Royal Astronomical Society of Canada

Dark-sky Preserve Guidelines (RASC-DSP)

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.

The goal of the Dark-sky Preserve (DSP) Program is to promote the reduction in light pollution, demonstrate night-time lighting practices, improve the nocturnal environment of wildlife, protect and expand dark observing sites for astronomy, and provide accessible locations for the general public to experience the naturally dark night sky.

Currently, both urban and rural sites are contaminated by sky glow from artificial lighting created by the use of improper artificial lighting. Sites with very dark skies without this sky glow are generally far from urban centres and are therefore less accessible to astronomers and the public.

To address the need for accessible dark sites near urban centres, and to preserve dark natural sites, the RASC defines two types of protected areas: Urban Star Parks (USP) and Dark-sky Preserves (DSP).

This document presents the guidelines for the establishment of Dark-sky Preserves within dark sites, herein after referred to as “Parks”. For sites significantly contaminated by urban sky glow, refer to the RASC Urban Star Park documentation.

The RASC recognizes the value of volunteers in establishing a DSP. These guidelines minimize administrative work for Park managers, 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 and protect them from light pollution.

The ultimate goal of the RASC is to enhance the public's enjoyment of the night sky. The goal of the RASC Dark-sky Preserve Program is to increase the quality of the night sky and accessibility to dark astronomical observing sites. Sites with very dark skies without city sky glow are generally found far from urban centres but the magnificent view of the star-filled sky is worth the trip.

A DSP 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

A DSP should improve the quality of the night sky for the enjoyment of visitors, and protect the habitats of the nocturnal animals. Unshielded lighting fixtures and high levels of artificial illumination significantly degrade our view of the night sky and compromise the natural behaviour of animals. They also affect 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 can exceed 100X brighter. Therefore in a city, people rarely experience the sensitivity of their night vision.

The DSP Guidelines to Outdoor Lighting (RASC-DSP-GOL) address three components to light pollution: glare, light trespass and sky glow, and reduce its impact 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. Fixtures that do not limit the area of illumination will shine light where it was not originally intended causing the nuisance and disruption 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 orange colour. 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 can be as bright as the full Moon and illuminates the land - affecting the behaviour and biology 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 concentrated high illumination levels prevent the retina from adapting to faint light. Indeed, in the presence of glare under a relatively dark sky, few stars may be visible. But if light fixtures are shielded, our eyes will adapt to the dark to a sufficient degree to see many stars.

The RASC has developed a lighting protocol for Dark-sky Preserves (RASC-DSP-GOL) that respects and protects the need for naturally dark nights, yet it allows sufficient lighting 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 (Full Cut-off fixtures) that minimize glare 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 DSP is to enhance the public’s enjoyment of the night sky. This requires the designated area to be free of light pollution and as accessible as practical to the public after dark.

A typical park only has daytime activities however; a DSP should be available for use after dark. Therefore, DSP managers must ensure that the designated DSP area remains accessible after normal hours of operation. This will require that gates and parking lots remain open for visitors at night.

Appropriate signage will also be required to help visitors navigate the site. This signage should conform to the RASC-DSP-GOL.

2.3 Quality of a Dark Sky

The brightness of a rural sky will be much darker than an urban site. Indeed the illumination level of a cityscape can be brighter than that illuminated by the full Moon. So for practical reasons, acceptable levels of illumination for a DSP will differ significantly from those for a city.

The illumination levels for artificial lighting in a DSP should be limited to those consistent with natural sources (e.g.. Moon). And, its extent should be restricted so as not to minimize the area of disruption and illumination of areas beyond where it is needed.

In rural observing sites, our eyes may detect the distant urban sky glow near the horizon. The closer the DSP 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 DSP outreach efforts.

3.0 DARK-SKY PRESERVE (DSP) GUIDELINES

The establishment of a DSP is a partnership between the Park management, local stargazers and astronomers and neighbouring municipalities, and it requires their active support. There are two principal requirements for a DSP: an acceptable lighting protocol, and an active outreach program.

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

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

3.1 Administrative Requirements

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

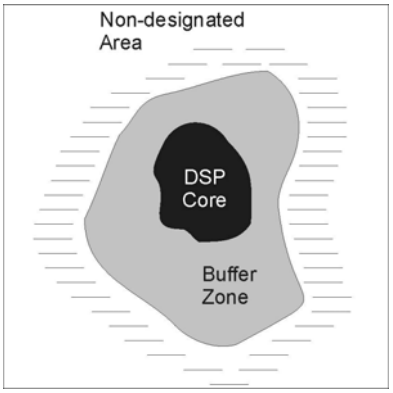
The application for DSP status should contain a written MEMORANDUM OF UNDERSTANDING between the Park, external sponsors and neighbouring municipalities supporting, and agreeing to, the requirements of the DSP.

The Park should be available for stargazing and astronomy after dark. Therefore, the Park should remain accessible to the public after normal operating hours.

The night sky quality should be sufficient for the local astronomy group to recommend the site as a DSP and to use the area for personal observing and outreach activities. The designated DSP should have an area large enough for lighting fixtures to be hidden from view from 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 DSP designation: RASC-DSP-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].

A buffer zone shall encompass the DSP 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 DSP. All light fixtures within the Buffer Zone should conform to the DSP-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 DSP.

Upon the award of the Designation, the DSP should display a sign identifying it as a RASC DSP. The RASC-DSP 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 DSPs

Outdoor lighting in the DSP should conform to the RASC DSP lighting protocol (RASC-DSP-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 DSP 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 further installation of lighting.

The extent, varied usage and lighting conditions within the park may conflict with stargazing. In large parks, the owners of private and rental properties may also limit widespread adoption of the lighting protocol. To accommodate these realities, a DSP 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 DSP-GOL.

3.3 Outreach Program

There are two major activities in the DSP Outreach Program. The goal of these Outreach Activities is to both protect the Park and improve the darkness of the sky above it. The Park

[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.

will benefit with increased usage of the Park facilities and by increasing its public visibility as an important protected area for public experience of the night environment.

3.3.1 Public Outreach Activity

The DSP should be open after dark to encourage the use of the site for stargazing, astronomy and night walks to experience the nocturnal wildlife. Local amateur astronomers should be contacted and encouraged to host public star nights in the DSP and these should be advertised by the Park. These activities should be further encouraged through brochures, DSP 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. 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

Urban growth outside Park boundaries can severely contaminate the night sky over the DSP with artificial sky glow. An active Municipal Outreach Program is needed to protect the DSP 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 local astronomy groups and scotobiologists, should give presentations to neighbouring municipalities to promote the use of full cut-off fixtures and lower illumination levels in order to protect and improve the quality of the night sky over the DSP. Digital files of presentation materials may be obtained from the RASC.

Park managers 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 the proposed DSP. However, managers and staff of remote sites may also nominate and submit nomination packages for consideration. Sponsors may be local astronomy groups, astronomers 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 DSP and lighting policies in the municipalities across the region. The submission requirements are used to document the DSP 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 DSP 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 DSP prior to the establishment of the DSP. However, the DSP 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 and astronomers. The entire park may not conform to this protocol, but is expected that the DSP Core shall conform prior to becoming a DSP. Non-conforming areas can be designated as Buffer Zones. Lighting conformance in the Buffer Zones must be budgeted and scheduled to conform to the DSP-GOL. (See item 5).

2. Memorandum of Understanding
The designation of a DSP 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 DSP and surroundings
The RASC web site requires sufficient maps and directions to promote the DSP. 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 DSP Core in the park. These maps can be updated as the DSP 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 DSP Core and Buffer Zones
This information should be presented in tabular form (MS-Exel 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 and our view of the night sky. This may be 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 DSP site protection)
Neighbouring urban areas are usually the major source of sky glow over the Park. In order to protect the DSP 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 DSP 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 light panoramas should be presented with the same scale so they can be compared.

Table 3.1 DSP Nomination Documentation List

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

3.5 Revision to Designation

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

4.0 RASC SUPPORT OF DSPs

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

The RASC will also promote the DSP 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 DSP

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

In the case of existing large Parks the DSP 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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