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Protecting the Starry Night: The Effects of Light Pollution

Protegendo a noite estrelada: os efeitos da poluição luminosa

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Abstract

The purpose of this paper is to explore the effects of light pollution. This paper will address the ramifications that artificial lighting has caused to human health, the ecosystem, the environment, and the night sky. Lighting solutions will be discussed as well as policies that have been implemented in cities to protect from the harm of light pollution in various capacities.

Keywords: Light Pollution. Astronomy. Wildlife. Human Health. Night Sky. Artificial Lighting. Environment.

Resumo

O objetivo deste artigo é examinar os efeitos da poluição luminosa. O trabalho aborda as ramificações que a luz artificial tem causado à saúde humana, ao ecossistema, ao meio ambiente, e ao céu noturno. Soluções de iluminação são discutidas, assim como políticas implementadas por cidades para se protegerem do dano causado pela poluição luminosa.

Palavras-chave: Poluição Luminosa. Astronomia. Vida selvagem. Saúde Humana. Céu noturno. Luz artificial. Meio Ambiente.

1 Introduction

For centuries, people have experienced and connected with the natural wonder of starry skies. The natural night sky has inspired religion, philosophy, music, literature, and art. However, due to light pollution that connection is becoming lost (INTERNATIONAL DARK SKY ASSOCIATION, n.d.). In addition to the night sky, light pollution is impacting wildlife, ecosystems, the environment, and human health (INTERNATIONAL DARK SKY ASSOCIATION, n.d.). Therefore, the purpose of this paper is to explore the impacts that light pollution has on wildlife, the environment, human health, and the night sky. In addition, the solutions and policies that are being used in cities to combat the problem of light pollution will be discussed as well as public misconceptions regarding light pollution.

2 What is Light Pollution?

Light pollution is defined as "the inappropriate or excessive use of artificial light" (INTERNATIONAL DARK SKY ASSOCIATION, n.d.). It comes in a variety of different forms:

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light trespass, sky glow, glare, and over illumination (CHEPESIUK, 2009). Light trespass occurs when "unwanted artificial light from floodlights or streetlights spills onto an adjacent property that would otherwise be dark" (CHEPESIUK, 2009). Sky glow is defined as "a bright halo that appears over urban areas at night, which is the product of light being scattered by water droplets or particles in the air" (CHEPESIUK, 2009). Glare is "created by light that shines horizontally" (CHEPESIUK, 2009) and over illumination "refers to the use of artificial light that is well beyond what is required for a specific activity such as keeping all the lights on in a building at night" (CHEPESIUK, 2009).

3 Light Pollution, Wildlife, and Ecosystems

For billions of years, life on Earth has relied on day and night cycles (INTERNATIONAL DARK SKY ASSOCIATION, n.d.). Wildlife and plant cycles have become greatly disrupted of their natural rhythms due to the use of artificial lighting at night which is turning night into day (INTERNATIONAL DARK SKY ASSOCIATION, n.d.). It is vital that these light and dark cycles do not become interrupted because they are imperative for reproduction, sleep, predator protection, and nourishment (INTERNATIONAL DARK SKY ASSOCIATION, n.d.). Furthermore, many animals are nocturnal, including 80% of marsupials and 20% of primates (CHEPESIUK, 2009).

Birds are significantly impacted by light pollution. Annually, in New York City, over 10,000 migratory birds are injured or killed due to building collisions (CHEPESIUK, 2009). Migration and hunting patterns are interrupted because the birds use the light of the moon and the stars to navigate (INTERNATIONAL DARK SKY ASSOCIATION, n.d.). Artificial light from lit buildings, communication towers, and other types of buildings cause them to fly off course into hazardous city landscapes (INTERNATIONAL DARK SKY ASSOCIATION, n.d.). Also, birds may migrate too early or too late which can cause birds to miss out on perfect climate conditions (INTERNATIONAL DARK SKY ASSOCIATION, n.d.). This is significant because approximately 200 different species of birds routinely migrate at night over North America (CHEPESIUK, 2009).

Sea turtles have been greatly affected by light pollution as well. Sea turtles lay their eggs at night and prefer a dark environment (CHEPESIUK, 2009). Many beaches where sea turtles are nesting are brightly lit which halts nesting, furthermore, sea turtles become confused by the lights and will often move towards roadways which can cause them to be struck by a vehicle (CHEPESIUK, 2009). Hundreds of thousands of sea turtles are killed in Florida alone (KLINKENBORG, 2008). Plants have been greatly affected by artificial lighting as well because it disrupts the dormancy and flowering times of plants (ROYAL ASTRONOMICAL SOCIETY OF CANADA, NOCTURNAL PRESERVE GUIDELINES, 2013). Furthermore, exposure to artificial lighting over a long time period causes many trees to stop adjusting to their natural seasonal variations (CHEPESIUK, 2009).

4 Lights and the Environment

Artificial lighting plays a significant role in harming the environment due to its high energy waste. Various naturalists, environmentalists, and medical researchers believe that light pollution is one of the fastest growing and ubiquitous types of environmental pollution that exists today (CHEPESIUK, 2009). The International Dark Sky Association states that in the United States, at least 30% of outdoor lighting is wasted energy because many outdoors lights are not shielded properly (INTERNATIONAL DARK SKY ASSOCIATION, 2015). Furthermore, the cost of these outdoor lights would amount to 3.3 billion dollars a year and they would create 21 million tons of carbon dioxide annually (INTERNATIONAL DARK SKY ASSOCIATION, 2015). The United States spends 2.2 billion dollars each year on wasted energy that serves no real purpose (NARISADA; SCHREUDER, 2004). Furthermore, approximately 2/3's of electricity used in America is derived from non-renewable fossil fuel sources (NARISADA; SCHREUDER, 2004).

5 Lights and the Impact on Human Health

Human health is taking a toll from artificial lighting as well. Artificial lighting is negatively linked to depression, sleep disorders, breast cancer, diabetes, and increased obesity risks (INTERNATIONAL DARK SKY ASSOCIATION, n.d.). Similar to wildlife, artificial lighting disrupts humans' circadian rhythm, which is a 24 hour night and day cycle that significantly impacts humans' physiological functions (CHEPESIUK, 2009). Furthermore, the circadian clock is said to control 10-15% of people's genes, so disruption can play a major role in health issues (CHEPESIUK, 2009). Artificial lighting interrupts melatonin production which is also an essential part of humans' circadian rhythm cycle (INTERNATIONAL DARK SKY ASSOCIATION, n.d.). Melatonin is released at vital times during the night and is a hormone that is essential for keeping people healthy due to that fact that is has antioxidant properties, boosts immunity, helps thyroid function, fosters sleep, regulates cells, and lowers cholesterol (INTERNATIONAL DARK SKY ASSOCIATION, n.d.). Exposure to artificial lighting at night causes melatonin levels to drop significantly (CHEPESIUK, 2009). In essence, artificial lighting is disrupting the synergistic flow between melatonin production and circadian rhythms which can lead to long term health issues (INTERNATIONAL DARK SKY ASSOCIATION, n.d.).

6 Impacts on the Night Sky

The night sky is a valuable natural resource for all living things on Earth (FLAGSTAFF DARK SKIES COALITION, 2015). It is noted that 60% of the world lives under skies that are polluted with light, with 99% of that population in Europe and United States (FALCHI et al., 2011). This means that approximately 1/5th of the world's landscape is impacted by light pollution

(FALCHI et al., 2011). However, the glow that comes from uncontrolled exterior lighting is masking the stars and is changing humans' perceptions of the night sky (FLAGSTAFF DARK SKIES COALITION, 2015). In the United States, 2/3's of people live under bright skies that have lost the ability to observe the Milky Way (FLAGSTAFF DARK SKIES COALITION, 2015). Unfortunately, the loss of the Milky Way is largely due to poor lighting practices (FLAGSTAFF DARK SKIES COALITION, 2015). In 1994, a big earthquake in Los Angeles caused a power outage and many people called emergency centers for help because of something that happening in the sky (CHEPESIUK, 2009). What was happening was that the people of Los Angeles were seeing the Milky Way for the first time because the sky glow from the city's lights had caused it to vanish (CHEPESIUK, 2009).

The stars have always been visible for people, only in the 20th century has humans' ability to view the stars been greatly impacted (MIZON, 2012). Each clear night, the starry night belonged to everyone, but it has been quietly and slowly taken away due to poor artificial lighting (MIZON, 2012). Before, the internet and enterprises, humans' examined the night sky and would ponder what the universe meant through stories and trade (PENPRASE, 2011). Furthermore, stars influenced many of the world's wonders such as the Pyramids of Giza and Stonehenge (PENPRASE, 2011). There are many stories of how the world came to be through creation stories that drew inspiration from the constellations (PENPRASE, 2011). At least 95% of First Nations star knowledge has been lost, tales that would take hours to explain only take a few minutes to tell now (McMAHON, 2014). In essence, the night sky provides insight, perspective, and allows for humans' to reflect on their place in the universe (INTERNATIONAL DARK SKY ASSOCIATION, n.d.). Without the night sky humans would not have: walked the moon, navigated Earth, learned about the universe, and found scientific discoveries (INTERNATIONAL DARK SKY ASSOCIATION). The International Dark Sky Association (n.d.) asks this question: "Van Gogh painted his famous "Starry Night" painting in Saint Remy, France in 1889, the Milky Way can no longer be seen from there, if he was alive today, would he still be inspired to paint "Starry Night?"

7 Lighting Solutions

To help reduce the impacts of light pollution different types of lighting can be used. This is important because in the United States alone, there are approximately 16.2 million different types of commercial and public lighting that is used which include: parking lot lights, commercial building lights, and streetlights (INTERNATIONAL DARK SKY ASSOCIATION, n.d.). Artificial lighting has many benefits such as increasing the length of the day and creating more nightly activities (CHEPESIUK, 2009). The real problem with artificial lighting lies in using unnecessary, inefficient, and poorly installed types of lighting (CHEPESIUK, 2009).

One of the key causes of light pollution is the way that lights are directed. Light is projected into the night sky because it shines upward or to the side without actually lighting up the area

that it is supposed to (FLAGSTAFF DARK SKIES COALITION, 2015). To prevent light from shining upward, fully shielded lighting has the ability to reduce sky glow by 50-90% in comparison to a half shielded or unshielded light (FLAGSTAFF DARK SKIES COALITION, 2015). It is noted that a normal unshielded lighting fixture wastes 50% of its light because the light shines upward (CHEPESIUK, 2009). Proper shielding has the ability to direct light where it is actually intended to go (CHEPESIUK, 2009). The type of light that is used is essential to reducing light pollution as well. Using the right type of lighting can decrease energy use by 60-70%, reduce carbon emissions, and save billions of dollars (INTERNATIONAL DARK SKY ASSOCIATION, 2015). Low pressure sodium lights (LPS) currently have the lowest environmental effect due to their energy efficiency in comparison to other types of outdoor lighting (FLAGSTAFF DARK SKIES COALITION, 2015). However, the downside to using LPS lights is that they require specific disposal and are more difficult for proper light distribution (FLAGSTAFF DARK SKIES COALITION, 2015). Furthermore, LPS lights have been criticized due to their preference by astronomers (POLLARD, 1994). LPS is used by astronomers because they filter out sodium lines from astronomers telescopes (POLLARD, 1994). Unfortunately, this type of lighting is not necessarily the best for all people (POLLARD, 1994). It is recommended that LPS be used in observatories and LPS compact lamps should be used for the general public (POLLARD, 1994).

Other types of effective lighting are high pressure sodium lights (HPS). The difference between HPS and LPS lights are that HPS lights have a better colour (INTERNATIONAL DARK SKY ASSOCIATION, n.d.). The other type of light is an LED light, they are effective because they can be adjusted or turned off completely (INTERNATIONAL DARK SKY ASSOCIATION, n.d.). The International Dark Sky Association (n.d.) recommends using a "warm" type of light as well as limiting or in best case practice avoiding blue lights (see Figure 1).

Falchi et al. (2011) outline various ways to limit the effects of light pollution. Along with fully shielded lights, they also recommend the prevention of over illumination. It would be beneficial to avoid using more lighting than is actually required (FALCHI et al., 2011). Also, turning off lights when they are not in use would be helpful, however, it is noted that turning off outdoor lighting in most cases is uncommon (FALCHI et al., 2011). Lastly, having lights installed by a professional would help direct the light properly (FALCHI et al., 2011).

Stray light is a growing concern as well. Stray light is caused by poor lighting designs and comes with various negative effects like the loss of the ability to see the stars and it wastes money and energy (POLLARD, 1994). Different factors were examined regarding stray light such as zoning, installation, and big scale lighting designs. For zoning, it is important to note that the type of lighting that is required in a city is much different than what is required in a rural area (POLLARD, 1994). Installing lights properly is imperative because it would limit the actual amount of light that is required for a specific task (POLLARD, 1994). Lastly, buildings, floodlighting, and sports areas should be examined. Some solutions to prevent the amount of light given off from these places would be administering a lighting curfew where lights are required to be turned off at a certain time, proper lighting types should be installed, screens could be used to reduce glare, and these places should not be over illuminated (POLLARD, 1994).

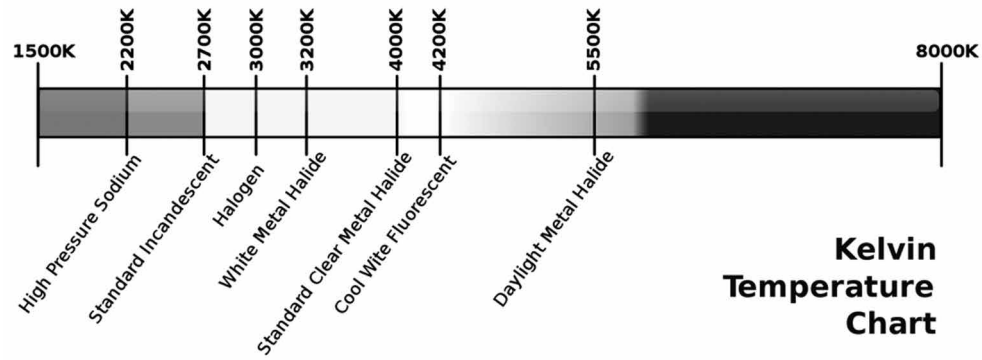

Figure 1 - Kelvin Temperature Chart
Fonte:LED Practical Guide from the International Dark Sky Association (2015)

8 Dark Sky Organizations

Various organizations have been set up to raise awareness and prevent light pollution. One of these groups is the International Dark Sky Association (IDA) which is based in the United States. The IDA was incorporated in 2001 (INTERNATIONAL DARK SKY ASSOCIATION, n.d.). The main goal of the IDA was to "encourage communities around the world to preserve and protect dark skies through responsible lighting policies and public education" (INTERNATIONAL DARK SKY ASSOCIATION, n.d.). The IDA administers five different designation types for communities that are making an effort in reducing light pollution (INTERNATIONAL DARK SKY ASSOCIATION, n.d.). The first designation is an International Dark Sky community. An International Dark Sky Community is defined as any community that uses quality outdoor light practices. The second designation is an International Dark Sky Park which focuses on natural conservation lighting and protection. The third designation is an International Dark Sky Reserve which emphasizes on the core of a nature reserve being in darkness. The fourth designation is an International Dark Sky Sanctuary that protects dark and remote sites where nature conservation is fragile. The last designation is a Dark Sky Development of Distinction which master planned communities, unincorporated neighbourhoods, subdivisions, and townships have on-going efforts to protect and promote a natural night sky. However, the Dark Sky Development of Distinction areas cannot qualify as an International Dark Sky Association community.

Another important organization is the Royal Astronomical Society of Canada (RASC). The main goal for RASC is to "enhance the publics' enjoyment of the night sky. If glare and light trespass are minimized, good views of the starry sky will exist for everyone". RASC has three types of designations for communities that are protecting the night sky. These designations are Urban Star Parks (USPs), Nocturnal Preserves (NPs), and Dark-Sky Preserves (DSP) (ROYAL ASTRONOMICAL SOCIETY OF CANADA, 2015). Key guidelines to qualify as an USP are that it should protect and preserve the quality of the night sky. A USP also focuses on using limited levels of illumination, and it promotes the use of natural barriers like berms, trees, and

bushes which will help prevent reflected and scattered light. Furthermore, a USP emphasizes the benefits of using a flashlight, this in turn allows the visitor of the park to have control of the lighting. The size of a USP should be large enough that unshielded lights have the ability to be hidden from within with of the park. Also, a USP needs to provide public access after normal operating hours of park and they must have an active community outreach program. The quality of the night sky in a USP can be measured in terms of that the sky should be good enough for an astronomy group to recommend the site as a USP. Lastly, there should be a municipal by law or policy that is adopted to protect the park from light trespass in glare from any commercial, private, or municipal lighting.

The guidelines for a Nocturnal Preserve (NP) is quite similar to the guidelines of an Urban Star Park (USP). The vision statement for a NP is to "promote the reduction of light pollution, demonstrate night time lighting practices, improve the nocturnal environment for wildlife, protect and expand dark observing sites for astronomy and provide accessible locations for the general public to experience the naturally dark night sky". Essentially, an NP protects the quality of the night sky for wildlife by preserving and protecting nocturnal animals' habitats, all while still being accessible to visitors (ROYAL ASTRONOMICAL SOCIETY OF CANADA, 2015).

A Dark-Sky Preserve (DSP) has the goal of being an area "in which no artificial lighting is visible and active measures are in place to educate and promote the reduction of light pollution to the public and nearby municipalities. Sky glow from beyond the borders of the Preserve will be of comparable intensity, or less, to that of natural sky glow". The DSP guidelines are essentially the same as a Nocturnal Preserve.

The Flagstaff Dark Skies Coalition (FDSC) is based out of Arizona and focuses on protecting the night skies in Flagstaff and Northern Arizona (FLAGSTAFF DARK SKIES COALITION, 2015). The FDSC provides guidelines to communities throughout the world in terms of what types of lighting should be used, types of lighting codes, and provides a general basis of the effects of light pollution (FLAGSTAFF DARK SKIES COALITION, 2015).

A local example of a dark sky organization is the Nanaimo Dark Skies Project (NDSP). The NDSP has 3 objectives: "to work with the local government, work with stakeholders (local businesses), and to participate in public outreach programs that educate people on preserving the night sky". Furthermore, the NDSP wants to limit greenhouse gas emissions, cut down on tax payer spending for poor lighting, and they want to preserve the quality of the night sky. One of the NDSP's major goals is to designate Westwood Lake as Dark Sky Park that is officially approved by the International Dark Sky Association (NANAIMO DARK SKIES PROJECT, 2015). In the past, star walks have been offered at Westwood Lake and it is an ideal place to stargaze because the park isn't greatly affected by light pollution due to its elevation. The NDSP also works to educate people on the energy wastes that come from artificial lighting. For instance, it is noted that 38% of Nanaimo's energy budget goes towards lighting streets which is wasting tax pay dollars because the lights that are used aren't the most efficient. The NDSP notes that better lighting greatly cuts down on energy costs because The City of Calgary installed better streetlights and the city saved over $11 million dollars in energy costs.

9 City Policies and Light Pollution

Light pollution is beginning to become more prevalent in city policies. A great example of this is the city of Flagstaff, Arizona. Flagstaff became the world's first International Dark Sky City in 2001. The title of a Dark Sky City is only given to communities that have demonstrated significant commitment to dark sky preservation through good quality outdoor lighting (FLAGSTAFF DARK SKIES COALITION, 2015). In 1958, Flagstaff was the first city to create the world's first lighting regulation which put in place to protect the night sky for astronomical purposes. The Lowell Observatory is of great importance in Flagstaff because Percival Lowell discovered Pluto in 1930.

In 1986, the director of the Lowell Observatory and the city planners in Flagstaff joined together with the Arizona Public Service (an electricity provider in Flagstaff) to install low pressure sodium lights in downtown Flagstaff. By 1987, 9 out 10 residents were agreeable to make the switch to this type of lighting. Residents were surprised how much they liked the low pressure sodium lights and they commented that the lights had a soft romantic visual appeal. In essence, the City of Flagstaff introduced cutting edge lighting codes for its city and the surrounding Coconino County. Furthermore, Flagstaff was a trailblazer in placing light restrictions on outdoor lighting. The Flagstaff Dark Skies Coalition notes that they are one of the only places that has effective lighting codes that have proven to actually reduce light pollution. Their website offers a lighting code that any communities can implement. The City of Flagstaff have used these lighting codes to build auto dealers, retail, and service stations that have all been successful. The Flagstaff Dark Skies Coalition, notes that many lighting codes exist in the United States but they cannot recommend them because they aren't that effective.

The City of Vancouver is also implementing policies on light pollution. Vancouver Councillor, Elizabeth Ball, implemented an outdoor lighting by law which would place limits on the number of lights in the City of Vancouver. Councillor Ball's main objective is to limit the amount of light in the night sky while making sure there still is sufficient lighting on the ground for safety. Furthermore, she stressed that it isn't about removing light it is about learning how to shield light properly. Approximately 60% of unshielded light is wasted. The motion that was brought forth to council focused on retrofitting outdated types of lighting with efficient lighting. In essence, Councillor Ball stated that "it's not changing everything in the city, it's just using a sensible approach to where we need light".

The community of Oak Bay which is part of the Greater Victoria region is using dark sky lighting. Oak Bay is committed to using energy efficient lighting (OAK BAY OFFICIAL COMMUNITY PLAN, 2015). Furthermore, Oak Bay has a designated Urban Star Park from the Royal Astronomical Society of Canada it is Cattle Point. The vision for the Cattle Point Urban Star Park is "a place for residents and tourists, old and young alike, to enjoy the stars, planets and our moon, meteor showers and satellites – and of course the International Space Station. A unique location where there is minimal light pollution, a place to think about our planet, its place in the universe and the importance of how we care for the earth, a place for students, young and old, to dream" (CATTLE POINT STAR PARK, 2014).

Cattle Point also provides a number of events and initiatives at the park such as: student summer camps, monthly star watching events, meteor shower watching, constellation and planet photography groups, and it is a place for the Oak Bay Astronomy Club to gather (CATTLE POINT STAR PARK, 2014). The municipality of Oak Bay received various input from the community about using dark sky lighting. The results were that some of the residents in the community were frightened that less lighting could cause people to fall and injure themselves and also would give them a feeling of insecurity. Other residents felt that there already is a lack of lighting and they could not comprehend why it would potentially be further reduced. Furthermore, various groups like the visually impaired, the elderly, and joggers said that they rely on the street lighting to prevent injury and that they sidewalks are in poor condition so the light helps them see where they are going. One individual stated that tall street lights could be replaced with energy saving lights and the light can be placed only where needed (OAK BAY OFFICIAL COMMUNITY PLAN, 2015).

Although it is not an urban area, Jasper National Park has become the world's second biggest Dark Sky Preserve in the world (JASPER NATIONAL PARK, 2015). The Park is approximately 11,000 square kilometers. The beauty of this park's dark sky can be viewed 365 days of the year (JASPER NATIONAL PARK, 2015). However, Jasper National Park has done an exceptional job at integrating dark sky concepts into the City of Jasper and raising public awareness. For instance, Jasper National Park offers "Kakasitipiskak" which is where aboriginal dark sky stories are told and it is a way of sharing aboriginal diversity (JASPER NATIONAL PARK, 2015). Also, the park offers sidewalk astronomy in the city center of Jasper (JASPER NATIONAL PARK, 2015). The public are invited to view the sky through telescopes that are placed on city sidewalks (JASPER NATIONAL PARK, 2015). There is also the annual Dark Sky Festival in October that takes place annually at the Jasper National Park (JASPER NATIONAL PARK, 2015). Lastly, there are other fun events that take place over the year such as Halloween ghost stories and moonlight hikes (JASPER NATIONAL PARK, 2015). It is noted that Canada has more protected star gazing areas that any country in the world combined (McMAHON, 2014).

10 Misconceptions of Light Pollution

Many people fear that limiting light will cause safety issues. However, there is no solid evidence that suggests that there is a correlation between crime and lighting (MIZON, 2012). If lighting is installed properly, it will be placed where it is most needed so there is no reason that people have to choose between protecting the night sky and their own security (MIZON, 2012). Many places will have their level of lighting on a high setting because they believe it will prevent crime (FALCHI et. al., 2011). According to the Flagstaff Dark Skies Coalition (2015) in 1998, there was a project in Chicago called the Chicago Alley Lighting Project. The project was partnership between the mayor of Chicago and the Department of Streets and Sanitation in an effort to reduce crime through improved lighting of alleys and streets. The first part of the plan was to improve and upgrade 175,000 of Chicago's streetlights. The second part was to repair lighting in

areas of transportation and viaducts. The third part was to improve lighting in alley ways. However, there has been no conclusive evidence that any of this lighting has had a positive effect on crime prevention (FLAGSTAFF DARK SKIES COALITION, 2015).

There is an overall impression among people that the more light the better, however this can be viewed as a sales ploy by businesses. To put it in perspective, the runway lights at an airport require a relatively low amount of lights so the glow will not confuse the pilot (MIZON, 2012). Also, tower strobe lights have a low wattage yet they can be visible for miles (MIZON, 2012). Another issue about light pollution is lack of a general public awareness (BERRY, 1976). According to Berry, besides astronomers and a few knowledgeable people, most people do not know that a true night sky should look like. Unfortunately, people do not know what they are missing out on because they do not know what a natural sky should be. In essence, the public is oblivious to the damaging effects that are being done to the night sky through light pollution. For people who live in big urban centers, looking at the stars is something they do at a planetarium (CHEPESIUK, 2009).

11 Conclusion

In conclusion, light pollution is growing a concern in a variety of different areas that all interconnect with each other such as health and the environment. Fortunately, light pollution is a form of pollution that is reversible (MIZON, 2012). As outlined in this paper, there are numerous ways to combat light pollution such as installing good quality lights and directing the lights properly, creating public awareness, adopting lighting codes in communities, and officially designating areas as a form of protection (such as Urban Star Parks). While light pollution is not commonly talked about it, communities are beginning to learn about it and understand its importance such as The Nanaimo Dark Sky Association. It is imperative that this problem is addressed and policies are created in cities to restore health, protect wildlife, prevent harm to the environment, and to allow people to reconnect to the beautiful wonder that is the night sky.

References

BERRY, R.L . Light pollution in southern Ontario. *The Journal of the Royal Astronomical Society of Canada,* v.70, n. 3, p. 97-115, 1976.

CATTLE Point Dark Sky Urban Star Park. 2014. Retrieved from: <https://www.cattlepointstarpark.org>. Available in: 2015. CANADIAN BROADCASTING CORPORATION. *Dark Sky Legislation for Vancouver Light Pollution*. 2015. Retrieved from: < http://www.cbc.ca/news/canada/british-columbia/elizabeth-ball-seeks-dark-skylegislation-for-vancouver-light-pollution-1.2943019>. Available in: 2015.

CHEPESIUK, R. . Missing the dark: health effects of light pollution. *Environmental Health Perspectives*, v.117, n.1, p.117-120, 2009.

FALCHI, F.; CIZANO, P.; ELVIDGE, C.; KEITH, D.; HAIM, A. Limiting the impact of light pollution on human health, environment, and stellar visability. *Journal of Environmental Management,* v. 92, n.10, p. 2714-2722, 2011.

FLAGSTAFF DARK SKIES COALITION. 2015. Retrieved from: <http://www.flagstaffdarkskies.org/dark-sky-solutions/dark-sky-solutions-2/light-pollution-the-problem/>. Available in: 2015.

INTERNATIONAL DARK-SKY ASSOCIATION. (n.d.). Retrieved from: <http://darksky.org/light-pollution/energy-waste/>. Available in: 2015.

JASPER NATIONAL PARK. 2015. Retrieved from: <http://www.pc.gc.ca/eng/pn-np/ab/jasper/edu/cieletoile-darksky.aspx>. Available in: 2015.

KLINKENBORG, V. Our vanishing night. *National Geographic Magazine*, v.1-2, 2008.

McMAHON, P. Canada's dark sky preserves. *Sky & Telescope,* v.128, n.2, p. 86, 2014.

MIZON, B. *Light Pollution:* Responses and Remedies. New York, NY: Springer New York, 2012.

NANAIMO Dark Sky Project. 2014. Retrieved from: <https://www.nanaimodarksky.org>. Available in: 2015.

NARISADA, K.;SCHREUDER, D. *Light Pollution Handbook*. Dordrecht, Netherlands: Springer, 2004.

OAK BAY OFFICIAL COMMUNITY PLAN. 2012-2015. Retrieved from: <https://www.oakbay.ca/municipal-hall/plans-reports/official-community-plan>. Available in: 2015.

PENPRASE, B.E. *The Power of Stars*. New York, NY: Springer, 2011.

POLLARD, N.E. . Sky-glow conscious lighting design. *Lighting Research and Technology,* v.26, n.3, p.151-156, 1994.

ROYAL ASTRONOMICAL SOCIETY OF CANADA. 2015. Retrieved from: <http://www.rasc.ca/sites/default/files/RASC%20NP%20GUIDELINES%20-%20Summer%202013_0.pdf>. Available in: 2015.