CANADIAN DARK SKY INITIATIVES

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During the 1980s Canadian astronomers became concerned that city sky glow could be seen for hundreds of kilometres, compromising the observation of faint celestial objects. These concerns took root in 1991 when the Royal Astronomical Society of Canada began to inform governments about light pollution impacts on astronomy, the environment, security and cultural values. Light during sleep is now also known to affect human health.

The environmental impacts of light pollution have attracted people interested in wildlife and its behaviour. For example, bird migration is affected by urban lighting. The Fatal Light Awareness Program was formed in 1993 to find a solution to the problem in Toronto. Volunteers document and publicize the magnitude of the problem. The City of Toronto recently adopted a lights-out policy for the protection of migratory birds.

The multiple impacts of light pollution are uniting Canadian astronomy and conservation communities in a movement to establish dark sky reserves. These are wilderness areas which have policies to prevent light pollution and which offer opportunities for the public to enjoy the heavens, to protect the night environment, and to preserve cultural traditions and values associated with the night sky. Canada's first such reserve, the Torrance Barrens Dark Sky Reserve, was established in 1998 in the Muskoka district north of Toronto. Several others have since been designated, such as Point Pelee and Elk Island National Parks. The adoption of dark sky policies by park agencies indicates their recognition of the issue and the need to find solutions for both environmental and social reasons.

As a result of the 2003 international symposium on the Ecology of the Night, one of the authors (Bidwell) coined the term scotobiology for the science of the dependence of plants, animals and their interactions upon natural dark periods. Ecosystems operate 24/7, and we encourage scientists to examine the consequences of artificial outdoor lighting on ecological integrity.

The conclusion is clear. Light pollution is seriously damaging to humans, plants and animals. It knows no boundaries: highway, city, transmission tower and building lights indiscriminately harm or kill wildlife, and attract it away from its natural environments. Social and legal constraints must be established on night-time lighting to make dark skies a fundamental property of the wilderness and our experience of it. Reducing stray light in urban and peri-urban areas will help to restore the public's attachment to the night sky and will contribute to energy efficiency targets for sustainable societies.

The Light Pollution Abatement Program of the Royal Astronomical Society (RASC)

Light pollution is composed of three aspects: glare, light trespass and sky glow. Glare is light that shines directly into the eyes and reduces visibility by inhibiting our ability to see into shaded areas. It usually results from unshielded or misdirected lighting. Light trespass is light that shines where it is not needed, typically across property lines and into windows. Sky glow is caused by light that shines upward and is scattered off dust and aerosols in the lower few kilometres of our atmosphere. It is seen at a great distance as the dome of light over urban areas.

There have been calls in the name of energy efficiency and privacy for the reduction of unnecessary outdoor lighting since the oil crises of the 1970s. However, Canadian concern about the impact of light pollution on astronomy started in 1989 with the publication of the second edition of Nightwatch by Terence Dickinson (1989; ref. 1). The growth of lighting within cities was increasing at an alarming rate, and city sky glow could be seen for hundreds of kilometres, compromising the observation of faint celestial objects. In 1991 the RASC established a committee to manage its Light Pollution Abatement (LPA) Program (www.rasc.ca/lpa/index.shtml), with chapters in six cities. The Committee created a focus for the growing discontent of RASC members with the erosion in the quality of their observing sites. The LPA Program mission was to assist members to promote better lighting practices within urban areas.

However, the program was labour intensive and volunteers were in short supply. A more efficient and effective program was needed if the growth in light pollution was to be stopped or reduced. Starting in 1998 a new LPA Program concentrated on contacting and speaking to officials of local and federal governments to inform them of the growing problem of light pollution and the degradation of the environment due to inappropriate lighting. The program focus moved from astronomy and concentrated on the harm it caused to the environment and its impact on public security. This change in focus attracted more established environmental groups involved with wildlife and its behaviour. For example, bird migration is severely affected by urban lighting. This message caught the attention of the public better than the complaints of a few astronomers. Although biologists and botanists have known about the affects of nocturnal lighting for some time, research of the last ten years has also revealed that nocturnal lighting adversely affects human health. This gives us another argument for reducing light pollution.

"Hunting the Future" by First Nations artist, poet and illustrator Michael Robinson.

Although the LPA Program began as a grass roots effort, it did not have national impact until the media became involved.

To bring the message of light as a form of pollution to the public, an RASC award program was extended to governments and corporations. Award ceremonies are organized to maximize media coverage. After less than ten years, light pollution was brought into the public eye and LPA has become adopted by municipalities and federal government departments. Media coverage also made volunteer efforts much more effective. Whereas a 7-hour display in a shopping mall with several volunteers would be seen by several thousand people, a thirty-minute interview with a reporter could be seen by a hundred thousand people during a prime time newscast and picked up by the networks and broadcast nationally.

In Canada, light pollution has been featured in a documentary on the nature of light and has been the subject of a planetarium program and display. It is a principal component in the Green Plan for Calgary, southern Alberta. Communities like Abbotsford in southern British Columbia, Oshawa in southern Ontario and Mississippi Mills in eastern Ontario have adopted fully shielded lighting fixtures wherever possible for all municipal lighting.

Although municipal bylaws are effective at limiting pollution, the process of bylaw enactment is complex and it is not guaranteed that a bylaw's effectiveness will survive committee review. A less political route can be more effective. By requiring that LPA policies be followed when a construction project is proposed, poor lighting practice can be prevented, thus avoiding the problem a bylaw might control. This process rarely attracts much attention on city councils or in the media. By using site control agreements to enforce the use of full cut-off fixtures, many municipal activities are regulated without fanfare.

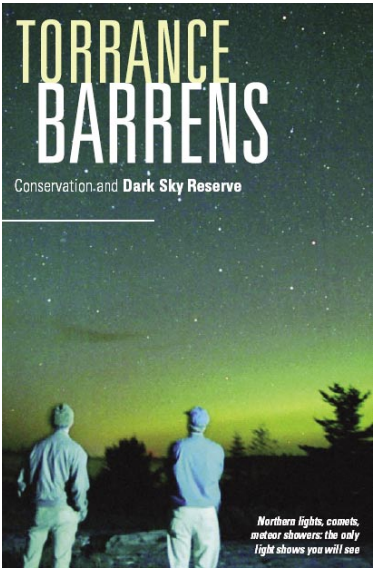
With the recognition by Parks Canada of the importance of the nocturnal environment to a healthy ecosystem, several provincial and federal parks have been designated dark sky reserves that will limit further degradation. More remote parks will receive the designation of dark sky preserve to prevent any degradation in the nocturnal environment.

The Fatal Light Awareness Program (FLAP)

Many species of birds migrate at night. Guided in part by the constellations, they are attracted to, or distracted by, lights from skyscrapers, broadcast towers, lighthouses, monuments and other tall structures. The birds either flutter about the light until they drop from exhaustion, or actually hit the object. Approximately half die from injuries suffered in the collision. Many require medical attention. Head trauma, broken beaks and feather damage are typical injuries. Others are just stunned and revive in a couple of hours. However, trapped in a maze of bright office towers, their chances of making it out alive are slim. Gulls, cats, crows and other predatory animals soon learn to patrol in search of easy meals. As day breaks the birds often collide with windows which reflect the surrounding environment, often with fatal results. Those that manage to avoid further window strikes may starve to death.

FLAP, a volunteer based-organization, was formed in 1993 to help to find a solution to this problem (www.flap.org). Volunteers patrol the financial district to recover fallen birds. Healthy birds are released back into their natural habitat, while the injured are transported to rehabilitation centres. They document and collect dead birds where

they are later used as specimens for accredited institutions. More importantly, FLAP educates tenants, cleaners, security staff and managers of office buildings on how best to minimize lights at night or to control the escape of light in areas where people work late. In an effort to reach a broader audience FLAP partnered with the City of Toronto. This resulted in Toronto being the first city in North America to pass a migratory bird protection policy. It is now working on a light pollution bylaw (www.toronto.ca/lightsout/index.htm).



Dark sky reserves

The World's first dark sky reserve may be Michigan's Lake Hudson State Park Dark Sky Preserve established in 1993. In Canada, the concept of extending dark sky friendly policies from an urban area to a rural area was proposed by one of the authors (Goering) at community meetings in the Muskoka District, north of Toronto, in the Spring of 1998. With the support of the Muskoka Heritage Foundation and the Ontario Ministry of Natural Resources (O.MNR), a group of interested parties met in July 1998 to recommend dark sky protection to the newly established Torrance Barrens Conservation Reserve. By July 1999 the Torrance Barrens was officially announced by the O.MNR as Canada's first dark sky reserve (www.muskokaheritage.org/natural/torrancebarrens.asp). Since then, all fifty-two conservation reserves in the Parry Sound region, east of Lake Huron, have had dark sky protection written into their management guidelines.

During the next two years, several articles were published in newspapers and magazines. The idea of permanently preserving the night sky in protected areas seized the attention of many people and groups. Television interviews and radio discussions indicated a broad public interest in the idea of establishing a dark sky reserve within a two hour drive of several million people. The Torrance Barrens story inspired the Fraser Valley Astronomy Society to lobby the city of Abbotsford, 75 km east of Vancouver, to declare its outlying McDonald Park to be a dark sky reserve in 2000. Like Torrance Barrens, the idea of a daylight park for conventional public park use and a dark park for amateur astronomers stuck a chord with local authorities and the public. In both cases there are policies to ensure a dark buffer zone around the park.

Since March 2003 the Mont Mégantic ASTROLab, southern Québec, has campaigned against light pollution from the surrounding communities and to establish a dark sky reserve in order to preserve the astronomical research at the Mont-Mégantic Observatory. See Legris, this conference, and www.astrolab.qc.ca. It developed an action plan based on raising public awareness, developing technical guidance and promoting regulation for the conversion of alternate lighting equipment. The city of Sherbrooke and

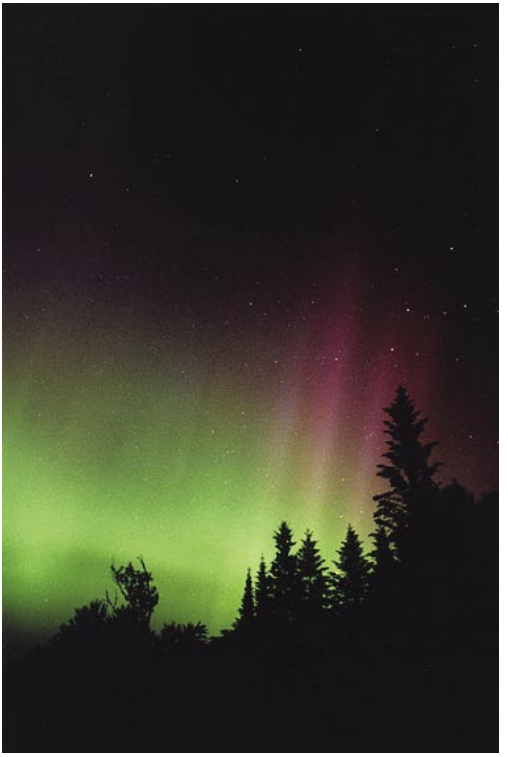
thirty-two surrounding communities within 50 km of the observatory have adopted light pollution regulations.

Typical activities at dark sky reserves, such as annual celebrations, public awareness, star parties (e.g. www.muskokastarparty.com), park interpretation and lobbying of local municipalities and land holders to control lighting, continue to involve many community groups.

Parks Canada initiatives

The Royal Astronomical Society of Canada recognizes three Parks Canada sites to be dark sky preserves. Fort Walsh National Historic Site is part of the interprovincial Cypress Hills Dark Sky Preserve declared in 2004. Point Pelee and Elk Island National Parks received the same status in 2006. Refer to www.pc.gc.ca for locations.

Even prior to these recent developments, Parks Canada protected its dark skies. There are seven small towns within national parks, and the management plan for each of gives direction to reduce light pollution (www.pc.gc.ca for downloadable copies of most plans). For example, from the Field Community Plan, Yoho National Park, "Star gazing is one of the highlights of a park visit for many visitors, particularly city dwellers" (p.12) and "Lighting should enhance the streetscape, draw attention to positive elements, and eliminate light pollution" (p.65). Or from the community plan for Jasper, "Although an appropriate level of street lighting is essential for public safety, poorly installed outdoor lighting is energy inefficient, intrudes on adjacent properties and reduces night sky visibility" (p.18). Both plans add more detailed guidance than cited here, and similar rationales and prescriptions can be found for Lake Louise in Banff National Park, Wasagaming in Riding Mountain National Park, Waskesiu in Prince Albert National Park, and Waterton in Waterton Lakes National Park, "Street lighting ... will have an illumination that will allow for night time viewing of stars, night vistas and moonlit peaks (p.33). Internationally, the best known national park and park town is Banff, but this became a self-governing town in 1990. Nevertheless, in 2005 it passed a bylaw to curb light pollution and render much of today's lighting non-conforming.



Northern lights from southern Québec. (http://epod.usra.edu)

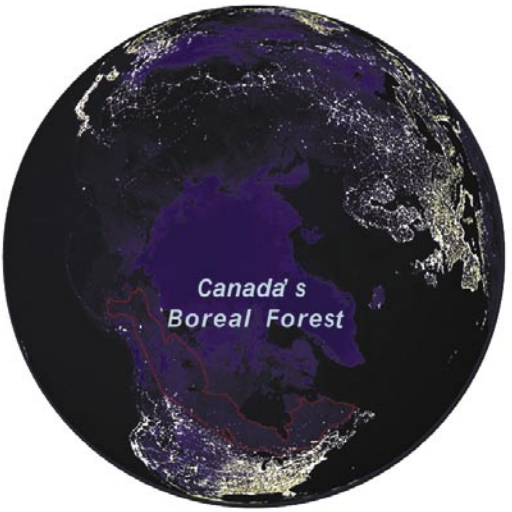
As well as these explicit protections of the night sky, Parks Canada has several other means to encourage the elimination of light pollution.

- Most of the land of national parks is truly wilderness, even by North American standards, and is zoned accordingly to prevent the intrusion of buildings, roads and other artefacts of the built environment.
- Light pollution reduction is included in its greenhouse gas emission reduction program.
- A pivotal ministers report on the ecological integrity of national parks stressed the importance that visitors should experience parks that are not disturbed by human activity. The report used the Torrance Barrens Dark Sky Reserve as an example of appropriate use and the provision of an unspoiled wilderness experience (Parks Canada 2000, p.11-5; ref. 2).
- Several parks promote night sky viewing as part of the park visit experience. Wapusk National Parks, for example, promotes "watching the northern lights dance in the night sky." In 2007 Elk Island National Park starts a program of night sky interpretation and star parties.

Parks Canada continues to develop and implement dark sky policies through such means as developing guidelines for outdoor lighting on Park Canada lands and sites, community plans that prescribe lighting standards, visitor experience programs and public education.

Ecology of the night

In September 2003 the Muskoka Heritage Foundation hosted the International Ecology of the Night Symposium (www.ecologyofthenight.org). This event brought together many experts on the impact of light pollution on biology, human health and public safety, and presented the argument for controlling light pollution. Symposium themes covered: 1) scientific and biological interests; 2) human health; 3) achieving dark sky compliance through voluntary and regulatory means, and 4) the importance of the night sky to the cultural, spiritual and historical worlds.



The biological and medical impacts of light pollution are increasingly well known, but there is less thought given to the subjective impacts on culture and society. Light pollution leads to the loss of first-hand experience and knowledge of an essential part of the natural world. It is sad and

astonishing that two-thirds of North Americans have never seen, and never will see, the Milky Way. The aurora borealis cannot be seen from within most Canadian cities and suburbs. We also lose the link to the inspiration of much mythology, exploration, art, music and literature. In the developed world, we have created a culture of the illuminated sky and lose our affection for the night.

The symposium helped to establish a new word, scotobiology, for the science of the behaviour and dependence of species and ecosystems on natural dark, and the disruptive effects of light pollution. Research has shown that light pollution seriously affects the health and behaviour of most animals, particularly mammals, birds, amphibians and insects (Rich and Longcore 2006; re. 3). Their food gathering and feeding habits, mating and sociological behaviour, and their health and well-being are all disturbed by flashes or periods of light during the night. In particular, birds and insects may be disorientated to the extent that their migration habits are affected, or they may fly into lights and be killed. Some plants are also adversely affected by nightly light pollution, to the extent that their capacity to reproduce or to enter winter dormancy may be compromised. Conversely, some plant species may benefit from extended illumination, but in naturel systems this causes unnatural changes in plant succession. In humans, sleep-time illumination interferes with hormone production, leading to increased susceptibility to diseases such as cancer and psychiatric or psychological disorders. The effects of light pollution on social behaviour are less well documented, but are reportedly sufficiently serious to cause concern, particularly for native populations for whom a clear and uninterrupted view of the night sky is an important part of their heritage. A web search will reveal many reference, such as http://en.wikipedia.org/wiki/Scotobiology.

Into the night ...

Efforts continue on various fronts. Every month web searches find more references to scotobiology. Environmental non-government organizations are starting to recognize dark skies as one more value to protect in the natural environment. Later this year, the Mont-Mégantic ASTROlab will host the 2007 Symposium of the International Dark Sky Association (www.astrolab-parc-national-mont-megantic.org/data/ida).

Opportunities to protect extensive biological systems are limited to countries like Canada, Brazil and Russia that have the Earth's last remaining large scale forested environments. Other highly industrialized regions and countries in the world, such as Western Europe, Japan and the contiguous United States, can no longer can provide similar pristine nocturnal environments on this scale. Canada can and does protect portions of its boreal forest, and such protection could be extended to include dark sky policies to guard against light pollution. Such an opportunity lies in the recent proposal of the Boreal Forest Framework introduced to the public in 2003 by an alliance of eleven groups representing conservation organizations, first nations and industry.

Conclusion

Light pollution is seriously damaging to humans, plants and animals. It knows no boundaries: highway, city, transmission tower and building lights indiscriminately harm or kill wildlife, and attract it from its natural environments. Social and legal constraints

must be established on night-time lighting to make dark skies a fundamental property of the wilderness and our experience of it. Reduced stray lighting in urban and peri-urban areas will help to restore the public's attachment to the night sky and will contribute to energy efficiency targets for more sustainable societies.

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