



## Light Pollution: Lighting our Path or Leaving Us in the Dark?

### INTRODUCTION

This lesson will explore the concept of light pollution and its implications for modern society. Students will read an article about light pollution and then conduct their own research before writing a persuasive letter on whether or not light pollution legislation should be implemented in their town.

### LESSON OVERVIEW

**Grade Level & Subject:** Grades 9-8: Science, English, Social Science

**Length:** Two class periods, or one class period with homework

#### Objectives:

After completing this lesson, students will be able to:

- Understand the concept of light pollution
- Understand the causes and effects of light pollution
- Understand the ways in which light pollution can be prevented or curtailed

#### National Standards Addressed<sup>1</sup>:

- **Content Standard:** [NS.5-8.6 PERSONAL AND SOCIAL PERSPECTIVES](#)  
As a result of activities in grades 5-8, all students should develop understanding of:
  - Personal health
  - Populations, resources, and environments
  - Natural hazards
  - Risks and benefits
  - Science and technology in society
- **Content Standard:** [NL-ENG.K-12.1 READING FOR PERSPECTIVE](#)
  - Students read a wide range of print and nonprint texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works.
- **Content Standard:** [NL-ENG.K-12.8 DEVELOPING RESEARCH SKILLS](#)
  - Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g., print and nonprint texts, artifacts, people) to communicate their discoveries in ways that suit their purpose and audience

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<sup>1</sup> Education World (2008). *U.S. National Education Standards*. Retrieved March 25, 2009, from <http://www.educationworld.com/standards/national/toc/index.shtml>

- **Content Standard:** [NL-ENG.K-12.12 APPLYING LANGUAGE SKILLS](#)
  - Students use spoken, written, and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion, and the exchange of information).
- **Content Standard:** [NSS-C.9-12.5 ROLES OF THE CITIZEN](#)  
What are the Roles of the Citizen in American Democracy?
  - What is citizenship?
  - What are the rights of citizens?
  - What are the responsibilities of citizens?
  - What civic dispositions or traits of private and public character are important to the preservation and improvement of American constitutional democracy?
  - How can citizens take part in civic life?

**Materials Needed:**

- Reproducible #1- **“Our Vanishing Night”**
- Reproducible #2- **Is Nighttime Lighting Leaving Us in the Dark?**
- Access to a computer w/ internet access or other research tools

**Assessment:** Students will be assessed through the following activities:

- Participation in class reading and discussion
- Completion of **Reproducible #2: Is Nighttime Lighting Leaving Us in the Dark?**

## LESSON BACKGROUND

**Relevant Vocabulary:**

- **Light Pollution:** excessive and obtrusive artificial light with adverse effects.
- **Sky Glow:** A type of light pollution where light is seen as a dome “glowing” over cities.
- **Light Trespass:** When unwanted light enters someone’s property from somewhere else.
- **Light Clutter:** Excessive grouping of lights in one area.
- **Glare:** Excessive contrast between light and dark areas.

**Information<sup>2</sup>:**

The way we see the night today is vastly different than the way people saw the night just a couple of centuries ago. When most of us look out our windows at night we see the soft glow of street lamps and porch lights. What most of us don’t see is the bright twinkle of stars and planets.

Light pollution is when large amounts of light hinder sky visibility and create adverse affects to those living around it. Light pollution is especially common in urban areas, where buildings are close together and lights are often left on all night long. This causes a waste of energy that could be saved by turning off the lights.

Light pollution has negative impacts on wildlife, astronomers, and people. All the extra light can cause confusion in animal migratory and mating patterns, which in turn causes problems within the

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<sup>2</sup> “Frequently Asked Questions” [International Dark Sky Association](http://www.darksky.org/mc/page.do?sitePageId=61045&orgId=idsa). Retrieved March 25, 2009 from <http://www.darksky.org/mc/page.do?sitePageId=61045&orgId=idsa>

entire ecosystem. Light pollution can also be confusing to nocturnal animals and those that rely on natural light for communication such as fireflies.

Astronomers feel the effects of light pollution as well, as it keeps them from having a clear view of the sky, and can prevent their instruments from working properly. Light pollution also means that it is harder for people to stargaze and enjoy nature because the lights are so bright.

When it comes to health effects, studies have shown that light pollution negatively affects humans' natural sleep pattern, and that an increase of exposure to artificial light can lead to an increased chance of cancer.

### Resources:

- International Dark Sky Associations Frequently Asked Questions: <http://www.darksky.org/mc/page.do?sitePageId=61045&orgId=idsa>
- National Geographic Photo Gallery of Light Pollution: <http://ngm.nationalgeographic.com/2008/11/light-pollution/richardson-photography>
- Example of how light pollution affects a local town in Michigan: <http://www.physics.emich.edu/sherzer/lightpol.htm>

## LESSON STEPS

### Warm-up: *Imagining the 1800s*

1. To get your students thinking about light pollution, have them close their eyes and picture what it was like to live in a city in the early 1800s. Prompt them by reading this paragraph and asking them to put themselves in the situation:

You are walking down a cobbled stone street late at night, and are determined to make it home as fast as possible. The only light you have to see by is the burning of your lantern and the lanterns of the few others who pass you. You must watch carefully where you are walking, and keep an eye out for any thieves who could materialize out of the darkness between the buildings. It is a clear summer night, and glancing up at the sky you can see numerous of the constellations that your grandfather had once pointed out to you when you were a child. The moon is also shining brightly, and you are silently grateful for that, as it pours more light onto the dark streets. As you reach home, not a single light shines from the windows, as your family has all gone to bed for the night. You open up the door and walk into pitch darkness, placing your hand out for the familiar feeling of the wall, as you slowly maneuver your way through the kitchen to retrieve a candle from the table. Your eyes have just adjusted to the darkness of the house as you light the candle with nearby matches and pull out a piece of parchment and quill pen from the desk in the front parlor. You start a letter to your brother-in-law about a recent business deal gone sour, hurrying to finish before the candle burns down to a mere puddle of wax. When you are finished, you take the candle with you as you climb the stairs and extinguish the flame as you crawl into bed. As you close your eyes to fall asleep you prepare yourself for waking early the next morning - after all, to wake any later than the rising of the sun would be a waste of precious daylight hours.

2. Ask students to compare the life of the person in the story to their own life. You may consider having students jot down a quick scenario or journal entry. Have them share their reactions with the class.

### **Activity One: *Reading about Light Pollutions***

1. Pass out **Reproducible #1- “Our Vanishing Night”** Article to students. Briefly explain what light pollution is and why it is a topic of discussion. (*Light pollution is excessive or obtrusive artificial lighting that has adverse affects on the species and places that surround it. It has a negative impacts on animal migration and mating patterns, is harmful to human health, reduces visibility of the sky, and wastes energy.*)
2. Have students read the article either by themselves or by taking turns.
3. When students are finished, talk about the article and what it discussed. Some questions to consider are:
  - a) What were the main points of the article?
  - b) What was the author’s viewpoint on light pollution?
  - c) Did you agree/disagree with this article?
  - d) Do you have any questions after reading this article?

### **Activity Two: *The Pros and Cons of Lights at Night***

1. Give students some time to research light pollution on their own. Have them use part 1 of **Reproducible #2- Is Nighttime Lighting Leaving Us in the Dark?** to keep track of the pros and cons of nighttime lights.

### **Activity Three: *Making an Argument***

1. Either in a second class period or for homework, have students complete part 2 of **Reproducible #2- Is Nighttime Lighting Leaving Us in the Dark?** where they will write a persuasive letter to the editor on light pollution. Have them use what they learned in activities 1 and 2 to support their argument.

### **Wrap Up: *Discuss the Options***

1. Lead a discussion with students on whether they chose to support the nighttime lighting ban or not. What evidence led to their decision? What aspects of the issue did they find the most important? Did anyone come up with alternatives or compromises to try?

### **Extension: *Mapping the Night Sky***

Have your students keep a “sky journal” for a month and record what they observe in the sky every night. Also have them record the weather for that day and any other information that they think might affect visibility. At the end of the month, have students analyze their journals to see if they notice any patterns or correlations.

## **CONCLUSION**

In this lesson students learned about light pollution and the pros and cons of nighttime lighting. Through research and critical thinking they were able to make a decision on which side they supported, and write a persuasive letter in response.

## National Geographic

Published: November 2008

### “Our Vanishing Night”

Most city skies have become virtually empty of stars.

By Verlyn Klinkenborg

If humans were truly at home under the light of the moon and stars, we would go in darkness happily, the midnight world as visible to us as it is to the vast number of nocturnal species on this planet. Instead, we are diurnal creatures, with eyes adapted to living in the sun's light. This is a basic evolutionary fact, even though most of us don't think of ourselves as diurnal beings any more than we think of ourselves as primates or mammals or Earthlings. Yet it's the only way to explain what we've done to the night: We've engineered it to receive us by filling it with light.

This kind of engineering is no different than damming a river. Its benefits come with consequences—called light pollution—whose effects scientists are only now beginning to study. Light pollution is largely the result of bad lighting design, which allows artificial light to shine outward and upward into the sky, where it's not wanted, instead of focusing it downward, where it is. Ill-designed lighting washes out the darkness of night and radically alters the light levels—and light rhythms—to which many forms of life, including ourselves, have adapted. Wherever human light spills into the natural world, some aspect of life—migration, reproduction, feeding—is affected.

For most of human history, the phrase "light pollution" would have made no sense. Imagine walking toward London on a moonlit night around 1800, when it was Earth's most populous city. Nearly a million people lived there, making do, as they always had, with candles and rushlights and torches and lanterns. Only a few houses were lit by gas, and there would be no public gaslights in the streets or squares for another seven years. From a few miles away, you would have been as likely to smell London as to see its dim collective glow.

Now most of humanity lives under intersecting domes of reflected, refracted light, of scattering rays from overlit cities and suburbs, from light-flooded highways and factories. Nearly all of nighttime Europe is a nebula of light, as is most of the United States and all of Japan. In the south Atlantic the glow from a single fishing fleet—squid fishermen luring their prey with metal halide lamps—can be seen from space, burning brighter, in fact, than Buenos Aires or Rio de Janeiro.

In most cities the sky looks as though it has been emptied of stars, leaving behind a vacant haze that mirrors our fear of the dark and resembles the urban glow of dystopian science fiction. We've grown so used to this pervasive orange haze that the original glory of an unlit night—dark enough for the planet Venus to throw shadows on Earth—is wholly beyond our experience, beyond memory almost. And yet above the city's pale ceiling lies the rest of the universe, utterly undiminished by the light we waste—a bright shoal of stars and planets and galaxies, shining in seemingly infinite darkness.

We've lit up the night as if it were an unoccupied country, when nothing could be further from the truth. Among mammals alone, the number of nocturnal species is astonishing. Light is a powerful biological force, and on many species it acts as a magnet, a process being studied by researchers such

as Travis Longcore and Catherine Rich, co-founders of the Los Angeles-based Urban Wildlands Group. The effect is so powerful that scientists speak of songbirds and seabirds being "captured" by searchlights on land or by the light from gas flares on marine oil platforms, circling and circling in the thousands until they drop. Migrating at night, birds are apt to collide with brightly lit tall buildings; immature birds on their first journey suffer disproportionately.

Insects, of course, cluster around streetlights, and feeding at those insect clusters is now ingrained in the lives of many bat species. In some Swiss valleys the European lesser horseshoe bat began to vanish after streetlights were installed, perhaps because those valleys were suddenly filled with light-feeding pipistrelle bats. Other nocturnal mammals—including desert rodents, fruit bats, opossums, and badgers—forage more cautiously under the permanent full moon of light pollution because they've become easier targets for predators.

Some birds—blackbirds and nightingales, among others—sing at unnatural hours in the presence of artificial light. Scientists have determined that long artificial days—and artificially short nights—induce early breeding in a wide range of birds. And because a longer day allows for longer feeding, it can also affect migration schedules. One population of Bewick's swans wintering in England put on fat more rapidly than usual, priming them to begin their Siberian migration early. The problem, of course, is that migration, like most other aspects of bird behavior, is a precisely timed biological behavior. Leaving early may mean arriving too soon for nesting conditions to be right.

Nesting sea turtles, which show a natural predisposition for dark beaches, find fewer and fewer of them to nest on. Their hatchlings, which gravitate toward the brighter, more reflective sea horizon, find themselves confused by artificial lighting behind the beach. In Florida alone, hatchling losses number in the hundreds of thousands every year. Frogs and toads living near brightly lit highways suffer nocturnal light levels that are as much as a million times brighter than normal, throwing nearly every aspect of their behavior out of joint, including their nighttime breeding choruses.

Of all the pollutions we face, light pollution is perhaps the most easily remedied. Simple changes in lighting design and installation yield immediate changes in the amount of light spilled into the atmosphere and, often, immediate energy savings.

It was once thought that light pollution only affected astronomers, who need to see the night sky in all its glorious clarity. And, in fact, some of the earliest civic efforts to control light pollution—in Flagstaff, Arizona, half a century ago—were made to protect the view from Lowell Observatory, which sits high above that city. Flagstaff has tightened its regulations since then, and in 2001 it was declared the first International Dark Sky City. By now the effort to control light pollution has spread around the globe. More and more cities and even entire countries, such as the Czech Republic, have committed themselves to reducing unwanted glare.

Unlike astronomers, most of us may not need an undiminished view of the night sky for our work, but like most other creatures we do need darkness. Darkness is as essential to our biological welfare, to our internal clockwork, as light itself. The regular oscillation of waking and sleep in our lives—one of our circadian rhythms—is nothing less than a biological expression of the regular oscillation of light on Earth. So fundamental are these rhythms to our being that altering them is like altering gravity.

For the past century or so, we've been performing an open-ended experiment on ourselves, extending the day, shortening the night, and short-circuiting the human body's sensitive response to light. The consequences of our bright new world are more readily perceptible in less adaptable creatures living in the peripheral glow of our prosperity. But for humans, too, light pollution may take a biological toll. At least one new study has suggested a direct correlation between higher rates of breast cancer in women and the nighttime brightness of their neighborhoods.

In the end, humans are no less trapped by light pollution than the frogs in a pond near a brightly lit highway. Living in a glare of our own making, we have cut ourselves off from our evolutionary and cultural patrimony—the light of the stars and the rhythms of day and night. In a very real sense, light pollution causes us to lose sight of our true place in the universe, to forget the scale of our being, which is best measured against the dimensions of a deep night with the Milky Way—the edge of our galaxy—arching overhead.

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## Is Nighttime Lighting Leaving Us in the Dark?

**Part 1:** Now that you've learned a little more about light pollution, consider the pros and cons of nighttime lighting. What are some of the rewards of brighter nights? What are the risks? Complete the chart below.

<b>Rewards of Artificial Nighttime Lighting</b>	<b>Risks of Artificial Nighttime Lighting</b>

**Part 2:** Imagine that your city council is considering a ban on outdoor nighttime lighting in residential areas. Your local newspaper recently ran an article detailing the proposed ban. Write a letter to the editor expressing your opinion on the ban. Should the city council approve the ban? Why or why not? Are there any alternatives to a complete ban on outdoor nighttime lighting? Use the pros and cons you came up with in **Part 1** to support your argument.

Please start by brainstorming your ideas on this piece of paper.