

Royal Astronomical Society of Canada

**Nocturnal Preserve Guidelines
(RASC-NP)**

**Adopted by the RASC
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1.0 SCOPE

The Royal Astronomical Society of Canada (RASC) is a national astronomy organization established in 1903 devoted to the promotion of astronomy and allied sciences. In this capacity, the RASC encourages the protection of the quality of the night sky by minimizing light pollution.

There is a growing need to identify and protect areas from the effects of artificial light at night (ALAN). The goal of the Nocturnal Preserve (NP) Program is to promote the reduction in outdoor lighting and thereby improve the nocturnal environment for wildlife, and to help provide accessible locations for the general public to experience the naturally dark night. This document presents the guidelines for the establishment of Nocturnal Preserve herein after referred to as “Parks”.

Even access by astronomers can affect the nocturnal environment and providing outdoor lighting for visitors affects the biology and behaviour of wildlife. By promoting the preservation of these protected areas after dark, the region will be a haven for rare and endangered species.

2.0 BACKGROUND

The ultimate goal of the RASC is to enhance the public's enjoyment of the night.

A NP is an area accessible to the public in which all lighting fixtures within its borders minimize their contribution to light pollution: glare, light trespass and sky glow.

The environmental impact of artificial lighting has been studied for many years. This research concludes that light can pollute the environment and this can profoundly affect the ecosystem. A summary of these effects is presented in the Appendix to this document.

Humans and wildlife are affected by light pollution. Many living creatures have evolved to require a day-night contrast to synchronize their biological rhythms. These organisms have adapted to variations in nighttime illumination from a dark sky to the brightness of a full Moon, but they have been found to modify their behaviour to adapt to this monthly cycle. In contrast, illumination levels in typical urban areas far exceed the brightness under a full moon. This dictates that urban lighting guidelines should not be applied in rural settings where stargazing is encouraged and wildlife habitat should be protected.

2.1 Lighting Guidelines

Outdoor artificial illumination and even the artificial sky glow from distant urban areas compromises the natural behaviour of animals. They also affect the flowering and dormancy period of plants. A NP provides the quality of the night for wildlife by protecting the habitats of the nocturnal animals, while still being accessible to visitors.

Our eyes are very sensitive to light. People have reported that they see "fine" under only the light of the full Moon. For comparison, the Illumination Engineering Society of North America (IESNA) recommends urban illumination levels that can exceed 100X brighter. Therefore in a city, people rarely experience the sensitivity of their night vision.

The RASC has developed a lighting protocol for Nocturnal Preserves (RASC-NP-GOL) that respects and protects the need for naturally dark nights, and it provides advise for safety and navigation around a protected area. The priority of this protocol is to minimize the impact of artificial lighting on the natural environment. This requires shielded lighting fixtures (Sharp Cut-off) that minimize glare, prevent horizontal illumination and restrict the extent of the illuminated area.

The protocol limits the illumination levels and suggests natural barriers (trees, bushes and berms) to further minimize the extent of scattered and reflected light. It does not permit "white" light to be used outdoors and also recommends lighting curfews, retro reflective signage and encourages the use of flashlights by visitors after dark.

2.2 Accessibility

The goal of a NP is to provide a naturally dark environment for wildlife and enhance the public's enjoyment of the night environment. This requires the designated area to be free of ALAN and as accessible as practical to the public after dark.

Appropriate signage maybe be required to help visitors navigate the site. This signage should conform to the RASC-NP-GOL.

2.3 Quality of a Dark Sky

In rural observing sites, our eyes may detect the distant urban sky glow near the horizon. The closer the NP is to an urban area the higher the sky glow will extend. A sky quality reading above the site (the zenith) will give only a partial indication of the quality of the sky because it provides no indication of sky glow on the horizon. Currently, the only form of documentation for recording the sky glow on the horizon is with descriptions by experienced observers and calibrated images of the horizon.

The amount of sky glow may be measured and monitored over time to assess the improvement in lighting conditions resulting in the NP outreach efforts.

3.0 NOCTURNAL PRESERVE (NP) GUIDELINES

The establishment of a NP is a partnership between the Park management and neighbouring municipalities, and it requires their active support. There are two principal requirements for a NP: an acceptable lighting protocol, and an active outreach program for the public and to promote light pollution abatement in neighbouring jurisdictions.

The lighting protocol is published in a separate document (RASC-NP-GOL). This section outlines what programs should be in place to satisfy the requirements for the establishment of a NP.

The RASC may choose to waive or amend any of these guidelines for a specific application provided that the integrity of the NP programme is not jeopardized

3.1 Administrative Requirements

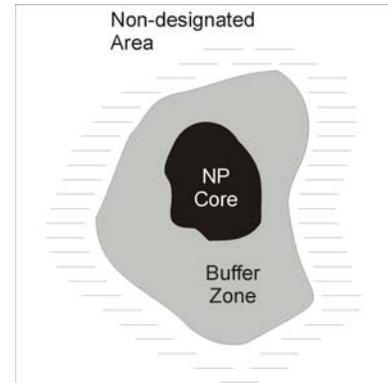
The area of the NP should be under the management of a single entity to ensure full adherence to these guidelines and the GOL throughout the area.

The application for NP status should contain a written MEMORANDUM OF UNDERSTANDING between the Park and neighbouring jurisdictions supporting, and agreeing to, the requirements of the NP.

The night sky quality should be sufficiently dark for the biochemistry and behaviour of the nocturnal wildlife. The NP should have an area large enough for lighting from neighbouring jurisdictions to have little effect and the environment within the Park.

The quality of the sky should be quantified by a zenith Sky Quality Meter reading (Unihedron, Inc). This reading could become part of the NP designation: RASC-NP-XX.X, where the last set of numbers refers to the best SQM reading obtained at that site (in units of “magnitudes / arcsecond²”)¹.

A buffer zone shall encompass the NP Core in order for light fixtures in non-designated areas to be out of view behind buildings, berms, coniferous bushes or trees. This Buffer Zone should be between the region outside of the park and the dark core of the NP. All light fixtures within the Buffer Zone should conform to the NP-GOL.



In order for the Park to be protected from the future encroachment of light from beyond the Park boundaries, Park managers and sponsors should maintain a good working relationship with neighbouring municipalities to help protect the Park from the increase in sky glow visible from within NP.

Upon the award of the Designation, the NP should display a sign identifying it as a RASC NP. The RASC-NP logo graphic will be provided by the RASC for use of the Park on their signage and communiqué at their discretion.



3.2 Lighting Protocol for NPs

Outdoor lighting in the NP should conform to the RASC NP lighting protocol (RASC-NP-GOL). This document is freely available from the RASC.

The lighting protocol is a guideline to limit the maximum amount of artificial lighting within a NP and its Buffer Zone, and it limits the area of impact of the artificial illumination. This limit on the type and level of lighting that might be introduced into the Park. It may require the Park to shield or change existing light fixtures, apply lighting curfews and will limit any additional installation of lighting.

The current extent, varied usage and lighting conditions within the park may conflict the protection of the natural habitat. In large parks, the owners of private and rental properties may also limit widespread adoption of the lighting protocol. To accommodate these realities, a NP may have small enclaves located within a larger Park where outdoor lighting may be permitted. However these properties must be strongly encouraged to comply with the NP-GOL.

¹ Operating instructions come with the Unihedron Sky Quality Meter. Take readings after astronomical twilight (1 hour after sunset). Northern locations may not darken for several hours after sunset. Consult local astronomy groups for advice.

3.3 Outreach Program

There are two major activities in the NP Outreach Program. The goal of these Outreach Activities is to both protect the natural darkness of the night within the Park. The Park will benefit with increased respect from visitors interested in the nocturnal environment and by increasing its public visibility for its importance as a protected area.

3.3.1 Public Outreach Activity

The NP should be open after dark to encourage the use of the site for night walks to study and experience the nocturnal wildlife. These activities should be further encouraged through brochures, NP promotional materials and in response to media inquiries.

Through their outreach activities, Park staff should promote an understanding of the importance of the night for a healthy nocturnal environment and the relationship between the skylore and the First Nations and other cultures. Reference may be made to the new science of scotobiology and how it is changing our awareness of our need for periods of darkness. A brief summary of scotobiology is presented in Appendix B.

Literature should be made available to the public during these sessions and in kiosks (if available) during the daytime.

3.3.2 Municipal Outreach Activity

Urban growth outside Park boundaries can severely contaminate the night sky over the NP with artificial sky glow. An active Municipal Outreach Program is needed to protect the NP from increases in sky glow and to improve the quality of the night sky into the future.

Park managers, with the support and assistance of scotobiologists, should give presentations to neighbouring municipalities to promote the use of sharp cut-off light fixtures and lower illumination levels in order to protect and improve the quality of the night sky over the NP. Digital files of presentation materials may be obtained from the Canadian Scotobiology Group (www.csbg.ca).

Park managers should regularly raise the issue of urban light pollution in the media and in the business community.

3.4 Nomination Process

An independent sponsor is required for the proposed NP. However, managers and staff of remote sites may also nominate and submit nomination packages for consideration. Sponsors may be environmental or other community groups. Park managers and sponsors shall together submit to the RASC documentation listed in Table 3.1 and other materials that may be requested by the RASC-LPAC to help them judge the suitability of the proposed area.

This information will also be used to document the initial characteristics of the site in terms of the quality of the night sky, lighting fixtures in the NP and lighting policies in the municipalities across the region. The submission requirements are used to document the NP and surrounding area. It will be used to provide a benchmark against which future

improvements or degradation can be assessed. It should also be noted that the establishment of the NP should reflect the current state of the site, not the future creation of the site. As such, the lighting protocol should be adhered to in the NP prior to the establishment of the NP. However, the NP may be expanded in the future as the lighting protocol encompasses larger areas. Support of the neighbouring municipalities through approved lighting policies is a strong asset in the nomination process.

The following paragraphs explain the requirements outlined in Table 3.1 on page 8.

1. The lighting protocol was developed to minimize the contamination of the area by artificial lighting. It addresses the needs of wildlife habitat. The entire park may not conform to this protocol, but is expected that the NP Core shall conform prior to becoming a NP. Non-conforming areas can be designated as Buffer Zones. Lighting conformance in the Buffer Zones must be budgeted and scheduled to conform to the NP-GOL. (See item 5).

2. Memorandum of Understanding

The designation of a NP requires a partnership between the Manager, the sponsor and neighbouring Municipalities. The MOU should be a statement to which all parties agree and signed. It should be explicit and clear about the responsibilities and expectations of all parties.

3. Scale Map of NP and surroundings

The RASC web site requires sufficient maps and directions to promote the NP. These maps must show the context of the site with respect to the region, including access roads. A map must also show with labels the park boundary, extent of the Buffer Zones under the park manager's control and the NP Core in the park. These maps can be updated as the NP area is permitted to expand with improved reduced lighting.

4. Zenith Sky Quality Measurements

Experienced observers will use the sky quality measurements, obtained with the Unihedron Sky Quality Meter, to rate the quality of the site. The locations where these readings were taken should be marked on a map of the Park. These reading will also be used to benchmark sky glow in the area. Subsequent annual readings will document improvements over time.

5. Existing Light Fixture Inventory within the proposed NP Core and Buffer Zones

This information should be presented in tabular form (MS-Excel for example). It should include the type of luminaire, quantity, wattage, shielding and lamp type. The make and model number should also be included if known. Locations of light fixtures should be plotted and referenced on supporting maps.

6. Current Lighting Plan for the Park

All non-conforming lighting fixtures should be scheduled for removal, replacement, or modification. A schedule for this work should accompany the submission. This work should be scheduled before the end of the next fiscal year. Explanations for delayed conformance, and a schedule for eventual conformance, should be provided by the Park manager.

7. Public Outreach Plan (education)

Outreach materials should be made available at kiosks and through public outreach programs to inform the public of the need for reducing light pollution. Park staff should provide information on the elements of scotobiology and how light pollution impacts animal habitat. This may be done with guided night walks and written literature available to visitors.

8. Municipal Outreach Plan (for NP site protection)

Neighbouring urban areas are usually the major source of sky glow over the Park. In order to protect the NP from the encroachment of external lighting, the growth of light pollution from these areas must be reduced. Therefore the Park Manager must discuss the problem of sky glow from the municipality with the goal of the municipality developing a lighting policy that reduces its light pollution. The submission should indicate the commencement of talks with local municipalities and demonstrate progress on the principle of reducing light pollution.

9. Images of NP site (showing tree height, bushes, buildings, etc.)

There are two purposes for these images. They will be used for promotion of the site on the RASC web page. The assembled sets of images should be panoramas of the site (stitched together from a series of images) showing the horizon with the cardinal directions marked. They will show potential visitors what the site looks like. They will also document the existence of sky glow around the horizon. They will be used as a benchmark to which future images can be compared to show improvement or degradation of the site. The day and night panoramas should be presented with the same scale so they can be compared.

Table 3.1 NP Nomination Documentation List

Statement of compliance to the Lighting Protocol (RASC-NP-GOL)
Memorandum of understanding between all parties
Scale Map of NP and surroundings
Zenith Sky Quality Measurements (location of reading marked on map)
Existing Light Fixture Inventory within the proposed NP Core and Buffer Zone
Current Lighting Plan for the Park
Public Outreach Plan (education)
Municipal Outreach Plan (for NP site protection)
Images of NP site for day and night (showing tree height, bushes, buildings, etc.)

3.5 Revision to Designation

It may become necessary to review the NP designation due to changes in priorities of any signatory of the MOU, or changes in the lighting within or beyond the NP boundaries or Park policies regarding access and lighting. If the NP is deemed to be no longer viable by the sponsors of the Park, signage referring to the NP designation should be removed and the Park shall no longer promote itself as a NP.

4.0 RASC SUPPORT OF NPs

The RASC encourages its members to sponsor a local NP. On request, the RASC may offer electronic files of outreach materials to the Park.

The RASC will also promote the NP in the media and to all RASC members when opportunities arise. The RASC will provide promotional support in the form of information on the RASC-LPAC web site.

4.1 Naming of NP

The name of the NP shall be determined by the RASC in consultation with the nominating organization. The NP designation shall be used to develop a commitment from the region around the NP and may include several municipal and private partners. Therefore, the NP designation shall usually refer to the geographical region.

In the case of existing large Parks the NP would most likely be named after the park itself. In most cases, one organization may have taken the lead in the nomination process. In recognition of this initiative and effort, this organization will also be identified.

5.0 REFERENCES

Standards and Guidelines for Outdoor Lighting
Parks Canada Contract No. 45198343

Ecological Consequences of Artificial Night Lighting,
C. Rich, T. Longcore, Island Press, 2006
ISBN 1-55963-129-5

Light Pollution and the Protection of the Night Environment
Pierantonio Cinzano, Ed. 202, ISBN 88-88517-01-4
www.lightpollution.it/istil/Venice/

Illumination Engineering Society of North America (IESNA)
IESNA Lighting Handbook, 9th edition

APPENDIX

SCOTOBIOLOGY: THE BIOLOGY OF THE DARK

An outline for public information prepared by Dr. R.G.S. Bidwell, Wallace, NS, 2008

What is Scotobiology?

The concept of scotobiology as a science was developed at a conference on light pollution held in Muskoka, Ontario, in 2003. It was recognised that the underlying principle was the deleterious effect of light pollution on the operation of biological systems, ranging from their biochemistry and physiology to their social behaviour. Scotobiology is the study of biological systems that require nightly darkness for their effective performance; systems that are inhibited or prevented from operating by light.

Why is Scotobiology important?

Virtually all biological systems evolved in an environment of alternating light and darkness. Furthermore, the light/dark periods in temperate zones vary with the seasons. Organisms have evolved to use the variations in the length of day and night to integrate their physiological and social behaviour with the seasons. Many organisms measure specifically the length of the night, and light pollution may prevent them from determining the season, with serious or deadly consequences. For this reason light pollution is recognised as being a major component of global pollution, and scotobiology, the study of its specific effects on organisms, has now become an important branch of biological research.

Summary of specific scotobiological responses

Insects: Insects tend to fly towards light. Light pollution thus causes insects to concentrate around bright lights at night with several serious consequences. First, they become easy prey for birds and predacious insects. Insect numbers are reduced by their disorientation and death around lights, and also because they are concentrated where natural predators have an unnatural advantage to capture them. This reduction in insect populations has been found to affect the populations of animals not strongly attracted to light, including frogs, salamanders, bats, some birds and small mammals. In addition, the mating and breeding habits of some insects require darkness, so that light pollution can interfere or prohibit normal reproduction. Finally, the migration habits and paths of many insects are affected by light pollution with resulting population depletion. The huge piles of dead insects such as mayflies that are found under streetlights in springtime give some idea of the extent of damage such lights can cause.

Birds: Many birds are powerfully attracted to lights, and over a hundred million birds die from collisions with illuminated structures in North America alone every year. The actual loss of bird populations is hard to calculate, but it is significantly large. Furthermore, as with insects, bird migration patterns may be affected by light pollution because the birds may become disoriented and unable to follow their normal flight paths. Finally, the concentration of birds around lights also encourages animals and birds of prey that feed on smaller birds, resulting in still further reductions in the population numbers of migrating birds.

Animals: The behaviour of many animals is seriously affected by light pollution. Mating, hunting and feeding habits of wolves and other large animals are altered, with resulting decreases in population. Salamanders, frogs and other amphibians, many of which are already under serious threat from chemical pollution, are subject to impacts from even low levels of artificial night lighting on their physiology, ecology, behaviour and evolution. It is very likely that the behaviour of many if not most of our wild animals is similarly and negatively affected by even low levels of light pollution.

Plants: Plants are seriously affected by light pollution. Probably the most important aspects of a plant's reaction to and interpretation of darkness are expressed in its developmental behaviour: flowering, dormancy and the onset of senescence. The plant's ability to measure and respond to day length is crucial in enabling it to dovetail its developmental behaviour with the seasons. We are all aware of "long-day" and "short-day" plants. What is not so widely known is that plants do not measure or react to the length of the day. Instead, they measure and respond to night length, i.e. the duration of darkness. So short-day plants really require long nights, and should properly be called long-night plants. The problem for short-day/long-night plants arises from the fact that if they are illuminated briefly during a long night, they interpret the event as if they had experienced two short nights, rather than one long night with an interruption. As a result, their flowering and developmental patterns may be completely interrupted. Short-day plants normally bloom in the fall, as the days shorten, and they respond to the lengthening nights to initiate the onset of flowering. As the nights further lengthen, they begin a period of dormancy, which enables them to withstand the rigours of winter. Thus, if the nights are interrupted by light pollution, the consequences can be severe or deadly. Furthermore, the effect of successive experiences of nightly illumination is cumulative. It follows that light pollution, particularly if it is repetitive on a nightly basis, can seriously affect the development, flowering and dormancy – and so the very existence – of short-day (long-night) plants.

Human Health: Humans, like other animals, are affected by nightly light pollution, and human health is more severely affected by light pollution than is generally realised. Human hormone regulation, physiology and behaviour evolved in a diurnal pattern of day and night. The normal operation of wake/sleep cycles, hormone cycles, the immune system and other biochemical behaviour, depends on the daily alternation of light and dark, and may be severely damaged by nighttime illumination. It has been shown that the human immune system works more strongly during the day to produce antibodies that protect the body against microbial invasion, which is normally more likely to occur during the activities of the day. At night the immune system switches from a defensive to a repair mode, and killer cells then become more active in attacking tumours as well as infections that may not have been successfully prevented during the day. Light pollution may thus compromise the operation of human hormone and immune systems leading to increased incidence of cancer and other diseases, as well as to other physical as well as psychological disorders including mental illness, psychiatric instability, and such problems as seasonal depression (SAD). This means that even turning on a night-light or bedside lamp may have negative effects on a person's health. This may have little relevance to light pollution in parks, but it is important to note that bright lights in camp-sites may be unhealthy to humans as well as to the wildlife inhabitants of the park.

Sociology: Human sociology is affected by light pollution. It is now commonplace to be concerned by the fact that few people alive today have had the opportunity to experience the glory of the night sky. This is sad for citizens of “advanced” or wealthy countries, but it is a serious loss of the cultural heritage of aboriginal peoples and those who live (or lived) under natural and unpolluted conditions. The darkness of the night and the ability to commune with the natural beauty of the moon and stars and the glories of the aurora are necessary for the well-being and sociological wholeness of native peoples all over the world. Most of those who live in places like Canada and the United States of America can no longer experience the wholeness of dark skies. Parks that emphasise dark skies are thus an essential part of our human and environmental heritage.

Astronomy: It hardly needs to be mentioned that astronomy depends on dark skies and the virtual absence of light pollution. Both the importance and cost of astronomical research to our present society are very high, and are as important as environmental concerns for the control of light pollution.

Prospects for abatement of light pollution: the importance of public opinion

Public pressure is the surest way to reduce light pollution. This will assist releasing more funds for basic research in scotobiology, and for helping to develop legislation to control light pollution if that is found to be necessary. Light pollution can be controlled by reducing unnecessary lighting, focussing required lighting where needed rather than shining it in every direction, and the use of directional light shades where appropriate. Lower levels of illumination are often advantageous, and have been found to provide better safety and protection for pedestrians than the normally used bright streetlights. All these approaches are already being developed and put to use, but the continued application of public pressure is essential to reduce not only the actual light pollution and the cost in dollars for unnecessary lights, but also to reduce the environmental pollution that results from making the electricity to power them. Anything that can be done to stimulate public appreciation of the dangers and costs of light pollution will be well worth the effort.

If there are further questions about scotobiology, please call:

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