Royal Astronomical Society of Canada

Urban Star Park Guidelines (RASC-USP)

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Written by
Robert Dick

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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.

The goal of the USP Program is to make available to people in cities accessible areas relatively free of glare for the enjoyment of the night sky and demonstrate good nighttime lighting practices.

Accessibility to dark observing sites is the ultimate goal of the RASC Light Pollution Abatement Program. However, sites in close proximity to urban areas are contaminated by urban sky glow from artificial lighting. Sites with very dark skies without this sky glow are generally found far from urban centres and are therefore less accessible.

The RASC acknowledges this conflict between the need for accessibility and the desire for dark skies by defining two types of protected areas: Urban Star Parks (USP) and Dark Sky Preserves (DSP).

This document presents the guidelines for the establishment of Urban Star Parks, herein after referred to as “Parks”. It has been developed to encourage the recognition of Parks from which citizens may view and enjoy the night sky.

The RASC recognizes the value of volunteers in establishing an USP. These guidelines minimize administrative work for the Recreation or Park Planning Representative (the Manager), local astronomy groups and the RASC.

By promoting the use of these protected areas after dark, these Parks will see increased usage and support from the community during non-peak hours.

2.0 BACKGROUND

There is a growing need to identify and protect accessible areas that permit the public, novice stargazers and astronomers to enjoy the night sky. There is also a growing need to identify these areas within or near cities and protect them from light pollution.

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.

The ultimate goal of the RASC is to enhance the public's enjoyment of the night sky. The goal of the RASC Urban Star Park Program is to increase the quality of the night sky and accessibility to dark astronomy observing sites. Sites in close proximity to urban areas are generally contaminated by urban sky glow but they can still provide good views of the starry sky if glare and light trespass are minimized. This is provided by the GOL of the Urban Star Park (USP).

This section summarizes critical aspects of lighting in and around a USP. For more detail review the RASC-USP-GOL Document.

2.1 Artificial Lighting and Quality of the Night

A USP should preserve the quality of the night sky for the enjoyment of visitors. This requires limiting the glare and light trespass from outdoor lighting. It will not only improve visibility but will reduce the attraction of disease-bearing insects and it will reduce the effect of artificial light at night on the flowering and dormancy period of plants.

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 are up and can exceed 100X this natural level. Therefore in a city, people rarely experience the sensitivity of their eyes and are understandably fear the night. By reducing glare, and the over-bright areas, they will experience better visibility and a new enjoyment of the night.

The USP Guidelines to Outdoor Lighting (RASC-USP-GOL) address three components to light pollution: glare, light trespass and it further reduces the impact of these by controlling the colour of the artificial light.

Glare is light that shines horizontally across the area and is most easily prevented with the use of properly mounted shielded fixtures. Glare causes our iris to close down making our vision much more sensitive to imperfections in our eyes. These imperfections increase with age.

Fixtures that do not limit the area of illumination will shine light where it was not originally intended causing the nuisance of light trespass. The glare from unshielded fixtures also scatters off dust particles and aerosols above the ground to illuminate the air above the site. This is seen as artificial sky glow.

Sky glow causes the sky to appear with a grey, or if it is very bright it may appear orange. From within a city, this glow covers the sky and overwhelms the light of the stars. It can be

seen for hundreds of kilometres as a dome of light above an urban centre. Sky glow illuminates the land and affects the behaviour of wildlife.

Glare and sky glow affects how much we can see at night. Our eyes can adapt to darkness in two ways. The iris in our eyes open to let in more light and the photoreceptors in the retina increase in sensitivity. The glare from a single unshielded light can prevent this dark adaptation. Bright light prevents the iris from opening and high illumination levels prevent the retina from adapting to faint light. Indeed, few stars may be visible in the presence of glare under an otherwise dark sky. However if light fixtures are properly shielded, our eyes will adapt to the dark to a sufficient degree to see many stars even from within an urban area.

The RASC has developed Guidelines for Outdoor Lighting for Urban Star Parks (RASC-USP-GOL) that limits glare across the site, yet it allows sufficient lighting for safety and navigation. 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 also passive signage and encourages the use of flashlights by visitors after dark rather than installed lighting. This last point puts the control of lighting into the hands of the visitor.

There will be incremental improvements over time when the neighbourhood lighting around the USP adopts FCO, non-white luminaires and takes advantage of the reduction in glare to lower illumination levels.

2.2 Accessibility

The goal of a USP is to enhance the public's enjoyment of the night sky. This requires the designated USP to be as free of light pollution and as accessible as practical to the public after dark. Therefore, USP manager should ensure access to the area after normal hours of operation.

If access to the USP can be monitored, perhaps with a turnstile or motion detection counter at the entrance points, a visitor record should be maintained to assess the site usage after dark. This will help manage the USP.

2.3 Quality of an Urban Sky

The night sky above an urban area will be much brighter than above a rural site. This sky glow is caused by artificial light that shines directly into the sky or scatters off the ground. Dust raised by traffic will also scatter this light and will further degrade the sky quality over a city. Indeed the sky glow in a city can be so bright as to permit the reading of a newspaper on a non-illuminated street and may be the limiting factor to how many stars will be visible.

Sky glow can be measured using a Sky Quality Meter™ (SQM) from Unihedron, Inc. A reading of the sky glow above the USP (the zenith) may be used to assess the quality of the site. Sky glow should be measured and monitored over time to assess any improvement in lighting conditions.

3.0 URBAN STAR PARK (USP) GUIDELINES

The establishment of a USP is a partnership between the Park management, the Municipality, local stargazers and astronomers, and it requires their active support. There are two principal requirements for a USP:

1. an acceptable lighting protocol,
2. public access after normal hours, and
3. an active outreach program.

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

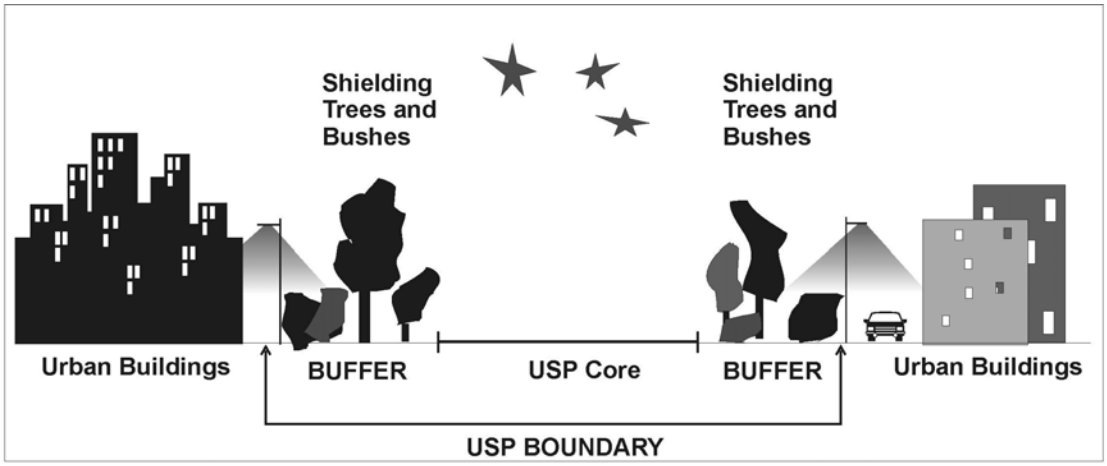
The RASC may choose to waive or amend any of these guidelines for a specific site provided that the integrity of the USP programme is not compromised.

3.1 Administrative Requirements

The Park should be available to pedestrians for stargazing and astronomy after dark. Therefore, the Park should be accessible to the public after normal operating hours to encourage viewing of the night sky.

In order to be an effective area to view the sky, the designated USP should have an area large enough for un-shielded lighting fixtures to be hidden from view from within the USP.

The night sky quality should be sufficient for the local astronomy group to recommend the site as an USP and to use the area for their outreach activities.



The quality of the sky should be quantified by a zenith Sky Quality Meter reading (Unihedron, Inc.[1]). This reading will become part of the USP designation: RASC-USP-XX.X, where the last set of numbers refers to the best SQM reading obtained at that site (in units of "magnitudes / arcsecond^2").

[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 advise.

A Buffer Zone shall encompass the USP Core in order for light fixtures in non-designated areas to be out of view behind buildings, berms, bushes or trees. These should also shield the USP Core from the lights of buildings outside the Buffer Zone and car headlights along adjacent roads.

In order for the Park to be protected from the future encroachment of light from beyond the Park boundaries, there should be a municipal policy or bylaw to help protect the area from the increase in glare or light trespass over the USP from municipal, commercial and private lighting.

Upon the award of the Designation, the USP should display a sign identifying it as a RASC USP. The digital file of the graphic for the sign will be provided by the RASC.

3.2 Lighting Protocol for USPs

Lighting within the USP should conform to the RASC USP lighting protocol (RASC-USP-GOL). This document is freely available from the RASC.

The lighting protocol is a guideline for the maximum amount of artificial lighting within a USP and its Buffer Zone, and it limits the area of impact. It also defines the luminaire shielding, duration and spectrum of the artificial light.

3.3 Outreach Program

There should be two major activities in the USP Outreach Program. The first activity should be public outreach and the second activity should be Municipal outreach.

The goal of these Outreach Activities is to both protect the Park and improve the darkness of the sky above the Park and promote the enjoyment of the night sky to the public. The Park will benefit with increased usage of the Park facilities and by increasing its profile as an important area for public activities.

3.3.1 Public Outreach Activity

The Manager should promote public observing sessions of the night sky from within the Park with the support and assistance of local astronomy groups.

Literature should be made available for the public at these observing sessions and in kiosks (if available) at the Park. As part of the Outreach Program, signage and information should be visible to site visitors. The signage should conform to the RASC-USP-GOL Lighting Protocol. Astronomy and light pollution information may be obtained from the Royal Astronomical Society of Canada on a cost recovery basis.

3.3.2 Municipal Outreach Activity

The Manager, with the support and assistance of local astronomy groups, should give presentations to the Municipality promoting the use of full cut-off fixtures, non-white colour and lower illumination levels in order to protect and improve the quality of the night sky over the Park. Presentation materials may be obtained free of charge from the RASC.

The Manager and local stargazers and astronomers 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 a proposed USP. However, the Manager and staff of remote sites may also nominate and submit nomination packages for consideration. Sponsors may be local astronomy groups or other community groups. The Manager and sponsors shall submit to the RASC documentation listed in Table 3.4 and other materials that may be requested by the RASC-LPAC to help them judge the suitability of the proposed area.

The information in Table 3.4 is to document the initial site in terms of the night sky quality and lighting fixtures in the Park and Buffer Zone. Support of the municipality is a strong asset in the nomination process.

The nomination should also include plans and schedules to up-grade any deficiencies in the current lighting plan for the site. SQM (Sky Quality Meter, Unihedron, Inc.) readings should be included with the submission document. Subsequent annual readings should be forwarded to the RASC to help review the improvement or degradation of the site.

A USP may be a portion of a larger park that may not comply with the USP requirements, however plans should be submitted detailing how and when these adjacent areas will be up-graded to comply with the USP lighting protocol.

The following explain the requirements outlined in Table 3.4 on page 8.

1. Statement of Compliance to the Lighting Protocol
The lighting protocol is designed to minimize the contamination of the area by artificial lighting. The statement should confirm compliance to the RASC-USP-GOL and the intention to maintain compliance.

2. Memorandum of Understanding
The designation of a USP requires a partnership between the Manager, the sponsor and the Municipality. 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 USP and Surroundings
The RASC web site requires sufficient maps and directions to promote the USP. 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 USP buffer zone under the Manager's control and the specific USP area within the park. These maps can be updated as the USP area is permitted to expand with improved reduced lighting.

4. Zenith SQM (location of reading marked on map)
Experienced observers will use the sky quality measurements to rate the quality of the site. These reading will also be used to benchmark sky glow in the area. Subsequent readings will document improvements over time.

5. Existing Light Fixture Inventory within the Proposed USP Core and Buffer Zone
This information should be presented in tabular form. 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.

7. Public Outreach Plan (education)
Kiosks and public outreach programs should 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 our view of the night sky. This is done through public stargazing sessions, guided night walks and written literature available to visitors. The illumination design of the park should provide good examples of how lighting can be used so as to minimize its impact the nocturnal environment.

8. Municipal Outreach Plan (for USP site protection)
The surrounding urban area is the sources of glare and sky glow in a park. In order to protect the USP from the encroachment of external lighting, the growth of light pollution around the Park must be reduced. Therefore the Manager must discuss the problem of glare and urban sky glow over the park with the municipality. The goal is for the municipality to develop a lighting policy that limits the increase in light pollution and reduces the per capita light pollution. Improvements can be readily measured with a Sky Quality Meter (Unihedron). The submission should indicate the commencement of talks with the municipality and demonstrate progress in the principle of reducing light pollution.

9. Images of USP 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 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 light panoramas should be presented with the same scale so they can be compared.

3.5 Revision to Designation

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

Table 3.4 USP Nomination Documentation List

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

4.0 RASC SUPPORT OF USPs

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

The RASC will also promote the USP 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 USP

The name of the USP shall be determined by the RASC in consulation with the nominating organization. The USP designation shall be used to develop a commitment from the region around the USP that may include a single or multiple municipalities and private partners. Therefore, the USP designation shall usually refer to the municipal location as may be identified on a road map (to assist visitors not familiar with the area to locate the site).

In the case of existing well-known parks the USP would most likely be named after the park itself. 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

Royal Astronomical Society of Canada, Urban Star Park Guidelines for Outdoor Lighting (RASC-USP-GOL)

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:

Dr. R.G.S. (Tony) Bidwell: (902) 257-2035; or e-mail: ts@ns.sympatico.ca
Robert Dick, 613-283-7815; or e-mail: rdick@csbg.ca