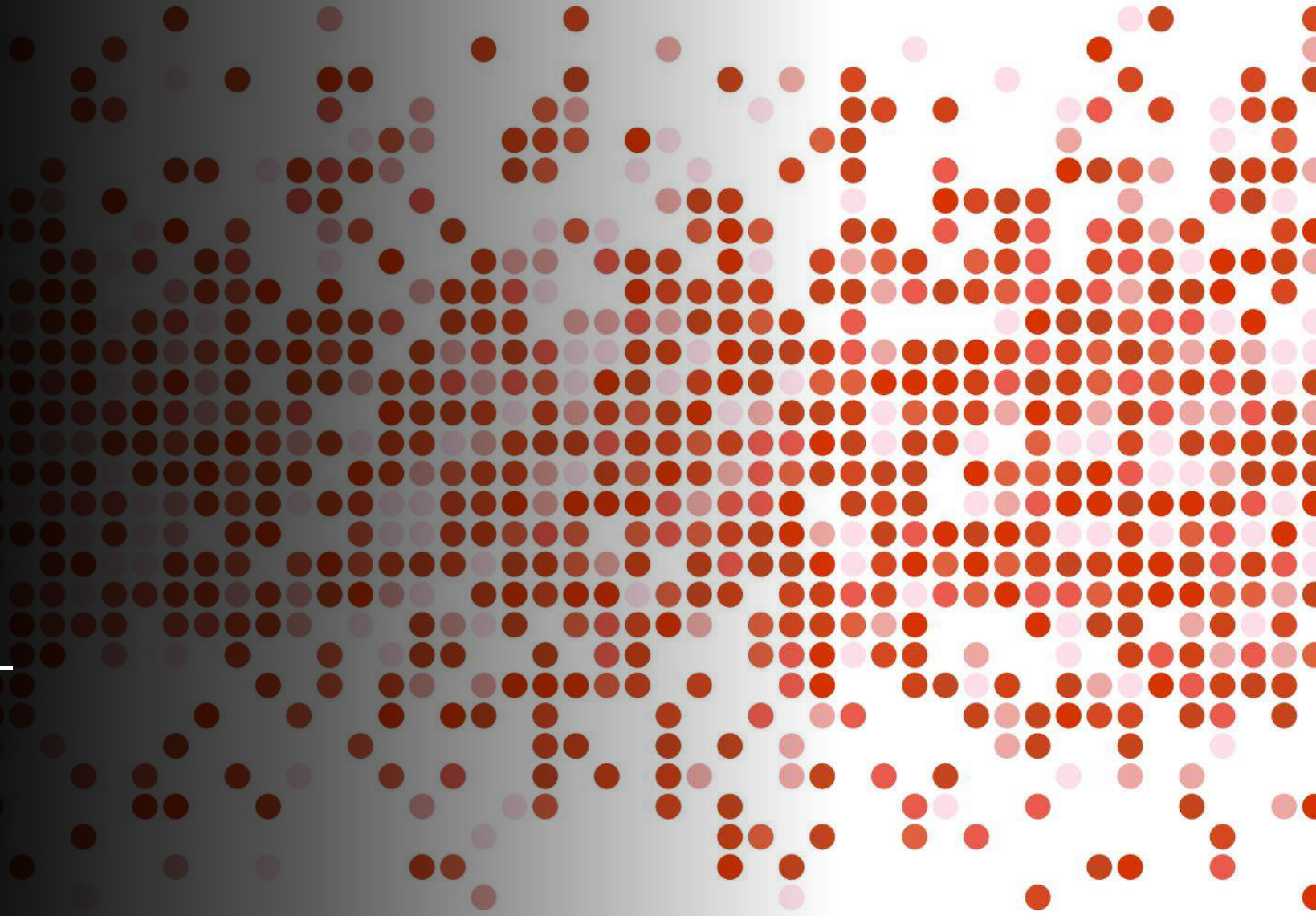
Light Pollution: Understanding the Issues, Raising Awareness and Supporting Solutions

Benson Wallace

American College of Education

SCI5203 Foundations of Integrated Science Education



Overview of the issues

- Lack of public awareness of the extent of the problem (beyond blue light exposure due to screen time)
- Confusing and sometimes misleading array of terminologies, measurement units and metrics used to define light levels and characteristics
- Lack of regulation coupled with increasingly pervasive use of blue-rich light sources with high luminous efficiency

Unknown unknowns – the tip of the iceberg

Figure 1. Different ways that artificial light affects us. Modified with permission from Freepik.com.

Artificial Light at Night (ALAN) – a wicked problem

- The link between blue light, circadian rhythm disruption and cancer is well established (International Dark-Sky Association, 2010), but the effect of the increased exposure to blue wavelengths caused by switching our indoor and outdoor lighting solutions to blue-rich LEDs requires further investigation
- Blue light contributes disproportionately to Sky Glow (Hattenbach, 2015), but its psychological and sociocultural effects are hard to quantify
- ALAN has far-reaching impacts on many animals and thus ecosystems (Commonwealth of Australia, 2020)

The problem with quantifying the problem

- The terms “brightness” and “intensity” are imprecise and can mean different things in different contexts
- Current measurement devices and measurement units for light in our everyday environment are photometric and photopic, meaning they only measure light over a similar spectrum to that of a human eye in daylight (Commonwealth of Australia, 2020)
- Traditional wattage measurements are inadequate as they do not account for luminous efficiency or relative spectral intensities
- The correlated colour temperature (CCT) scale is counterintuitive (high temperature blue light is described as “cool”) and not directly related to the blue light content of a source

What exactly do you mean by “bright”?

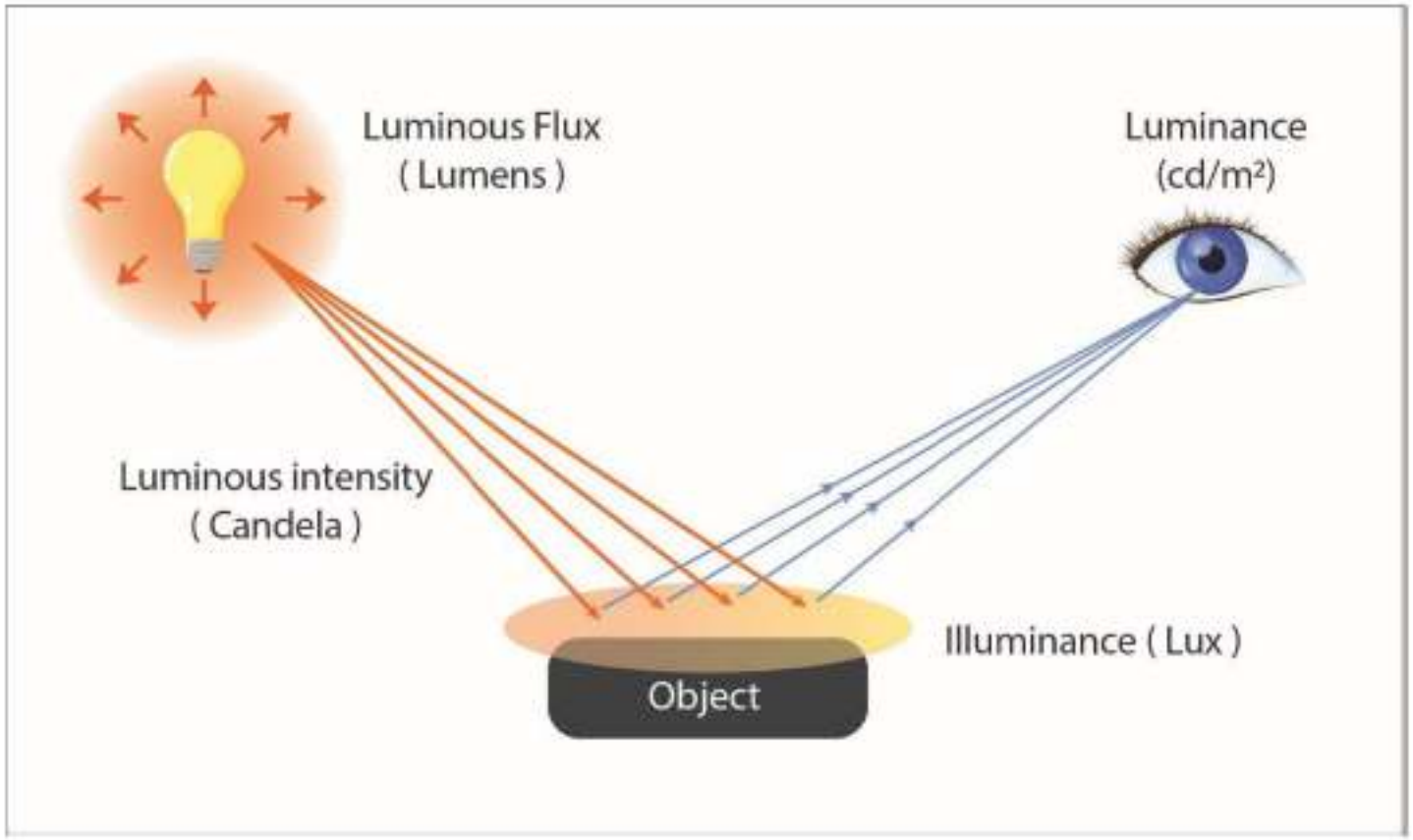


Figure 2. A small sample of the dazzling array of technical terms and units used in the measurement of light (Commonwealth of Australia, 2020)

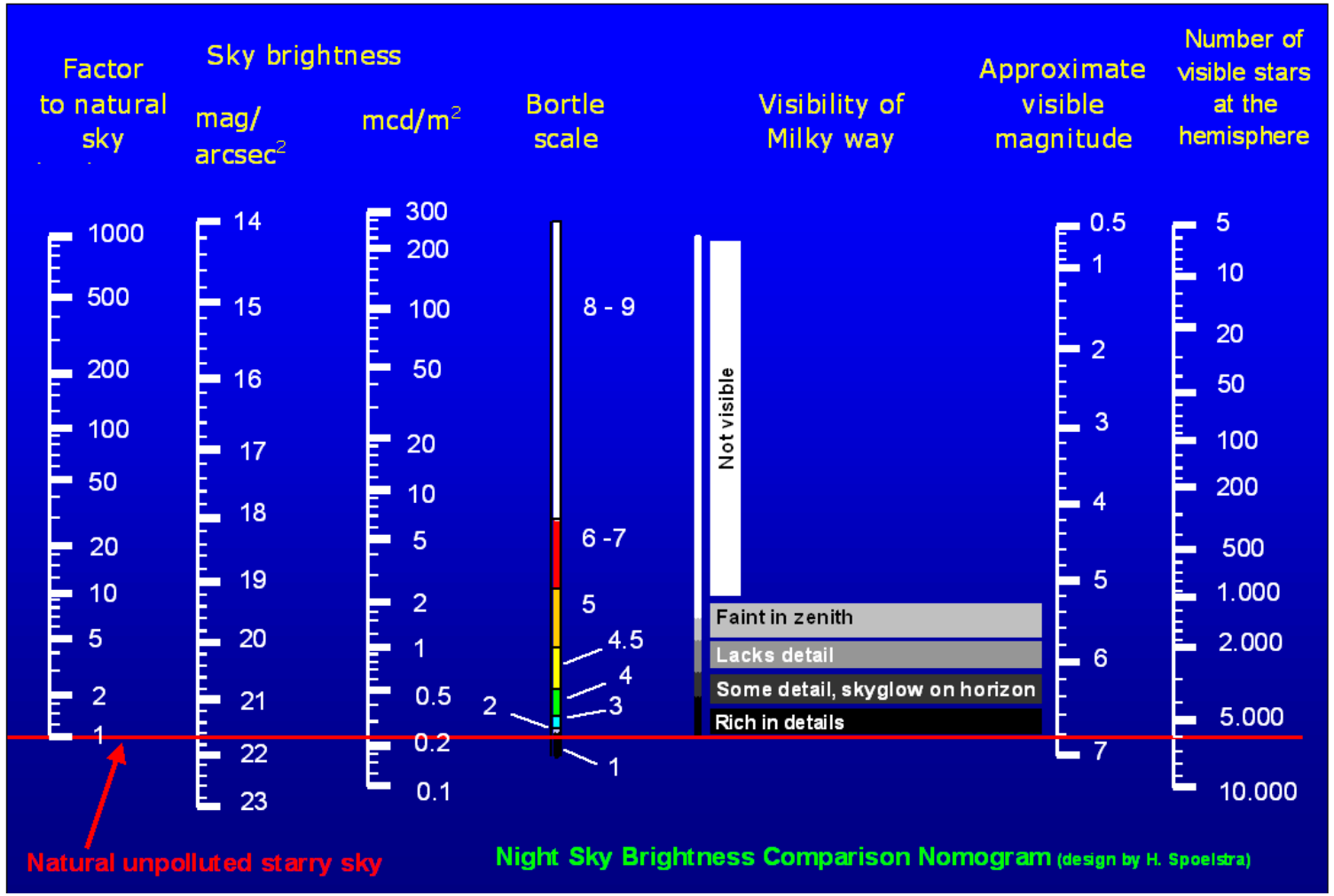


Figure 3. A comparison of the different units and scales used to measure sky brightness (Spoelstra, n.d.)

Even the scientists are confused…

Beyond astronomy

- Light level measurements were typically the domain of physicists and astronomers, but now there is a need for biologists and environmental scientists to collect reliable and relevant field data
- There is currently a lack of affordable and easy-to-use tools for this purpose, especially those which can measure spectral distributions relevant to nocturnal animals
- Night sky brightness (sky glow) is just one of several light level measurements relevant to light pollution in animal habitats

(Hänel et al., 2017)

Blue light – the new cigarettes?

- There is currently no federal regulation of light pollution (Lystrup, 2017)
- Most light-related legislation to date has been focused on provision of adequate lighting levels in public spaces rather than protecting human health and ecosystems (International Dark-Sky Association, 2010)
- LEDs have the potential to solve many of our energy use and light pollution challenges, but also come with the temptation to over-light due to their high luminous efficiency (International Dark-Sky Association, 2018)

Suggested solutions

- Refer to and quantify blue light in terms of the energy of its photons rather than as “low wavelength” or “cool colour temperature”
- Change units and labelling for light sources to include information about blue light percentage and total light power output
- Standardise the reporting of sky brightness units in magnitudes per square arc second to match the measurements of the Sky Quality Meter and the Dark Sky Meter app, to facilitate citizen science in the field of dark sky preservation
- Mandate the production and use of low blue light content LEDs

References

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Description of gathering and reflection

- This presentation could be adapted for use as a keynote at a science educators or science communicators conference, or as a workshop or breakout session at a more general education conference for those interested in the topic, such as this one hosted by my school
- Prior to studying this module, I was aware of the issues surrounding exposure to screens and fluorescent lighting at night, and some of the more well-known examples of light pollution affecting animals, such as sea turtles. Through conducting research for my discussion post and this assignment, I have gained a deeper understanding of the various measurements used to quantify light pollution, and a greater awareness of the extent of its impact on ecosystems.