Statement of the
EU-COST Action ES 1204 LoNNe
Loss of the Night Network

PROTECTED AREAS IN EUROPE: ESSENTIAL FOR SAFEGUARDING THE NIGHTTIME ENVIRONMENT

What if we woke up one morning only to realize that all of the conservation planning of the last thirty years told only half the story – the daytime story?

Rich and Longcore, 2006

NASA/NOAA

To the Managing Bodies of Protected Areas in Europe:

The EU-funded "Loss of the Night Network" (EU Cooperation of Science and Technology Action COST ES1204 LoNNe) brings together leading European researchers and practitioners in the field of nighttime lighting and light pollution. As members of this group, we would like to draw your attention to the environmental and other challenges associated with outdoor lighting at night.

Below you will find our rationale and **guidelines for the reduction of light pollution in protected areas** as well as sources of information for further advice.

We hope that this brief overview of issues and ways forward will inspire you to take the steps needed to help safeguard the nighttime environment in your protected area and to promote sustainable and environmentally sound lighting.

The problem of light pollution

The use of outdoor artificial light at night (ALAN) has many benefits, such as allowing us to extend activities into the night and increasing visibility. However, research has clearly shown that lighting up the night comes with substantial negative side-effects.
These negative effects are collectively known as light pollution: The natural darkness of the night is polluted by artificial light.

Excessive, poorly directed or unnecessary artificial light at night:

- wastes energy and money,
- affects the natural day-night/light-dark cycle under which all terrestrial species and ecosystems have evolved,
- endangers nighttime habitats and disrupts biological (e.g. circadian and seasonal) rhythms of both diurnal and nocturnal species,
- destroys the natural darkness of nocturnal landscapes (“nightscapes”) and obscures the view of the star-filled sky,
- disorients insects and other animals, thereby reducing ecosystem services,
- affects human well-being and health through its association with e.g. insomnia, obesity, metabolic disorder and hormonal cancers,
- potentially decreases safety due to glare,
- causes annoyance and reduces privacy through light trespass.

The increase in artificial light at night

Artificial light at night is increasing around the world at an estimated average rate of 6 % per year. Reasons for this increase include the growth of settlements, the increasing illumination of populated areas and the increased energy efficiency of lamps. These developments are intensified through the use of white light with a high blue light content and the inappropriate use of lighting technology.

Light travels far in the atmosphere and causes skyglow, which can be detected from hundreds of kilometres away (for example the light dome of Berlin is visible from a distance of 100 km and the light dome of Barcelona from a distance of over 200 km). As a result, areas with naturally dark nights are becoming rare. This is also the case for a significant portion of protected areas in densely populated Europe, where natural nighttime environment conditions are being altered by the intrusion of artificial light. Satellite data exhibits high levels of nighttime lighting in more than 24% of protected areas in Europe, and there were alarming increases in the average nighttime light in many protected areas between 1992 and 2010.

At a global scale, already **32–42% of protected areas in Europe**, Asia, South and Central America **experience significant increases in artificial light at night**, and only very few protected areas worldwide had significant decreases.

Protected Areas are key to safeguarding the nighttime environment

Since light pollution is particularly far-reaching, it is important that measures to protect natural darkness are taken over extensive areas. Protected areas (e.g. nature parks, biosphere reserves, national parks) offer an ideal starting point for safeguarding natural nights, because

- they are frequently large in size,
- are often still relatively dark at night and
- mechanisms for the protection from light pollution can generally be added on to existing protection regulations fairly easily.

By safeguarding not only the daytime, but also the nighttime environment, protected areas will:

- preserve their nocturnal landscape,
- retain the natural darkness and natural diurnal-nocturnal cycles under which species and ecosystems have evolved and upon which they depend,
- provide healthy living conditions for residents and visitors,
- offer people the rare opportunity to experience natural darkness and the star-filled night sky,
- set best practice examples for how to minimise light pollution, thus spreading knowledge about practical solutions for careful lighting to visitors and to other territories.

In addition, protected areas that are committed to safeguarding their nighttime environment can profit from these efforts by receiving formal recognition as a “Dark Sky Place” from international organisations such as the International Dark-Sky Association or the Starlight Foundation. This type of branding can help increase awareness for and visitation to the protected areas.

Reducing and avoiding light pollution does not necessarily imply switching off all lights. Rather, it demands considering the use of artificial lighting carefully, as outlined in the following guidelines.

The Members of the EU-COST Action Loss of the Night Network

With thanks for valuable commentary from John Barentine, Ph.D. (International Dark-Sky Association) and Robert Dick (Royal Astronomical Society of Canada)

GUIDELINES FOR THE REDUCTION OF LIGHT POLLUTION IN PROTECTED AREAS

This document contains a **basic set of recommended policies and monitoring options** for protected areas regarding the protection of the nighttime environment and sources of information for further guidance. These recommendations are intended to provide you with a first practical orientation. They reflect practices that have already been adopted successfully in numerous protected areas around the world, including parks that have been certified as “Dark Sky Areas”. The values provided in this document are based on the state of knowledge in early 2015.

Constellation Orion over a star park

I. Basic Principles

Management of lighting and natural darkness is essential for the protection of natural darkness. This essentially means that decisions must be taken concerning where light is considered necessary – and where it is not needed. A **zoning concept** is an important tool, especially if the protected area includes visitor facilities or settlements. A zoning concept usually identifies a dark core zone without any installed lighting, which is protected by extensive buffer zones in which artificial lighting is used responsibly and sustainably (e.g. in visitor centres, campgrounds or villages).

As a basic principle, no artificial lighting, especially no illuminated advertising, is permitted outside of settlement areas, unless objective indications show that safety would be at risk without artificial lighting.

Where lighting is considered absolutely essential, the following guidelines will help to reduce its negative impacts.

II. Guidelines for Lighting in Protected Areas

1. Directing Light

Light must be directed carefully, so that it will only shine on the target to be illuminated (especially traffic areas). The light source shall not be visible at large distances in any direction beyond the target area, which means that additional shielding will be required in some cases (for example on slopes).

In particular, no light may be directly emitted towards the sky. Ground-recessed floodlights and searchlights must therefore not be used, and any illumination of signs must be directed from top to bottom.

For traffic areas, only fully shielded luminaires may be installed, so that they only radiate light below the horizon when they are in use (i.e. with an Upward Light Ratio or ULR = 0%) and create as little glare as possible (e.g. luminosity class G6) (Autonome Provinz Bozen-Südtirol, 2012, Baddiley, Webster, 2007, IDA, IES, 2011, UNESCO, IAU, IAC, 2009).

For area lighting (e.g. for sports fields or town squares), these conditions must be complied with by using, for example, horizontally mounted asymmetric floodlights.

Architectural illumination is to be avoided or, in exceptional cases, must be designed such that no light passes beyond the object to be illuminated (e.g. by using masking such as the Gobo – Graphical optical blackout – projection technique).

2. Light Quantity

The amount of light (i.e. the total installed lumens) should be kept as small as possible. Because the human eye is capable of adapting to low levels of light, reduced overall brightness levels (luminance) will be sufficient for many needs as long as blindingly bright light sources (high luminance) – which trigger the eye to adapt to high lighting levels – are avoided. What is important here is that low levels of brightness are applied uniformly: This allows for the eye to remain adapted to the relative darkness.

The European standards for street lighting define lighting criteria for different road classes. For each road class, there is a range of minimum levels of brightness that can apply, depending on factors such as the speed and volume of traffic. The most relaxed minimum requirements are recommended for road classes that are typical in rural areas (e.g. for road classes ME6 or CE5 or S6). If there is no objective reason for compliance with these non-binding standards, streets in protected areas can and should be illuminated *no higher than* the stipulated minimum levels. This means rural streets should not have an average luminance of more than 0.3 cd/m², which typically corresponds to an illuminance of 4 lux, and residential streets should not have an illuminance of more than 2 lux. Floodlighting must not exceed a luminance of 2 cd/m² on the illuminated area.

3. Timing Light

Artificial lighting should only be used when it is really needed to satisfy a demand (e.g. safety, visitor frequency). If the use of public space in the (often rural) settlements of protected areas generally ends in the late evening hours, public lighting should be significantly reduced or switched off during the late hours of the night (e.g. from 22:00 hours, but at the latest from midnight; dimming is possible especially with LEDs).

By switching street lights off for 5 ½ hours daily (e.g. from midnight to 5:30 in the morning), the energy consumed during the ca. 4.000 hours of night per year is halved. The energy consumption per kilometre of road and year can be used as a measure for orientation: a value of 5 MWh/(km year) should not be exceeded.

4. Spectral Distribution

Blue components of the lighting spectrum should be as low as possible, since these

- scatter more in the atmosphere (e.g. Aubé et al., 2013),
- strongly attract insects (e.g. Eisenbeis, Eick, 2011),
- make glare worse and may even damage the retina (e.g. Reidenbach et al., 2008),
- significantly affect the circadian rhythm of humans and other animals at night (e.g. Stevens and Zhu 2015),
- considerably disturb the night vision of the eye (e.g. Duriscoe et al., 2007).

Especially light with wavelengths shorter than 480 nm (“cold white” or “blue” light) should be avoided: It should ideally represent a maximum of 10% of the total amount of light in the visible range. The correlated colour temperature (CCT) of the light source can be used as a rough measure. Warm white light with a colour temperature of 3000 K or less fulfils this criterion, and should be used. Light with a colour temperature below 2000 K, as provided by sodium vapour lamps or yellow (narrowband amber or phosphor converted amber) LEDs, is even better (ANPCEN, 2014, Aubé et al., 2013, Diaz-Castro, 2013, Falchi et al., 2011, Junta de Andalucía 2011, ÖNORM, 2012, RASC, IDA, 2012,).

5. Monitoring

Regular monitoring of brightness levels at night provides important information concerning the overall development in terms of light pollution as well as the effectivity of the implemented lighting policies. Measurement devices, for example the Sky Quality Meter (SQM-L), or all-sky photography provide good options for judging and communicating the darkness of the night sky.

For further guidance on monitoring brightness levels in your protected area, please contact the members of COST-LoNNe listed at the end of this document.

6. Awareness-Raising

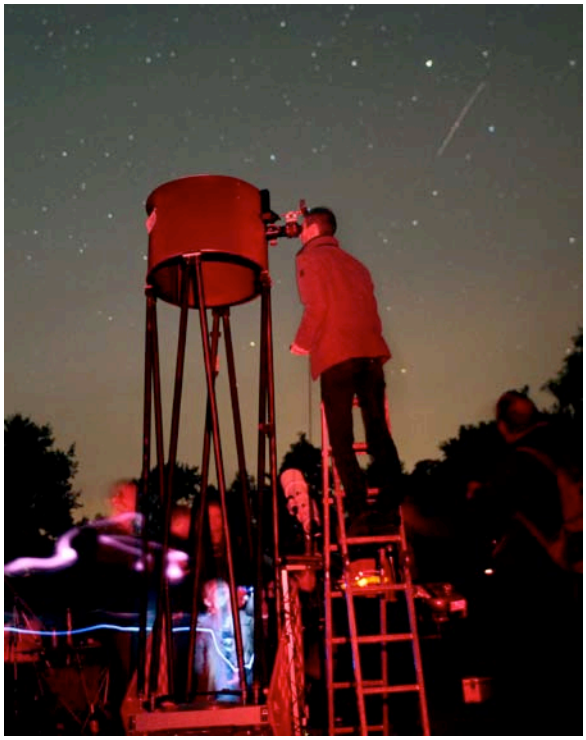
Raising awareness by communicating with all stakeholders, including the general public, about artificial light at night is very important for ensuring the long-term sustainability of efforts to reduce light pollution. With the help of public relations and participative initiatives, residents and visitors alike can learn about sustainable lighting options for their homes and businesses along the lines of the above criteria. Information centres in the protected areas must set good examples for careful lighting and for how light pollution can be prevented in practice. Nighttime environmental tours and stargazing in particularly dark natural environments are impressive experiences that can help residents and visitors appreciate the value of nights with little or no artificial lighting. Citizen science initiatives, in which visitors of natural areas are directly engaged in the collection of data related to light pollution, represent a valid awareness-raising complement to any recreational or educational activity.

7. Branding

There are a number of different national and international schemes for branding or labelling protected areas that contribute to the preservation of natural darkness. Being formally labelled as a “Dark Sky Place” can contribute significantly to increased awareness for and a higher number of visitors to a protected area. The criteria and modalities for gaining such recognition differ in detail. However, the guidelines above outline the main common criteria.

There are currently two international organisations that recognise protected areas working to preserve their natural darkness:

- the International Dark-Sky Association (IDA) designates "International Dark Sky Parks", "International Dark Sky Reserves", and “Dark Sky Sanctuaries” and
- the Starlight Initiative awards the labels of "Starlight Tourism Destination" and "Starlight Reserve".



Star gazers in a star park

RESOURCES

For further information, please contact:

- Dr. Sibylle **Schroer**, Co-Ordinator of the COST-LoNNe Action, schroer@igb-berlin.de
- Dr. Andrea **Giacomelli**, Italy, Member of COST-LoNNe Working Group 4, info@pibinko.org
- Dr. Andreas **Hänel**, Germany, Member of COST-LoNNe Working Group 3, ahaenel@uos.de
- Dr. Zoltán **Kolláth**, Hungary, Member of COST-LoNNe Working Group 3, zkollath@gmail.com
- Dr. Noam **Leader**, Israel, Member of COST-LoNNe Working Group 3 leader@npa.org.il
- DDr. Thomas **Posch**, Austria, Member of COST-LoNNe Working Group 4, thomas.posch@univie.ac.at
- Dr. Salvador **Ribas**, Spain, Member of COST-LoNNe Working Group 1, sjribas@montsec.cat

International organisations and initiatives for the protection of the night:

- **International Dark-Sky Association** (IDA): www.darksky.org
- **Starlight Initiative**: www.starlight2007.net
- **IUCN Dark Skies Advisory Group**: http://interenvironment.org/Dark.html
- **Initiative for an International Association of Dark-Sky Parks**: www.darkskyparks.org
- **Royal Astronomical Society of Canada**: www.rasc.ca/light-pollution-abatement

European organisations and initiatives primarily focused on the reduction of light pollution:

- **Austria**: Die Helle Not, www.hellenot.org
- **France**: Association Nationale pour la Protection du Ciel et de l'Environnement Nocturne, www.anpcen.fr
- **Germany**: Fachgruppe Dark Sky der Vereinigung der Sternfreunde, www.lichtverschmutzung.de and Forschungsverbund „Verlust der Nacht“; www.verlustdernacht.de
- **Italy**: Cielo Buio, http://www.cielobuio.org/ and BuioMetria Partecipativa Project, www.buiometriapartecipativa.org
- **Malta**: Light Pollution Awareness Group Malta, www.maltastro.org
- **Netherlands**: Sotto Le Stelle, www.sotto.nl
- **Slovenia**: Dark Sky Slovenia, www.temnonebo.si
- **Spain**: Cel Fosc, www.celfosc.org
- **Switzerland**: Dark Sky Switzerland, www.darksky.ch
- **United Kingdom**: Campaign for Dark Skies, www.britastro.org/dark-skies/index.html

References

- ANPCEN – Association Nationale pour la Protection du Ciel et de l'Environnement Nocturnes: Eclairage extérieur, Eclairage public et prive, Diagnostic et définition de projet, 2014.
- Aubé, M., Roby, J., Kocifaj, M.: Evaluating Potential Spectral Impacts of Various Artificial Lights on Melatonin Suppression, Photosynthesis, and Star Visibility, PLOS one, 8, 7, e67798, 2013.
- Aubrecht, C., Jaiteh, M., & de Sherbinin, A.: Global Assessment of Light Pollution - Impact on Protected Areas. CIESIN/AIT Working Paper January 2010.
- Autonome Provinz Bozen-Südtirol: Kriterien für Maßnahmen zur Einschränkung der Lichtverschmutzung und zur Energieeinsparung, 2012.
- Baddiley, C., Webster, T.: Towards understanding skyglow, British Astronomical Association und Institution of Lighting Engineers, 2007.
- Bennie, J., Davies, T.W., Duffy, J.P., Inger, R., Gaston, K.J.: Contrasting trends in light pollution across Europe based on satellite observed night time lights, Science Reports 4, 3789, 2014.
- CIE – International Commission on Illumination: Guide on the limitation of the effects of obtrusive light from outdoor lighting installations, Technical report CIE 150, 2003.
- Diaz-Castro, J.: Rationale for the future change to LED technology for outdoor light in La Palma, Canarian Observatories updates 1-2013.
- Dick, R., Applied Scotobiology in Luminaire Design, Lighting Research and Technology, Vol 46: 50–66, 2014.
- Duriscoe, D.M., Luginbuhl, C.A, Moore, C.A.: Measuring Night-Sky Brightness with a Wide-Field CCD Camera. Publ.Astron.Soc.Pac. 119, 192-213, 2007.
- Eisenbeis G, Eick K. (2011): Studie zur Anziehung nachtaktiver Insekten an die Straßenbeleuchtung unter Einbeziehung von LEDs [Attraction of nocturnal insects to street lights: a study of lighting systems, with consideration of LEDs]. Nat. Landschaft. 86, 298–306.
- Falchi, F., Cinzano, P., Elvidge C. D., Keith D. M., Haim A.: Limiting the impact of light pollution on human health, environment and stellar visibility, Journ. Envir. Management 92, 2714-2722, 2011.
- Gaston, Kevin J., Duffy, James P., Bennie, Jonathan: Quantifying the erosion of natural darkness in the global protected area system. In: Conservation Biology, 1–10, 2015.
- Hölker F. et al.: The dark side of light: a transdisciplinary research agenda for light pollution policy. Ecol. Soc. 15(4), 13, 2010.
- IDA – International Dark-Sky Association: International Dark Sky Reserves. Oct. 2014.
- IDA – International Dark-Sky Association: International Dark Sky Park Program Ver. 1.31. Oct. 2014.
- IDA, IES – International Dark-Sky Association & Illuminating Engineering Society: Model lighting ordinance. 2011.
- IUCN – International Union for Conservation of Nature: Dark Skies Advisory Group: IUCN's first step toward preserving natural darkness. Available online at: interenvironment.org/Dark.html, 2012.
- Junta de Andalucia: Guia tecnica de aplicacion del regalmento para la proteccion del cielo norcturno, Barcelona, 2011.
- ÖNORM O 1052: Lichtimmissionen – Messung und Beurteilung. 2012.
- Rich, C., Longcore. T. (Eds.): Ecological Consequences of Artificial Night Lighting. Island Press, 2006.
- RASC; IDA – Royal Astronomical Society of Canada & International Dark-Sky Association: Guidelines for Outdoor Lighting in RASC Dark-Sky Preserves and IDA Dark Sky Places. Royal Astronomical Society of Canada, International Dark Sky Association, Nov. 2012.
- Reidenbach H.-D., Dollinger K., Ott G., Janßen M., Brose M.: Blendung durch optische Strahlungsquellen. Bundesanstalt für Arbeitsschutz und Arbeitsmedizin, 2008.
- Stevens, R. Zhu, Y.: Electric light, particularly at night, disrupts human circadian rhythmicity: is that a problem?, Phil. Trans. R. Soc. B, 2015.
- UNESCO, IAU, IAC – United Nations Educations, Scientific and Cultural Organization, International Astronomical Union & Instituto de Astrofísica de Canarias: Starlight Reserves and World Heritage. 2009.