 10.1088/1755-1315/269/1/012014.
4. Kyba, C.C.M., Altıntaş, Y.Ö., Walker, C.E. and Newhouse, M. Citizen scientists report global rapid reductions in the visibility of stars from 2011 to 2022. *Science*, 379(6629): 265–268, jan 2023. doi: 10.1126/science.abq7781.
5. Falchi, F. Light pollution. In Charlesworth, S.M. and Booth, C.A., editors, *Urban Pollution: Science and Management*, chapter 11, pages 147–156. Wiley-Blackwell, 2018.
6. Gaston, K.J. and de Miguel, A.S. Environmental impacts of artificial light at night. *Annual Review of Environment and Resources*, 47(1):373–398, oct 2022. doi: 10.1146/annurev-environ-112420-014438.
7. Gaston, K.J., Gardner, A.S. and Cox, D.T.C. Anthropogenic changes to the nighttime environment. *BioScience*, 73(4):280–290, April 2023. ISSN 1525-3244. doi: 10.1093/biosci/biad017.
8. Cox, D.T. and Gaston, K.J. Global erosion of terrestrial environmental space by artificial light at night. *Science of The Total Environment*, 904:166701, December 2023. ISSN 0048-9697. doi: 10.1016/j.scitotenv.2023.166701.
9. Bará, S., Bao-Varela, C. and Falchi, F. Light pollution and the concentration of anthropogenic photons in the terrestrial atmosphere. *Atmospheric Pollution Research*, 13(9): 101541, sep 2022. doi: 10.1016/j.apr.2022.101541.
10. Bará, S. and Falchi, F. Artificial light at night: a global disruptor of the night-time environment. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 378(1892), October 2023. ISSN 1471-2970. doi: 10.1098/rstb.2022.0352.
11. Leng, W., He, G. and Jiang, W. Investigating the spatiotemporal variability and driving factors of artificial lighting in the beijing-tianjin-hebei region using remote sensing imagery and socioeconomic data. *International Journal of Environmental Research and Public Health*, 16(11):1950, jun 2019. doi: 10.3390/ijerph16111950.
12. Pothukuchi, K. City light or star bright: A review of urban light pollution, impacts, and planning implications. *Journal of Planning Literature*, 36(2):155–169, jan 2021. doi: 10.1177/0885412220986421.
13. Bará, S. A note on the overall efficiency of outdoor lighting systems. *Zenodo*, 2022. doi: 10.5281/ZENODO.6588230.
14. Gaston, K.J., Gaston, S., Bennie, J. and Hopkins, J. Benefits and costs of artificial nighttime lighting of the environment. *Environmental Reviews*, 23(1):14–23, mar 2015. doi: 10.1139/er-2014-0041.
15. Stone, T. Light pollution: A case study in framing an environmental problem. *Ethics, Policy & Environment*, 20(3):279–293, sep 2017. doi: 10.1080/21550085.2017.1374010.
16. Hearnshaw, J.B. A sustainable world requires darkness at night. *Proceedings of the Royal Society of Victoria*, 135(2):50–57, December 2023. ISSN 2204-1362. doi: 10.1071/rs23009.
17. Schäfer, M. and Henninger, S. Perspective chapter: Innovative modernisation and sustainable transformation processes as a municipal remedy against light pollution. In *Urban Pollution - Environmental Challenges in Healthy Modern Cities [Working Title]*. IntechOpen, December 2024. doi: 10.5772/intechopen.1007547.
18. Kocifaj, M., Petržala, J. and Medveď, I. Skyglow from ground-reflected radiation: model improvements. *Monthly Notices of the Royal Astronomical Society*, 533(2):2356–2363, August 2024. ISSN 1365-2966. doi: 10.1093/mnras/stae1992.
19. Kocifaj, M. and Novák, T. Ground-reflected light: The invariance principle and the effect of luminaire height, emission pattern, and non-uniform albedo. *Journal of Quantitative Spectroscopy and Radiative Transfer*, 328:109173, December 2024. ISSN 0022-4073. doi: 10.1016/j.jqsrt.2024.109173.
20. Levin, N., Kyba, C.C., Zhang, Q., de Miguel, A.S., Román, M.O., Li, X., Portnov, B.A., Molthan, A.L., Jechow, A., Miller, S.D., Wang, Z., Shrestha, R.M. and Elvidge, C.D. Remote sensing of night lights: A review and an outlook for the future. *Remote Sensing of Environment*, 237:111443, feb 2020. doi: 10.1016/j.rse.2019.111443.
21. Combs, C.L. and Miller, S.D. A review of the far-reaching usage of low-light nighttime data. *Remote Sensing*, 15(3):623, January 2023. ISSN 2072-4292. doi: 10.3390/rs15030623.
22. Barentine, J.C. Night sky brightness measurement, quality assessment and monitoring. *Nature Astronomy*, 6(10):1120–1132, aug 2022. doi: 10.1038/s41550-022-01756-2.
23. Falchi, F., Ramos, F., Bará, S., Sanhueza, P., Jaque Arancibia, Marcelo Arancibia, M., Damke, G. and Cinzano, P. Light pollution indicators for all the major astronomical observatories. *Monthly Notices of the Royal Astronomical Society*, 519(1):26–33, dec 2022. ISSN 1365-2966. doi: 10.1093/mnras/stac2929.
24. Varela Perez, A.M. The increasing effects of light pollution on professional and amateur astronomy. *Science*, 380(6650):1136–1140, jun 2023. ISSN 1095-9203. doi: 10.1126/science.adg0269.
25. Kocifaj, M., Markoš, P., Kundracik, F., Barentine, J.C. and Wallner, S. An accurate and realistic polarization model for night-sky brightness. *Monthly Notices of the Royal Astronomical Society: Letters*, 532(1):L70–L74, May 2024. ISSN 1745-3933. doi: 10.1093/mnrasl/slae048.
26. Kocifaj, M., Markoš, P., Kundracik, F., Barentine, J.C. and Wallner, S. Night sky polarization model for a cloud-free atmosphere illuminated by ground-based light sources. *Monthly Notices of the Royal Astronomical Society*, 532(4):4864–4875, July 2024. ISSN 1365-2966. doi: 10.1093/mnras/stae1803.
27. Deverchère, P., Vauclair, S., Bosch, G., Moulherat, S. and Cornuau, J.H. Towards an absolute light pollution indicator. *Scientific Reports*, 12(1), oct 2022. doi: 10.1038/s41598-022-21460-5.
28. Jägerbrand, A., Gasparovsky, D., Bouroussis, C., Schlangen, L., Lau, S. and Donners, M. Correspondence: Obtrusive light, light pollution and sky glow: Areas for research, development and standardisation. *Lighting Research & Technology*, 54(2):191–194, apr 2022. doi: 10.1177/14771535211040973.
29. Linares Arroyo, H., Abascal, A., Degen, T., Aubé, M., Espey, B.R., Gyuk, G., Hölker, F., Jechow, A., Kuffer, M., Sánchez de Miguel, A., Simoneau, A., Walczak, K. and Kyba, C.C.M. Monitoring, trends and impacts of light pollution. *Nature Reviews Earth & Environment*, 5 (6):417–430, May 2024. ISSN 2662-138X. doi: 10.1038/s43017-024-00555-9.
30. Kyba, C.C.M., Hänel, A. and Hölker, F. Redefining efficiency for outdoor lighting. *Energy Environ. Sci.*, 7(6):1806–1809, 2014. doi: 10.1039/c4ee00566j.
31. Bará, S., Rodríguez-Arós, Á., Pérez, M., Tosar, B., Lima, R., de Miguel, A.S. and Zamorano, J. Estimating the relative contribution of streetlights, vehicles, and residen-

tial lighting to the urban night sky brightness. *Lighting Research & Technology*, 51(7): 1092–1107, oct 2018. doi: 10.1177/1477153518808337.

32. Barentine, J.C., Kundracik, F., Kocifaj, M., Sanders, J.C., Esquerdo, G.A., Dalton, A.M., Foott, B., Grauer, A., Tucker, S. and Kyba, C.C. Recovering the city street lighting fraction from skyglow measurements in a large-scale municipal dimming experiment. *Journal of Quantitative Spectroscopy and Radiative Transfer*, 253:107120, sep 2020. doi: 10.1016/j.jqsrt.2020.107120.
33. Kyba, C., Ruby, A., Kuechly, H., Kinzey, B., Miller, N., Sanders, J., Barentine, J., Kleinodt, R. and Espey, B. Direct measurement of the contribution of street lighting to satellite observations of nighttime light emissions from urban areas. *Lighting Research & Technology*, 53(3):189–211, oct 2020. ISSN 1477-0938. doi: 10.1177/1477153520958463.
34. Zamorano, J., Bará, S., Barco, M., García, C. and Caballero, A.L. Controlling the artificial radiance of the night sky: The añora urban laboratory. *Journal of Quantitative Spectroscopy and Radiative Transfer*, 296:108454, feb 2023. doi: 10.1016/j.jqsrt.2022.108454.
35. Falchi, F., Cinzano, P., Elvidge, C.D., Keith, D.M. and Haim, A. Limiting the impact of light pollution on human health, environment and stellar visibility. *Journal of Environmental Management*, 92(10):2714–2722, oct 2011. doi: 10.1016/j.jenvman.2011.06.029.
36. Schroer, S. and Hölker, F. Light pollution reduction. In *Handbook of Advanced Lighting Technology*, pages 1–17. Springer International Publishing, 2014. doi: 10.1007/978-3-319-00295-8_43-1.
37. Bettanini, C., Bartolomei, M., Aboudan, A., Colombatti, G. and Olivieri, L. Flight test of an autonomous payload for measuring sky brightness and ground light pollution using a stratospheric sounding balloon. *Acta Astronautica*, 191:11–21, feb 2022. doi: 10.1016/j.actaastro.2021.11.003.
38. Cavazzani, S., Fiorentin, P., Bettanini, C., Bartolomei, M., Bertolin, C., Ortolani, S., Bertolo, A., Binotto, R., Olivieri, L., Aboudan, A. and Colombatti, G. Launch of a sounding balloon for horizontal and vertical modelling of ALAN propagation in the atmosphere. *Monthly Notices of the Royal Astronomical Society*, 517(3):4220–4228, oct 2022. doi: 10.1093/mnras/stac2977.
39. Aubé, M., Simoneau, A. and Kolláth, Z. Hablan: Multispectral and multiangular remote sensing of artificial light at night from high altitude balloons. *Journal of Quantitative Spectroscopy and Radiative Transfer*, 306:108606, September 2023. ISSN 0022-4073. doi: 10.1016/j.jqsrt.2023.108606.
40. Walczak, K., Wisbrock, L., Tarr, C., Gyuk, G., Amezcua, J., Cheng, C., Cris, J., Jimenez, C., Mehta, M., Mujahid, A., Pritchard, L., Suquino, K. and Turkic, L. Quantifying nighttime light emission by land use from the stratosphere. *Journal of Quantitative Spectroscopy and Radiative Transfer*, 310:108739, December 2023. ISSN 0022-4073. doi: 10.1016/j.jqsrt.2023.108739.
41. Kuechly, H.U., Kyba, C.C., Ruhtz, T., Lindemann, C., Wolter, C., Fischer, J. and Hölker, F. Aerial survey and spatial analysis of sources of light pollution in berlin, germany. *Remote Sensing of Environment*, 126:39–50, nov 2012. doi: 10.1016/j.rse.2012.08.008.
42. Bouroussis, C.A. and Topalis, F.V. Assessment of outdoor lighting installations and their impact on light pollution using unmanned aircraft systems - the concept of the drone-goniophotometer. *Journal of Quantitative Spectroscopy and Radiative Transfer*, 253:107155, sep 2020. doi: 10.1016/j.jqsrt.2020.107155.
43. Zhang, D., Li, D., Zhou, L. and Wu, J. Fine classification of uav urban nighttime light images based on object-oriented approach. *Sensors*, 23(4):2180, February 2023. ISSN 1424-8220. doi: 10.3390/s23042180.
44. Bobkowska, K., Burdziakowski, P., Tysiac, P. and Pulas, M. An innovative new approach to light pollution measurement by drone. *Drones*, 8(9):504, September 2024. ISSN 2504-446X. doi: 10.3390/drones8090504.
45. Bachmann, M. and Storch, T. First nighttime light spectra by satellite—by enmap. *Remote Sensing*, 15(16):4025, August 2023. ISSN 2072-4292. doi: 10.3390/rs15164025.
46. Guo, H., Dou, C., Chen, H., Liu, J., Fu, B., Li, X., Zou, Z. and Liang, D. Sdgsat-1: the world's first scientific satellite for sustainable development goals. *Science Bulletin*, 68(1): 34–38, jan 2023. ISSN 2095-9273. doi: 10.1016/j.scib.2022.12.014.
47. de Miguel, A.S., Kyba, C.C., Aubé, M., Zamorano, J., Cardiel, N., Tapia, C., Bennie, J. and Gaston, K.J. Colour remote sensing of the impact of artificial light at night (i): The potential of the international space station and other DSLR-based platforms. *Remote Sensing of Environment*, 224:92–103, apr 2019. doi: 10.1016/j.rse.2019.01.035.
48. Román, M.O., Wang, Z., Sun, Q., Kalb, V., Miller, S.D., Molthan, A., Schultz, L., Bell, J., Stokes, E.C., Pandey, B., Seto, K.C., Hall, D., Oda, T., Wolfe, R.E., Lin, G., Golpayegani, N., Devadiga, S., Davidson, C., Sarkar, S., Praderas, C. et al. NASA's black marble nighttime lights product suite. *Remote Sensing of Environment*, 210:113–143, jun 2018. doi: 10.1016/j.rse.2018.03.017.
49. Elvidge, C.D., Baugh, K., Ghosh, T., Zhizhin, M., Hsu, F.C., Sparks, T., Bazilian, M., Sutton, P.C., Houngbedji, K. and Goldblatt, R. Fifty years of nightly global low-light imaging satellite observations. *Frontiers in Remote Sensing*, 3, aug 2022. doi: 10.3389/frsen.2022.919937.
50. Akandil, C., Plekhanova, E., Rietze, N., Oehri, J., Román, M.O., Wang, Z., Radeloff, V.C. and Schaepman-Strub, G. Artificial light at night reveals hotspots and rapid development of industrial activity in the arctic. *Proceedings of the National Academy of Sciences*, 121 (44), October 2024. ISSN 1091-6490. doi: 10.1073/pnas.2322269121.
51. Kayode-Edwards, I.I. and Agbontaen, D.O. *Light Pollution in the Arctic Marine Environment*, pages 275–282. Springer Nature Switzerland, 2024. ISBN 9783031735844. doi: 10.1007/978-3-031-73584-4_13.
52. Falchi, F., Furgoni, R., Gallaway, T., Rybnikova, N., Portnov, B., Baugh, K., Cinzano, P. and Elvidge, C. Light pollution in USA and europe: The good, the bad and the ugly. *Journal of Environmental Management*, 248:109227, oct 2019. doi: 10.1016/j.jenvman.2019.06.128.
53. de Miguel, A.S., Bennie, J., Rosenfeld, E., Dzurjak, S. and Gaston, K.J. First estimation of global trends in nocturnal power emissions reveals acceleration of light pollution. *Remote Sensing*, 13(16):3311, aug 2021. doi: 10.3390/rs13163311.
54. Petržala, J. and Kómar, L. The contribution of scattered radiation to the upward radiance of a city. *Journal of Quantitative Spectroscopy and Radiative Transfer*, 333:109330, March 2025. ISSN 0022-4073. doi: 10.1016/j.jqsrt.2024.109330.
55. Bará, S. Detecting changes in anthropogenic light emissions: Limits due to atmospheric variability. *Journal of Quantitative Spectroscopy and Radiative Transfer*, 329:109187, December 2024. ISSN 0022-4073. doi: 10.1016/j.jqsrt.2024.109187.
56. Rybnikova, N. and Broitman, D. The power of spectrally enhanced artificial night-time lights data: Assessing ntl risks along the urban-natural interface. *Remote Sensing Applications: Society and Environment*, 36:101309, November 2024. ISSN 2352-9385. doi: 10.1016/j.rsase.2024.101309.
57. Kyba, C.C.M., Aubé, M., Bará, S., Bertolo, A., Bouroussis, C.A., Cavazzani, S., Espey, B.R., Falchi, F., Gyuk, G., Jechow, A., Kocifaj, M., Kolláth, Z., Lamphar, H., Levin, N., Liu, S., Miller, S.D., Ortolani, S., Pun, C.S.J., Ribas, S.J., Ruhtz, T. et al. Multiple angle observations would benefit visible band remote sensing using night lights. *Journal of Geophysical Research: Atmospheres*, 127(12), jun 2022. doi: 10.1029/2021jd036382.
58. De Miguel, A.S. and Krupansky, S. Importance of the time acquisition difference between dmsp/ols and snpp/viirs/dnb and the raw trends in europe, 2022.
59. Kolláth, Z., Száz, D. and Kolláth, K. Measurements and modelling of aritificial sky brightness: Combining remote sensing from satellites and ground-based observations. *Remote Sensing*, 13(18):3653, sep 2021. doi: 10.3390/rs13183653.
60. Espey, B.R., Yan, X. and Patrascu, K. Real-world urban light emission functions and quantitative comparison with spacecraft measurements. *Remote Sensing*, 15(12):2973, June 2023. ISSN 2072-4292. doi: 10.3390/rs15122973.
61. Zhao, Zhou, Li, Cao, He, Yu, Li, Elvidge, Cheng and Zhou. Applications of satellite remote sensing of nighttime light observations: Advances, challenges, and perspectives. *Remote Sensing*, 11(17):1971, aug 2019. doi: 10.3390/rs11171971.
62. Barentine, J.C., Walczak, K., Gyuk, G., Tarr, C. and Longcore, T. A case for a new satellite mission for remote sensing of night lights. *Remote Sensing*, 13(12):2294, jun 2021. doi: 10.3390/rs13122294.
63. Kyba, C.C.M., Ruhtz, T., Fischer, J. and Hölker, F. Cloud coverage acts as an amplifier for ecological light pollution in urban ecosystems. *PLoS ONE*, 6(3):e17307, mar 2011. doi: 10.1371/journal.pone.0017307.
64. Ścieżor, T. The impact of clouds on the brightness of the night sky. *Journal of Quantitative Spectroscopy and Radiative Transfer*, 247:106962, may 2020. doi: 10.1016/j.jqsrt.2020.106962.
65. Jechow, A., Hölker, F. and Kyba, C.C.M. Using all-sky differential photometry to investigate how nocturnal clouds darken the night sky in rural areas. *Scientific Reports*, 9(1), feb 2019. doi: 10.1038/s41598-018-37817-8.
66. Kocifaj, M. and Barentine, J.C. Air pollution mitigation can reduce the brightness of the night sky in and near cities. *Scientific Reports*, 11(1), July 2021. doi: 10.1038/s41598-021-94241-1.
67. Liu, M., Li, W., Zhang, B., Hao, Q., Guo, X. and Liu, Y. Research on the influence of weather conditions on urban night light environment. *Sustainable Cities and Society*, 54: 101980, mar 2020. doi: 10.1016/j.scs.2019.101980.
68. Wallner, S. and Kocifaj, M. Aerosol impact on light pollution in cities and their environment. *Journal of Environmental Management*, 335:117534, June 2023. ISSN 0301-4797. doi: 10.1016/j.jenvman.2023.117534.
69. Stark, H., Brown, S.S., Wong, K.W., Stutz, J., Elvidge, C.D., Pollack, I.B., Ryerson, T.B., Dube, W.P., Wagner, N.L. and Parrish, D.D. City lights and urban air. *Nature Geoscience*, 4(11):730–731, oct 2011. doi: 10.1038/ngeo1300.
70. Shith, S., Ramli, N.A., Awang, N.R., Ismail, M.R., Latif, M.T. and Zainordin, N.S. Does light pollution affect nighttime ground-level ozone concentrations? *Atmosphere,* 13(11):1844, nov 2022. doi: 10.3390/atmos13111844.
71. Shith, S., Ramli, N.A., Mohd Nadzir, A.U., Awang, N.R. and Ismail, M.R. Drivers of nocturnal interactions between ground-level ozone and nitrogen dioxide. *Global NEST Journal*, 25(6):149–155, June 2023. ISSN 2241-777X. doi: 10.30955/gnj.004843.
72. Thurairajah, U. *Discovery of Artificial Photolysis that Influences Air Pollution in Urban Versus Rural Areas in Changing Climate*, pages 55–79. B P International (a part of SCIENCEDOMAIN International), September 2023. ISBN 9788119761746. doi: 10.9734/bpi/eieges/v1/10956f.
73. Aubé, M. Physical behaviour of anthropogenic light propagation into the nocturnal environment. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 370(1667): 20140117, may 2015. doi: 10.1098/rstb.2014.0117.
74. Falchi, F. Campaign of sky brightness and extinction measurements using a portable CCD camera. *Monthly Notices of the Royal Astronomical Society*, 412(1):33–48, dec 2010. doi: 10.1111/j.1365-2966.2010.17845.x.
75. Jechow and Hölker. Snowglow—the amplification of skyglow by snow and clouds can exceed full moon illuminance in suburban areas. *Journal of Imaging*, 5(8):69, aug 2019. doi: 10.3390/jimaging5080069.
76. Kocifaj, M. Ground albedo impacts on higher-order scattering spectral radiances of night sky. *Journal of Quantitative Spectroscopy and Radiative Transfer*, 239:106670, dec 2019. doi: 10.1016/j.jqsrt.2019.106670.
77. Wallner, S. and Kocifaj, M. Impacts of surface albedo variations on the night sky brightness – a numerical and experimental analysis. *Journal of Quantitative Spectroscopy and Radiative Transfer*, 239:106648, dec 2019. doi: 10.1016/j.jqsrt.2019.106648.
78. Zissis, G., Bertoldi, P. and Serrenho, T. *Update on the status of LED-lighting world market since 2018*. Publications Office, European Commission Joint Research Centre, 2021. doi: 10.2760/759859.
79. Zielińska-Dąbkowska, K.M. Healthier and environmentally responsible sustainable cities and communities. a new design framework and planning approach for urban illumination. *Sustainability*, 14(21):14525, nov 2022. doi: 10.3390/su142114525.

80. de Miguel, A.S., Aubé, M., Zamorano, J., Kocifaj, M., Roby, J. and Tapia, C. Sky quality meter measurements in a colour-changing world. *Monthly Notices of the Royal Astronomical Society*, 467(3):2966–2979, mar 2017. doi: 10.1093/mnras/stx145.
81. Kolláth, Z., Száz, D., Kolláth, K. and Tong, K.P. Light pollution monitoring and sky colours. *Journal of Imaging*, 6(10):104, oct 2020. doi: 10.3390/jimaging6100104.
82. Robles, J., Zamorano, J., Pascual, S., de Miguel, A.S., Gallego, J. and Gaston, K.J. Evolution of brightness and color of the night sky in madrid. *Remote Sensing*, 13(8):1511, April 2021. doi: 10.3390/rs13081511.
83. Luginbuhl, C.B., Boley, P.A. and Davis, D.R. The impact of light source spectral power distribution on sky glow. *Journal of Quantitative Spectroscopy and Radiative Transfer*, 139:21–26, may 2014. doi: 10.1016/j.jqsrt.2013.12.004.
84. Hung, L.W., Anderson, S.J., Pipkin, A. and Fristrup, K. Changes in night sky brightness after a countywide LED retrofit. *Journal of Environmental Management*, 292:112776, August 2021. doi: 10.1016/j.jenvman.2021.112776.
85. Lamphar, H., Wallner, S. and Kocifaj, M. Modelled impacts of a potential light emitting diode lighting system conversion and the influence of an extremely polluted atmosphere in Mexico City. *Environment and Planning B: Urban Analytics and City Science*, page 239980832110127, May 2021. doi: 10.1177/23998083211012702.
86. Tabaka, P. and Kołomański, S. Influence of replacing discharge lamps with led sources in outdoor lighting installations on astronomical observations. *Bulletin of the Polish Academy of Sciences Technical Sciences*, page 147915, October 2023. ISSN 2300-1917. doi: 10.24425/bpasts.2023.147915.
87. McNaughton, E.J., Gaston, K.J., Beggs, J.R., Jones, D.N. and Stanley, M.C. Areas of ecological importance are exposed to risk from urban sky glow: Auckland, aotearoa-new zealand as a case study. *Urban Ecosystems*, August 2021. doi: 10.1007/s11252-021-01149-9.
88. Baddiley, C. Light pollution colour changes at MHAONB, from distant town conversions to blue-rich LED lighting, implications for rural UK skies. *Journal of Quantitative Spectroscopy and Radiative Transfer*, 267:107574, jun 2021. doi: 10.1016/j.jqsrt.2021.107574.
89. Green, R.F., Luginbuhl, C.B., Wainscoat, R.J. and Duriscoe, D. The growing threat of light pollution to ground-based observatories. *The Astronomy and Astrophysics Review*, 30(1), jan 2022. doi: 10.1007/s00159-021-00138-3.
90. Hearnshaw, J. Light pollution as a risk for astronomical research and how to manage it. In *Risk Management in Outer Space Activities*, pages 177–220. Springer Nature Singapore, 2022. doi: 10.1007/978-981-16-4756-7_7.
91. Bhagavathula, R. and Gibbons, R.B. Light levels for parking facilities based on empirical evaluation of visual performance and user perceptions. *LEUKOS*, 16(2):115–136, feb 2019. doi: 10.1080/15502724.2018.1551724.
92. Barentine, J.C., Walker, C.E., Kocifaj, M., Kundracik, F., Juan, A., Kanemoto, J. and Monrad, C.K. Skyglow changes over tucson, arizona, resulting from a municipal LED street lighting conversion. *Journal of Quantitative Spectroscopy and Radiative Transfer*, 212:10–23, June 2018. doi: 10.1016/j.jqsrt.2018.02.038.
93. Ściężor, T. Effect of street lighting on the urban and rural night-time radiance and the brightness of the night sky. *Remote Sensing*, 13(9):1654, apr 2021. doi: 10.3390/rs13091654.
94. Bará, S., Falchi, F., Lima, R.C. and Pawley, M. Can we illuminate our cities and (still) see the stars? *International Journal of Sustainable Lighting*, 23(2):58–69, oct 2021. doi: 10.26607/ijsl.v23i2.113.
95. Pásková, M., Budinská, N. and Zelenka, J. Astrotourism–exceeding limits of the earth and tourism definitions? *Sustainability*, 13(1):373, jan 2021. doi: 10.3390/su13010373.
96. Smith, J.W., Miller, Z., Miller, A. and Lamborn, C.C. Characteristics, management preferences, and spending profiles of night sky recreationists in utah. Technical report, Utah State University, Logan, Utah, feb 2023.
97. Collison, F.M. and Poe, K. "astronomical tourism": The astronomy and dark sky program at bryce canyon national park. *Tourism Management Perspectives*, 7:1–15, jul 2013. doi: 10.1016/j.tmp.2013.01.002.
98. Rodrigues, A.L.O., Rodrigues, A. and Peroff, D.M. The sky and sustainable tourism development: A case study of a dark sky reserve implementation in alqueva. *International Journal of Tourism Research*, 17(3):292–302, jan 2014. doi: 10.1002/jtr.1987.
99. Mitchell, D. and Gallaway, T. Dark sky tourism: economic impacts on the colorado plateau economy, USA. *Tourism Review*, 74(4):930–942, sep 2019. doi: 10.1108/tr-10-2018-0146.
100. Beeco, J.A., Wilkins, E.J., Miller, A.B., Lamborn, C.C., Anderson, S.J., Miller, Z.D. and Smith, J.W. Support for management actions to protect night sky quality: Insights from visitors to state and national park units in the u.s. *Journal of Environmental Management*, 345:118878, November 2023. ISSN 0301-4797. doi: 10.1016/j.jenvman.2023.118878.
101. Hvenegaard, G.T. and Banack, C.S. Visitor outcomes from dark sky tourism: a case study of the jasper dark sky festival. *Journal of Ecotourism*, 24(1):75–84, February 2024. ISSN 1747-7638. doi: 10.1080/14724049.2024.2320698.
102. Rodrigues, Á. and Loureiro, S.M.C. Exploring community self-efficacy to light pollution mitigation in a tourism destination. *Tourism Planning & Development*, 21(6):818–840, March 2024. ISSN 2156-8324. doi: 10.1080/21568316.2024.2332243.
103. Crumey, A. Human contrast threshold and astronomical visibility. *Monthly Notices of the Royal Astronomical Society*, 442(3):2600–2619, jun 2014. doi: 10.1093/mnras/stu992.
104. Duriscoe, D.M. Photometric indicators of visual night sky quality derived from all-sky brightness maps. *Journal of Quantitative Spectroscopy and Radiative Transfer*, 181:33–45, sep 2016. doi: 10.1016/j.jqsrt.2016.02.022.
105. Hung, L.W. Identifying distinct metrics for assessing night sky brightness. *Monthly Notices of the Royal Astronomical Society*, 511(4):5683–5688, sep 2021. doi: 10.1093/mnras/stab2662.
106. Barentine, J.C. Methods for assessment and monitoring of light pollution around ecologically sensitive sites. *Journal of Imaging*, 5(5):54, may 2019. doi: 10.3390/jimaging5050054.
107. Kyba, C.C.M. and Coesfeld, J. Satellite observations show reductions in light emissions at international dark sky places during 2012-2020. *International Journal of Sustainable Lighting*, 23(2):51–57, oct 2021. doi: 10.26607/ijsl.v23i2.111.
108. Beier, P. Effects of artificial night lighting on terrestrial mammals. In Rich, C. and Longcore, T., editors, *Ecological consequences of artificial night lighting*, pages 19–42, Washington, D.C., 2005. Island Press.
109. Dacke, M., Baird, E., Byrne, M., Scholtz, C.H. and Warrant, E.J. Dung beetles use the milky way for orientation. *Current Biology*, 23(4):298–300, feb 2013. doi: 10.1016/j.cub.2012.12.034.
110. Hagen, O., Santos, R.M., Schlindwein, M.N. and Viviani, V.R. Artificial night lighting reduces firefly (coleoptera: Lampyridae) occurrence in sorocaba, brazil. *Advances in Entomology*, 03(01):24–32, 2015. doi: 10.4236/ae.2015.31004.
111. Hirt, M.R., Evans, D.M., Miller, C.R. and Ryser, R. Light pollution in complex ecological systems. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 378 (1892), October 2023. ISSN 1471-2970. doi: 10.1098/rstb.2022.0351.
112. Sanders, D., Frago, E., Kehoe, R., Patterson, C. and Gaston, K.J. A meta-analysis of biological impacts of artificial light at night. *Nature Ecology & Evolution*, 5(1):74–81, nov 2020. doi: 10.1038/s41559-020-01322-x.
113. Falcón, J., Torriglia, A., Attia, D., Viénot, F., Gronfier, C., Behar-Cohen, F., Martinsons, C. and Hicks, D. Exposure to artificial light at night and the consequences for flora, fauna, and ecosystems. *Frontiers in Neuroscience*, 14, nov 2020. doi: 10.3389/fnins.2020.602796.
114. Brayley, O., How, D.M. and Wakefield, D.A. Biological effects of light pollution on terrestrial and marine organisms. *International Journal of Sustainable Lighting*, 24(1):13–38, mar 2022. doi: 10.26607/ijsl.v24i1.121.
115. Premke, K., Wurzbacher, C., Felsmann, K., Fabian, J., Taube, R., Bodmer, P., Attermeyer, K., Nitzsche, K.N., Schroer, S., Koschorreck, M., Hübner, E., Mahmoudinejad, T.H., Kyba, C.C., Monaghan, M.T. and Hölker, F. Large-scale sampling of the freshwater microbiome suggests pollution-driven ecosystem changes. *Environmental Pollution*, 308:119627, sep 2022. doi: 10.1016/j.envpol.2022.119627.
116. Rodríguez, A., Holmes, N.D., Ryan, P.G., Wilson, K.J., Faulquier, L., Murillo, Y., Raine, A.F., Penniman, J.F., Neves, V., Rodríguez, B., Negro, J.J., Chiaradia, A., Dann, P., Anderson, T., Metzger, B., Shirai, M., Deppe, L., Wheeler, J., Hodum, P., Gouveia, C. et al. Seabird mortality induced by land-based artificial lights. *Conservation Biology*, 31(5):986–1001, may 2017. doi: 10.1111/cobi.12900.
117. de Jong, M., van den Eertwegh, L., Beskers, R.E., de Vries, P.P., Spoelstra, K. and Visser, M.E. Timing of avian breeding in an urbanised world. *Ardea*, 106(1):31, may 2018. doi: 10.5253/arde.v106i1.a4.
118. Adams, C.A., Fernández-Juricic, E., Bayne, E.M. and Clair, C.C.S. Effects of artificial light on bird movement and distribution: a systematic map. *Environmental Evidence*, 10(1), dec 2021. doi: 10.1186/s13750-021-00246-8.
119. Knight, K. Blue and white light pollution is disastrous for cory's shearwater fledglings. *Journal of Experimental Biology*, 227(19), October 2024. ISSN 1477-9145. doi: 10.1242/jeb.249593.
120. Bassi, A., Love, O.P., Cooke, S.J., Warriner, T.R., Harris, C.M. and Madliger, C.L. Effects of artificial light at night on fishes: A synthesis with future research priorities. *Fish and Fisheries*, 23(3):631–647, dec 2021. doi: 10.1111/faf.12638.
121. Robert, K.A., Lesku, J.A., Partecke, J. and Chambers, B. Artificial light at night desynchronizes strictly seasonal reproduction in a wild mammal. *Proceedings of the Royal Society B: Biological Sciences*, 282(1816):20151745, oct 2015. doi: 10.1098/rspb.2015.1745.
122. Hoffmann, J., Palme, R. and Eccard, J.A. Long-term dim light during nighttime changes activity patterns and space use in experimental small mammal populations. *Environmental Pollution*, 238:844–851, jul 2018. doi: 10.1016/j.envpol.2018.03.107.
123. Kumari, R., Verma, V., Kronfeld-Schor, N. and Singaravel, M. Differential response of diurnal and nocturnal mammals to prolonged altered light-dark cycle: a possible role of mood associated endocrine, inflammatory and antioxidant system. *Chronobiology International*, 38(11):1618–1630, jun 2021. doi: 10.1080/07420528.2021.1937200.
124. Kamrowski, R., Limpus, C., Moloney, J. and Hamann, M. Coastal light pollution and marine turtles: assessing the magnitude of the problem. *Endangered Species Research*, 19(1):85–98, nov 2012. doi: 10.3354/esr00462.
125. Zheleva, M. The dark side of light. light pollution kills leatherback turtle hatchlings. *Biodiscovery*, sep 2012. doi: 10.7750/biodiscovery.2012.3.4.
126. Baxter-Gilbert, J., Baider, C., Florens, F.V., Hawlitschek, O., Mohan, A.V., Mohanty, N.P., Wagener, C., Webster, K.C. and Riley, J.L. Nocturnal foraging and activity by diurnal lizards: Six species of day geckos (phelsuma spp.) using the night-light niche. *Austral Ecology*, 46(3):501–506, feb 2021. doi: 10.1111/aec.13012.
127. Dananay, K.L. and Benard, M.F. Artificial light at night decreases metamorphic duration and juvenile growth in a widespread amphibian. *Proceedings of the Royal Society B: Biological Sciences*, 285(1882):20180367, jul 2018. doi: 10.1098/rspb.2018.0367.
128. Deng, K., Zhu, B.C., Zhou, Y., Chen, Q.H., Wang, T.L., Wang, J.C. and Cui, J.G. Mate choice decisions of female serrate-legged small treefrogs are affected by ambient light under natural, but not enhanced artificial nocturnal light conditions. *Behavioural Processes*, 169:103997, dec 2019. doi: 10.1016/j.beproc.2019.103997.
129. Dias, K.S., Dosso, E.S., Hall, A.S., Schuch, A.P. and Tozetti, A.M. Ecological light pollution affects anuran calling season, daily calling period, and sensitivity to light in natural brazilian wetlands. *The Science of Nature*, 106(7-8), jul 2019. doi: 10.1007/s00114-019-1640-y.
130. Davies, T.W., Bennie, J., Cruse, D., Blumgart, D., Inger, R. and Gaston, K.J. Multiple night-time light-emitting diode lighting strategies impact grassland invertebrate assemblages. *Global Change Biology*, 23(7):2641–2648, jan 2017. doi: 10.1111/gcb.13615.
131. Bennie, J., Davies, T.W., Cruse, D., Inger, R. and Gaston, K.J. Artificial light at night causes top-down and bottom-up trophic effects on invertebrate populations. *Journal of Applied Ecology*, 55(6):2698–2706, aug 2018. doi: 10.1111/1365-2664.13240.
132. Desouhant, E., Gomes, E., Mondy, N. and Amat, I. Mechanistic, ecological, and evolution-

ary consequences of artificial light at night for insects: review and prospective. *Entomologia Experimentalis et Applicata*, 167(1):37–58, jan 2019. doi: 10.1111/eea.12754.

133. Kavassilas, Z., Mittmannsgruber, M., Gruber, E. and Zaller, J.G. Artificial light at night reduces the surface activity of earthworms, increases the growth of a cover crop and reduces water leaching. *Land*, 13(10):1698, October 2024. ISSN 2073-445X. doi: 10.3390/land13101698.
134. Gao, X., Zhang, M., Luo, Q., Lin, S., Lyu, M. and Ke, C. Persistent exposure to artificial light at night (alan) accelerates metamorphosis and colonization in larvae of marine shellfish. *Ecological Indicators*, 158:111472, January 2024. ISSN 1470-160X. doi: 10.1016/j.ecolind.2023.111472.
135. Zhang, M., Gao, X., Luo, Q., Lin, S., Lyu, M., Luo, X., Ke, C. and You, W. Risk assessment of persistent exposure to artificial light at night revealed altered behavior and metabolic patterns of marine nocturnal shellfish. *Ecological Indicators*, 160:111807, March 2024. ISSN 1470-160X. doi: 10.1016/j.ecolind.2024.111807.
136. Calbet, A. *The Unseen Threats: Effects of Sound and Light Pollution on Plankton*, pages 163–167. Springer Nature Switzerland, 2024. ISBN 9783031761218. doi: 10.1007/978-3-031-76121-8_26.
137. Wang, G., Yuan, X., Xue, Q., Yu, Q., Yang, Z. and Sun, Y. The impact of artificial light pollution at night on the life history parameters of rotifer brachionus plicatilis with different food experiences. *Marine Pollution Bulletin*, 205:116527, August 2024. ISSN 0025-326X. doi: 10.1016/j.marpolbul.2024.116527.
138. Roux, C., Madru, C., Millan Navarro, D., Jan, G., Mazzella, N., Moreira, A., Vedrenne, J., Carassou, L. and Morin, S. Impact of urban pollution on freshwater biofilms: Oxidative stress, photosynthesis and lipid responses. *Journal of Hazardous Materials*, 472:134523, July 2024. ISSN 0304-3894. doi: 10.1016/j.jhazmat.2024.134523.
139. Di Bari, D. Natural light vs artificial light. effects of light pollution on the bioluminescence of dinoflagellate pyrocystis lunula. *Revista Ciencias Marinas y Costeras*, pages 79–98, December 2024. ISSN 1659-455X. doi: 10.15359/revmar.16-2.5.
140. Škvareninová, J., Tuhárska, M., Škvarenina, J., Babálová, D., Slobodníková, L., Slobodník, B., Středová, H. and Minďaš, J. Effects of light pollution on tree phenology in the urban environment. *Moravian Geographical Reports*, 25(4):282–290, dec 2017. doi: 10.1515/mgr-2017-0024.
141. Brelsford, C.C. and Robson, T.M. Blue light advances bud burst in branches of three deciduous tree species under short-day conditions. *Trees*, 32(4):1157–1164, mar 2018. doi: 10.1007/s00468-018-1684-1.
142. Dani, M., Molnár, P. and Skribanek, A. The sensitivity of herbaceous plants to light pollution. *Acta Universitatis de Carolo Eszterházy Nominatae. Sectio Biologiae*, 46:173–181, 2021. doi: 10.33041/actauniveszterhazybiol.2021.46.173.
143. Hou, Y., Li, J., Li, G. and Qi, W. Negative effects of urbanization on plants: A global meta-analysis. *Ecology and Evolution*, 13(4), March 2023. ISSN 2045-7758. doi: 10.1002/ece3.9894.
144. Khanduri, M. and Saxena, A. Ecological light pollution: Consequences for the aquatic ecosystem. *International Journal of Fisheries and Aquatic Studies*, 8(3):1–5, 2020.
145. Hölker, F., Jechow, A., Schroer, S., Tockner, K. and Gessner, M.O. Light pollution of freshwater ecosystems: principles, ecological impacts and remedies. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 378(1892), October 2023. ISSN 1471-2970. doi: 10.1098/rstb.2022.0360.
146. Davies, T.W., McKee, D., Fishwick, J., Tidau, S. and Smyth, T. Biologically important artificial light at night on the seafloor. *Scientific Reports*, 10(1), jul 2020. doi: 10.1038/s41598-020-69461-6.
147. Tidau, S., Smyth, T., McKee, D., Wiedenmann, J., D'Angelo, C., Wilcockson, D., Ellison, A., Grimmer, A.J., Jenkins, S.R., Widdicombe, S., Queirós, A.M., Talbot, E., Wright, A. and Davies, T.W. Marine artificial light at night: An empirical and technical guide. *Methods in Ecology and Evolution*, 12(9):1588–1601, jul 2021. doi: 10.1111/2041-210x.13653.
148. Fobert, E.K., Miller, C.R., Swearer, S.E. and Mayer-Pinto, M. The impacts of artificial light at night on the ecology of temperate and tropical reefs. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 378(1892), October 2023. ISSN 1471-2970. doi: 10.1098/rstb.2022.0362.
149. Miller, C.R. and Rice, A.N. A synthesis of the risks of marine light pollution across organismal and ecological scales. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 33(12):1590–1602, September 2023. ISSN 1099-0755. doi: 10.1002/aqc.4011.
150. Stanton, D.L. and Cowart, J.R. The effects of artificial light at night (alan) on the circadian biology of marine animals. *Frontiers in Marine Science*, 11, February 2024. ISSN 2296-7745. doi: 10.3389/fmars.2024.1372889.
151. Berge, J., Geoffroy, M., Daase, M., Cottier, F., Priou, P., Cohen, J.H., Johnsen, G., McKee, D., Kostakis, I., Renaud, P.E., Vogedes, D., Anderson, P., Last, K.S. and Gauthier, S. Artificial light during the polar night disrupts arctic fish and zooplankton behaviour down to 200 m depth. *Communications Biology*, 3(1), mar 2020. doi: 10.1038/s42003-020-0807-6.
152. Davies, T.W., Bennie, J., Inger, R., Ibarra, N.H. and Gaston, K.J. Artificial light pollution: are shifting spectral signatures changing the balance of species interactions? *Global Change Biology*, 19(5):1417–1423, mar 2013. doi: 10.1111/gcb.12166.
153. Longcore, T., Rodríguez, A., Witherington, B., Penniman, J.F., Herf, L. and Herf, M. Rapid assessment of lamp spectrum to quantify ecological effects of light at night. *Journal of Experimental Zoology Part A: Ecological and Integrative Physiology*, 329(8-9):511–521, jun 2018. doi: 10.1002/jez.2184.
154. Svechkina, A., Portnov, B.A. and Trop, T. The impact of artificial light at night on human and ecosystem health: a systematic literature review. *Landscape Ecology*, 35(8):1725–1742, jun 2020. doi: 10.1007/s10980-020-01053-1.
155. Farnworth, B., Innes, J. and Waas, J.R. Converting predation cues into conservation tools: The effect of light on mouse foraging behaviour. *PLOS ONE*, 11(1):e0145432, jan 2016. doi: 10.1371/journal.pone.0145432.
156. Silva, A.D., Diez-Méndez, D. and Kempenaers, B. Effects of experimental night lighting on the daily timing of winter foraging in common european songbirds. *Journal of Avian Biology*, 48(6):862–871, apr 2017. doi: 10.1111/jav.01232.
157. Leveau, L.M. Artificial light at night (ALAN) is the main driver of nocturnal feral pigeon (columba livia f. domestica) foraging in urban areas. *Animals*, 10(4):554, mar 2020. doi: 10.3390/ani10040554.
158. Tidau, S., Whittle, J., Jenkins, S.R. and Davies, T.W. Artificial light at night reverses monthly foraging pattern under simulated moonlight. *Biology Letters*, 18(7), jul 2022. doi: 10.1098/rsbl.2022.0110.
159. Stone, E.L., Jones, G. and Harris, S. Street lighting disturbs commuting bats. *Current Biology*, 19(13):1123–1127, jul 2009. doi: 10.1016/j.cub.2009.05.058.
160. Kurvers, R.H.J.M., Drägestein, J., Hölker, F., Jechow, A., Krause, J. and Bierbach, D. Artificial light at night affects emergence from a refuge and space use in guppies. *Scientific Reports*, 8(1), sep 2018. doi: 10.1038/s41598-018-32466-3.
161. Agarwal, N., Srivastava, S., Malik, S., Rani, S. and Kumar, V. Altered light conditions during spring: effects on timing of migration and reproduction in migratory redheaded bunting (emberiza bruniceps). *Biological Rhythm Research*, 46(5):647–657, may 2015. doi: 10.1080/09291016.2015.1046245.
162. Tallec, T.L., Théry, M. and Perret, M. Melatonin concentrations and timing of seasonal reproduction in male mouse lemurs (microcebus murinus) exposed to light pollution. *Journal of Mammalogy*, 97(3):753–760, jan 2016. doi: 10.1093/jmammal/gyw003.
163. Dominoni, D.M., Jensen, J.K., Jong, M., Visser, M.E. and Spoelstra, K. Artificial light at night, in interaction with spring temperature, modulates timing of reproduction in a passerine bird. *Ecological Applications*, 30(3), jan 2020. doi: 10.1002/eap.2062.
164. Meng, L., Zhou, Y., Román, M.O., Stokes, E.C., Wang, Z., Asrar, G.R., Mao, J., Richardson, A.D., Gu, L. and Wang, Y. Artificial light at night: an underappreciated effect on phenology of deciduous woody plants. *PNAS Nexus*, 1(2), apr 2022. doi: 10.1093/pnasnexus/pgac046.
165. Torres, D., Tidau, S., Jenkins, S. and Davies, T. Artificial skyglow disrupts celestial migration at night. *Current Biology*, 30(12):R696–R697, jun 2020. doi: 10.1016/j.cub.2020.05.002.
166. Horton, K.G., Buler, J.J., Anderson, S.J., Burt, C.S., Collins, A.C., Dokter, A.M., Guo, F., Sheldon, D., Tomaszewska, M.A. and Henebry, G.M. Artificial light at night is a top predictor of bird migration stopover density. *Nature Communications*, 14(1), December 2023. ISSN 2041-1723. doi: 10.1038/s41467-023-43046-z.
167. Geffen, K.G.V., Groot, A.T., Grunsven, R.H.A.V., Donners, M., Berendse, F. and Veenedaal, E.M. Artificial night lighting disrupts sex pheromone in a noctuid moth. *Ecological Entomology*, 40(4):401–408, apr 2015. doi: 10.1111/een.12202.
168. Borges, R.M. Dark matters: Challenges of nocturnal communication between plants and animals in delivery of pollination services. *Yale Journal of Biology and Medicine*, 91:33–42, 2018.
169. Dickerson, A.L., Hall, M.L. and Jones, T.M. Effects of variation in natural and artificial light at night on acoustic communication: a review and prospectus. *Animal Behaviour*, 198:93–105, apr 2023. ISSN 0003-3472. doi: 10.1016/j.anbehav.2023.01.018.
170. Moralia, M.A., Quignon, C., Simonneaux, M. and Simonneaux, V. Environmental disruption of reproductive rhythms. *Frontiers in Neuroendocrinology*, 66:100990, jul 2022. doi: 10.1016/j.yfrne.2022.100990.
171. Hopkins, G.R., Gaston, K.J., Visser, M.E., Elgar, M.A. and Jones, T.M. Artificial light at night as a driver of evolution across urban–rural landscapes. *Frontiers in Ecology and the Environment*, 16(8):472–479, sep 2018. doi: 10.1002/fee.1828.
172. Keinath, S., Hölker, F., Müller, J. and Rödel, M.O. Impact of light pollution on moth morphology–a 137-year study in germany. *Basic and Applied Ecology*, 56:1–10, nov 2021. doi: 10.1016/j.baae.2021.05.004.
173. Alaasam, V.J., Hui, C., Lomas, J., Ferguson, S.M., Zhang, Y., Yim, W.C. and Ouyang, J.Q. What happens when the lights are left on? transcriptomic and phenotypic habituation to light pollution. *iScience*, 27(2):108864, February 2024. ISSN 2589-0042. doi: 10.1016/j.isci.2024.108864.
174. Van de Schoot, E., Merckx, T., Ebert, D., Wesselingh, R.A., Altermatt, F. and Van Dyck, H. Evolutionary change in flight-to-light response in urban moths comes with changes in wing morphology. *Biology Letters*, 20(3), March 2024. ISSN 1744-957X. doi: 10.1098/rsbl.2023.0486.
175. May, D., Shidemantle, G., Melnick-Kelley, Q., Crane, K. and Hua, J. The effect of intensified illuminance and artificial light at night on fitness and susceptibility to abiotic and biotic stressors. *Environmental Pollution*, 251:600–608, aug 2019. doi: 10.1016/j.envpol.2019.05.016.
176. Walker, W.H., Meléndez-Fernández, O.H., Nelson, R.J. and Reiter, R.J. Global climate change and invariable photoperiods: A mismatch that jeopardizes animal fitness. *Ecology and Evolution*, 9(17):10044–10054, aug 2019. doi: 10.1002/ece3.5537.
177. Lian, X., Jiao, L., Zhong, J., Jia, Q., Liu, J. and Liu, Z. Artificial light pollution inhibits plant phenology advance induced by climate warming. *Environmental Pollution*, 291:118110, dec 2021. doi: 10.1016/j.envpol.2021.118110.
178. Durrant, J., Green, M.P. and Jones, T.M. Dim artificial light at night reduces the cellular immune response of the black field cricket, teleogryllus commodus. *Insect Science*, 27(3):571–582, mar 2019. doi: 10.1111/1744-7917.12665.
179. Thoenen, J., Ripper, D. and Duke, E. Light pollution and immunosuppression: Determining the role of artificial lighting in coccidiosis in non-migratory birds. *The Bluebird*, 86(3):131–140, 2019.
180. Walker, W.H., Bumgarner, J.R., Becker-Krail, D.D., May, L.E., Liu, J.A. and Nelson, R.J. Light at night disrupts biological clocks, calendars, and immune function. *Seminars in Immunopathology*, nov 2021. doi: 10.1007/s00281-021-00899-0.
181. Bonfoey, A.M., Chen, J. and Stahlschmidt, Z.R. Stress tolerance is influenced by artificial

light at night during development and life-history strategy. *Journal of Experimental Biology*, 226(4), February 2023. ISSN 1477-9145. doi: 10.1242/jeb.245195.

182. Pham, K., Lazenby, M., Yamada, K., Lattin, C.R. and Wada, H. Zebra finches (taeniopygia castanotis) display varying degrees of stress resilience in response to constant light. *General and Comparative Endocrinology*, 361:114644, January 2025. ISSN 0016-6480. doi: 10.1016/j.ygcen.2024.114644.
183. Cissé, Y.M., Russart, K.L. and Nelson, R.J. Parental exposure to dim light at night prior to mating alters offspring adaptive immunity. *Scientific Reports*, 7(1), mar 2017. doi: 10.1038/srep45497.
184. Cissé, Y.M., Russart, K. and Nelson, R.J. Exposure to dim light at night prior to conception attenuates offspring innate immune responses. *PLOS ONE*, 15(4):e0231140, apr 2020. doi: 10.1371/journal.pone.0231140.
185. Brown, J.A., Lockwood, J.L., Piana, M.R. and Beardsley, C. Introduction of artificial light at night increases the abundance of predators, scavengers, and parasites in arthropod communities. *iScience*, 26(3):106203, March 2023. ISSN 2589-0042. doi: 10.1016/j.isci.2023.106203.
186. Moyse, E., Firth, L.B., Smyth, T., Tidau, S. and Davies, T.W. Artificial light at night alters predation on colour-polymorphic camouflaged prey. *Basic and Applied Ecology*, 73:88–93, December 2023. ISSN 1439-1791. doi: 10.1016/j.baae.2023.11.002.
187. Becker, D.J., Singh, D., Pan, Q., Montoure, J.D., Talbott, K.M., Wanamaker, S.M. and Ketterson, E.D. Artificial light at night amplifies seasonal relapse of haemosporidian parasites in a widespread songbird. *Proceedings of the Royal Society B: Biological Sciences*, 287 (1935):20201831, sep 2020. doi: 10.1098/rspb.2020.1831.
188. Poulin, R. Light pollution may alter host-parasite interactions in aquatic ecosystems. *Trends in Parasitology*, 39(12):1050–1059, December 2023. ISSN 1471-4922. doi: 10.1016/j.pt.2023.08.013.
189. Buxton, R.T., Seymoure, B.M., White, J., Angeloni, L.M., Crooks, K.R., Fristrup, K., McKenna, M.F. and Wittemyer, G. The relationship between anthropogenic light and noise in u.s. national parks. *Landscape Ecology*, 35(6):1371–1384, may 2020. doi: 10.1007/s10980-020-01020-w.
190. Halfwerk, W. and Jerem, P. A systematic review of research investigating the combined ecological impact of anthropogenic noise and artificial light at night. *Frontiers in Ecology and Evolution*, 9, nov 2021. doi: 10.3389/fevo.2021.765950.
191. Willems, J.S., Phillips, J.N. and Francis, C.D. Artificial light at night and anthropogenic noise alter the foraging activity and structure of vertebrate communities. *Science of The Total Environment*, 805:150223, jan 2022. doi: 10.1016/j.scitotenv.2021.150223.
192. Easton, A., Komyakova, V. and Coughlin, T. Evaluating ecological risk in artificial habitat failure: A systematic review and risk assessment considering noise and light pollution in the marine environment. *Environmental Impact Assessment Review*, 107:107560, July 2024. ISSN 0195-9255. doi: 10.1016/j.eiar.2024.107560.
193. Mathiaparanam, K.J., Mulder, R.A. and Hale, R. Anthropogenic double jeopardy: Urban noise and artificial light at night interact synergistically to influence abundance. *Environmental Pollution*, 363:125078, December 2024. ISSN 0269-7491. doi: 10.1016/j.envpol.2024.125078.
194. Gaston, K.J., Duffy, J.P., Gaston, S., Bennie, J. and Davies, T.W. Human alteration of natural light cycles: causes and ecological consequences. *Oecologia*, 176(4):917–931, sep 2014. doi: 10.1007/s00442-014-3088-2.
195. Russart, K.L. and Nelson, R.J. Light at night as an environmental endocrine disruptor. *Physiology & Behavior*, 190:82–89, jun 2018. doi: 10.1016/j.physbeh.2017.08.029.
196. Yang, Y., Liu, Q., Wang, T. and Pan, J. Wavelength-specific artificial light disrupts molecular clock in avian species: A power-calibrated statistical approach. *Environmental Pollution*, 265:114206, oct 2020. doi: 10.1016/j.envpol.2020.114206.
197. Foster, J.J., Kirwan, J.D., el Jundi, B., Smolka, J., Khaldy, L., Baird, E., Byrne, M.J., Nilsson, D.E., Johnsen, S. and Dacke, M. Orienting to polarized light at night – matching lunar skylight to performance in a nocturnal beetle. *The Journal of Experimental Biology*, 222 (2):jeb188532, dec 2018. doi: 10.1242/jeb.188532.
198. Lao, S., Robertson, B.A., Anderson, A.W., Blair, R.B., Eckles, J.W., Turner, R.J. and Loss, S.R. The influence of artificial light at night and polarized light on bird-building collisions. *Biological Conservation*, 241:108358, jan 2020. doi: 10.1016/j.biocon.2019.108358.
199. Qu, X., Huang, Q., Li, H. and Lou, F. Comparative transcriptomics revealed the ecological trap effect of linearly polarized light on oratosquilla oratoria. *Comparative Biochemistry and Physiology Part D: Genomics and Proteomics*, 50:101234, June 2024. ISSN 1744-117X. doi: 10.1016/j.cbd.2024.101234.
200. Fraleigh, D.C., Heitmann, J.B. and Robertson, B.A. Ultraviolet polarized light pollution and evolutionary traps for aquatic insects. *Animal Behaviour*, 180:239–247, oct 2021. doi: 10.1016/j.anbehav.2021.08.006.
201. Pérez Vega, C., Hölker, F., Zielinska-Dabkowska, K.M. and Jechow, A. Polarised light pollution on river water surfaces caused by artificial light at night from illuminated bridges and surroundings. *Journal of Limnology*, 83, May 2024. ISSN 1129-5767. doi: 10.4081/jlimnol.2024.2173.
202. Horváth, G. *Polarized Light Pollution and Ecological/Evolutionary Traps Induced by It for Polarotactic Aquatic Insects*, pages 477–560. Springer Nature Switzerland, 2024. ISBN 9783031628634. doi: 10.1007/978-3-031-62863-4_25.
203. Kyba, C.C.M., Ruhtz, T., Fischer, J. and Hölker, F. Lunar skylight polarization signal polluted by urban lighting: Pollution of lunar skylight signal. *Journal of Geophysical Research: Atmospheres*, 116(D24):n/a–n/a, December 2011. ISSN 0148-0227. doi: 10.1029/2011jd016698.
204. Horváth, G., Kriska, G., Malik, P. and Robertson, B. Polarized light pollution: a new kind of ecological photopollution. *Frontiers in Ecology and the Environment*, 7(6):317–325, aug 2009. doi: 10.1890/080129.
205. Degen, T., Kolláth, Z. and Degen, J. X,y, and z: A bird's eye view on light pollution. *Ecology and Evolution*, 12(12), dec 2022. doi: 10.1002/ece3.9608.
206. Kehoe, R., Sanders, D. and van Veen, F.J. Towards a mechanistic understanding of the effects of artificial light at night on insect populations and communities. *Current Opinion in Insect Science*, 53:100950, oct 2022. doi: 10.1016/j.cois.2022.100950.
207. Sanders, D., Hirt, M.R., Brose, U., Evans, D.M., Gaston, K.J., Gauzens, B. and Ryser, R. How artificial light at night may rewire ecological networks: concepts and models. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 378(1892), October 2023. ISSN 1471-2970. doi: 10.1098/rstb.2022.0368.
208. Li, X.M., Li, S., Huang, F.Y., Wang, Z., Zhang, Z.Y., Chen, S.C. and Zhu, Y.G. Artificial light at night triggers negative impacts on nutrients cycling and plant health regulated by soil microbiome in urban ecosystems. *Geoderma*, 436:116547, August 2023. ISSN 0016-7061. doi: 10.1016/j.geoderma.2023.116547.
209. Russart, K.L. and Nelson, R.J. Artificial light at night alters behavior in laboratory and wild animals. *Journal of Experimental Zoology Part A: Ecological and Integrative Physiology*, 329(8-9):401–408, may 2018. doi: 10.1002/jez.2173.
210. Jägerbrand, A.K. and Spoelstra, K. Effects of anthropogenic light on species and ecosystems. *Science*, 380(6650):1125–1130, June 2023. ISSN 1095-9203. doi: 10.1126/science.adg3173.
211. Maggi, E., Bongiorni, L., Fontanini, D., Capocchi, A., Bello, M.D., Giacomelli, A. and Benedetti-Cecchi, L. Artificial light at night erases positive interactions across trophic levels. *Functional Ecology*, 34(3):694–706, dec 2019. doi: 10.1111/1365-2435.13485.
212. Fisher, D.N., Kilgour, R.J., Siracusa, E.R., Foote, J.R., Hobson, E.A., Montiglio, P.O., Saltz, J.B., Wey, T.W. and Wice, E.W. Anticipated effects of abiotic environmental change on intraspecific social interactions. *Biological Reviews*, 96(6):2661–2693, jul 2021. doi: 10.1111/brv.12772.
213. Grubisic, M. and van Grunsven, R.H. Artificial light at night disrupts species interactions and changes insect communities. *Current Opinion in Insect Science*, 47:136–141, oct 2021. doi: 10.1016/j.cois.2021.06.007.
214. Cieraad, E., Strange, E., Flink, M., Schrama, M. and Spoelstra, K. Artificial light at night affects plant-herbivore interactions. *Journal of Applied Ecology*, dec 2022. doi: 10.1111/1365-2664.14336.
215. Sullivan, S.M.P., Hossler, K. and Meyer, L.A. Artificial lighting at night alters aquatic-riparian invertebrate food webs. *Ecological Applications*, 29(1), dec 2018. doi: 10.1002/eap.1821.
216. Parkinson, E., Lawson, J. and Tiegs, S.D. Artificial light at night at the terrestrial-aquatic interface: Effects on predators and fluxes of insect prey. *PLOS ONE*, 15(10):e0240138, oct 2020. doi: 10.1371/journal.pone.0240138.
217. Farnworth, B., Meitern, R., Innes, J. and Waas, J.R. Increasing predation risk with light reduces speed, exploration and visit duration of invasive ship rats (rattus rattus). *Scientific Reports*, 9(1), mar 2019. doi: 10.1038/s41598-019-39711-3.
218. Russo, D., Cosentino, F., Festa, F., Benedetta, F.D., Pejic, B., Cerretti, P. and Ancillotto, L. Artificial illumination near rivers may alter bat-insect trophic interactions. *Environmental Pollution*, 252:1671–1677, sep 2019. doi: 10.1016/j.envpol.2019.06.105.
219. Mcmunn, M.S., Yang, L.H., Ansalmo, A., Bucknam, K., Claret, M., Clay, C., Cox, K., Dungey, D.R., Jones, A., Kim, A.Y., Kubacki, R., Le, R., Martinez, D., Reynolds, B., Schroder, J. and Wood, E. Artificial light increases local predator abundance, predation rates, and herbivory. *Environmental Entomology*, 48(6):1331–1339, sep 2019. doi: 10.1093/ee/nvz103.
220. Katz, N., Pruitt, J.N. and Scharf, I. The complex effect of illumination, temperature, and thermal acclimation on habitat choice and foraging behavior of a pit-building wormlion. *Behavioral Ecology and Sociobiology*, 71(9), aug 2017. doi: 10.1007/s00265-017-2362-9.
221. Fobert, E.K., da Silva, K.B. and Swearer, S.E. Artificial light at night causes reproductive failure in clownfish. *Biology Letters*, 15(7):20190272, jul 2019. doi: 10.1098/rsbl.2019.0272.
222. Thompson, E.K., Cullinan, N.L., Jones, T.M. and Hopkins, G.R. Effects of artificial light at night and male calling on movement patterns and mate location in field crickets. *Animal Behaviour*, 158:183–191, dec 2019. doi: 10.1016/j.anbehav.2019.10.016.
223. Shlesinger, T. and Loya, Y. Breakdown in spawning synchrony: A silent threat to coral persistence. *Science*, 365(6457):1002–1007, sep 2019. doi: 10.1126/science.aax0110.
224. Hillón-Salas, J.S., Pineda-Dueñas, J.D., Romero-Chacón, A.M., Fonseca-Tellez, J., Cardona-Restrepo, M., Garrido-Villegas, S.C., Mejía-Tovar, D., Arenas-Ríos, C., Gaitán-Botero, L., Barón-Garzón, Z.S., Robayo-Salek, A.F., Pulido-Guarín, H., Ovalle-Barrera, J.J., Macías-González, A.D., Bernal-Guatibonza, N. and Maldonado-Chaparro, A.A. Artificial light at night reduces flashing in photinus and photuris fireflies during courtship and predation. *Journal of Insect Behavior*, 37(1):49–57, March 2024. ISSN 1572-8889. doi: 10.1007/s10905-024-09849-8.
225. Cammaerts, M.C. and Cammaerts, R. Effect of nocturnal lighting on an ant's ethological and physiological traits. *MOJ Ecology & Environmental Sciences*, 4(5), oct 2019. doi: 10.15406/mojes.2019.04.00156.
226. Aguilera, M.A. and González, M.G. Urban infrastructure expansion and artificial light pollution degrade coastal ecosystems, increasing natural-to-urban structural connectivity. *Landscape and Urban Planning*, 229:104609, January 2023. ISSN 0169-2046. doi: 10.1016/j.landurbplan.2022.104609.
227. Lacoeuilhe, A., Machon, N., Julien, J.F., Bocq, A.L. and Kerbiriou, C. The influence of low intensities of light pollution on bat communities in a semi-natural context. *PLoS ONE*, 9 (10):e103042, oct 2014. doi: 10.1371/journal.pone.0103042.
228. Firebaugh, A. and Haynes, K.J. Light pollution may create demographic traps for nocturnal insects. *Basic and Applied Ecology*, 34:118–125, feb 2019. doi: 10.1016/j.baae.2018.07.005.
229. Murphy, S.M., Vyas, D.K., Sher, A.A. and Grenis, K. Light pollution affects invasive and native plant traits important to plant competition and herbivorous insects. *Biological Invasions*, 24(3):599–602, nov 2021. doi: 10.1007/s10530-021-02670-w.

230. Atchoi, E., Mitkus, M., Machado, B., Medeiros, V., Garcia, S., Juliano, M., Bried, J. and Rodríguez, A. Do seabirds dream of artificial lights? understanding light preferences of procellariiformes. *Journal of Experimental Biology*, 227(19), October 2024. ISSN 1477-9145. doi: 10.1242/jeb.247665.
231. Parkins, K.L., Elbin, S.B. and Barnes, E. Light, glass, and bird—building collisions in an urban park. *Northeastern Naturalist*, 22(1):84–94, mar 2015. doi: 10.1656/045.022.0113.
232. Hüppop, O., Hüppop, K., Dierschke, J. and Hill, R. Bird collisions at an offshore platform in the north sea. *Bird Study*, 63(1):73–82, jan 2016. doi: 10.1080/00063657.2015.1134440.
233. Voigt, C.C., Roeleke, M., Marggraf, L., Pētersons, G. and Voigt-Heucke, S.L. Migratory bats respond to artificial green light with positive phototaxis. *PLOS ONE*, 12(5):e0177748, may 2017. doi: 10.1371/journal.pone.0177748.
234. Krafft, B.A. and Krag, L.A. Antarctic krill (euphausia superba) exhibit positive phototaxis to white LED light. *Polar Biology*, 44(3):483–489, feb 2021. doi: 10.1007/s00300-021-02814-7.
235. Syposz, M., Padget, O., Willis, J., Doren, B.M.V., Gillies, N., Fayet, A.L., Wood, M.J., Alejo, A. and Guilford, T. Avoidance of different durations, colours and intensities of artificial light by adult seabirds. *Scientific Reports*, 11(1), sep 2021. doi: 10.1038/s41598-021-97986-x.
236. Vowles, A.S. and Kemp, P.S. Artificial light at night (ALAN) affects the downstream movement behaviour of the critically endangered european eel, anguilla anguilla. *Environmental Pollution*, 274:116585, apr 2021. doi: 10.1016/j.envpol.2021.116585.
237. Hauptfleisch, M. Arthropod phototaxis and its possible effect on bird strike risk at two namibian airports. *Applied Ecology and Environmental Research*, 13(4):957–965, Dec 2015. doi: 10.15666/aeer/1304_957965.
238. van Grunsven, R.H., Creemers, R., Joosten, K., Donners, M. and Veenendaal, E.M. Behaviour of migrating toads under artificial lights differs from other phases of their life cycle. *Amphibia-Reptilia*, 38(1):49–55, 2017. doi: 10.1163/15685381-00003081.
239. Kühne, J.L., van Grunsven, R.H.A., Jechow, A. and Hölker, F. Impact of different wavelengths of artificial light at night on phototaxis in aquatic insects. *Integrative and Comparative Biology*, 61(3):1182–1190, jun 2021. doi: 10.1093/icb/icab149.
240. Koen, E.L., Minnaar, C., Roever, C.L. and Boyles, J.G. Emerging threat of the 21st century lightscape to global biodiversity. *Global Change Biology*, 24(6):2315–2324, apr 2018. doi: 10.1111/gcb.14146.
241. Garrett, J.K., Donald, P.F. and Gaston, K.J. Skyglow extends into the world's key biodiversity areas. *Animal Conservation*, 23(2):153–159, feb 2019. doi: 10.1111/acv.12480.
242. Karan, S., Saraswat, S. and Anusha, B.S. Light pollution and the impacts on biodiversity: the dark side of light. *Biodiversity*, 24(4):194–199, August 2023. ISSN 2160-0651. doi: 10.1080/14888386.2023.2244920.
243. Giavi, E., Blösch, S., Schuster, G. and Knop, E. Artificial light at night can modify ecosystem functioning beyond the lit area. *Scientific Reports*, 10(1), jul 2020. doi: 10.1038/s41598-020-68667-y.
244. Boyes, D.H., Evans, D.M., Fox, R., Parsons, M.S. and Pocock, M.J.O. Street lighting has detrimental impacts on local insect populations. *Science Advances*, 7(35), aug 2021. doi: 10.1126/sciadv.abi8322.
245. Murphy, S.M., Vyas, D.K., Hoffman, J.L., Jenck, C.S., Washburn, B.A., Hunnicutt, K.E., Davidson, A., Andersen, J.M., Bennet, R.K., Gifford, A., Herrera, M., Lawler, B., Lorman, S., Peacock, V., Walker, L., Watkins, E., Wilkinson, L., Williams, Z. and Tinghitella, R.M. Streetlights positively affect the presence of an invasive grass species. *Ecology and Evolution*, 11(15):10320–10326, jul 2021. doi: 10.1002/ece3.7835.
246. Liu, Y. and Heinen, R. Plant invasions under artificial light at night. *Trends in Ecology & Evolution*, 39(8):703–705, August 2024. ISSN 0169-5347. doi: 10.1016/j.tree.2024.05.005.
247. Tougeron, K. and Sanders, D. Combined light pollution and night warming as a novel threat to ecosystems. *Trends in Ecology & Evolution*, 38(8):701–704, August 2023. ISSN 0169-5347. doi: 10.1016/j.tree.2023.05.012.
248. Seymoure, B.M., Linares, C. and White, J. Connecting spectral radiometry of anthropogenic light sources to the visual ecology of organisms. *Journal of Zoology*, 308(2):93–110, feb 2019. doi: 10.1111/jzo.12656.
249. Jägerbrand, A. and Brutemark, A. Correspondence: Addressing and mitigating the ecological effects of light pollution requires ecological perspectives. *Lighting Research & Technology*, page 147715352211424, dec 2022. doi: 10.1177/14771535221142489.
250. Sordello, R., Busson, S., Cornuau, J.H., Deverchère, P., Faure, B., Guetté, A., Hölker, F., Kerbiriou, C., Lengagne, T., Viol, I.L., Longcore, T., Moeschler, P., Ranzoni, J., Ray, N., Reyjol, Y., Roulet, Y., Schroer, S., Secondi, J., Valet, N., Vanpeene, S. et al. A plea for a worldwide development of dark infrastructure for biodiversity – practical examples and ways to go forward. *Landscape and Urban Planning*, 219:104332, mar 2022. doi: 10.1016/j.landurbplan.2021.104332.
251. Morrell, S., Hatchell, J., Wordingham, F., Bennie, J., Inston, M.J. and Gaston, K.J. Changing streetlighting schemes and the ecological availability of darkness. *Journal of The Royal Society Interface*, 21(211), February 2024. ISSN 1742-5662. doi: 10.1098/rsif.2023.0555.
252. Dietenberger, M., Jechow, A., Kalinkat, G., Schroer, S., Saathoff, B. and Hölker, F. Reducing the fatal attraction of nocturnal insects using tailored and shielded road lights. *Communications Biology*, 7(1), May 2024. ISSN 2399-3642. doi: 10.1038/s42003-024-06304-4.
253. Durmus, D., Jägerbrand, A. and Tengelin, M. Research note: Red light to mitigate light pollution: Is it possible to balance functionality and ecological impact? *Lighting Research & Technology*, 56(3):304–308, January 2024. ISSN 1477-0938. doi: 10.1177/14771535231225362.
254. Owens, A.C., Pocock, M.J. and Seymoure, B.M. Current evidence in support of insect-friendly lighting practices. *Current Opinion in Insect Science*, 66:101276, December 2024. ISSN 2214-5745. doi: 10.1016/j.cois.2024.101276.
255. Wiltschko, W. and Wiltschko, R. Magnetic orientation in birds. *Journal of Experimental Biology*, 199(1):29–38, jan 1996. doi: 10.1242/jeb.199.1.29.
256. Cochran, W.W., Mouritsen, H. and Wikelski, M. Migrating songbirds recalibrate their magnetic compass daily from twilight cues. *Science*, 304(5669):405–408, apr 2004. doi: 10.1126/science.1095844.
257. Wiltschko, R., Stapput, K., Thalau, P. and Wiltschko, W. Directional orientation of birds by the magnetic field under different light conditions. *Journal of The Royal Society Interface*, 7(suppl_2), oct 2009. doi: 10.1098/rsif.2009.0367.focus.
258. Wiltschko, W., Munro, U., Ford, H. and Wiltschko, R. Red light disrupts magnetic orientation of migratory birds. *Nature*, 364(6437):525–527, aug 1993. doi: 10.1038/364525a0.
259. Sorte, F.A.L., Horton, K.G., Johnston, A., Fink, D. and Auer, T. Seasonal associations with light pollution trends for nocturnally migrating bird populations. *Ecosphere*, 13(3), mar 2022. doi: 10.1002/ecs2.3994.
260. Sorte, F.A.L., Fink, D., Buler, J.J., Farnsworth, A. and Cabrera-Cruz, S.A. Seasonal associations with urban light pollution for nocturnally migrating bird populations. *Global Change Biology*, 23(11):4609–4619, jul 2017. doi: 10.1111/gcb.13792.
261. Horton, K.G., Nilsson, C., Doren, B.M.V., Sorte, F.A.L., Dokter, A.M. and Farnsworth, A. Bright lights in the big cities: migratory birds' exposure to artificial light. *Frontiers in Ecology and the Environment*, 17(4):209–214, apr 2019. doi: 10.1002/fee.2029.
262. Bolshakov, C.V., Bulyuk, V.N., Sinelschikova, A.Y. and Vorotkov, M.V. Influence of the vertical light beam on numbers and flight trajectories of night-migrating songbirds. *Avian Ecology and Behaviour*, 24:35–49, 2013.
263. Cabrera-Cruz, S.A., Larkin, R.P., Gimpel, M.E., Gruber, J.G., Zenzal, T.J. and Buler, J.J. Potential effect of low-rise, downcast artificial lights on nocturnally migrating land birds. *Integrative and Comparative Biology*, 61(3):1216–1236, jul 2021. doi: 10.1093/icb/icab154.
264. Nichols, K.S., Homayoun, T., Eckles, J. and Blair, R.B. Bird-building collision risk: An assessment of the collision risk of birds with buildings by phylogeny and behavior using two citizen-science datasets. *PLOS ONE*, 13(8):e0201558, aug 2018. doi: 10.1371/journal.pone.0201558.
265. Sorte, F.A.L., Lepczyk, C.A. and Aronson, M.F.J. Light pollution enhances ground-level exposure to airborne toxic chemicals for nocturnally migrating passerines. *Global Change Biology*, 29(1):57–68, oct 2022. doi: 10.1111/gcb.16443.
266. Sorte, F.A.L., Aronson, M.F.J., Lepczyk, C.A. and Horton, K.G. Assessing the combined threats of artificial light at night and air pollution for the world's nocturnally migrating birds. *Global Ecology and Biogeography*, 31(5):912–924, feb 2022. doi: 10.1111/geb.13466.
267. Cabrera-Cruz, S.A., Cohen, E.B., Smolinsky, J.A. and Buler, J.J. Artificial light at night is related to broad-scale stopover distributions of nocturnally migrating landbirds along the yucatan peninsula, mexico. *Remote Sensing*, 12(3):395, jan 2020. doi: 10.3390/rs12030395.
268. Cabrera-Cruz, S.A., Smolinsky, J.A., McCarthy, K.P. and Buler, J.J. Urban areas affect flight altitudes of nocturnally migrating birds. *Journal of Animal Ecology*, 88(12):1873–1887, aug 2019. doi: 10.1111/1365-2656.13075.
269. Doren, B.M.V., Horton, K.G., Dokter, A.M., Klinck, H., Elbin, S.B. and Farnsworth, A. High-intensity urban light installation dramatically alters nocturnal bird migration. *Proceedings of the National Academy of Sciences*, 114(42):11175–11180, oct 2017. doi: 10.1073/pnas.1708574114.
270. Wong, M.K.L. and Didham, R.K. Global meta-analysis reveals overall higher nocturnal than diurnal activity in insect communities. *Nature Communications*, 15(1), April 2024. ISSN 2041-1723. doi: 10.1038/s41467-024-47645-2.
271. Rydin, C. and Bolinder, K. Moonlight pollination in the gymnosperm ephedra (gnetales). *Biology Letters*, 11(4):20140993, apr 2015. doi: 10.1098/rsbl.2014.0993.
272. Dyer, A., Ryser, R., Brose, U., Amyntas, A., Bodnar, N., Boy, T., Franziska Bucher, S., Cesarz, S., Eisenhauer, N., Gebler, A., Hines, J., Kyba, C.C.M., Menz, M.H.M., Rackwitz, K., Shatwell, T., Terlau, J.F. and Hirt, M.R. Insect communities under skyglow: diffuse nighttime illuminance induces spatio-temporal shifts in movement and predation. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 378(1892), October 2023. ISSN 1471-2970. doi: 10.1098/rstb.2022.0359.
273. Anderson, S.J., Kubiszewski, I. and Sutton, P.C. The ecological economics of light pollution: Impacts on ecosystem service value. *Remote Sensing*, 16(14):2591, July 2024. ISSN 2072-4292. doi: 10.3390/rs16142591.
274. Grubisic, M., van Grunsven, R., Kyba, C., Manfrin, A. and Hölker, F. Insect declines and agroecosystems: does light pollution matter? *Annals of Applied Biology*, 173(2):180–189, jun 2018. doi: 10.1111/aab.12440.
275. Briolat, E.S., Gaston, K.J., Bennie, J., Rosenfeld, E.J. and Troscianko, J. Artificial nighttime lighting impacts visual ecology links between flowers, pollinators and predators. *Nature Communications*, 12(1), jul 2021. doi: 10.1038/s41467-021-24394-0.
276. Wilson, A.A., Seymoure, B.M., Jaeger, S., Milstead, B., Payne, H., Peria, L., Vosbigian, R.A. and Francis, C.D. Direct and ambient light pollution alters recruitment for a diurnal plant–pollinator system. *Integrative and Comparative Biology*, 61(3):1122–1133, mar 2021. doi: 10.1093/icb/icab010.
277. Shivanna, K.R. Impact of light pollution on nocturnal pollinators and their pollination services. *Proceedings of the Indian National Science Academy*, 88(4):626–633, nov 2022. doi: 10.1007/s43538-022-00134-w.
278. Jones, T.M. and McNamara, K.B. Harmonic radar suggests greater impact of light pollution for nocturnal insects. *Proceedings of the National Academy of Sciences*, 121(42), October 2024. ISSN 1091-6490. doi: 10.1073/pnas.2417219121.
279. Borges, R.M. Impacts of artificial light at night on nocturnal and diurnal insect biology and diversity. *Indian Journal of Entomology*, pages 483–492, mar 2022. doi: 10.55446/ije.2022.182.
280. Kurahara, Y. and Itsubo, N. Quantitative environmental impact assessment for agricultural products caused by exposure of artificial light at night. In *Towards a Sustainable Future - Life Cycle Management*, pages 27–38. Springer International Publishing, oct 2021. doi: 10.1007/978-3-030-77127-0_3.
281. Cordeiro, G.D., Liporoni, R., Caetano, C.A., Krug, C., Martínez-Martínez, C.A., Martins,

H.O.J., Cardoso, R.K.O.A., Araujo, F.F., Araújo, P.C.S., Oliveira, R., Schlindwein, C., Warrant, E.J., Dötterl, S. and dos Santos, I.A. Nocturnal bees as crop pollinators. *Agronomy*, 11(5):1014, may 2021. doi: 10.3390/agronomy11051014.

282. Knop, E., Zoller, L., Ryser, R., Gerpe, C., Hörler, M. and Fontaine, C. Artificial light at night as a new threat to pollination. *Nature*, 548(7666):206–209, aug 2017. doi: 10.1038/nature23288.
283. Owens, A.C., Cochard, P., Durrant, J., Farnworth, B., Perkin, E.K. and Seymoure, B. Light pollution is a driver of insect declines. *Biological Conservation*, 241:108259, jan 2020. doi: 10.1016/j.biocon.2019.108259.
284. Boyes, D.H., Evans, D.M., Fox, R., Parsons, M.S. and Pocock, M.J.O. Is light pollution driving moth population declines? a review of causal mechanisms across the life cycle. *Insect Conservation and Diversity*, sep 2020. doi: 10.1111/icad.12447.
285. Macgregor, C.J., Evans, D.M., Fox, R. and Pocock, M.J.O. The dark side of street lighting: impacts on moths and evidence for the disruption of nocturnal pollen transport. *Global Change Biology*, 23(2):697–707, jul 2016. doi: 10.1111/gcb.13371.
286. Macgregor, C.J., Pocock, M.J.O., Fox, R. and Evans, D.M. Effects of street lighting technologies on the success and quality of pollination in a nocturnally pollinated plant. *Ecosphere*, 10(1), jan 2019. doi: 10.1002/ecs2.2550.
287. Boom, M.P., Spoelstra, K., Biere, A., Knop, E. and Visser, M.E. Pollination and fruit infestation under artificial light at night:light colour matters. *Scientific Reports*, 10(1), oct 2020. doi: 10.1038/s41598-020-75471-1.
288. Soteras, F., Camps, G.A., Costas, S.M., Giaquinta, A., Peralta, G. and Cocucci, A.A. Fragility of nocturnal interactions: Pollination intensity increases with distance to light pollution sources but decreases with increasing environmental suitability. *Environmental Pollution*, 292:118350, jan 2022. doi: 10.1016/j.envpol.2021.118350.
289. Akacem, L.D., Wright, K.P. and LeBourgeois, M.K. Bedtime and evening light exposure influence circadian timing in preschool-age children: A field study. *Neurobiology of Sleep and Circadian Rhythms*, 1(2):27–31, nov 2016. doi: 10.1016/j.nbscr.2016.11.002.
290. il Lee, S., Matsumori, K., Nishimura, K., Nishimura, Y., Ikeda, Y., Eto, T. and Higuchi, S. Melatonin suppression and sleepiness in children exposed to blue-enriched white LED lighting at night. *Physiological Reports*, 6(24), dec 2018. doi: 10.14814/phy2.13942.
291. Yang, H.Y., Wu, S.H., Zhang, S., Zou, H.X., Wang, L.B., Lin, L.Z., Gui, Z.H., Zeng, X.W., Yang, B.Y., Liu, R.Q., Dong, G.H. and Hu, L.W. Association between outdoor light at night exposure and executive function in chinese children. *Environmental Research*, 257:119286, September 2024. ISSN 0013-9351. doi: 10.1016/j.envres.2024.119286.
292. Wilson, M. Artificial blue light and teenagers: Does artificial blue light exposure at night have negative health and wellbeing implications on teenagers? *Otago Polytechnic School of Nursing Online Journal*, 6, 2019.
293. Paksarian, D., Rudolph, K.E., Stapp, E.K., Dunster, G.P., He, J., Mennitt, D., Hattar, S., Casey, J.A., James, P. and Merikangas, K.R. Association of outdoor artificial light at night with mental disorders and sleep patterns among US adolescents. *JAMA Psychiatry*, 77(12):1266, dec 2020. doi: 10.1001/jamapsychiatry.2020.1935.
294. Ricketts, E.J., Joyce, D.S., Rissman, A.J., Burgess, H.J., Colwell, C.S., Lack, L.C. and Gradisar, M. Electric lighting, adolescent sleep and circadian outcomes, and recommendations for improving light health. *Sleep Medicine Reviews*, 64:101667, aug 2022. doi: 10.1016/j.smrv.2022.101667.
295. Hatori, M., Gronfier, C., Gelder, R.N.V., Bernstein, P.S., Carreras, J., Panda, S., Marks, F., Sliney, D., Hunt, C.E., Hirota, T., Furukawa, T. and Tsubota, K. Global rise of potential health hazards caused by blue light-induced circadian disruption in modern aging societies. *npj Aging and Mechanisms of Disease*, 3(1), jun 2017. doi: 10.1038/s41514-017-0010-2.
296. Shen, J. and Tower, J. Effects of light on aging and longevity. *Ageing Research Reviews*, 53:100913, aug 2019. doi: 10.1016/j.arr.2019.100913.
297. Skwarło-Sońta, K. *Achieving Healthy Aging in the Light-Polluted World*, pages 445–459. Springer International Publishing, 2023. ISBN 9783031224683. doi: 10.1007/978-3-031-22468-3_21.
298. Wahl, S., Engelhardt, M., Schaupp, P., Lappe, C. and Ivanov, I.V. The inner clock—blue light sets the human rhythm. *Journal of Biophotonics*, 12(12), sep 2019. doi: 10.1002/jbio.201900102.
299. Lu, J., Zou, R., Yang, Y., Bai, X., Wei, W., Ding, R. and Hua, X. Association between nocturnal light exposure and melatonin in humans: a meta-analysis. *Environmental Science and Pollution Research*, 31(3):3425–3434, December 2023. ISSN 1614-7499. doi: 10.1007/s11356-023-31502-8.
300. Walmsley, L., Hanna, L., Mouland, J., Martial, F., West, A., Smedley, A.R., Bechtold, D.A., Webb, A.R., Lucas, R.J. and Brown, T.M. Colour as a signal for entraining the mammalian circadian clock. *PLOS Biology*, 13(4):e1002127, apr 2015. doi: 10.1371/journal.pbio.1002127.
301. Xu, Y.x., Zhang, J.h., Tao, F.b. and Sun, Y. Association between exposure to light at night (lan) and sleep problems: A systematic review and meta-analysis of observational studies. *Science of The Total Environment*, 857:159303, January 2023. ISSN 0048-9697. doi: 10.1016/j.scitotenv.2022.159303.
302. Jerigova, V., Zeman, M. and Okuliarova, M. Circadian disruption and consequences on innate immunity and inflammatory response. *International Journal of Molecular Sciences*, 23(22):13722, nov 2022. doi: 10.3390/ijms232213722.
303. Jerigova, V., Zeman, M. and Okuliarova, M. Chronodisruption of the acute inflammatory response by night lighting in rats. *Scientific Reports*, 13(1), August 2023. ISSN 2045-2322. doi: 10.1038/s41598-023-41266-3.
304. Neves, A.R., Albuquerque, T., Quintela, T. and Costa, D. Circadian rhythm and disease: Relationship, new insights, and future perspectives. *Journal of Cellular Physiology*, 237(8):3239–3256, jun 2022. doi: 10.1002/jcp.30815.
305. Su, K., Din, Z.U., Cui, B., Peng, F., Zhou, Y., Wang, C., Zhang, X., Lu, J., Luo, H., He, B., Kelley, K.W. and Liu, Q. A broken circadian clock: The emerging neuro-immune link connecting depression to cancer. *Brain, Behavior, & Immunity - Health*, 26:100533, dec 2022. doi: 10.1016/j.bbih.2022.100533.
306. Brown, T.M., Brainard, G.C., Cajochen, C., Czeisler, C.A., Hanifin, J.P., Lockley, S.W., Lucas, R.J., Münch, M., O'Hagan, J.B., Peirson, S.N., Price, L.L.A., Roenneberg, T., Schlangen, L.J.M., Skene, D.J., Spitschan, M., Vetter, C., Zee, P.C. and Wright, K.P. Recommendations for daytime, evening, and nighttime indoor light exposure to best support physiology, sleep, and wakefulness in healthy adults. *PLOS Biology*, 20(3):e3001571, mar 2022. doi: 10.1371/journal.pbio.3001571.
307. Lewy, A., Wehr, T., Goodwin, F., Newsome, D. and Markey, S. Light suppresses melatonin secretion in humans. *Science*, 210(4475):1267–1269, dec 1980. doi: 10.1126/science.7434030.
308. Carrillo-Vico, A., Guerrero, J.M., Lardone, P.J. and Reiter, R.J. A review of the multiple actions of melatonin on the immune system. *Endocrine*, 27(2):189–200, 2005. doi: 10.1385/endo:27:2:189.
309. Phillips, A.J.K., Vidafar, P., Burns, A.C., McGlashan, E.M., Anderson, C., Rajaratnam, S.M.W., Lockley, S.W. and Cain, S.W. High sensitivity and interindividual variability in the response of the human circadian system to evening light. *Proceedings of the National Academy of Sciences*, page 201901824, may 2019. doi: 10.1073/pnas.1901824116.
310. Grubisic, M., Haim, A., Bhusal, P., Dominoni, D.M., Gabriel, K.M.A., Jechow, A., Kupprat, F., Lerner, A., Marchant, P., Riley, W., Stebelova, K., van Grunsven, R.H.A., Zeman, M., Zubidat, A.E. and Hölker, F. Light pollution, circadian photoreception, and melatonin in vertebrates. *Sustainability*, 11(22):6400, nov 2019. doi: 10.3390/su11226400.
311. Stebelova, K., Roska, J. and Zeman, M. Impact of dim light at night on urinary 6-sulphatoxymelatonin concentrations and sleep in healthy humans. *International Journal of Molecular Sciences*, 21(20):7736, oct 2020. doi: 10.3390/ijms21207736.
312. Gibbons, R.B., Bhagavathula, R., Warfield, B., Brainard, G.C. and Hanifin, J.P. Impact of solid state roadway lighting on melatonin in humans. *Clocks & Sleep*, 4(4):633–657, nov 2022. doi: 10.3390/clockssleep4040049.
313. Bauducco, S., Pillion, M., Bartel, K., Reynolds, C., Kahn, M. and Gradisar, M. A bidirectional model of sleep and technology use: A theoretical review of how much, for whom, and which mechanisms. *Sleep Medicine Reviews*, 76:101933, August 2024. ISSN 1087-0792. doi: 10.1016/j.smrv.2024.101933.
314. Brainard, G.C., Hanifin, J.P., Greeson, J.M., Byrne, B., Glickman, G., Gerner, E. and Rollag, M.D. Action spectrum for melatonin regulation in humans: Evidence for a novel circadian photoreceptor. *The Journal of Neuroscience*, 21(16):6405–6412, aug 2001. doi: 10.1523/jneurosci.21-16-06405.2001.
315. Lucas, R.J., Peirson, S.N., Berson, D.M., Brown, T.M., Cooper, H.M., Czeisler, C.A., Figueiro, M.G., Gamlin, P.D., Lockley, S.W., O'Hagan, J.B., Price, L.L., Provencio, I., Skene, D.J. and Brainard, G.C. Measuring and using light in the melanopsin age. *Trends in Neurosciences*, 37(1):1–9, jan 2014. doi: 10.1016/j.tins.2013.10.004.
316. Berson, D.M., Dunn, F.A. and Takao, M. Phototransduction by retinal ganglion cells that set the circadian clock. *Science*, 295(5557):1070–1073, feb 2002. doi: 10.1126/science.1067262.
317. Buijs, F.N., León-Mercado, L., Guzmán-Ruiz, M., Guerrero-Vargas, N.N., Romo-Nava, F. and Buijs, R.M. The circadian system: A regulatory feedback network of periphery and brain. *Physiology*, 31(3):170–181, may 2016. doi: 10.1152/physiol.00037.2015.
318. Fleury, G., Masís-Vargas, A. and Kalsbeek, A. Metabolic implications of exposure to light at night: Lessons from animal and human studies. *Obesity*, 28(S1), jul 2020. doi: 10.1002/oby.22807.
319. Nicholls, S. Evidence for internal desynchrony caused by circadian clock resetting. *Yale Journal of Biology and Medicine*, 92(2):259–270, 2019.
320. Koronowski, K.B., Kinouchi, K., Welz, P.S., Smith, J.G., Zinna, V.M., Shi, J., Samad, M., Chen, S., Magnan, C.N., Kinchen, J.M., Li, W., Baldi, P., Benitah, S.A. and Sassone-Corsi, P. Defining the independence of the liver circadian clock. *Cell*, 177(6):1448–1462.e14, may 2019. doi: 10.1016/j.cell.2019.04.025.
321. Haim, A. and Zubidat, A.E. Artificial light at night: melatonin as a mediator between the environment and epigenome. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 370(1667):20140121, may 2015. doi: 10.1098/rstb.2014.0121.
322. Yonis, M., Haim, A. and Zubidat, A.E. Altered metabolic and hormonal responses in male rats exposed to acute bright light-at-night associated with global DNA hypo-methylation. *Journal of Photochemistry and Photobiology B: Biology*, 194:107–118, may 2019. doi: 10.1016/j.jphotobiol.2019.03.020.
323. Joska, T., Zaman, R. and Belden, W. Regulated DNA methylation and the circadian clock: Implications in cancer. *Biology*, 3(3):560–577, sep 2014. doi: 10.3390/biology3030560.
324. Agbaria, S., Haim, A., Fares, F. and Zubidat, A.E. Epigenetic modification in 4t1 mouse breast cancer model by artificial light at night and melatonin – the role of DNA-methyltransferase. *Chronobiology International*, 36(5):629–643, feb 2019. doi: 10.1080/07420528.2019.1574265.
325. Zahra, H.S., Iqbal, A., Hassan, S.H., Shakir, H.A., Khan, M., Irfan, M., Ara, C. and Ali, S. Epigenetics: A bridge between artificial light at night and breast cancer. *Punjab University Journal of Zoology*, 34(2), 2019. doi: 10.17582/journal.pujz/2019.34.2.231.238.
326. Ishihara, A., Courville, A.B. and Chen, K.Y. The complex effects of light on metabolism in humans. *Nutrients*, 15(6):1391, March 2023. ISSN 2072-6643. doi: 10.3390/nu15061391.
327. Zhu, F., Zhang, W., Li, L., Wang, W., liu, S., Zhao, Y., Ji, X., Yang, Y., Kang, Z., Guo, X. and Deng, F. Short-term exposure to indoor artificial light at night during sleep impairs cardiac autonomic function of young healthy adults in china. *Environmental Research*, 262:119786, December 2024. ISSN 0013-9351. doi: 10.1016/j.envres.2024.119786.
328. Muscogiuri, G., Poggiogalle, E., Barrea, L., Tarsitano, M.G., Garifalos, F., Liccardi, A., Pugliese, G., Savastano, S., Colao, A., Colao, A., Alviggi, C., Aprano, S., Barazzoni, R., Barrea, L., Beguinot, F., Belfiore, A., Bellastella, G., Bettini, S., Bifulco, G., Bifulco, M. et al.

Exposure to artificial light at night: A common link for obesity and cancer? *European Journal of Cancer*, 173:263–275, sep 2022. doi: 10.1016/j.ejca.2022.06.007.

329. Park, Y.M.M., White, A.J., Jackson, C.L., Weinberg, C.R. and Sandler, D.P. Association of exposure to artificial light at night while sleeping with risk of obesity in women. *JAMA Internal Medicine*, 179(8):1061, aug 2019. doi: 10.1001/jamainternmed.2019.0571.
330. Lai, K.Y., Sarkar, C., Ni, M.Y., Gallacher, J. and Webster, C. Exposure to light at night (LAN) and risk of obesity: A systematic review and meta-analysis of observational studies. *Environmental Research*, 187:109637, aug 2020. doi: 10.1016/j.envres.2020.109637.
331. Mao, B., Luo, C., Li, S., Zhang, J., Xiang, W. and Yang, Y.d. Exposure to light at night (lan) and risk of overweight/obesity, hypertension, and diabetes: a systematic review and meta-analysis. *International Journal of Environmental Health Research*, pages 1–15, July 2024. ISSN 1369-1619. doi: 10.1080/09603123.2024.2378941.
332. Russart, K.L., Chbeir, S.A., Nelson, R.J. and Magalang, U.J. Light at night exacerbates metabolic dysfunction in a polygenic mouse model of type 2 diabetes mellitus. *Life Sciences*, 231:116574, aug 2019. doi: 10.1016/j.lfs.2019.116574.
333. Baek, J.H., Zhu, Y., Jackson, C.L. and Mark Park, Y.M. Artificial light at night and type 2 diabetes mellitus. *Diabetes & Metabolism Journal*, 48(5):847–863, September 2024. ISSN 2233-6087. doi: 10.4093/dmj.2024.0237.
334. Windred, D.P., Burns, A.C., Rutter, M.K., Ching Yeung, C.H., Lane, J.M., Xiao, Q., Saxena, R., Cain, S.W. and Phillips, A.J. Personal light exposure patterns and incidence of type 2 diabetes: analysis of 13 million hours of light sensor data and 670,000 person-years of prospective observation. *The Lancet Regional Health - Europe*, 42:100943, July 2024. ISSN 2666-7762. doi: 10.1016/j.lanepe.2024.100943.
335. Hu, X., Ou, Y., Zhou, Y., Dong, G. and Dong, H. Outdoor artificial light at night and cardiovascular disease in adults: a chinese nationwide cohort study. *European Heart Journal*, 44(Supplement 2), November 2023. ISSN 1522-9645. doi: 10.1093/eurheartj/ehad655.3005.
336. Hu, X., Wang, L.B., Jalaludin, B., Knibbs, L.D., Yim, S.H.L., Lao, X.Q., Morawska, L., Nie, Z., Zhou, Y., Hu, L.W., Huang, W.Z., Ou, Y., Dong, G.H. and Dong, H. Outdoor artificial light at night and incident cardiovascular disease in adults: A national cohort study across china. *Science of The Total Environment*, 918:170685, March 2024. ISSN 0048-9697. doi: 10.1016/j.scitotenv.2024.170685.
337. Kim, S.H., Kim, Y.K., Shin, Y.I., Kang, G., Kim, S.P., Lee, H., Hong, I.H., Chang, I.B., Hong, S.B., Yoon, H.J. and Ha, A. Nighttime outdoor artificial light and risk of age-related macular degeneration. *JAMA Network Open*, 7(1):e2351650, January 2024. ISSN 2574-3805. doi: 10.1001/jamanetworkopen.2023.51650.
338. Salceda, R. Light pollution and oxidative stress: Effects on retina and human health. *Antioxidants*, 13(3):362, March 2024. ISSN 2076-3921. doi: 10.3390/antiox13030362.
339. Adeniyi, M.J., Awosika, A., Idaguko, C.A. and Ekhoye, E. The influence of artificial light exposure on indigenous populations: Exploring its impact on menarcheal age and reproductive function. *Journal of Reproduction & Infertility*, November 2024. ISSN 2228-5482. doi: 10.18502/jri.v25i3.17011.
340. Liu, P.Y. Light pollution: time to consider testicular effects. *Frontiers in Toxicology*, 6, September 2024. ISSN 2673-3080. doi: 10.3389/ftox.2024.1481385.
341. Tian, R., Yang, T., Xiao, C., Li, F., Fu, L., Zhang, L., Cai, J., Zeng, S., Liao, J., Song, G., Yu, C., Zhang, B. and Liu, Z. Outdoor artificial light at night and male sperm quality: A retrospective cohort study in china. *Environmental Pollution*, 341:122927, January 2024. ISSN 0269-7491. doi: 10.1016/j.envpol.2023.122927.
342. Grunst, M.L. and Grunst, A.S. Endocrine effects of exposure to artificial light at night: A review and synthesis of knowledge gaps. *Molecular and Cellular Endocrinology*, 568-569: 111927, June 2023. ISSN 0303-7207. doi: 10.1016/j.mce.2023.111927.
343. Deprato, A., Maidstone, R., Cros, A.P., Adan, A., Haldar, P., Harding, B.N., Lacy, P., Melenka, L., Moitra, S., Navarro, J.F., Kogevinas, M., Durrington, H.J. and Moitra, S. Influence of light at night on allergic diseases: a systematic review and meta-analysis. *BMC Medicine*, 22(1), February 2024. ISSN 1741-7015. doi: 10.1186/s12916-024-03291-5.
344. Zubidat, A.E. and Haim, A. Artificial light-at-night – a novel lifestyle risk factor for metabolic disorder and cancer morbidity. *Journal of Basic and Clinical Physiology and Pharmacology*, 28(4), jan 2017. doi: 10.1515/jbcpp-2016-0116.
345. Erren, T.C. and Lewis, P. Hypothesis: ubiquitous circadian disruption can cause cancer. *European Journal of Epidemiology*, 34(1):1–4, dec 2018. doi: 10.1007/s10654-018-0469-6.
346. Walker, W.H., Bumgarner, J.R., Walton, J.C., Liu, J.A., Meléndez-Fernández, O.H., Nelson, R.J. and DeVries, A.C. Light pollution and cancer. *International Journal of Molecular Sciences*, 21(24):9360, dec 2020. doi: 10.3390/ijms21249360.
347. Palomar-Cros, A., Deprato, A., Papantoniou, K., Straif, K., Lacy, P., Maidstone, R., Adan, A., Haldar, P., Moitra, S., Navarro, J.F., Durrington, H., Moitra, S., Kogevinas, M. and Harding, B.N. Indoor and outdoor artificial light-at-night (alan) and cancer risk: A systematic review and meta-analysis of multiple cancer sites and with a critical appraisal of exposure assessment. *Science of The Total Environment*, 955:177059, December 2024. ISSN 0048-9697. doi: 10.1016/j.scitotenv.2024.177059.
348. Dickerman, B. and Liu, J. Does current scientific evidence support a link between light at night and breast cancer among female night-shift nurses?: Review of evidence and implications for occupational and environmental health nurses. *Workplace Health & Safety*, 60(6):273–290, jun 2012. doi: 10.3928/21650799-20120529-06.
349. He, C., Anand, S.T., Ebell, M.H., Vena, J.E. and Robb, S.W. Circadian disrupting exposures and breast cancer risk: a meta-analysis. *International Archives of Occupational and Environmental Health*, 88(5):533–547, sep 2014. doi: 10.1007/s00420-014-0986-x.
350. Hansen, J. and Pedersen, J.E. Night shift work and breast cancer risk – 2023 update of epidemiologic evidence. *Journal of the National Cancer Center*, 5(1):94–103, February 2025. ISSN 2667-0054. doi: 10.1016/j.jncc.2024.07.004.
351. Wang, R., Wang, Q., Li, J., Zhang, J., Lyu, S., Chi, W., Ye, Z., Lu, X., Shi, Y., Wang, Y., Wu, X., Hu, R., Pérez-Ríos, M., He, J. and Liang, W. Light at night and lung cancer risk: A worldwide interdisciplinary and time-series study. *Chinese Medical Journal Pulmonary and Critical Care Medicine*, 2(1):56–62, March 2024. ISSN 2772-5588. doi: 10.1016/j.pccm.2024.02.004.
352. Tselebis, A., Koukkou, E., Milionis, C., Zabuliene, L., Pachi, A. and Ilias, I. Artificial night light and thyroid cancer. *World Journal of Methodology*, 14(1), March 2024. ISSN 2222-0682. doi: 10.5662/wjm.v14.i1.89853.
353. Rybnikova, N.A., Haim, A. and Portnov, B.A. Is prostate cancer incidence worldwide linked to artificial light at night exposures? review of earlier findings and analysis of current trends. *Archives of Environmental & Occupational Health*, 72(2):111–122, jun 2016. doi: 10.1080/19338244.2016.1169980.
354. Kim, K.Y., Lee, E., Kim, Y.J. and Kim, J. The association between artificial light at night and prostate cancer in gwangju city and south jeolla province of south korea. *Chronobiology International*, 34(2):203–211, dec 2016. doi: 10.1080/07420528.2016.1259241.
355. Chowdhury-Paulino, I.M., Hart, J.E., James, P., Iyer, H.S., Wilt, G.E., Booker, B.D., Nethery, R.C., Laden, F., Mucci, L.A. and Markt, S.C. Association between outdoor light at night and prostate cancer in the health professionals follow-up study. *Cancer Epidemiology, Biomarkers & Prevention*, 32(10):1444–1450, July 2023. ISSN 1538-7755. doi: 10.1158/1055-9965.epi-23-0208.
356. Areshidze, D.A., Kozlova, M.A., Mnikhovich, M.V., Bezuglova, T.V., Chernikov, V.P., Gioeva, Z.V. and Borisov, A.V. Influence of various light regimes on morphofunctional condition of transplantable melanoma b16. *Biomedicines*, 11(4):1135, April 2023. ISSN 2227-9059. doi: 10.3390/biomedicines11041135.
357. Anbalagan, M., Dauchy, R., Xiang, S., Robling, A., Blask, D., Rowan, B. and Hill, S. SAT-337 disruption of the circadian melatonin signal by dim light at night promotes bone-lytic breast cancer metastases. *Journal of the Endocrine Society*, 3(Supplement 1), apr 2019. doi: 10.1210/js.2019-sat-337.
358. Xiang, S., Dauchy, R.T., Hoffman, A.E., Pointer, D., Frasch, T., Blask, D.E. and Hill, S.M. Epigenetic inhibition of the tumor suppressor ARHI by light at night-induced circadian melatonin disruption mediates STAT3-driven paclitaxel resistance in breast cancer. *Journal of Pineal Research*, 67(2), jun 2019. doi: 10.1111/jpi.12586.
359. Lee, H.S., Lee, E., Moon, J.H., Kim, Y. and Lee, H.J. Circadian disruption and increase of oxidative stress in male and female volunteers after bright light exposure before bed time. *Molecular & Cellular Toxicology*, 15(2):221–229, mar 2019. doi: 10.1007/s13273-019-0025-9.
360. Wu, Y., Shen, P., Yang, Z., Yu, L., Xu, L., Zhu, Z., Li, T., Luo, D., Lin, H., Shui, L., Tang, M., Jin, M., Chen, K. and Wang, J. Outdoor light at night, air pollution, and risk of cerebrovascular disease: A cohort study in china. *Stroke*, 55(4):990–998, April 2024. ISSN 1524-4628. doi: 10.1161/strokeaha.123.044904.
361. James, P., Bertrand, K.A., Hart, J.E., Schernhammer, E.S., Tamimi, R.M. and Laden, F. Outdoor light at night and breast cancer incidence in the nurses' health study II. *Environmental Health Perspectives*, 125(8):087010, aug 2017. doi: 10.1289/ehp935.
362. Garcia-Saenz, A., de Miguel, A.S., Espinosa, A., Valentin, A., Aragonés, N., Llorca, J., Amiano, P., Sánchez, V.M., Guevara, M., Capelo, R., Tardón, A., Peiró-Perez, R., Jiménez-Moleón, J.J., Roca-Barceló, A., Pérez-Gómez, B., Dierssen-Sotos, T., Fernández-Villa, T., Moreno-Iribas, C., Moreno, V., García-Pérez, J. et al. Evaluating the association between artificial light-at-night exposure and breast and prostate cancer risk in spain (MCC-spain study). *Environmental Health Perspectives*, 126(4):047011, apr 2018. doi: 10.1289/ehp1837.
363. Harding, B.N., Palomar-Cros, A., Valentín, A., Espinosa, A., Sánchez de Miguel, A., Castaño-Vinyals, G., Pollán, M., Perez, B., Moreno, V. and Kogevinas, M. Comparing data from three satellites on artificial light at night (alan): Focusing on blue light's influence on colorectal cancer in a case–control study in spain. *Environmental Health Perspectives*, 132(5), May 2024. ISSN 1552-9924. doi: 10.1289/ehp14414.
364. Zheng, R., Xin, Z., Li, M., Wang, T., Xu, M., Lu, J., Dai, M., Zhang, D., Chen, Y., Wang, S., Lin, H., Wang, W., Ning, G., Bi, Y., Zhao, Z. and Xu, Y. Outdoor light at night in relation to glucose homoeostasis and diabetes in chinese adults: a national and cross-sectional study of 98,658 participants from 162 study sites. *Diabetologia*, 66(2):336–345, nov 2022. doi: 10.1007/s00125-022-05819-x.
365. McIsaac, M.A., Sanders, E., Kuester, T., Aronson, K.J. and Kyba, C.C.M. The impact of image resolution on power, bias, and confounding. *Environmental Epidemiology*, 5(2): e145, apr 2021. doi: 10.1097/ee9.0000000000000145.
366. Sweeney, M.R., Nichols, H.B., Jones, R.R., Olshan, A.F., Keil, A.P., Engel, L.S., James, P., Jackson, C.L., Sandler, D.P. and White, A.J. Light at night and the risk of breast cancer: Findings from the sister study. *Environment International*, 169:107495, nov 2022. doi: 10.1016/j.envint.2022.107495.
367. Medgyesi, D.N., Trabert, B., Fisher, J.A., Xiao, Q., James, P., White, A.J., Madrigal, J.M. and Jones, R.R. Outdoor light at night and risk of endometrial cancer in the NIH-AARP diet and health study. *Cancer Causes & Control*, 34(2):181–187, oct 2022. doi: 10.1007/s10552-022-01632-4.
368. Park, Y., Ramirez, Y., Xiao, Q., Liao, L.M., Jones, G.S. and McGlynn, K.A. Outdoor light at night and risk of liver cancer in the NIH-AARP diet and health study. *Cancer Causes & Control*, 33(9):1215–1218, jul 2022. doi: 10.1007/s10552-022-01602-w.
369. Bożejko, M., Tarski, I. and Małodobra-Mazur, M. Outdoor artificial light at night and human health: A review of epidemiological studies. *Environmental Research*, 218:115049, feb 2023. doi: 10.1016/j.envres.2022.115049.
370. Prayag, A., Münch, M., Aeschbach, D., Chellappa, S. and Gronfier, C. Light modulation of human clocks, wake, and sleep. *Clocks & Sleep*, 1(1):193–208, mar 2019. doi: 10.3390/clockssleep1010017.
371. Dautovich, N.D., Schreiber, D.R., Imel, J.L., Tighe, C.A., Shoji, K.D., Cyrus, J., Bryant, N., Lisech, A., O'Brien, C. and Dzierzewski, J.M. A systematic review of the amount and timing of light in association with objective and subjective sleep outcomes in community-dwelling

adults. *Sleep Health*, 5(1):31–48, feb 2019. doi: 10.1016/j.sleh.2018.09.006.

372. Dumont, M., Lanctôt, V., Cadieux-Viau, R. and Paquet, J. Melatonin production and light exposure of rotating night workers. *Chronobiology International*, 29(2):203–210, feb 2012. doi: 10.3109/07420528.2011.647177.
373. Böhmer, M.N., Hamers, P.C., Bindels, P.J., Oppewal, A., van Someren, E.J. and Festen, D.A. Are we still in the dark? a systematic review on personal daily light exposure, sleep-wake rhythm, and mood in healthy adults from the general population. *Sleep Health*, 7(5): 610–630, oct 2021. doi: 10.1016/j.sleh.2021.06.001.
374. Léger, D. and Bayon, V. Societal costs of insomnia. *Sleep Medicine Reviews*, 14(6): 379–389, dec 2010. doi: 10.1016/j.smrv.2010.01.003.
375. Wade, A. The societal costs of insomnia. *Neuropsychiatric Disease and Treatment*, page 1, dec 2010. doi: 10.2147/ndt.s15123.
376. Eastman, C. and Smith. Shift work: health, performance and safety problems, traditional countermeasures, and innovative management strategies to reduce circadian misalignment. *Nature and Science of Sleep*, page 111, sep 2012. doi: 10.2147/nss.s10372.
377. Figueiro, M.G., Sahin, L., Wood, B. and Plitnick, B. Light at night and measures of alertness and performance. *Biological Research For Nursing*, 18(1):90–100, feb 2015. doi: 10.1177/1099800415572873.
378. Berkalieva, A., Plitnick, B., Mazumdar, M. and Figueiro, M. Light at night, melatonin levels and nurses working at night. *Lighting Research & Technology*, 57(1):71–81, August 2024. ISSN 1477-0938. doi: 10.1177/14771535241269792.
379. Windred, D.P., Burns, A.C., Lane, J.M., Olivier, P., Rutter, M.K., Saxena, R., Phillips, A.J.K. and Cain, S.W. Brighter nights and darker days predict higher mortality risk: A prospective analysis of personal light exposure in >88,000 individuals. *Proceedings of the National Academy of Sciences*, 121(43), October 2024. ISSN 1091-6490. doi: 10.1073/pnas.2405924121.
380. Fonken, L.K., Bedrosian, T.A., Zhang, N., Weil, Z.M., DeVries, A.C. and Nelson, R.J. Dim light at night impairs recovery from global cerebral ischemia. *Experimental Neurology*, 317:100–109, jul 2019. doi: 10.1016/j.expneurol.2019.02.008.
381. Weil, Z.M., Fonken, L.K., Walker, W.H., Bumgarner, J.R., Liu, J.A., Melendez-Fernandez, O.H., Zhang, N., DeVries, A.C. and Nelson, R.J. Dim light at night exacerbates stroke outcome. *European Journal of Neuroscience*, 52(9):4139–4146, aug 2020. doi: 10.1111/ejn.14915.
382. Obayashi, K., Yamagami, Y., Tatsumi, S., Kurumatani, N. and Saeki, K. Indoor light pollution and progression of carotid atherosclerosis: A longitudinal study of the HEIJO-KYO cohort. *Environment International*, 133:105184, dec 2019. doi: 10.1016/j.envint.2019.105184.
383. Walker, W.H., Meléndez-Fernández, O.H. and Nelson, R.J. Prior exposure to dim light at night impairs dermal wound healing in female c57bl/6 mice. *Archives of Dermatological Research*, 311(7):573–576, may 2019. doi: 10.1007/s00403-019-01935-8.
384. Mindel, J.W., Rojas, S.L., Kline, D., Bao, S., Rezai, A., Corrigan, J.D., Nelson, R.J., D, P. and Magalang, U.J. Sleeping with low levels of artificial light at night increases systemic inflammation in humans. *Sleep*, 42(Supplement 1):A15–A16, apr 2019. doi: 10.1093/sleep/zsz067.037.
385. Xu, Y.x., Shen, Y.t., Li, J., Ding, W.q., Wan, Y.h., Su, P.y., Tao, F.b. and Sun, Y. Real-ambient bedroom light at night increases systemic inflammation and disrupts circadian rhythm of inflammatory markers. *Ecotoxicology and Environmental Safety*, 281:116590, August 2024. ISSN 0147-6513. doi: 10.1016/j.ecoenv.2024.116590.
386. Simons, K., van den Boogaard, M. and de Jager, C. Impact of intensive care unit light and noise exposure on critically ill patients. *Netherlands Journal of Critical Care*, 27(4), 2019.
387. da Silva Higa, K.T., Böhme, F.A.F., Paschoa, S., Conte, A.C.R., Santos, V.B. and Avelar, A.F.M. Dark nighttime interventions and sleep quality in intensive care unit patients: A systematic review and meta-analysis. *Nursing in Critical Care*, aug 2022. doi: 10.1111/nicc.12827.
388. Odebrecht Vergne de Abreu, A.C., Alves Braga de Oliveira, M., Alquati, T., Tonon, A.C., de Novaes Reis, M., Camargo Rossi, A., Sbaraini Bonatto, F. and Paz Hidalgo, M. Use of light protection equipment at night reduces time until discharge from the neonatal intensive care unit: A randomized interventional study. *Journal of Biological Rhythms*, 39(1):68–78, October 2023. ISSN 1552-4531. doi: 10.1177/07487304231201752.
389. Hosseini, S.N., Walton, J.C., SheikhAnsari, I., Kreidler, N. and Nelson, R.J. An architectural solution to a biological problem: A systematic review of lighting designs in healthcare environments. *Applied Sciences*, 14(7):2945, March 2024. ISSN 2076-3417. doi: 10.3390/app14072945.
390. Kernbach, M.E., Martin, L.B., Unnasch, T.R., Hall, R.J., Jiang, R.H.Y. and Francis, C.D. Light pollution affects west nile virus exposure risk across florida. *Proceedings of the Royal Society B: Biological Sciences*, 288(1947), mar 2021. doi: 10.1098/rspb.2021.0253.
391. Coetzee, B.W.T., Burke, A.M., Koekemoer, L.L., Robertson, M.P. and Smit, I.P.J. Scaling artificial light at night and disease vector interactions into socio-ecological systems: a conceptual appraisal. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 378(1892), October 2023. ISSN 1471-2970. doi: 10.1098/rstb.2022.0371.
392. Khan, Z.A., Yumnamcha, T., Mondal, G., Devi, S.D., Rajiv, C., Labala, R.K., Devi, H.S. and Chattoraj, A. Artificial light at night (ALAN): A potential anthropogenic component for the COVID-19 and HCoVs outbreak. *Frontiers in Endocrinology*, 11, sep 2020. doi: 10.3389/fendo.2020.00622.
393. He, S., Shao, W. and Han, J. Have artificial lighting and noise pollution caused zoonosis and the COVID-19 pandemic? a review. *Environmental Chemistry Letters*, 19(6):4021–4030, jul 2021. doi: 10.1007/s10311-021-01291-y.
394. Stock, D. and Schernhammer, E. Does night work affect age at which menopause occurs? *Current Opinion in Endocrinology & Diabetes and Obesity*, 26(6):306–312, dec 2019. doi: 10.1097/med.0000000000000509.
395. young Min, J. and bok Min, K. Outdoor light at night and the prevalence of depressive symptoms and suicidal behaviors: A cross-sectional study in a nationally representative sample of korean adults. *Journal of Affective Disorders*, 227:199–205, feb 2018. doi: 10.1016/j.jad.2017.10.039.
396. Walker, W.H., Borniger, J.C., Gaudier-Diaz, M.M., Meléndez-Fernández, O.H., Pascoe, J.L., DeVries, A.C. and Nelson, R.J. Acute exposure to low-level light at night is sufficient to induce neurological changes and depressive-like behavior. *Molecular Psychiatry*, 25(5): 1080–1093, may 2019. doi: 10.1038/s41380-019-0430-4.
397. Esaki, Y., Obayashi, K., Saeki, K., Fujita, K., Iwata, N. and Kitajima, T. Effect of evening light exposure on sleep in bipolar disorder: A longitudinal analysis for repeated measures in the APPLE cohort. *Australian & New Zealand Journal of Psychiatry*, 55(3):305–313, oct 2020. doi: 10.1177/0004867420968886.
398. Tancredi, S., Urbano, T., Vinceti, M. and Filippini, T. Artificial light at night and risk of mental disorders: A systematic review. *Science of The Total Environment*, 833:155185, aug 2022. doi: 10.1016/j.scitotenv.2022.155185.
399. Chen, M., Zhao, Y., Lu, Q., Ye, Z., Bai, A., Xie, Z., Zhang, D. and Jiang, Y. Artificial light at night and risk of depression: a systematic review and meta-analysis. *Environmental Health and Preventive Medicine*, 29(0):73–73, 2024. ISSN 1347-4715. doi: 10.1265/ehpm.24-00257.
400. Menculini, G., Cirimbilli, F., Raspa, V., Scopetta, F., Cinesi, G., Chieppa, A.G., Cuzzucoli, L., Moretti, P., Balducci, P.M., Attademo, L., Bernardini, F., Erfurth, A., Sachs, G. and Tortorella, A. Insights into the effect of light pollution on mental health: Focus on affective disorders—a narrative review. *Brain Sciences*, 14(8):802, August 2024. ISSN 2076-3425. doi: 10.3390/brainsci14080802.
401. Fasciani, I., Petragnano, F., Aloisi, G., Marampon, F., Rossi, M., Coppolino, M.F., Rossi, R., Longoni, B., Scarselli, M. and Maggio, R. A new threat to dopamine neurons: The downside of artificial light. *Neuroscience*, 432:216–228, apr 2020. doi: 10.1016/j.neuroscience.2020.02.047.
402. Sharma, A. and Goyal, R. Long-term exposure to constant light induces dementia, oxidative stress and promotes aggregation of sub-pathological aβ42 in wistar rats. *Pharmacology Biochemistry and Behavior*, 192:172892, may 2020. doi: 10.1016/j.pbb.2020.172892.
403. Mazzoleni, E., Vinceti, M., Costanzini, S., Garuti, C., Adani, G., Vinceti, G., Zamboni, G., Tondelli, M., Galli, C., Salemme, S., Teggi, S., Chiari, A. and Filippini, T. Outdoor artificial light at night and risk of early-onset dementia: A case-control study in the modena population, northern italy. *Heliyon*, 9(7):e17837, July 2023. ISSN 2405-8440. doi: 10.1016/j.heliyon.2023.e17837.
404. Filippini, T., Costanzini, S., Chiari, A., Urbano, T., Despini, F., Tondelli, M., Bedin, R., Zamboni, G., Teggi, S. and Vinceti, M. Outdoor artificial light at night and risk of conversion from mild cognitive impairment to dementia. *European Journal of Public Health*, 34(Supplement 3), October 2024. ISSN 1464-360X. doi: 10.1093/eurpub/ckae144.1419.
405. Karska, J., Kowalski, S., Gadka, A., Brzecka, A., Sochocka, M., Kurpas, D., BeszÅej, J.A. and Leszek, J. Artificial light and neurodegeneration: does light pollution impact the development of alzheimer's disease? *GeroScience*, 46(1):87–97, September 2023. ISSN 2509-2723. doi: 10.1007/s11357-023-00932-0.
406. Gorbachevskii, A., Kicherova, O. and Reikhert, L. The role of astrocytes, circadian rhythms and light pollution in the pathogenesis of alzheimer's disease. *S.S. Korsakov Journal of Neurology and Psychiatry*, 124(6):20, 2024. ISSN 1997-7298. doi: 10.17116/jnevro202412406120.
407. Xie, Y., Jin, Z., Huang, H., Li, S., Dong, G., Liu, Y., Chen, G. and Guo, Y. Outdoor light at night and autism spectrum disorder in shanghai, china: A matched case-control study. *Science of The Total Environment*, 811:152340, mar 2022. doi: 10.1016/j.scitotenv.2021.152340.
408. Mishra, A., Lin, H., Singla, R., Le, N., Oraebosi, M., Liu, D. and Cao, R. Circadian desynchrony in early life leads to enduring autistic-like behavioral changes in adulthood. *Communications Biology*, 7(1), November 2024. ISSN 2399-3642. doi: 10.1038/s42003-024-07131-3.
409. Haraguchi, S., Kamata, M., Tokita, T., ichiro Tashiro, K., Sato, M., Nozaki, M., Okamoto-Katsuyama, M., Shimizu, I., Han, G., Chowdhury, V.S., Lei, X.F., Miyazaki, T., ri Kim-Kaneyama, J., Nakamachi, T., Matsuda, K., Ohtaki, H., Tokumoto, T., Tachibana, T., Miyazaki, A. and Tsutsui, K. Light-at-night exposure affects brain development through pineal allopregnanolone-dependent mechanisms. *eLife*, 8, sep 2019. doi: 10.7554/elife.45306.
410. Li, Y., Cheng, S., Li, L., Zhao, Y., Shen, W. and Sun, X. Light-exposure at night impairs mouse ovary development via cell apoptosis and DNA damage. *Bioscience Reports*, 39 (5), may 2019. doi: 10.1042/bsr20181464.
411. Nagai, N., Ayaki, M., Yanagawa, T., Hattori, A., Negishi, K., Mori, T., Nakamura, T.J. and Tsubota, K. Suppression of blue light at night ameliorates metabolic abnormalities by controlling circadian rhythms. *Investigative Opthalmology & Visual Science*, 60(12):3786, sep 2019. doi: 10.1167/iovs.19-27195.
412. Klepeis, N.E., Nelson, W.C., Ott, W.R., Robinson, J.P., Tsang, A.M., Switzer, P., Behar, J.V., Hern, S.C. and Engelmann, W.H. The national human activity pattern survey (nhaps): a resource for assessing exposure to environmental pollutants. *Journal of Exposure Science & Environmental Epidemiology*, 11(3):231–252, July 2001. ISSN 1559-064X. doi: 10.1038/sj.jea.7500165.
413. Matz, C., Stieb, D., Davis, K., Egyed, M., Rose, A., Chou, B. and Brion, O. Effects of age, season, gender and urban-rural status on time-activity: Canadian human activity pattern survey 2 (chaps 2). *International Journal of Environmental Research and Public Health*, 11(2):2108–2124, February 2014. ISSN 1660-4601. doi: 10.3390/ijerph11020208.
414. Kim, D., Guak, S. and Lee, K. Temporal trend of microenvironmental time-activity patterns of the seoul population from 2004 to 2022 and its potential impact on exposure assessment. *Journal of Exposure Science & Environmental Epidemiology*, 35(2):315–324, March 2024. ISSN 1559-064X. doi: 10.1038/s41370-024-00662-1.
415. Wanvik, P.O. Effects of road lighting: An analysis based on dutch accident statistics

1987–2006. *Accident Analysis & Prevention*, 41(1):123–128, jan 2009. doi: 10.1016/j.aap.2008.10.003.

416. Bullough, J.D., Donnell, E.T. and Rea, M.S. To illuminate or not to illuminate: Roadway lighting as it affects traffic safety at intersections. *Accident Analysis & Prevention*, 53: 65–77, apr 2013. doi: 10.1016/j.aap.2012.12.029.
417. Bhagavathula, R., , Gibbons, R. and Kassing, A. Roadway lighting's effect on pedestrian safety at intersection and midblock crosswalks. Technical report, Illinois Center for Transportation, aug 2021.
418. Sullivan, J.M. and Flannagan, M.J. The role of ambient light level in fatal crashes: inferences from daylight saving time transitions. *Accident Analysis & Prevention*, 34(4): 487–498, jul 2002. doi: 10.1016/s0001-4575(01)00046-x.
419. Marchant, P.R. and Norman, P.D. To determine if changing to white light street lamps improves road safety: A multilevel longitudinal analysis of road traffic collisions during the relighting of leeds, a UK city. *Applied Spatial Analysis and Policy*, 15(4):1583–1608, jul 2022. doi: 10.1007/s12061-022-09468-w.
420. Wanvik, P.O. Effects of road lighting on motorways. *Traffic Injury Prevention*, 10(3):279–289, jun 2009. doi: 10.1080/15389580902826866.
421. Jägerbrand, A.K. and Sjöbergh, J. Effects of weather conditions, light conditions, and road lighting on vehicle speed. *SpringerPlus*, 5(1), apr 2016. doi: 10.1186/s40064-016-2124-6.
422. Steinbach, R., Perkins, C., Tompson, L., Johnson, S., Armstrong, B., Green, J., Grundy, C., Wilkinson, P. and Edwards, P. The effect of reduced street lighting on road casualties and crime in england and wales: controlled interrupted time series analysis. *Journal of Epidemiology and Community Health*, 69(11):1118–1124, jul 2015. doi: 10.1136/jech-2015-206012.
423. Marchant, P. Bad science: Comments on the paper 'quantifying the impact of road lighting on road safety – a new zealand study' by jacket & frith (2013). *Radican Statistics*, 131: 1–19, 2022.
424. Marchant, P. Why lighting claims might well be wrong. *International Journal of Sustainable Lighting*, 19(1):69–74, jun 2017. doi: 10.26607/ijsl.v19i1.71.
425. Marchant, P. Do brighter, whiter street lights improve road safety? *Significance*, 16(5):8–9, oct 2019. doi: 10.1111/j.1740-9713.2019.01313.x.
426. Jackett, M. and Frith, W. Quantifying the impact of road lighting on road safety — a new zealand study. *IATSS Research*, 36(2):139–145, mar 2013. doi: 10.1016/j.iatssr.2012.09.001.
427. Fotios, S. and Gibbons, R. Road lighting research for drivers and pedestrians: The basis of luminance and illuminance recommendations. *Lighting Research & Technology*, 50(1): 154–186, jan 2018. doi: 10.1177/1477153517739055.
428. Lyytimäki, J., Tapio, P. and Assmuth, T. Unawareness in environmental protection: The case of light pollution from traffic. *Land Use Policy*, 29(3):598–604, jul 2012. doi: 10.1016/j.landusepol.2011.10.002.
429. Gaston, K.J. and Holt, L.A. Nature, extent and ecological implications of night-time light from road vehicles. *Journal of Applied Ecology*, 55(5):2296–2307, apr 2018. doi: 10.1111/1365-2664.13157.
430. Stone, T., de Sio, F.S. and Vermaas, P.E. Driving in the dark: Designing autonomous vehicles for reducing light pollution. *Science and Engineering Ethics*, 26(1):387–403, mar 2019. doi: 10.1007/s11948-019-00101-7.
431. Welsh, B.C., Farrington, D.P. and Douglas, S. The impact and policy relevance of street lighting for crime prevention: A systematic review based on a half-century of evaluation research. *Criminology & Public Policy*, 21(3):739–765, apr 2022. doi: 10.1111/1745-9133.12585.
432. Gupta, P., Kolhe, N.P. and Vyas, S. Coupling and coordination association between night light intensity and women safety – a comparative assessment of indian metropolitan cities. *Journal of Cleaner Production*, 481:144135, November 2024. ISSN 0959-6526. doi: 10.1016/j.jclepro.2024.144135.
433. Morrow, N. and Hutton, S. The chicago alley lighting project: Final evaluation report. Technical report, Illinois Criminal Justice Information Authority, 2000.
434. Lee, J., Leitner, M. and Paulus, G. Spatiotemporal analysis of nighttime crimes in vienna, austria. *ISPRS International Journal of Geo-Information*, 13(7):247, July 2024. ISSN 2220-9964. doi: 10.3390/ijgi13070247.
435. Marchant, P.R. A demonstration that the claim that brighter lighting reduces crime is unfounded. *British Journal of Criminology*, 44(3):441–447, apr 2004. doi: 10.1093/bjc/azh009.
436. Marchant, P. Have new street lighting schemes reduced crime in london? *Radical Statistics*, 104(39–48), 2011.
437. Tompson, L., Steinbach, R., Johnson, S.D., Teh, C.S., Perkins, C., Edwards, P. and Armstrong, B. Absence of street lighting may prevent vehicle crime, but spatial and temporal displacement remains a concern. *Journal of Quantitative Criminology*, mar 2022. doi: 10.1007/s10940-022-09539-8.
438. Svechkina, A., Trop, T. and Portnov, B.A. How much lighting is required to feel safe when walking through the streets at night? *Sustainability*, 12(8):3133, apr 2020. doi: 10.3390/su12083133.
439. Son, D., Hyeon, T., Park, Y. and Kim, S.N. Analysis of the relationship between nighttime illuminance and fear of crime using a quasi-controlled experiment with recorded virtual reality. *Cities*, 134:104184, March 2023. ISSN 0264-2751. doi: 10.1016/j.cities.2022.104184.
440. McGlashan, E.M., Poudel, G.R., Jamadar, S.D., Phillips, A.J.K. and Cain, S.W. Afraid of the dark: Light acutely suppresses activity in the human amygdala. *PLOS ONE*, 16(6): e0252350, jun 2021. doi: 10.1371/journal.pone.0252350.
441. Marchant, P., Hale, J.D. and Sadler, J.P. Does changing to brighter road lighting improve road safety? multilevel longitudinal analysis of road traffic collision frequency during the relighting of a UK city. *Journal of Epidemiology and Community Health*, 74(5):467–472, mar 2020. doi: 10.1136/jech-2019-212208.
442. Saad, R., Portnov, B.A. and Trop, T. Saving energy while maintaining the feeling of safety associated with urban street lighting. *Clean Technologies and Environmental Policy*, 23 (1):251–269, nov 2020. doi: 10.1007/s10098-020-01974-0.
443. Singh, R. Pedestrian post-twilight illuminance levels for security, visual comfort, and related parameters: the case of public parks in new delhi. *Cities & Health*, 8(1):14–20, July 2023. ISSN 2374-8842. doi: 10.1080/23748834.2023.2231591.
444. Son, D., Im, B., Her, J., Park, W., Kang, S.J. and Kim, S.N. Street lighting environment and fear of crime: a simulated virtual reality experiment. *Virtual Reality*, 29(1), December 2024. ISSN 1434-9957. doi: 10.1007/s10055-024-01080-2.
445. Davoudian, N., Raynham, P. and Barrett, E. Disability glare: A study in simulated road lighting conditions. *Lighting Research & Technology*, 46(6):695–705, nov 2013. doi: 10.1177/1477153513510168.
446. Yang, Y., Luo, M.R. and Ma, S. Assessing glare. part 2: Modifying unified glare rating for uniform and non-uniform LED luminaires. *Lighting Research & Technology*, 49(6):727–742, apr 2016. doi: 10.1177/1477153516642622.
447. Bullough, J. Spectral sensitivity for extrafoveal discomfort glare. *Journal of Modern Optics*, 56(13):1518–1522, jul 2009. doi: 10.1080/09500340903045710.
448. Skinner, N. and Bullough, J. Influence of LED spectral characteristics on glare recovery. In *SAE Technical Paper Series*. SAE International, apr 2019. doi: 10.4271/2019-01-0845.
449. Sweater-Hickcox, K., Narendran, N., Bullough, J. and Freyssinier, J. Effect of different coloured luminous surrounds on LED discomfort glare perception. *Lighting Research & Technology*, 45(4):464–475, feb 2013. doi: 10.1177/1477153512474450.
450. IEA. Light's labour's lost: Policies for energy-efficient lighting. Technical report, International Energy Agency, Paris, 2006.
451. IEA. World energy outlook. Technical report, International Energy Agency, Paris, 2006.
452. Brown, R. *World On the Edge: How to Prevent Environmental and Economic Collapse*. W. W. Nortion & Company, New York, 2010.
453. UNEP. Accelerating the global adoption of energy efficient lighting. Technical report, United Nations Environment Programme, 2017.
454. Fouquet, R. and Pearson, P. Seven centuries of energy services: The price and use of light in the united kingdom (1300-2000). *Energy Journal*, 27:139–177, 2006.
455. Schulte-Römer, N., Meier, J., Söding, M. and Dannemann, E. The LED paradox: How light pollution challenges experts to reconsider sustainable lighting. *Sustainability*, 11(21): 6160, nov 2019. doi: 10.3390/su11216160.
456. Jones, B.A. Spillover health effects of energy efficiency investments: Quasi-experimental evidence from the los angeles LED streetlight program. *Journal of Environmental Economics and Management*, 88:283–299, mar 2018. doi: 10.1016/j.jeem.2018.01.002.
457. Azad, S. and Ghandehari, M. A study on the association of socioeconomic and physical cofactors contributing to power restoration after hurricane maria. *IEEE Access*, 9:98654–98664, 2021. doi: 10.1109/access.2021.3093547.
458. Jägerbrand, A. New framework of sustainable indicators for outdoor LED (light emitting diodes) lighting and SSL (solid state lighting). *Sustainability*, 7(1):1028–1063, jan 2015. doi: 10.3390/su7011028.
459. Muñoz Ccuro, F.E., Benites-Alfaro, E., Criado-Davila, Y.V., Sandoval-Bocanegra, R.J.M. and Arce Vizcarra, F.G. Impact of light pollution on human rights and biodiversity. *Academic Journal of Interdisciplinary Studies*, 13(1):402, January 2024. ISSN 2281-3993. doi: 10.36941/ajis-2024-0030.
460. Motairek, I., Chen, Z., Makhlouf, M.H.E., Rajagopalan, S. and Al-Kindi, S. Historical neighbourhood redlining and contemporary environmental racism. *Local Environment*, pages 1–11, dec 2022. doi: 10.1080/13549839.2022.2155942.
461. Gaston, S., Wilkerson, J., MacNell, N., Jackson, W.B. and Jackson, C. Racial residential segregation and outdoor artificial light at night: Potential contributors to sleep disparities. *SLEEP*, 47(Supplement 1):A108–A109, April 2024. ISSN 1550-9109. doi: 10.1093/sleep/zsae067.0251.
462. Pritchard, S.B. "memory effects" and dark histories. *Environmental Humanities*, 16(1): 118–141, March 2024. ISSN 2201-1919. doi: 10.1215/22011919-10943129.
463. Helbich, M., Burov, A., Dimitrova, D., Markevych, I., Nieuwenhuijsen, M.J. and Dzhambov, A.M. Sociodemographic inequalities in residential nighttime light pollution in urban bulgaria: An environmental justice analysis. *Environmental Research*, 262:119803, December 2024. ISSN 0013-9351. doi: 10.1016/j.envres.2024.119803.
464. Blair, A. *Sark in the Dark: Wellbeing and Community on the Dark Sky Island of Sark*. Sophia Centre Master Monographs. Sophia Centre Press, 2016.
465. Barnes, C. and Passmore, H.A. Development and testing of the night sky connectedness index (nsci). *Journal of Environmental Psychology*, 93:102198, February 2024. ISSN 0272-4944. doi: 10.1016/j.jenvp.2023.102198.
466. Nadybal, S.M., Collins, T.W. and Grineski, S.E. Light pollution inequities in the continental united states: A distributive environmental justice analysis. *Environmental Research*, 189: 109959, oct 2020. doi: 10.1016/j.envres.2020.109959.
467. Xiao, Q., Lyu, Y., Zhou, M., Lu, J., Zhang, K., Wang, J. and Bauer, C. Artificial light at night and social vulnerability: An environmental justice analysis in the u.s. 2012–2019. *Environment International*, 178:108096, August 2023. ISSN 0160-4120. doi: 10.1016/j.envint.2023.108096.
468. Li, H., Hart, J.E., Mahalingaiah, S., Nethery, R.C., James, P., Bertone-Johnson, E., Schernhammer, E. and Laden, F. Associations of long-term exposure to environmental noise and outdoor light at night with age at natural menopause in a US women cohort. *Environmental Epidemiology*, 5(3):e154, may 2021. doi: 10.1097/ee9.0000000000000154.
469. Zhong, C., Longcore, T., Benbow, J., Chung, N.T., Chau, K., Wang, S.S., Jr, J.V.L. and Franklin, M. Environmental influences on sleep in the california teachers study cohort. *American Journal of Epidemiology*, oct 2021. doi: 10.1093/aje/kwab246.
470. Kuhn, L., Johansson, M., Laike, T. and Govén, T. Residents' perceptions following retrofitting of residential area outdoor lighting with LEDs. *Lighting Research & Technol-*

ogy, 45(5):568–584, nov 2012. doi: 10.1177/1477153512464968.

471. Johansson, M., Pedersen, E., Maleetipwan-Mattsson, P., Kuhn, L. and Laike, T. Perceived outdoor lighting quality (POLQ): A lighting assessment tool. *Journal of Environmental Psychology*, 39:14–21, sep 2014. doi: 10.1016/j.jenvp.2013.12.002.
472. Frey, S. and Harper, N.J. Healing with the night: Investigations into experiences of natural darkness in overnight recollective practices. *Ecopsychology*, 15(3):259–266, September 2023. ISSN 1942-9347. doi: 10.1089/eco.2022.0073.
473. Boomsma, C. and Steg, L. Feeling safe in the dark. *Environment and Behavior*, 46(2): 193–212, sep 2012. doi: 10.1177/0013916512453838.
474. Radicchi, A. and Henckel, D. Planning artificial light at night for pedestrian visual diversity in public spaces. *Sustainability*, 15(2):1488, January 2023. ISSN 2071-1050. doi: 10.3390/su15021488.
475. Zielinska-Dabkowska, K.M., Schernhammer, E.S., Hanifin, J.P. and Brainard, G.C. Reducing nighttime light exposure in the urban environment to benefit human health and society. *Science*, 380(6650):1130–1135, June 2023. ISSN 1095-9203. doi: 10.1126/science.adg5277.
476. Edensor, T. The gloomy city: Rethinking the relationship between light and dark. *Urban Studies*, 52(3):422–438, sep 2013. doi: 10.1177/0042098013504009.
477. Pritchard, S.B. The trouble with darkness: NASA's suomi satellite images of earth at night. *Environmental History*, 22(2):312–330, apr 2017. doi: 10.1093/envhis/emw102.
478. Venkatesan, A. and Barentine, J.C. Noctalgia (sky grief): Our brightening night skies and loss of environment for astronomy and sky traditions, 2023.
479. Hamacher, D.W., de Napoli, K. and Mott, B. Whitening the sky: light pollution as a form of cultural genocide, 2020.
480. Freeman, R.H. Overview: Satellite constellations. *Journal of Space Operations & Communicator*, 17(2):2, 2020.
481. Rawls, M.L., Thiemann, H.B., Chemin, V., Walkowicz, L., Peel, M.W. and Grange, Y.G. Satellite constellation internet affordability and need. *Research Notes of the American Astronomical Society*, 4(10):189, oct 2020. doi: 10.3847/2515-5172/abc48e.
482. Levchenko, I., Xu, S., Wu, Y.L. and Bazaka, K. Hopes and concerns for astronomy of satellite constellations. *Nature Astronomy*, 4(11):1012–1014, jun 2020. doi: 10.1038/s41550-020-1141-0.
483. Massey, R., Lucatello, S. and Benvenuti, P. The challenge of satellite megaconstellations. *Nature Astronomy*, 4(11):1022–1023, nov 2020. doi: 10.1038/s41550-020-01224-9.
484. Boley, A.C. and Byers, M. Satellite mega-constellations create risks in low earth orbit, the atmosphere and on earth. *Scientific Reports*, 11(1), may 2021. doi: 10.1038/s41598-021-89909-7.
485. Langston, S. and Taylor, K. Evaluating the benefits of dark and quiet skies in an age of satellite mega-constellations. *Space Policy*, 68:101611, May 2024. ISSN 0265-9646. doi: 10.1016/j.spacepol.2024.101611.
486. Hearnshaw, J. *Light Pollution and the Future of Space Science and Astronomy*, pages 259–271. Springer Nature Singapore, 2024. ISBN 9789819707140. doi: 10.1007/978-981-97-0714-0_12.
487. Garland, S.P. Losing our dark skies: The space-biased medium of satellite megaconstellations. *Astropolitics*, 22(3):194–204, September 2024. ISSN 1557-2943. doi: 10.1080/14777622.2024.2439789.
488. Nandakumar, S., Eggl, S., Tregloan-Reed, J., Adam, C., Anderson-Baldwin, J., Bannister, M.T., Battle, A., Benkhaldoun, Z., Campbell, T., Colque, J.P., Damke, G., Plauchu Frayn, I., Ghachoui, M., Guillen, P.F., Kaeouach, A.E., Krantz, H.R., Langbroek, M., Rattenbury, N., Reddy, V., Ridden-Harper, R. et al. The high optical brightness of the bluewalker 3 satellite. *Nature*, 623(7989):938–941, October 2023. ISSN 1476-4687. doi: 10.1038/s41586-023-06672-7.
489. Hainaut, O.R. and Williams, A.P. Impact of satellite constellations on astronomical observations with ESO telescopes in the visible and infrared domains. *Astronomy & Astrophysics*, 636:A121, apr 2020. doi: 10.1051/0004-6361/202037501.
490. Barentine, J.C., Venkatesan, A., Heim, J., Lowenthal, J., Kocifaj, M. and BarÃ!', S. Aggregate effects of proliferating low-earth-orbit objects and implications for astronomical data lost in the noise. *Nature Astronomy*, 7(3):252–258, March 2023. ISSN 2397-3366. doi: 10.1038/s41550-023-01904-2.
491. Hasan, P. Dark skies and bright satellites: The threat to ground-based astronomy. *Resonance*, 28(4):547–565, April 2023. ISSN 0973-712X. doi: 10.1007/s12045-023-1582-8.
492. Hainaut, O.R. and Moehler, S. Contamination of spectroscopic observations by satellite constellations. *Astronomy & Astrophysics*, 683:A147, March 2024. ISSN 1432-0746. doi: 10.1051/0004-6361/202348249.
493. Mallama, A. and Cole, R.E. Extreme flaring of starlink satellites, 2024.
494. Mallama, A. The Sky Distribution and Magnitudes of Starlink Satellites by the Year 2027, September 2022. arXiv:2209.12060 [astro-ph].
495. Gaston, K.J., Anderson, K., Shutler, J.D., Brewin, R.J. and Yan, X. Environmental impacts of increasing numbers of artificial space objects. *Frontiers in Ecology and the Environment*, 21(6):289–296, April 2023. ISSN 1540-9309. doi: 10.1002/fee.2624.
496. Murphy, D.M., Abou-Ghanem, M., Cziczo, D.J., Froyd, K.D., Jacquot, J., Lawler, M.J., Maloney, C., Plane, J.M.C., Ross, M.N., Schill, G.P. and Shen, X. Metals from spacecraft reentry in stratospheric aerosol particles. *Proceedings of the National Academy of Sciences*, 120(43), October 2023. ISSN 1091-6490. doi: 10.1073/pnas.2313374120.
497. Solter-Hunt, S. Potential perturbation of the ionosphere by megaconstellations and corresponding artificial re-entry plasma dust, 2023.
498. Bassa, C.G., Hainaut, O.R. and Galadi-Enriquez, D. Analytical simulations of the effect of satellite constellations on optical and near-infrared observations. *Astronomy & Astrophysics*, in press(arXiv:2108.12335), 2022.
499. Bassa, C.G., Hainaut, O.R. and Galadí-Enríquez, D. Analytical simulations of the effect of satellite constellations on optical and near-infrared observations. *Astronomy & Astrophysics*, 657:A75, jan 2022. doi: 10.1051/0004-6361/202142101.
500. Kocifaj, M., Kundracik, F., Barentine, J.C. and Bará, S. The proliferation of space objects is a rapidly increasing source of artificial night sky brightness. *Monthly Notices of the Royal Astronomical Society*, 504(1):L40–L44, mar 2021. doi: 10.1093/mnrasl/slab030.
501. Lawler, S.M., Boley, A.C. and Rein, H. Visibility predictions for near-future satellite megaconstellations: Latitudes near 50° will experience the worst light pollution. *The Astronomical Journal*, 163(1):21, dec 2021. doi: 10.3847/1538-3881/ac341b.
502. Mallama, A., Cole, R.E., Harrington, S. and Respler, J. Brightness characterization for starlink direct-to-cell satellites, 2024.
503. ConstanceWalker, JeffreyHall, LoriAllen, RichardGreen, PatrickSeitzer, TonyTyson, AmandaBauer, KelsieKrafton, JamesLowenthal, JoelParriott, PhilPuxley, TimAbbott, GasparBakos, JohnBarentine, CeesBassa, JohnBlakeslee, AndrewBradshaw, JeffCooke, DanielDevost, DavidGaladí-Enríquez et al. Impact of satellite constellations on optical astronomy and recommendations toward mitigations. *Vol. 52, Issue 2*, 52(2), aug 2020. doi: 10.3847/25c2cfeb.346793b8.
504. Walker, C. and Benvenuti, P. Dark and Quiet Skies II Working Group Reports. Technical document techdoc051, Zenodo, January 2022.
505. Józsa, G.I.G., Williams, A., Green, R., Marsh, I., Antoniadis, J., Barbosa, D., Barentine, J., Blanc, G., Boley, A., Coelho, B., Cooper, P., Dalledonne, S., Di Vruno, F., Diamond, J., Dong, A., Drimmel, R., Eggl, S., Habeeb, N., Heim, J., Hofer, C. et al. Call to protect the dark and quiet sky from harmful interference by satellite constellations, 2024.
506. Cole, R.E. Measurement of the brightness of the starlink spacecraft named "DARKSAT". *Research Notes of the American Astronomical Society*, 4(3):42, mar 2020. doi: 10.3847/2515-5172/ab8234.
507. Tregloan-Reed, J., Otarola, A., Ortiz, E., Molina, V., Anais, J., González, R., Colque, J.P. and Unda-Sanzana, E. First observations and magnitude measurement of starlink's darksat. *Astronomy & Astrophysics*, 637:L1, apr 2020. doi: 10.1051/0004-6361/202037958.
508. Boley, A.C., Wright, E., Lawler, S., Hickson, P. and Balam, D. Plaskett 1.8 metre observations of starlink satellites. Technical report, University of British Columbia, http://arxiv.org/abs/2109.12494, September 2021 2021.
509. Tregloan-Reed, J., Otarola, A., Unda-Sanzana, E., Haeussler, B., Gaete, F., Colque, J.P., González-Fernández, C., Anais, J., Molina, V., González, R., Ortiz, E., Mieske, S., Brillant, S. and Anderson, J.P. Optical-to-NIR magnitude measurements of the starlink LEO darksat satellite and effectiveness of the darkening treatment. *Astronomy & Astrophysics*, 647:A54, mar 2021. doi: 10.1051/0004-6361/202039364.
510. Halferty, G., Reddy, V., Campbell, T., Battle, A. and Furfaro, R. Photometric characterization and trajectory accuracy of starlink satellites: implications for ground-based astronomical surveys. *Monthly Notices of the Royal Astronomical Society*, 516(1):1502–1508, jul 2022. doi: 10.1093/mnras/stac2080.
511. Venkatesan, A., Lowenthal, J., Prem, P. and Vidaurri, M. The impact of satellite constellations on space as an ancestral global commons. *Nature Astronomy*, 4(11):1043–1048, nov 2020. doi: 10.1038/s41550-020-01238-3.
512. Venkatesan, A. Stewardship of space as shared environment and heritage. *Nature Astronomy*, 7(3):236, March 2023. ISSN 2397-3366. doi: 10.1038/s41550-023-01915-z.
513. Neilson, H. Overview of indigenous rights and outer space for the iau-cps policy hub, 2024.
514. Falchi, F., BarÃ!', S., Cinzano, P., Lima, R.C. and Pawley, M. A call for scientists to halt the spoiling of the night sky with artificial light and satellites. *Nature Astronomy*, 7(3):237–239, March 2023. ISSN 2397-3366. doi: 10.1038/s41550-022-01864-z.
515. Hall, J. and Walker, C. Executive summary. In *SATCON2 Workshop Report*, https://noirlab.edu/public/media/archives/techdocs/pdf/techdoc031.pdf, October 2021 2021. NSF's NOIRLab.
516. Grotch, S.E. Mega-constellations: Disrupting the space legal order. *Emory International Law Review*, 37(1):102–134, 2022.
517. Koplow, D.A. Blinded by the light: Resolving the conflict between satellite megaconstellations and astronomy. *SSRN Electronic Journal*, 2023. ISSN 1556-5068. doi: 10.2139/ssrn.4346299.
518. Lawrence, A., Rawls, M.L., Jah, M., Boley, A., Vruno, F.D., Garrington, S., Kramer, M., Lawler, S., Lowenthal, J., McDowell, J. and McCaughrean, M. The case for space environmentalism. *Nature Astronomy*, 6(4):428–435, apr 2022. doi: 10.1038/s41550-022-01655-6.
519. Barentine, J.C., Heim, J., Venkatesan, A., Lowenthal, J. and Vidaurri, M. Reimagining near-earth space policy in a post-covid world. *Virginia Policy Review*, 15(1):58–86, 2022. doi: 10.48550/ARXIV.2207.12292.
520. Runnels, M.B. On launching environmental law into orbit in the age of satellite constellations. *Journal of Air Law and Commerce*, 88(1):181, 2023. ISSN 0021-8642. doi: 10.25172/jalc.88.1.5.
521. Latson, J. Higher altitudes and higher standards: Advocating the fcc require environmental assessments for mega-constellations. *The Journal of Business, Entrepreneurship & the Law*, 16(1):105–138, 2023.
522. Kernbach, M.E., Miller, C., Alaasam, V., Ferguson, S. and Francis, C.D. Introduction to the symposium: Effects of light pollution across diverse natural systems. *Integrative and Comparative Biology*, 61(3):1089–1097, jul 2021. doi: 10.1093/icb/icab157.
523. Rodrigo-Comino, J., Seeling, S., Seeger, M.K. and Ries, J.B. Light pollution: A review of the scientific literature. *The Anthropocene Review*, page 205301962110512, nov 2021. doi: 10.1177/20530196211051209.
524. Ahmadi, M. and Ahmadi, M.A. The indication methods and techniques of urban light pollution. *International Journal of Architectural Engineering & Urban Planning*, 32(1), Jan 2022. doi: 10.22068/ijaup.528.
525. Kyba, C.C., Pritchard, S.B., Ekirch, A.R., Eldridge, A., Jechow, A., Preiser, C., Kunz, D., Henckel, D., Hölker, F., Barentine, J., Berge, J., Meier, J., Gwiazdzinski, L., Spitschan, M., Milan, M., Bach, S., Schroer, S. and Straw, W. Night matters—why the interdisciplinary field of "night studies" is needed. *J — Multidisciplinary Scientific Journal*, 3(1):1–6, jan

2020. doi: 10.3390/j3010001.