



Light Pollution and You

GOAL

Students will gain an understanding of what light pollution is, how it impacts our environment, and how we can reduce it.

Understandings

- Light pollution is human-caused and increasing worldwide.
- Light pollution disrupts a wide variety of critical wildlife behaviors.
- Light pollution wastes energy and contributes to climate change.

Knowledge (K) and Skills (S)

K: Define nocturnal and diurnal.

K: Explain how light pollution affects wildlife survival (foraging, migration, reproduction and pollination behaviors).

K: Explain how we can get our night sky back.

S: Identify animals requiring dark skies for their survival.

S: Identify sources of light pollution around you.

S: Develop a plan to reduce light pollution around you.

1) Background Exploration -- 20 minutes

Start by leading a brainstorm about how we use light in our daily lives.

Did you know that light can be a form of pollution, too?

Even though humans have been using fire for a million years, electric light has only been around since 1878. That's only 150 years! Since then, our skies have continued to get brighter and brighter, currently averaging between 3 and 5% each year. Many people on Earth have never seen the Milky Way galaxy in their entire lifetimes, including 8 out of 10 Americans on any given evening.



The United States from space at night.

What are some impacts you can think of our night sky having so much artificial light?

Let's learn more about why artificial light can be harmful to us and our environment.

Review each of the sections below, leaving time for discussion.

Optional [video](#) on light pollution, *Losing the Dark* (7 minutes).

Light pollution is excessive, misdirected, or obtrusive artificial light, created by *human activity*. This is light that is not helping us live better, but excess light that impacts us and the rest of the environment in a negative way. Some of these impacts are:

1) Light pollution washes out starlight in the night sky.

Why is this a problem? Why do we need to see the stars?

Starlight helps teach us our location in the universe and gives us perspective on the size and relative location of our planet. Starlight has been used in nighttime navigation throughout human history -- overland and on water. Starlight inspires us in storytelling and the arts in countless ways.

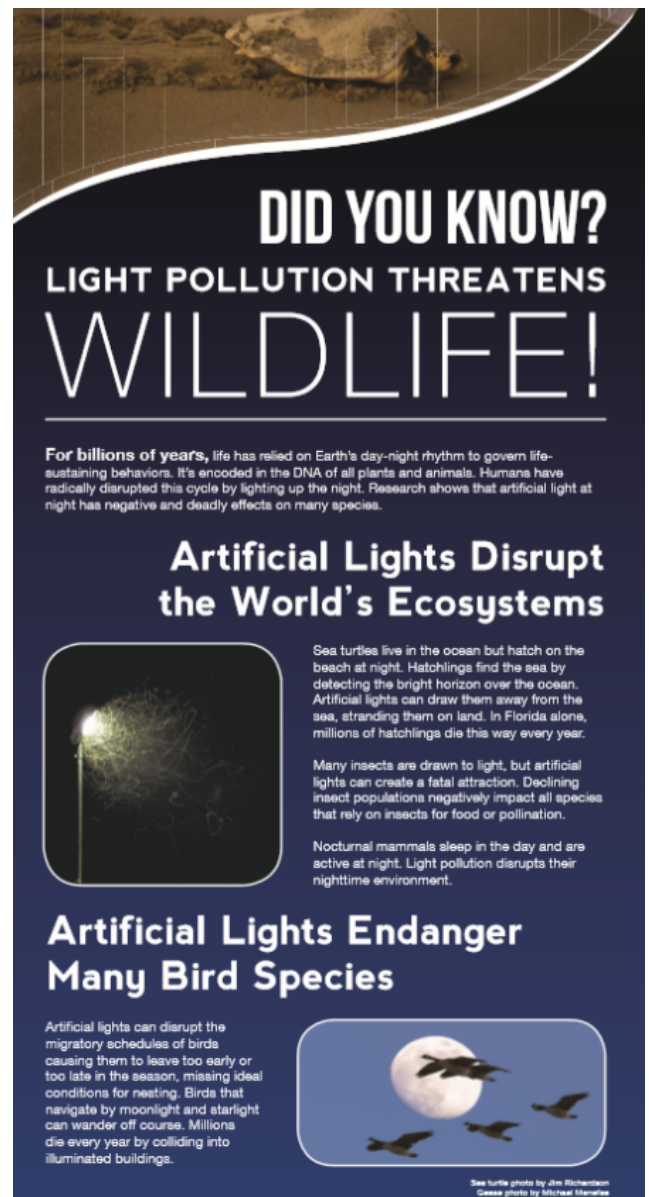
Bright artificial light at night also interferes with astronomical research. West Virginia is home to the [Green Bank Observatory](#) and the world's largest fully steerable radio telescope. Pocahontas County, West Virginia was chosen as the site for this important research station due to its relatively unspoiled night sky.

Without a dark sky full of stars, we would not have learned as much as we have about the universe, and the history of our unique planet.

2) Light pollution disrupts ecosystems, from nocturnal to diurnal species.

Nocturnal species are adapted to primarily be active at night -- from hunting for food, to reproduction, to pollination, to regulating body temperature.

- **Hunting.** Bats use sound (echolocation) to hunt at night. Owls are adapted to hunt at night so they do not compete with hawks and other raptors for the same food sources during the day.



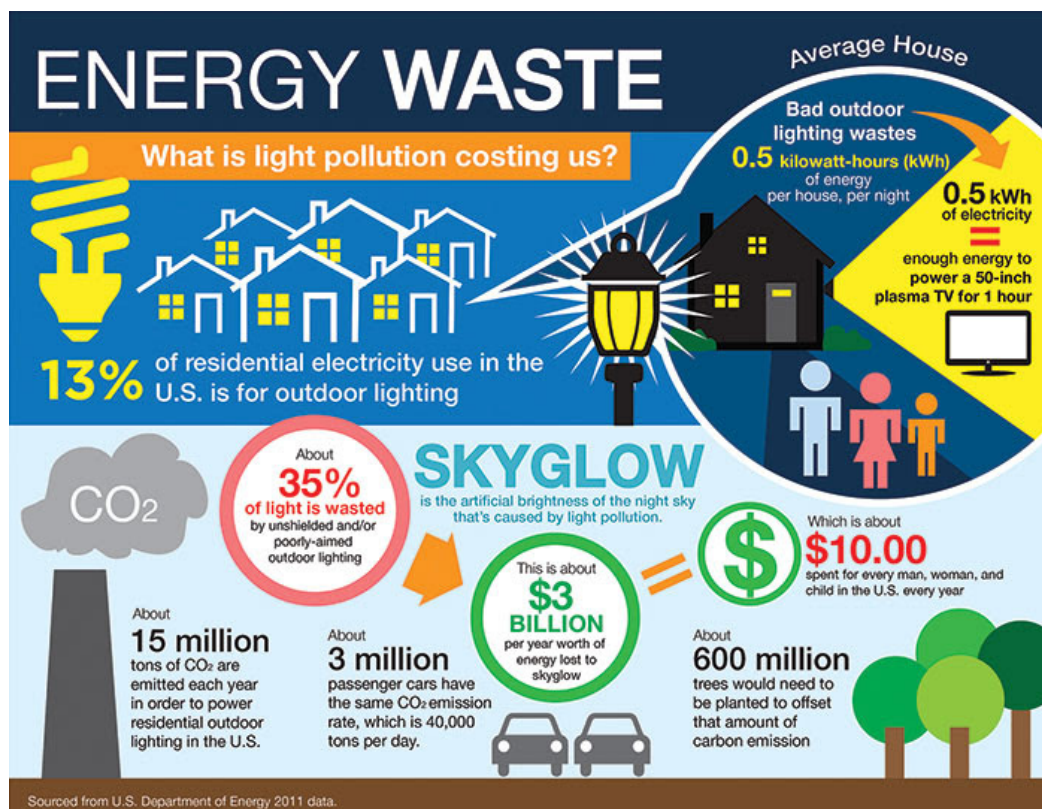
- **Reproduction.** Frogs and crickets use sound to find a mate under the cover of darkness, when predators are less active. Sea turtles make their nests on beaches at night to avoid predators. Lightning bugs use their own [bioluminescence](#) to find a mate at night, when there are fewer predators and competitors for space.
- **Pollination.** Some plants open their flowers at night to attract pollinators that are active at night, like moths.

How might these activities be impacted by a brighter night?

Diurnal species are adapted to primarily be active during the day. Diurnal species also require darkness to develop, navigate and survive.

- **Humans are diurnal animals, and require a certain amount of dark to get good quality sleep.** Good sleep supports our [circadian rhythm](#), and leads to clearer thinking, better muscle recovery and a stronger immune system.
- **Diurnal animals require dark for cover from nighttime predators.**
- **Migrating animals navigate by natural light cycles.** Birds are disoriented by artificial light, and can lose track of their surroundings, jeopardizing their survival.

- 3) **Light pollution wastes energy.** Light pollution wastes *a lot* of energy. 40,000 tons of carbon dioxide enters the atmosphere -- every day -- to produce the energy for unnecessary outdoor light. 600 million trees would need to be planted to offset that amount of CO₂!



How does all of this make you feel? Do you think we can do better?

2) Backyard Adventure -- 30 minutes + for each option

Option 1: Firefly Survey

Materials:

- 1 jar with lid per group (of 2 - 4 participants)
- 1 - 2 headlamps per group
- 1 [Firefly Watch observation form](#)
- 1 firefly [flash pattern guide](#)
- Clipboard
- Writing utensil

Have you ever tried to catch a firefly?

Fireflies -- or lightning bugs -- are a favorite sight for many people on late spring and summer evenings in West Virginia. There are 2,000 species of fireflies worldwide! Several of those make their homes in West Virginia.

Fireflies are actually not flies, or even true bugs. *They are beetles!* Fireflies are the very last stage of life for this insect. Like other insects, most of its life is spent as a larva, living in the grass or moist leaf litter.



Firefly larva.

All life phases of a firefly -- egg, larva, pupa and adult -- have natural bioluminescence. In other words, they can glow throughout their lives. Scientists think this glow helps them signal to predators, like birds, bats, and other insects, that they do not taste good at all.

Male fireflies use their bioluminescence to attract a mate on warm, dark nights, using a special flash pattern for their particular species. Some use one flash at a time, some use two, and some use several flashes in a row. The males flash while they fly or perch on branches, while females stay close to the ground, observing. Females usually do not flash back. *The females of one species, however, will flash as if they are males looking to attract a mate, and then they eat who comes to visit!*

Some people say fireflies are becoming less common. Scientists are trying to understand why, and people like us are helping them figure out how firefly populations are changing. We can conduct a firefly survey of our backyard to see how many different types of fireflies are there. We can do this on a regular basis to compare the number and variety we see over time. When we send in our data to [Firefly Watch](#), they will use our data to get a better picture of how fireflies are doing all over the country.

Let's hunt for some fireflies!

Activity Steps:

- 1) Divide participants into groups of 2 - 4.
- 2) Provide each group with headlamps, a Firefly Watch observation form and flash pattern guide, a clipboard, a writing utensil, and a jar.
- 3) Go over instructions on the Firefly Watch observation form together and check for understanding.
- 4) Station groups around available space so the area to be surveyed is covered and so groups will not interrupt each others' work. Encourage minimal use of light.
- 5) Once their survey is completed, groups can try to catch a firefly in their jar.
- 6) Gather group back together in about 10 minutes to share results. [What species did we see?](#)
- 7) Release fireflies back into the grass.

Reflection

What did you observe? What did you find interesting?

Do you think we could conduct this survey as easily with more outdoor light? Or on a full moon?

There are a [number of reasons](#) scientists believe fireflies are declining.

- **Light pollution** -- because the night sky is increasingly obstructed by light, fireflies have more difficulty communicating with their mates. They may also be more vulnerable to predators in lighter night skies.
- **Pesticides** -- Fireflies depend on grass as habitat in all of their life phases. Pesticide on grass can kill or harm developing fireflies.
- **Habitat loss** -- Mowing reduces firefly habitat and cover. Have you ever noticed how a hayfield is suddenly absent of fireflies after it's been cut? Mowing less frequently, or leaving strips of higher grass, help fireflies stick around. Firefly larvae also depend on moist leaf litter. Leaving leaves around trees will allow these larva to survive the 1 - 2 years before maturing into adult fireflies.

What's one thing you can do for fireflies?

Option 2: Moth Survey

Have you heard of Mothman?

Mothman may not live around here, but moths certainly are all around us!

Moths are primarily nocturnal. Scientists believe they use the light of the moon to forage for food. Moths are pollinators -- they are attracted to light-colored flowers that open during the night. Without them, these plants would not be able to reproduce.

Have you ever heard of "like a moth to a flame?" Have you seen moths gathered around a porch light, or other outdoor light?

[Scientists believe](#) moths are attracted to outdoor light like they are to moonlight, but because the quality of outdoor light is different from the moon, their instincts are overwhelmed and they do not continue to forage normally. These moths will end up being electrocuted or burned needlessly.

There is a tremendous [diversity of moths](#) in West Virginia. Let's see what kinds of moths we can find in our backyard.

See: [Moth survey options](#)

Reflection -- see Firefly survey reflection section above, but discussing moths in the environment.

Option 3: Outdoor Light Survey

This activity can be conducted in the daytime.

Let's take a look at the outdoor lights we have around us. We use lights to see where we need to go, to highlight an area we use, and to provide a sense of safety. Each group will be identifying fixed outdoor lights, mapping where they are located, determining what type they are and what job they are doing for us, and evaluating whether we can reduce or even eliminate their light pollution.

If possible, the group will also make note of dead insects (particularly moths) that may be present around outdoor light fixtures.

Blue, white and other short-wavelength colors tend to be more disruptive to animals, while yellow, amber and green tend to be less harmful.

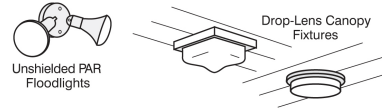
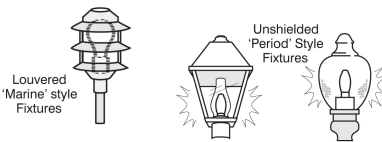
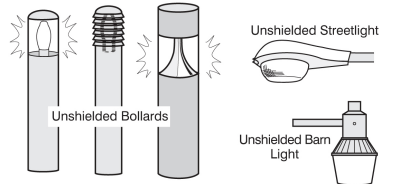
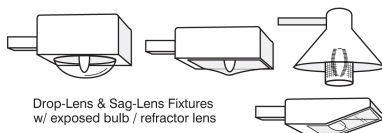
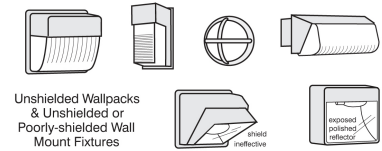
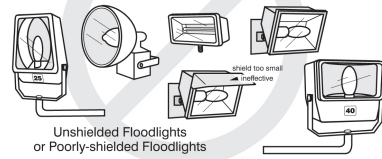
Activity steps:

- 1) Divide participants into groups of 2 - 4.
- 2) Provide each group with an [outdoor lighting survey form](#), outdoor [lighting ID form](#) (also below), clipboard, and writing utensil. Colored pencils work well to allow groups to distinguish types of lights on their maps (e.g. walkway or streetlights, lights on buildings, floodlights). Provide insect viewers and gloves if a dead insect survey is possible around outdoor lights.
- 3) Divide the available outdoor space into areas each group is responsible for surveying. Encourage groups to look high and low, and imagine how the area would look at night. Review survey form together.
- 4) Conduct survey in groups.
- 5) Bring the groups back together to share their findings, one at a time. Facilitator will collate recommendations on how to reduce light pollution. Useful recommendations for dark sky-friendly outdoor lighting are available [here](#).
- 6) Discuss these ideas as a larger group. Make an [action plan](#) on priority steps.

Examples of Acceptable / Unacceptable Lighting Fixtures

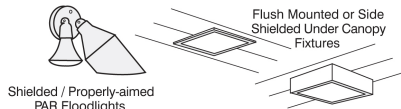
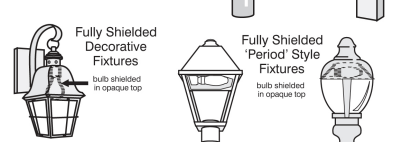
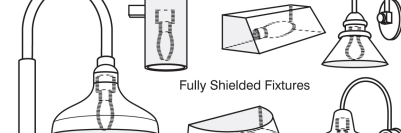
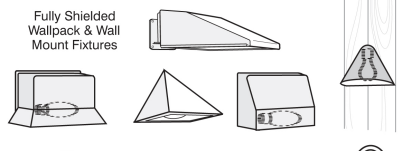
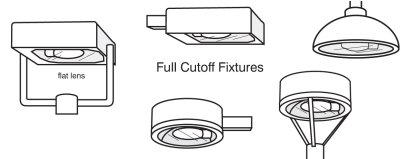
Unacceptable / Discouraged

Fixtures that produce glare and light trespass



Acceptable

Fixtures that shield the light source to minimize glare and light trespass and to facilitate better vision at night



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3) Stewardship in Action

- Participate in a [Globe at Night](#) citizen science assessment.
- According to the outdoor light survey recommendations above, modify outdoor lighting or outdoor lighting usage to reduce light pollution around you.
- [Join or start](#) a campaign to make local outdoor lighting more wildlife-friendly and less polluting.

More Activity Ideas

- [Bat Echoes](#) or [Bat and Moth Game](#) -- exploring bat communication and foraging behaviors at night
- **Create A Constellation** -- Break into groups to identify constellations. Read the [mythological inspiration](#) behind some of these constellations. Each participant can then create a new constellation with its own backstory. Have participants illustrate their constellation, in reference to stars they can identify, so they can be shared with the group later.

Additional Resources

- [Globe at Night](#) -- international citizen-science campaign to raise public awareness of the impact of light pollution
- [International Dark Sky Association](#) -- education and advocacy around reducing light pollution
- [The New World Atlas of Artificial Sky Brightness](#) -- University of Colorado

Related WV Middle School CSOs

S.6.LS.5

Students will analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

S.6.LS.7

Students will construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

S.7.ESS.7

Students will apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

S.8.LS.5

Students will gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms.

S.8.ESS.1

Students will construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.