Light management in night works

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This technical note serves to complement the BIA guidelines on construction impacts and mitigation measures.

1. Impacts of light pollution on biodiversity

Previous studies have shown that light can be detrimental to sensitive biodiversity receptors such as nocturnal animals, migratory birds and seabirds, as well as sea turtles which come ashore to nest. Light can disorient animals and affect foraging behaviours of animals such as bats (Jägerbrand & Spoelstra, 2023). Animals such as light-opportunistic insectivorous bat species may be drawn out of the forest to feed on insects swarming at artificial light sources (Salinas-Ramos et al., 2021). This may increase human-wildlife conflict and fatality due to construction site works. Conversely, light-averse species are at a disadvantage as phototactic insect prey is being displaced from forested sites where they usually hunt, reducing food availability (Rowse et al., 2016). Marine species such as sea turtle are also negatively affected as they are driven out of nesting sites (Brei et al., 2016) and hatchlings are falsely oriented by artificial lights, moving further inland instead of towards the beach (Verutes et al., 2014). As such, there is a need to mitigate these impacts on biodiversity.

2. Light measurement and colour

The amount of light cast onto a surface (illuminance) will be used as measurement for the impact of light disturbance at construction sites, rather than the amount of light produced (lumen) or amount of energy used (watt). Luminance describes the amount of light emitted and is measured by candela/square meter (cd/m2). Illuminance is the amount of light cast onto a fixed surface area and is measured by lux (lx) and decreases with increasing distance between the light source and illuminated surface (Shaw et al., 2018). While luminance is fixed by the lamp's specifications, illuminance can change based on the number of lamps and position of the light source. Illuminance can be measured in the field with a lux meter or calculated with the inverse square law if the distance is known. Hence, it is recommended that level of illuminance is also considered.

Colour temperature of lamps can be measured in degrees Kelvin (K), and this indicates how 'warm' (2000 to 3000K) or 'cool' (4000 to 6000K) the colour is. Lights of higher colour temperature, which appear cooler due to its higher blue light content, should be avoided because they are known to affect bats (EDF Energy, 2020).

3. Light pollution and recommended lights to use

Lights commonly used at construction sites includes Portable tower lights, Perimeter/ambient lights, Equipment-mounted lights (e.g. crane lighting), Interior lights. Depending on the intended purpose and design, they can be installed with flood lights, light tubes or solar lights. Portable tower lights

fixed with flood lights are intense light sources and should be pointed downwards and only turned on at active work sites.

Lamp types typically used arranged in order of suitability for wildlife:

- Light Emitting Diode (LED)
- Low Pressure Sodium
- High Pressure Sodium
- Metal halide
- Mercury Vapor
- Fluorescent
- Halogen

Coloured in green and orange are preferred lamp types are that wildlife friendly while those in red should be avoided as outdoor lighting unless filtered against blue and UV light.

The blue spectral and ultra-violet (UV) component of light attracts insects and affects circadian rhythm of plants and animals and amber light is preferred (Australia Department of the Environment and Energy, 2020). Therefore, warm light with colour temperature of 2700K is optimum, although 3000K can be tolerated if lighting fixtures are properly shielded and spaced out (Dick, 2021).

LED light sources are preferred as they tend to have a specific wavelength. Metal halide and mercury lamps emit high UV levels which is especially harmful to wildlife and should not be used in construction sites. Lights such as fluorescent and halogens, as well as cool white LEDs are rich in blue light and should be avoided (Australia Department of the Environment and Energy, 2020). Low- and high-pressure sodium lamps have negligible and minimal effects respectively and high-pressure sodium lamps should be avoided whenever possible (EDF Energy, 2020).

4. Additional light mitigation measures

Housing design

To reduce glare and night sky pollution, lighting fixtures should be either cut-off or full cut-off. Alternatively, housing/shield/reflector-diffusers should be used to prevent glare, spillover, sky glow and light trespass into sensitive habitat.

Mounting of light source

Lamps should all face inwards and downwards towards the work site and mounted at the height of the hoarding or lower and at zero-degree angle to horizon, as much as possible. Perimeter lights should not be installed unnecessarily, and portable tower lights are preferred to directly illuminate active work areas. Low intensity ambient light for the safety of pedestrians can be mounted on railings or bollards and on higher lamp posts for vehicle access routes, while keeping to a height lower than hoarding and facing away from sensitive areas. Ensure as much as possible that housing/shield/reflector-diffusers are used to prevent uplight and backlight into the night sky or sensitive habitat.

Management of light pollution

I. Reduce production
   - Plan an optimum illumination layout to use the minimal number of lighting fixtures to achieve minimum lux required for safe outdoor works
   - Use portable tower lights as much as possible for targeted illumination of work site
   - Low intensity lights can be used for ambient lighting to facilitate the movement of pedestrians and to light up access routes
   - Limit hours of lighting as much as possible by switching off lights after use
   - Recommended standards from USA Department of Civil and Environmental Engineering Wisconsin-Madison (Shaw et al., 2018) as well as UK standards for outdoor workplace lighting (The British Standards Institution, 2014; EDF Energy, 2020) will be used as a suggested reference for local construction activities. The minimum lux recommended for pedestrian area is 5 lux, for access route is 10 lux, excavation is 20 lux, 40 lux for general construction, 80 lux for specialized construction and 160 lux for precision operations involving detailed works.

II. Attenuate light
   - Use non reflective and dark (i.e. matt paint) surfaces as much as possible within work site, especially for hoarding which should also be opaque
   - Use housing/shield/reflector-diffusers to reduce intrusive light outside of work site
   - Where light spillage into the adjacent forest cannot be avoided, an opaque tarp should be installed in a way that masks the light spill
   - Where possible, the illuminance layout should be planned such that planted vegetation and natural landscape can attenuate the light from the construction site

III. Reducing animal encounters with impact
   - Ensure that lighting fixture is installed at the lowest possible mounting height and at same height or lower than hoarding, with a downward tilt, preferably with a zero degree angle to horizon
   - Lights should only be on where and when works are necessary or for safety purpose
   - Adjustable and portable lights should be used as much as possible to restrict lighting within work zone
   - Lights should not be placed in the vicinity of an identified bat roost, or higher site hoarding should be used
   - Illumination mounted on tower cranes should be kept as low as possible below 12m (EDF Energy, 2020) and switched off outside of working hours, other than what is required for safe operation and obstacle avoidance
   - Shift worksite location to provide a 10 m dark buffer zone (EDF Energy, 2020) next to sensitive habitats or avoid night works entirely near ecologically sensitive areas
   - Where the dark buffer zone is not possible, high hoarding of at least 6 m should be installed along forest perimeter

Environmental Monitoring and Management Plan (EMMP)

Under the EMMP, a Light Management Plan (LMP) complete with illuminance layout plan, lighting fixture specifications and night work schedule should be supplemented. On the layout plan, the type of lighting (portable tower light/LED flood light/fluorescent light tubes) and height of mounting should also be indicated. Minimum, maximum and preferred illumination levels should preferably

be specified in construction work site light management plan and these levels should be adhered to for illumination layout (Shaw et al., 2018). Light spilling into adjacent sensitive receptors will need to be monitored. EMMP inspection should focus on ensuring that the guidelines stated above are met and corrective actions must be taken for any non-compliance.

Conclusion

In summary, light pollution can impact sensitive biodiversity. As such, proper implementation of mitigation measures will need to be in place to minimise such impacts.

References

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Appendix

Recommended wildlife friendly lighting

SPARTAN Flood FL48 Wildlife friendly floodlight zone 1/21 600nm 10,000 lumens

Siteco Floodlight FL 11 (colour temp of 3000K)

Killark VML-X Series LED Area light 55 Watt,120-277VAC, 7000 Lumen ¾" Wall Bracket (Option for migratory bird and marine life)

ASD LED Area Turtle Light (with shield)

Sunlite LED PAR38 Orange Floodlight Bulb

Viento Area Site LED Large Lighting fixture Wildlife Lighting

Coolon DLK2 LED Conveyor/Area Light (or any Dark Sky Compliant & Wildlife friendly product from their catalogue)

Schreder OMNIblast (adjusted to warm light and with hood installed)