



Fight for the Stars: Be a Knight for the Night ©

Grades 6 & 7

Lessons 1-7

Welcome!

This curriculum aims to teach students about light pollution. Students will learn about its causes, effects, and solutions to dive into the past, present, and future of light pollution in our world. The rhythms for all forms of life, from animals to humans to plants, stem from the natural patterns of day and night, so when this is disrupted by artificial lights, there are severe repercussions. There are simple actions such as shielding a light that can be taken to reduce light pollution, but many people have not received adequate information surrounding light pollution and its causes, effects, and solutions. Therefore, this curriculum aims to address the lack of education and awareness by teaching students about light pollution. The majority of light pollution stems from the lack of knowledge about the things that are causing this problem.

My hope in creating this curriculum is that students, teachers, parents, advocates, etc. will have a concise place to learn and teach about light pollution. With every person who gains knowledge about light pollution, we are one step closer to saving our stars!

Logo Note

The logo incorporates the knight from the game Chess that is referenced in this curriculum's name. This knight is meant to remind students that, similar to the game of Chess, advocating for the night sky and the stars takes strategy and knowledge, both of which students will gain from this curriculum. Through this curriculum, students will learn strategies to preserve and protect the night sky and all its benefits. Students will soon learn that fighting for the stars is worthwhile and fun!

Curriculum at a glance

This Fight for the Stars[®] curriculum aims to teach students around sixth and seventh grade about light pollution. Throughout these seven lessons, students will become knowledgeable about the effects of light pollution and the ways we can fix lights to reduce light pollution. The curriculum ends in a culminating activity which walks students through how to complete a lighting inventory and assessment. By completing this curriculum, students will not only learn about light pollution but also have a tangible way to create beneficial change in their community.

Each lesson contains several different sections. Here is an overview of what to expect from each section.

- ★ Student Objectives
 - This section is a list of what students should gain from this lesson.
- ★ Activity
 - This section contains games and other activities for students to complete. On the Online Training portion of the txnsf.org website, you will find the Level 2 Activity Handout Packet. This packet contains any special documents you may need for these activities. The original links to any of these wonderful educational materials produced by others are documented here in this Curriculum. They have been downloaded and gathered in the packet for educational purposes only.
- ★ Demonstrations (Demos)
 - This section is a great way for students to learn through watching and doing rather than listening and talking. Most of these Demos are videos.
- ★ Key Discussion Phrases
 - This is the main section of each lesson where much of the formal learning happens. In this section, you will find potential talking points to spark conversation and teach your student(s) about that lesson's topics. Important phrases are **bolded**.
- ★ Extension of Learning and "Why is this important to me?"
 - This section lists ways you can incorporate this knowledge into other aspects of teaching. This could be other topics to talk about or an informal way to remind students of what they have learned. This section also includes ways you can make these lessons personal for your student(s) so that they realize that light pollution affects all aspects of our lives.

Each of these lessons has a corresponding video. These videos follow along with the lesson walkthroughs below. You can use these videos to help teach your student(s). You may be prompted to pause the video to contribute to the teaching, but the videos will take the load off you and teach (mostly) by themselves. These videos can be found at txnsf.org/online-learning/.

Standards Alignment

This curriculum is pertinent to the following TEKS (Texas Essential Knowledge and Skills):

- Science
 - 6.2.A & 7.2.A The student is expected to: plan and implement comparative and descriptive investigations by making observations, asking well defined questions, and using appropriate equipment and technology
 - 6.2.C & 7.2.C The student is expected to: collect and record data using the International System of Units (SI) and qualitative means such as labeled drawings, writing, and graphic organizers
 - 7.13.A The student is expected to: investigate how organisms respond to external stimuli found in the environment such as phototropism and fight or flight
- Mathematics
 - 6.1.A & 7.1.A The student is expected to: apply mathematics to problems arising in everyday life, society, and the workplace
 - 6.3.A-E The student applies mathematical process standards to represent addition, subtraction, multiplication, and division while solving problems and justifying solutions
 - 6.10.A The student is expected to: model and solve one-variable, one-step equations and inequalities that represent problems, including geometric concepts
 - 6.14.A-H & 7.13.A-F The student applies mathematical process standards to develop an economic way of thinking and problem solving useful in one's life as a knowledgeable consumer and investor
 - 7.3.A-B The student applies mathematical process standards to add, subtract, multiply, and divide while solving problems and justifying solutions
 - 7.11.A The student is expected to: model and solve one-variable, two-step equations and inequalities
- Language Arts
 - 6.1.A The student is expected to: listen actively to interpret a message, ask clarifying questions, and respond appropriately
 - 6.5.D & 7.5.D The student is expected to: create mental images to deepen understanding
 - 6.5.E & 7.5.D The student is expected to: make connections to personal experiences, ideas in other texts, and society
 - 6.5.F & 7.5.F The student is expected to: make inferences and use evidence to support understanding
 - 6.5.H & 7.5.H The student is expected to: synthesize information to create new understanding
 - 6.6.F & 7.6.F The student is expected to: respond using newly acquired vocabulary as appropriate

- 6.6.I & 7.6.I The student is expected to: reflect on and adjust responses as new evidence is presented
- 6.11.D & 7.11.D The student is expected to: compose correspondence that reflects an opinion, registers a complaint, or requests information in a business or friendly structure
- 6.12.B & 7.12.B The student is expected to: develop and revise a plan
- 7.1.A-D Developing and sustaining foundational language skills: listening, speaking, discussion, and thinking--oral language. The student develops oral language through listening, speaking, and discussion
- History/Social Studies
 - 6.7 The student understands the impact of interactions between people and the physical environment on the development and conditions of places and regions
 - 6.20 The student understands the influences of science and technology on contemporary societies
 - 6.23 & 7.23 The student uses problem-solving and decision-making skills, working independently and with others, in a variety of settings
 - 7.10 The student understands the effects of the interaction between humans and the environment in Texas during the 19th, 20th, and 21st centuries.
- Technology
 - 6.4.A-F & 7.4.A-F The student makes informed decisions by applying critical-thinking and problem-solving skills
 - 7.3.D The student is expected to: process data and communicate results

This curriculum is pertinent to the following NGSS (Next Generation Science Standards):

- MS-ETS1-1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking in account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions
- MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem
- MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment

Light Pollution Curriculum Lessons Overview

Write a couple paras here about what this is and why it matters

Lesson 1: How humans have been connected to the night sky through the ages. What is light pollution and how is it causing us to lose this connection?

Theme: Light pollution affects each of us.

Lesson 2: Ecological issues with light pollution.

Theme: The loss of the night sky affects our world (e.g. animals, plants, and humans) in a bad way.

Lesson 3: Non-ecological problems from outdoor lighting and why this all matters.

Theme: Light pollution's effects on our whole world are important to pay attention to (glare, light trespass/private property rights, safety & security, saving money & energy).

Lesson 4: What causes light pollution & how can we select better lighting to reduce it?

Theme: The root causes of light pollution are mostly fixable to lessen this problem in our communities.

Lessons 5 and 6: Introduction to culminating activity (Lighting Assessment).

Theme: How can we incorporate this knowledge into our community?

Lesson 7: Culminating activity (Lighting Assessment).

Theme: By completing this activity, you will be able to create real change in your community.

Student Objectives

- Students will hear the story of Pegasus and Bellerophon.
- Students will create their own constellation in order to connect our modern world with the stars.
- Students will learn about the Maya civilization's relationship with the night sky.
- Students will learn and discover what light pollution is.
- Students will connect their experiences with the night sky to light pollution.
- Students will complete Activity #1 to experience light pollution firsthand.
- Students will investigate animals that are affected by light pollution.
- Students will determine how light pollution affects plants.
- Students will learn about light in the blue wavelength.
- By examining different light sources, students will tangibly understand blue light.
- Students will learn about the repercussions of light in the blue wavelength.
- Students will learn about the Circadian Rhythm and how it connects to blue light.
- Students will spend time outside after dark to connect with the nighttime.
- Students will learn about glare and light shields.
- Students will focus on how to create safety and security and save money and energy while reducing light pollution.
- Students will learn about light trespass.
- Students will begin to learn how to improve lights to reduce light pollution's ecological effects.
- Students will compare a light's wattage and targeted lumen output with how useful and bright the light is.
- Students will be introduced to evaluating lights through a picture game.
- Students will formulate ideas for how to determine if a light is acceptable.
- Students will learn about and discuss the Five Principles for Responsible Lighting and how they will use them in the lessons to come.
- Students will practice evaluating a light using the Five Principles.
- By the end of the lesson, students will have the knowledge to outline improvements for a light to become acceptable.
- Students will be shown the different kinds of light fixtures and sources.
- Students will categorize lights beyond simply acceptable or not acceptable.
- Students will learn more about the energy of a light.
- Students will learn about a light's Kelvin Rating and color temperature.
- Students will apply the Five Principles to the different kinds of light fixtures and sources to determine how each principle affects a light.
- Students will learn about wattage and lumens of a light.

- Students will utilize their knowledge to identify and label different light fixtures and sources.
- Students will define and practice using lighting terminology.
- Students will begin to work on the culminating activity (lighting inventory and assessment) and complete about half of the activity.
- Students will brainstorm how evaluating and improving lights can help reduce the problems discussed in Lessons 2 and 3.
- Students will practice reaching out to a professional for help on their activity.
- Students will review the Five Principles in relation to evaluating lights and creating an inventory.
- Students will prepare for their inventory and data collection.
- Students will fill out their Data Collection sheets.
- Students will create their inventory.
- Students will complete their evaluation.
- Students will finish the culminating activity (lighting inventory and assessment).
- Students will calculate the cost of running and replacing lights to create the cost analysis.
- Students will determine the proper action to take after evaluating all lights (e.g. replacing the fixture or bulb).
- Students will write up a report and letter of change with their recommendations.
- Students will have the chance to create tangible, beneficial change!

Lesson 1: Human Connection to the Night Sky

How humans have been connected to the night sky through the ages. What is light pollution and how is it causing us to lose this connection?

Light pollution affects each of us.

Student Objectives

- Students will hear the story of Pegasus and Bellerophon.
- Students will create their own constellation in order to connect our modern world with the stars.
- Students will learn about the Maya civilization's relationship with the night sky.
- Students will learn and discover what light pollution is.
- Students will connect their experiences with the night sky to light pollution.

Activity #1 Walk Through

To bring your student(s) into this curriculum, start by asking them some questions. You may ask questions like, "Have you ever sat under the stars? Did anyone tell you about any of the constellations?" Let them think about and answer these questions to really connect with the stars and the night sky.

To introduce students to this curriculum, you can tell them about the constellation Pegasus. This story is a Greek myth about Pegasus. There are many constellation stories from many different cultures, so feel free to find a different story for your student(s) interests.

"Has anyone ever heard of the story of Pegasus from Greek Mythology and its connections to the constellation? Once, there was a flying horse named Pegasus. Pegasus lived on a mountain in Greece where he enjoyed flying and playing around. No one had ever been able to tame Pegasus. One day a man named Bellerophon decided to try to ride on Pegasus! Bellerophon went to Pegasus' mountain, where he talked to Pegasus and asked him if he could ride on his back. Pegasus had grown tired of flying alone, so he agreed to let Bellerophon ride with him! Bellerophon and Pegasus quickly became friends and had so much fun flying together. However, Zeus, the king of the gods, grew mad when he saw that Bellerophon had tamed Pegasus. So, Zeus sent a fly to bite Pegasus. Just like us, Pegasus didn't like it when the fly bit him. When Pegasus tried to get the fly off, he accidentally sent Bellerophon tumbling down to the ground. Pegasus went to ask Zeus why he had sent the fly to bite him when he was carrying Bellerophon! Zeus was so impressed by Pegasus' care for his new friend that he gave

Pegasus the important job of the carrier of lightning bolts! To honor Pegasus, Zeus took the shape of Pegasus and put it into the stars. These stars form the constellation 'Pegasus'."

Many stories like the story of Pegasus and Bellerophon were made up as our ancestors looked to the stars and told stories. Over time, constellations have been known by many different names and stories. One theme of naming constellations throughout vast cultures and times has been to name constellations after heroes, such as our constellation Perseus found in the Northern sky named after the Greek hero or the Pegasus constellation we just learned about.

For this activity, students may be split into groups or may work individually. Their task is to act as modern astronomers who are deciding to replace the old constellations based on modern heroes. Encourage students to think of non-fictional modern heroes, from celebrities to actors to sports stars to scientists to activists.

Hand out one of the star maps found at this link and also found in the Level 2 Activity Handout Packet: https://www-tc.pbs.org/seeinginthedark/pdfs/family_heros_charts.pdf. Remind students that their constellation does not need to look like a person; their constellation could be a symbol. For example, if a student chooses Serena Williams, they could find the outline of a tennis racket, or if a group chooses Beethoven, they may find the outline of a piano.

Encourage students to think outside of the box to connect our world with the night sky. Once students have created their modern constellations, let them share their constellations with the class, friends, or family and emphasize our world's connection to the stars and the night sky.

Key Discussion Phrases

"Just as we have connected the stars to our modern heroes, many, many people from all over the world and over many years have looked up to the stars for inspiration and felt so connected to the stars that they created stories about them."

"But the stars inspire more than just stories like the one about Pegasus. Humans have also created artwork, songs, philosophy, and more to connect with the night sky. The stars have influenced innovations in science, technology, and math for millennia. Now, we're going to watch a video about the ancient Maya civilization from Central America and how they connected with the night sky years ago!"

The video can be found at this link: <https://www.youtube.com/watch?v=43kbf30fFGU>.

“For thousands of years this connection that the Maya felt with the night sky and its stars has grown stronger, but recently it has been getting harder and harder for us to see the stars at night. This is because of light pollution. Can anyone tell me what light pollution is? Think about what pollution is and what light is.”

“As many of you guessed, **light pollution is when artificial lights make the world filled with more light than it should be and pollute our night sky.** Also, these artificial lights put too much light where light isn’t needed or wanted. These artificial lights can be any nighttime light, from street lamps to porch lights. When used incorrectly, these lights glow so bright that we aren’t able to see the stars as well.”

“Since we rely so much on artificial light after sunset, we spend less time looking at stars and are slowly losing such a strong connection with the nighttime. The nighttime is very important! It’s a time when we get to rest, and important processes in our brains and bodies happen while we sleep. At night, stars, planets, constellations, the moon, and more light up the night sky. Have any of you been stargazing? Is there anything special you have noticed at night? What did you feel?”

- Let a few students share experiences after dark to demonstrate connection.

“Now, imagine if you weren’t able to see the stars and planets because the lights around you were too bright! Luckily, as we progress through these lessons you will learn that there are many ways to help make our lights safer for the night sky so that we will still be able to see the stars in a thousand years.”

Extension of Learning and “Why is this important to me?”

- Encourage students to go outside after dark to enhance their connection with the night sky.
- If you have a story time or reading time, include another story of a constellation.
- What is a star? Information about stars can be found here: <https://science.nasa.gov/astrophysics/focus-areas/how-do-stars-form-and-evolve>. Students are innately curious, so teaching them about what a star is will fuel more curiosity when they look at the night sky.
- If you are talking about a hero (e.g. scientist, celebrity) during another time, you could bring up the hero constellation activity to remind them of our important connection with the stars.

- Do the optional activity sheet (found in the Level 2 Activity Handout Packet) from the Jr. Ranger program: Navigating at Night
- Use the moon journal (found in the Level 2 Activity Handout Packet) as an additional activity and as a chance for students to go outside.

Lesson 2: Ecological Components

Ecological issues with light pollution.

The loss of the night sky affects our world (e.g. animals and plants) in a bad way.

Student Objectives

- Students will complete Activity #1 to experience light pollution firsthand.
- Students will investigate animals that are affected by light pollution.
- Students will determine how light pollution affects plants.
- Students will learn about light in the blue wavelength.
- By examining different light sources, students will tangibly understand blue light.
- Students will learn about the repercussions of light in the blue wavelength.
- Students will learn about the Circadian Rhythm and how it connects to blue light.
- Students will spend time outside after dark to connect with the nighttime.

Material Review // Activity #1 Walk Through



This activity will be used to physically demonstrate light pollution. It may be useful to review what light pollution is before going into the activity. For this activity, you will need a room that can be made dark and a flashlight such as one that can be found on a phone.

In a dark room, point the flashlight down at the ground. Show the student(s) that the flashlight allows them to see the ground. Then, look up at the ceiling, where the flashlight is lighting up the ceiling even though you are not pointing the flashlight up.

This activity can be compared to a street light or other outdoor light. These lights are meant to illuminate the space/ground below them, but end up spewing light up and around, creating the light pollution that disconnects us from the sky. To take this activity further, discuss how the flashlight could be fixed so that the light only lights the intended area and reduces light pollution.

Key Discussion Phrases

- This section describes the ecological effects of light pollution. If you have a bigger group, you may want to split up the class into groups. Each group can be assigned a topic to research and present to the rest of the class. Topics include: navigation, reproduction, circadian rhythm (Melatonin production), annual rhythm, ecosystem degradation, and interactions between predators and prey. If the group project model doesn't work for your group, you can teach this to your class instead.



“When a mother sea turtle is ready to lay her eggs, she comes out of the sea onto the beach. She digs a pit in the sand, lays her eggs, and covers them so they are safely tucked in. The baby turtles know when to hatch when the weather gets cooler. Those cooler temperatures normally come during the night! When the baby sea turtles are ready to hatch and make their way to the sea, they climb out of the nest their mother built and find their way to the ocean. Imagine you are one of those baby sea turtles. You just hatched out of your egg and need to find the ocean. How do you get there? How do you and your siblings find the water? The turtles are born knowing to follow the brightest thing they see. Since it’s nighttime, the moon and the stars reflect on the water, and should be the brightest thing you see. When you see the bright reflection of the moon on the waves, you know which way to go. But what happens when there are artificial lights nearby? What if you confuse a street light with the moon?”

“Just like in the activity we just did, some lights give off too much light, and that light goes to places it doesn’t belong. If our flashlight was actually a street light, the light we saw on the ceiling would be light spewed up into the sky! The light pollution that light creates affects all living things. For example, those sea turtles can confuse it for the

direction to the ocean, leading the turtles the wrong way and into danger. If there is a parking lot right next to the ocean, the turtles could follow the parking lot's lights right into the street! Just being confused can delay their entry into the ocean and allow predators to eat them."

"Have any of you been outside near a flashlight at night? You might have noticed that many insects are quickly attracted to your light. Sometimes, lights are left on all night. Whether it's a porch light, street light, or another light, moths and other insects may be attracted to a light for the entire night! Imagine if you spent your entire day looking at a light instead of doing important things like school and eating! When insects spend their entire night attracted to a light, they do not have time to find a home, mate, lay eggs, and other important processes."

"Another example of a creature that has difficulties because of artificial light is a firefly or a lightning bug. There are over 150 different kinds of fireflies in North America. Does anyone know why fireflies flash their lights?" (*Fireflies/lightning bugs flash their lights to find a mate.*)

"There are many, many different types of fireflies. Each of these kinds of fireflies has a different light pattern. For example, one kind of firefly may light up for five seconds and rest for thirty seconds while another lights up for ten seconds and rests for ten seconds. These light patterns are one way fireflies find fireflies of the same species! Fireflies need to find the same kind of firefly to mate and reproduce. When the sky is too bright, it's hard for fireflies to see each other's flashes."



“In this picture, what do you notice about the field? Why do you think there are waves of green crops beside the ripe (brown) crops?”

“Well, the crops in this picture grow based on the balance of daylight and darkness around them. Because of those lights on the highway, the soybeans planted there think it is still summer. In the Summer, the days are longer, so when the lights are left on all night, the plants think the days are longer, like in Summer! The waves of green plants surrounding the lights are the areas of plants that the lights reached to make them think the days were longer. Because the plants never got enough darkness, their beans were never ready to be harvested!”

“Trees are also affected by nearby lights. Think about a tree during Fall when it’s losing its leaves. A tree knows when to lose its leaves because the days begin to get shorter and the night gets longer. So, when a tree is around a light during the night, it thinks that the day is longer, and the tree doesn’t lose its leaves! A tree needs to lose its leaves to not only save water and energy to survive the Winter but also to just generally be healthy!”



The part of this tree that was lit by the light on the pole didn't get the message that the nights were getting longer and that it was time to drop its leaves.

Demo Walk Through

In this demo, we will be discussing how **bright artificial light, especially in the blue wavelength, disrupts our ability to sleep well.** The demo can be found in Lesson 2's corresponding video.

Key Discussion Phrases

"What are your daily routines? What are things that you do every day?"

"Even though all of us do different things during our day, most of us do the same thing everyday... sleep during the night and work and play during the day. Our bodies rely on the sun and the darkness to tell us what time it is. Our bodies use the sun and the darkness to keep a daily routine. The fancy name for this routine is called the **Circadian Rhythm**. This rhythm is how our bodies balance sleep and being awake."

"As we saw in the demo, most lights have blue light in them. Can someone recap what blue light is?"

“That’s right! Light in the blue wavelength is a kind of light that lots of artificial light sources give off. Light in the blue wavelength is very bad for human and animal health. It can confuse our Circadian Rhythm and confuse our bodies about what time it is. Phones and other electronics produce blue light. Because of this, phones or other lights can make our bodies think that it’s daytime when it’s really time to go to bed. When we are surrounded by natural darkness, our bodies produce a chemical called Melatonin. Melatonin helps us sleep and is what triggers the process that makes us feel well-rested. How do you feel when you don’t get enough sleep?”

“It doesn’t feel very good when you’re tired, right? Light in the blue wavelength can stop our bodies from producing the chemicals we need to sleep well. Not only does that make us feel very tired, but it is also very harmful to our bodies. When our bodies don’t make enough Melatonin, it is harder for our bodies to fight diseases like cancer and obesity and can increase our likelihood to get depression. To get enough Melatonin, we can reduce time on electronics before bed, dim lights at night, and limit lights in the blue wavelength. We all want to stay healthy and get enough sleep!”

Activity #2 Walk Through (Worksheet in Level 2 Downloadable Handout Packet)

It’s important for your student(s) to realize how important the dark is to our health. Not only does the dark help us sleep, but it also protects us from illnesses and other unhealthy habits. For this activity, students should go outside once it is dark with a responsible adult. Students should turn off any artificial outdoor lighting that they have control of.

Once outdoors, they should focus on the senses, preparing to answer the following questions in writing when they come back in. This will help them connect with the nighttime. When students first go outside, they should sit outside to let their eyes adjust to the dark. It usually takes around ten minutes.

- Seeing: Can you see the moon and the stars?
- Seeing: What is the brightest thing you see?
- Hearing: Close your eyes and listen. What do you hear?
- Smelling: What can you smell?
- Touching: What can you feel using your sense of touch? Is there any wind?
- Touching: Does the air feel different at night than during the day?

Extension of Learning and “Why is this important to me?”

- When outside, ask them to recall this information to help the information and its importance sink in.
- In this lesson, we juxtaposed daylight and darkness. Continue this by discussing the importance of sunlight (i.e. Vitamin D, circadian rhythm, etc.).
- Encourage students to spend time before bed only using warm temperature lights that emit less blue light.
- Discuss with students what they noticed during their nighttime observation. This will help them connect with the night sky.
- Continue the discussion of human health and diseases from lack of darkness.
- Discuss with your student(s) why the Moon looks different on different nights. This video can be very helpful for understanding this concept:
<https://www.youtube.com/watch?v=wz01pTvuMa0&list=LLVTrCP-E5zF-ug81Olv-qCA&index=231>.
- Ask students to think about their own lives. Have them consider how blue light and light pollution has affected their own lives. Maybe they spend less time outside at night than they want. Maybe they read before bed using a white (blue light emitting) light. Maybe they aren't able to see the stars where they live.

Lesson 3: Non-Ecological Components

Non-ecological problems from outdoor lighting and why this all matters.

Light pollution's effects on our whole world are important to pay attention to (glare, light trespass/private property rights, safety & security, saving money & energy).

Student Objectives

- Students will learn about glare and light shields.
- Students will focus on how to create safety and security and save money and energy while reducing light pollution.
- Students will learn about light trespass.
- Students will begin to learn how to improve lights to reduce light pollution's ecological effects.
- Students will compare a light's wattage and targeted lumen output with how useful and bright the light is.

Review

Now let's do a quick review. I want everyone to brainstorm four ways that light pollution negatively affects humans, plants, and animals. Take a couple minutes to think about four things we've learned in the past couple lessons, and then I want you to share with me the four ways you came up with."

"You came up with some great examples!"

Demo (video) #1 Walk Through

Now that we know that light pollution is too much light where we don't want it and how light pollution affects us and plants and animals around us, it's time to learn about light pollution's non-ecological problems. This video is a demonstration of light pollution and one way to make the problem better. The demonstration can be found at this link:

<https://www.youtube.com/watch?v=XTjR4vef8JU&feature=youtu.be>

Key Discussion Phrases

"Thank you Scott! That was a great demonstration. In Scott's demonstration, what did he show us that adds to our understanding of light pollution? What did he do to make it better? What kind of light did that represent in our own lives?"

“Exactly! Scott showed us a light that could be a streetlight near where you live. And he made it look so much better by actually covering up the source of the light! Now Scott used a word for the problem caused by this light fixture: **glare**. Glare is what happens when a light directly hits your eyes. Imagine a bright light shining right into your eyes! Imagine how uncomfortable that light would make you! You would probably shut your eyes, right? Well that light was creating glare. A bright light that creates glare is both uncomfortable, and it’s limiting your ability to see other things around that light!”

“Scott also shielded the “streetlight” to keep it from shining up into the sky where the light wouldn’t help anyone see. **Shielding to stop glare and up-light lets us see better and protect our common view of the sky at the same time.**”



“In the first picture, can you see the glare from that light? Can you imagine how hard it would be to see when that light is shining right into your eyes? Well, in the second picture, we can see that we weren’t able to see the man standing right in front of us because of the glare the light created! That glare is dangerous because we need to be able to see around us to stay safe! From these pictures, we can see that reducing or taking away that glare directly affects our safety and security.”

Demo #2 Walk Through

In this demo, we are going to examine lights outside of two small houses. We will be introduced to light trespass. This demo can be found in Lesson 3's corresponding video. After watching the demonstration, ask your student(s) if they have seen any examples of light trespass in their own life.

Key Discussion Phrases

"We saw that light trespass is light being directed onto another property where it is not intended or wanted and can be very irritating and create sleep problems for neighbors. It is often caused when an unshielded or poorly placed light fixture spills light onto the property of a neighbor. Light trespass can create bad feelings between neighbors and make being outside less enjoyable. Plus, the neighbor who owns the lights is paying extra to light up other properties. The neighbor creating the light trespass may not be aware of the problem at all. Each of us should consider how our lights look from other properties. We can usually get rid of glare and light trespass by shielding our lights, just like Scott showed us! Let's look at an example of this!"



“Look carefully at the two pictures above. Which picture do you like better? Look at the lights in each picture. In the second picture, the lights look a lot better, don’t they? Can someone tell me why that is?” (student(s) should mention glare and/or unwanted lighting)

“Exactly right! The lights in the first picture create a lot of glare! It would probably be uncomfortable to walk down this street. In the second picture, you can still see everything! When the lights are shielded and you get rid of the glare, you can see a lot better. Think about the pictures I showed before these. When the bright light was

shielded by the photographer's hand, we were able to see the man in the photo clearer. If we were walking in the dark and couldn't see in front of us because of a light's glare, we may trip on a rock or bump into someone else. It's so important to our safety to be able to see around us."

"We all agreed that when the town shielded their lights, they got rid of the glare AND made the street look so much better! By shielding the streetlights, they also got rid of the wasted light that was creating glare and going up into the sky. Not having to produce that wasted light means the light fixture can use less energy than before and still give off the light we need to see. The light doesn't have to shine upwards, so the energy that used to shine up is saved. The energy that we save from shielding our lights and only putting light where we need it also saves us money. So, **shielding our lights can help with several things: taking away the glare which lets us see better and feel safer, saving energy, AND saving money!!**"

"When we are surrounded by darkness, our eyes adjust so that we are able to see more without as much light. Once our eyes have adjusted, we don't need so much light to be able to see well in our surroundings. We can also save money and energy by only using the amount of light that we need to see."

"Think about the lamps you might have in your living room or bedroom. Can you see the lightbulb? You probably have a shade over them. This is just like the demonstration Scott showed us and the demonstration with the small houses. The lights in your house would create severe glare if we didn't shade them. So, why don't we cover the lights outside too?"

Demo #3 Walk Through

In this demo, students will compare a light's wattage and targeted lumen output with how useful and bright the light is. Refer to Lesson 3's video for this demo.

If you would like to learn more or go into more detail with your student(s), the Shielded vs Unshielded Stats Chart can be found in the Level 2 Downloadable Handout Packet.

Extension of Learning and "Why is this important to me?"

- Continue to reference the ecological effects. Light pollution's effects like glare go hand in hand with effects such as the suppression of Melatonin production.

- If you are outside near a light, be sure to talk with your student(s) about whether or not it is shielded and what effects that might have on the surrounding wildlife.
- One of the most compelling facts from this lesson is that reducing glare and light pollution actually makes us safer. A lot of times we are told that lighting areas makes us safer, but sometimes that is not true. Be sure to discuss with or demonstrate to your student(s) about the importance of having enough lights but in a safe way to ensure security.

Lesson 4: Root Causes

What causes light pollution & how can we select better lighting to reduce it?

The root causes of light pollution are mostly fixable to lessen this problem in our communities.

Student Objectives

- Students will be introduced to evaluating lights through a picture game.
- Students will formulate ideas for how to determine if a light is acceptable.
- Students will learn about and discuss the Five Principles for Responsible Lighting and how they will use them in the lessons to come.
- Students will practice evaluating a light using the Five Principles.
- By the end of the lesson, students will have the knowledge to outline improvements for a light to become acceptable.

Review

“During the last lesson, we examined each of these issues:

- Glare (which goes hand in hand with safety and security)
- Uplighting
- Wasted light, energy, and money
- Light Trespass

In this lesson, we’ll learn how to evaluate and solve these outdoor lighting issues.”

Activity #1 Walk Through

Based on what we have learned about light shielding, glare, light brightness, and more, students will decide whether they think a light fixture is acceptable. You can find the questions at the beginning of the Lesson 4 video or in the Level 2 Downloadable Handout Packet.

- Do you think this light is acceptable? Talk about reasons why lights are/aren’t acceptable

Key Discussion Phrases

“You did great on those questions. You were able to combine what we’ve learned about glare, light shielding, light brightness, and more to figure out what makes a light fixture acceptable! So, what kind of things should we look for in a light fixture? We want to make sure our lights are safe and night sky friendly, so how can we make sure a light fixture is acceptable?”

Brainstorm with student(s) what unacceptable and acceptable lights/light fixtures look like. Unacceptable lights are lights that give off excess light, contributes to light pollution, creates glare, gives off blue light, etc. Acceptable lights are shielded lights that shine only on the intended places, can be turned off when not in use, has a purpose, isn't too bright, etc. Encourage student(s) to think about more ways to determine if a light is acceptable or not than simply shielding a light.

“Great job! One of the main ways a light fixture creates light pollution and glare is by not being shielded. Acceptable outdoor light fixtures are shielded so that they only put light where we want it and are there for a reason. Acceptable lights do not create glare or increase light pollution. On the other hand, unacceptable light fixtures create glare and give off light in places we don't want, such as a light that gives off light upward. Unacceptable outdoor light fixtures may also give off blue light or be too bright, which are both really unhealthy for us.”

At this point, you should show or hand out the “Five Principles for Responsible Outdoor Lighting” expanded handout sheet located in the Level 2 Downloadable Handout Packet. “Now that we know about the differences between acceptable and unacceptable outdoor light fixtures, let's talk about how we evaluate the use of a potentially acceptable outdoor light fixture. Can someone read the first principle aloud?”

“Thank you! **A light should always have a purpose.** A light has a purpose when it helps us see and do certain tasks. In this principle's illustrations, the light on the left is being used to illuminate the front pathway and stairs. In the right photo, there are more lights, and most of them don't have a specific use. Not only do we want to save money and energy, but we also want to decrease light pollution by only having lights with a purpose. Can someone read the second principle aloud?”

“Thank you! **A light should always be directed to the place the light is needed.** We should never be able to see a light source from beyond our property. Just like we talked about in the previous lessons, it is very important to shield, target, or hide a light source so that we only use the necessary amount of light. Can someone read the third principle aloud?”

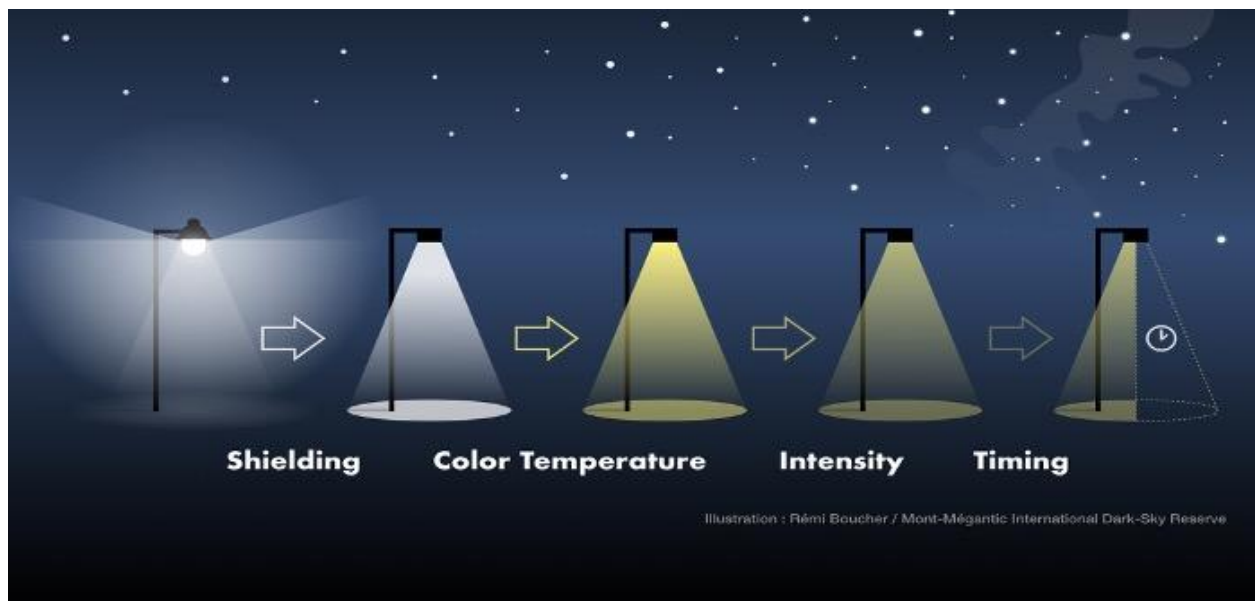
“This is another important one, thank you! Think back to the demonstration in the last video. We saw that even though the lights were very different levels of brightness, because one was targeted, they gave off the same amount of light onto the table! The brightness of lights also affects our production of Melatonin, so it is important to select the right level of lighting. Light levels are measured in units of lumens. When choosing

our light level, we want the **lowest lumen level appropriate** for its use. Can someone read the fourth principle aloud?”

“Great, thank you! Lights can be very useful. However, **it is important that when light sources are not being used, they are turned off**. Whether this is as simple as flipping a switch or having a motion sensor for a light, it is important that our light fixtures are only on when needed. Can someone read the last principle?”

“Thank you! Like we learned before, the wavelength of a light can stop our bodies from making the chemical Melatonin which helps prevent diseases. This is also true for plants and animals. Think about all the living things that live outside our houses. Those animals and plants also need to produce Melatonin. If you look closely at the illustration on the right, you can see that the white light attracts way more bugs than the yellow light on the left. Humans need to be considerate of all animals and plants by limiting the blue wavelength in our outdoor lights.”

“When we combine the five principles, we can evaluate a potentially acceptable outdoor light fixture. This picture combines the principles to change a light’s effect on light pollution!” *Picture below:*



“Now that we have talked about five big ways we can evaluate a potentially acceptable outdoor light, let’s look at a real life example!”



“This is a potentially acceptable light fixture. How can we use the five principles to evaluate this outdoor light? What about this light is acceptable and what else do we need to learn about this light to fully evaluate it?”

Principle 1 (purpose): We would want to look into whether this light has a clear purpose.

Principle 2 (targeted): This light looks very targeted because we cannot see the light source and the light is pointed towards the ground where we may need the light to walk.

Principle 3 (brightness): We would want to learn how many lumens this light is producing and whether that amount is appropriate for its use.

Principle 4 (controlled): We need to learn whether this light is on a timer, motion detector, or will it be turned off when not needed.

Principle 5 (color): We would need to look at the light source to see what color temperature the light is. Hopefully, the temperature is 2700 Kelvin or less (warm in temperature) to emit less light in the blue wavelength.

Activity #2 Walk Through

Now that the student(s) understand how to evaluate an outdoor lighting fixture, your group will play an evaluation game. Students can either play individually or in groups of 2-5 students. Each student or group will receive the pictures printed and cut out.

Students should look at each picture of an outdoor light and go through the five principles to pick which principles need to be improved upon. They should brainstorm

an idea relating to each problematic principle. For example, if a light is not a warm temperature light, students should identify principle 5 as needing to be improved; for principle 5, we could replace the light bulb with a warmer light.

The pictures and answers can be found in the Level 2 Downloadable Handout Packet.

To take this activity further, students could use their brainstormed solutions to pick an effect that comes from that solution. For example, when we choose a warmer light bulb, more animals and plants around that light will be able to produce more Melatonin (the important sleep chemical our brains give off).

Extension of Learning and “Why is this important to me?”

- Students could complete an activity where they get to design a light fixture that abides by these Five Principles.
- Students can prepare for the lighting inventory and assessment by reviewing their Five Principles while evaluating an outdoor light fixture.
- Review with your student(s) the ecological and non-ecological effects. Then, talk about the principles that can help reduce those problems.
- Students could do the fun Junior Ranger activity, “Where should the light go? And Nocturnal Animals” in the Level 2 Downloadable Handout Packet.

Lesson 5: Introduction to Culminating Activity

Introduction to culminating activity (Lighting Assessment).

How can we incorporate this knowledge into our community?

Student Objectives

- Students will be shown the different kinds of light fixtures and sources.
- Students will categorize lights beyond simply acceptable or not acceptable.
- Students will learn more about the energy of a light.
- Students will learn about a light's Kelvin Rating and color temperature.
- Students will apply the Five Principles to the different kinds of light fixtures and sources to determine how each principle affects a light.
- Students will learn about wattage and lumens of a light.
- Students will utilize their knowledge to identify and label different light fixtures and sources.

Key Discussion Phrases

Use this lesson's handout in the Level 2 Downloadable Handout Packet to show pictures of the different types of light fixtures, light bulbs, and color temperatures. In this lesson's video, there is an ongoing demonstration of the different kinds of light fixtures and bulbs and their brightness and color temperatures.

“Although light fixtures can generally be put into acceptable vs. unacceptable categories, there are many different types of light fixtures. In the next lesson, we are going to start assessing and taking inventory of our outdoor lighting! To do this, we first need to know what kinds of lights we are going to see. Let's look at the most common kinds of light fixtures and light bulbs. As we learn about the kinds, we will also talk about some of their qualities. When evaluating a light source, we are going to look at three things: **wattage, color, and lumens**. Let's break down those terms.”

“Wattage, measured in watts, is how we measure how much power a light uses. Watts measure how much power or energy is needed to light up a light source. So if we say a light's wattage is 50 watts, that means we need 50 watts of power or energy to light that bulb.”

“Lumens measure how much light a light bulb gives off rather than how much power or energy it uses. Lumens relate to the wattage of a light only when we are comparing the

same kind of light bulbs from the same company. We use watts to figure out how much energy a light uses and therefore how much money a light costs to operate. On the other hand, we use lumens to figure out how bright a light source is.”

“We have talked about a light bulb’s color a lot. A light’s color temperature is measured in Kelvins. Lights with lower Kelvin ratings are considered warmer lights and usually create less glare. In general, the higher a light’s Kelvin rating is, the more light in the blue wavelength it contains.”

“The first kind of light fixture is called a barn light. Where do you think this light would be used?”

“This kind of light fixture is often used in yards, parking lots, or as a light to make people feel safe. But this light fixture creates a lot of glare and general light pollution! And we know that glare actually makes us less safe because our eyes aren’t able to see past the light source. Remember that picture in Lesson 3 of the light in the backyard? Is there a way to make a barn light better? If we need to replace the fixture, what should we look for in a new light fixture?”

“You had some great ideas! We could shield the light and change the bulb to a lower wattage bulb of the same type. We could also replace the whole fixture with a shielded fixture using a different light source. The next kind of light fixture is called a Cobra Head. Where do you think this kind of light would be used?”

“You’re right; this light looks like a street light or another common outdoor light. There are two kinds of Cobra Head light fixtures. The first is a drop lens. As you can see in this picture, a drop lens fixture is called that because the reflective lens is “dropping down” out of the bottom of the cobra head. A flat lens Cobra Head is when the reflective lens is flat and doesn’t come out of the Cobra Head. Thinking about the Five Principles, what do you think is wrong with the Cobra Head light fixtures? How could we improve these lights?” *Students may discuss shielding the fixture to direct the light, changing the bulb to have a lower wattage and/or lumens, using a warmer colored bulb, or replacing the fixture.*

“Exactly right! The drop lens creates a lot of glare because we can see the reflective lens coming out of the bottom of the fixture. Although the flat lens isn’t shining light upwards, it is not always targeted. The flat lens fixture is often spilling light beyond where it is needed. To improve these lights, we could shield the sides of the lights to direct the light better and stop the glare.”

“The next kind of light fixture is called shoebox style. Where do you think we could find this kind of light fixture?”

“We could find this light in a lot of parking lots! If the light source in this fixture does not stick out of the bottom of the shoebox, it probably doesn’t create a lot of glare. The best way we could improve this light is by focusing on the color temperature of the lights. A lot of parking lots leave their lights on all night, so we don’t want insects to be attracted to those lights the entire night!”

“The next kind of light fixture is called a Wall Pack. This kind of fixture is found on the side of a lot of buildings! What do you notice is wrong with these lights? How could we fix or replace these lights?”

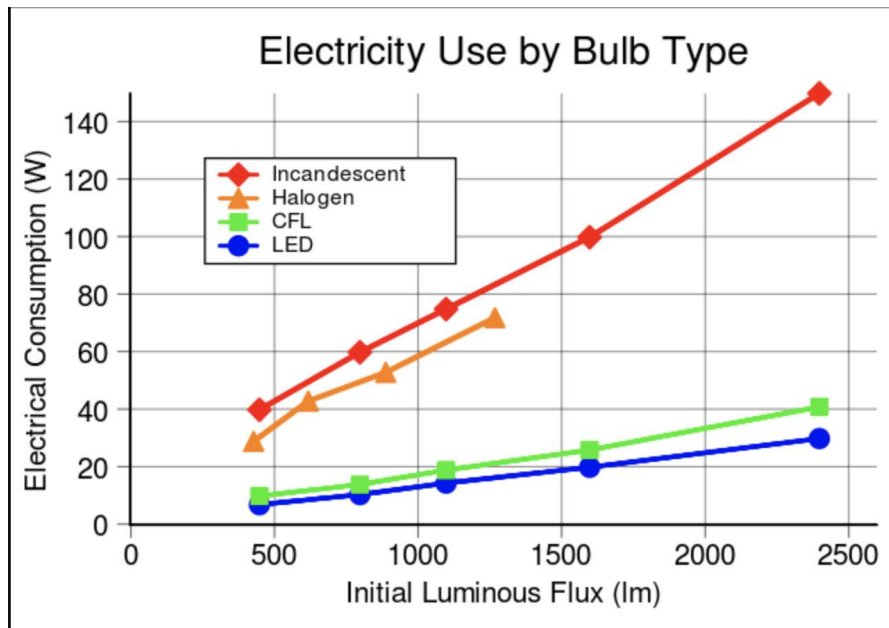
“You’re right! All five of the Principles could be applied to a normal Wall Pack. First, we should make sure the Wall Pack just like all of our lighting serves a purpose. Then, we should shield these Wall Packs to direct them to prevent glare and increasing light pollution. Next, we should be sure that the light bulb is not too bright and is a warm color temperature. Finally, we should add a motion sensor to the Wall Pack so that it isn’t on when it is not being used.”

“The next kind of light fixture is called a spot or flood light. spot or flood lights are very common outdoor lights. What do you notice is wrong with this picture of a spot or flood light? How could this light be improved?”

“Great job! These lights definitely need to be targeted. We don’t want the light going everywhere; we only want the light going where we want it to. We could also change the color temperature and brightness.”

“Now, let’s look at the six most common kinds of outdoor light sources. First up is the Halogen Bulb. These are the bulbs in car headlights, some older sports field flood lights, and home spotlights. Metal Halides are used in street and parking lot lights. High Pressure Sodium or HPS lights used to be the most common type of street light. You have probably seen High Pressure Sodium lights in shoebox and cobrahead style lights. Incandescent bulbs are the light bulbs that Thomas Edison invented! These light bulbs are extremely inefficient and used to be the standard type of bulb for most residential fixtures. Compact fluorescent light bulbs or CFL bulbs are also used in homes. CFL bulbs are efficient little spirals that give off white light. CFL bulbs contain Mercury, a toxic chemical, and must be disposed of correctly to avoid harming the environment!

Finally, LED lights have become really popular recently! These lights save a lot of energy, but they are usually very blue-light heavy. LED lights could be in any of the light fixtures! LED lights easily create glare when they are in the white / blue color range, so they almost always need to be recessed in the fixture or have a shield to prevent glare.”



This graph shows how efficient the different kinds of light bulbs are. As we can see, incandescent bulbs are the most inefficient of the bulbs in the chart whereas LED lights are the most efficient of the ones being compared. This means that by using LED lights, we can save energy and therefore the money that energy costs.

Demonstration Walk Through

In this demonstration, students will investigate further just how much the Five Principles affect a light fixture/source. They will also get to see some of the fixtures and bulbs. Refer to Lesson 5's video for this demonstration.

Key Discussion Phrases

Electrical power equivalents for differing lamps

Minimum light output (lumens)	Electrical power consumption (watts)		
	Incandescent	Compact fluorescent	LED
450	40	9–11	6–8
800	60	13–15	9–12
1100	75	18–20	13–16
1600	100	23–28	15–22
2400	150	30–52	24–28
3100	200	49–75	30
4000	300	75–100	38

In this chart, your student(s) can use a light's wattage to estimate that light's lumen output.

“To find out a light's wattage, there are a couple things we will do. Some lights say on the fixture what the light's watts are. If our lighting doesn't, we will talk to the property manager or a lighting expert to find out how many watts a light is.”

“Once we know a light's wattage and the kind of lamp, we will use our chart to estimate the light's lumen output.”

“To estimate a light's Kelvin rating, we are going to get an app! This free app is called Nurus LV (Light Wellness) and allows us to point the app at a light, and it will estimate the light's Kelvins! We can also use our color chart from our handout to estimate the Kelvin rating!”

Activity Walk Through

Now that the student(s) have learned about the five common light fixtures and the six common light bulbs, your group will play a labeling game. Students can either play individually or in groups of 2-4 students. Each student or group will receive the pictures and labels of lights printed and cut out. They should then pick out the name of the fixture or bulb. There is one label for each picture.

The pictures, labels, and answers can be found in the Level 2 Downloadable Handout Packet.

To take this activity further, students can also decide where each kind of fixture or lamp is used most commonly. Also, students can come up with pros and cons for each fixture and lamp.

Extension of Learning and “Why is this important to me?”

- Go out into the physical world and find the different kinds of light fixtures and sources. If you are near multiple types of fixtures or sources of light, this could take the form of a sort of scavenger hunt.
- For the lighting assessment, we will combine the Five Principles and the types of lights we just learned, so start discussing with your student(s) the types of lights in relation to whether it is acceptable.
- It may be easier to identify indoor light bulbs, so it may be beneficial to start by looking at and identifying indoor lights.
- As you go through the evaluations and beyond, be sure to reference the ecological effects to bring it back to humans, animals, and plants.
- Research the connection between wasted energy and the water used to create that energy.

Lesson 6: Introduction to Culminating Activity

Introduction to culminating activity (Lighting Inventory and Assessment).

How can we incorporate this knowledge into our community?

Student Objectives

- Students will define and practice using lighting terminology.
- Students will begin to work on the culminating activity (lighting inventory and assessment) and complete about half of the activity.
- Students will brainstorm how evaluating and improving lights can help reduce the problems discussed in Lessons 2 and 3.
- Students will practice reaching out to a professional for help on their activity.
- Students will review the Five Principles in relation to evaluating lights and creating an inventory.
- Students will prepare for their inventory and data collection.
- Students will fill out their Data Collection sheets.
- Students will create their inventory.
- Students will complete their evaluation.

Activity Walk Through

In this activity, students can either work individually or in groups of 2-4. This activity is a fill in the blanks and vocabulary exercise. For either each student or each group, print out the Glossary of Lighting Terminology and Vocabulary Fill in the Blank Worksheet. This will help them learn some of the vocabulary they may need during the lighting assessment. Once everyone has finished the activity, go over the answers to make sure your student(s) understand the vocabulary.

The Glossary of Light Terminology, Vocabulary Fill in the Blank Worksheet, and Fill in the Blank Answer Sheet are in the Level 2 Downloadable Handout Packet.

Overview

To complete the lighting inventory and assessment, you will need to complete six steps. Lesson 6 covers three of these steps. For the six steps, there are worksheets to assist in completing these tasks. Here are those first three steps:

- Data Collection Sheets
 - Collect data on your outdoor lights during the daytime and after dark.
- Inventory

- ❑ Once you have collected your data, create an electronic inventory of your lighting.
- ❑ Evaluation
 - ❑ Evaluate your outdoor lighting to determine which lights should be changed.

Key Discussion Phrases

“Now that we have learned so much about light pollution and its causes, effects, and solutions, let’s learn about something we can do! Today, we are starting a lighting inventory and assessment of our *(fill in where you will be completing the lighting inventory and assessment, e.g. home, school, park, library)*! So what is a lighting inventory and assessment? Well, when we do our lighting inventory and assessment, we will be documenting and evaluating all the outdoor lighting to see if we can help reduce light pollution! By documenting and evaluating our outdoor lights, we can suggest ways to make them better based on what we have learned during these lessons! How will we be helping our community with this inventory and assessment? Who or what do you think we’ll be helping?”

“Great job discussing!! This lighting inventory and assessment will affect so many things! By fixing our lighting, we will be fighting for the stars by protecting the night sky and reducing light pollution. We’ll be saving energy and money. We will reduce glare to make our community safer after dark. We will help all the living things around us, from plants to humans to animals! Are you ready to get started on our inventory and assessment?!”

“Our first step is to talk to someone who is responsible for the property and someone who knows the property well to ask permission and gather information from them.” *Talk about who you can talk to. This may be a principal, a parent, a property manager, etc. Now it’s time to email or meet/talk with this person to ask permission.*

In your letter, you may want to explain that you have been studying how to improve lighting for efficiency, visibility, and safety. Also explain that the lighting inventory and assessment is an important tool in figuring out improvements that can be made. You may want to talk about what you will be doing as you complete the lighting inventory and assessment. Be sure to emphasize the benefits of your work such as safety and security, operating expenses, efficient lighting, reduction of glare, etc. Make sure to let them know that you will need daytime and after dark hours access to the exterior of the property. They may want to meet to discuss it or they may just give you permission.

“Now that we have gotten permission and guidance, we can start to evaluate the lights. If possible, it would be helpful to have the property manager or maintenance staff accompany us while we complete our inventory. If not, we will consult with them after we have done our best to find out all the information. Even though these lights are used at night, we want to start our evaluation during the day. We need to be able to see the light fixtures and bulbs to evaluate the lights! At each light, we are going to go through our Five Principles. Can someone remind me of those Five Principles?”

“Thank you! Once we start our inventory, the first thing we are going to look at is the purpose and location of each light. We are going to take a picture of each light and note the photo order. Then, we will identify what kind of light fixture it is and what kind of light source it has. Next, we will try to find out how many watts it uses and its lumen output to look at the amount of energy it uses and the brightness of the light. We can find out the watts and lumens of each light by either looking at the fixture or talking to someone who knows the property well (*i.e. property manager or maintenance staff*). If we can’t get the information this way, we can use our Nurus Light phone app to estimate it. We will continue with the other Principles by looking at the lights after dark. We can look at the timing of the light to see if it has a motion sensor or is turned off when not in use. If it is not immediately obvious, we will ask the property manager or maintenance staff. Then, we will determine the color temperature, measured in Kelvins, using our app if the maintenance staff or property manager does not know. Next, with our knowledge of the lumens, we will notice the brightness level of each light. We can ask ourselves: is it too bright; is it too dim; does it create glare? Finally, by looking at the fixture, we can see whether the light is directed well. We want to make sure to take a picture of each light after dark too. Now that we have finished taking inventory, let’s review the Five Principles. Is the light useful? Is the light targeted? Is the light too bright or too dim? Is the light controlled? Is the light warm in color temperature? Once we have finished looking at the Five Principles for each light, we can figure out which lights need to be improved or replaced.”

“During our physical inventory, we are going to keep track of all of this using our Data Collection Sheet! Then, we will use our data to create an electronic inventory of all our outdoor lights! Using that inventory, we can evaluate our lights to know which of our lights we want to change or replace. Now, let’s see an example of how to use our data collection sheets and inventory before we go out to use ours!”

Demo Walk Through

This Demo shows your student(s) how to use the Data Collection Sheet (available in the Level 2 Activity Handbook Packet) and Inventory Spreadsheet (available individually in the Online Training webpage of www.txnsf.org). It goes through what you should look at during the assessment and inventory and gives several examples of assessing lights you might encounter during your assessment. Refer to Lesson 6's video for this demo.

Extension of Learning and "Why is this important to me?"

- While completing the data collection sheets, be sure to emphasize how acceptable lighting can better protect humans, plants, and animals.
- Try to incorporate the vocabulary into your data collection and allow for students to take the lead on the inventory and assessment.

Lesson 7: Culminating Activity

Culminating activity (Lighting Assessment).

By completing this activity, you will be able to create real change in your community.

Student Objectives

- Students will finish the culminating activity (lighting inventory and assessment).
- Students will calculate the cost of running and replacing lights to create the cost analysis.
- Students will determine the proper action to take after evaluating all lights (e.g. replacing the fixture or bulb).
- Students will write up a report and letter of change with their recommendations.
- Students will have the chance to create tangible, beneficial change!

Overview

To complete the lighting inventory and assessment, you will need to complete six steps. Lesson 7 covers three of these steps. For the six steps, there are worksheets to assist in completing these tasks. Here are those final three steps:

- Replacement Recommendation Options
 - Once you have evaluated your lights to know which lights you will improve or replace, you must select the replacement fixtures/bulbs you will recommend to your property manager or maintenance staff.
- Cost Analysis
 - Fill out the cost analysis sheet on the lights you hope to change. You will only analyze the lights you plan to change.
- Report and Letter of Change
 - In this letter and report, you will review the lights you think should be improved or replaced and why they should be changed. Here is where you can use the cost analysis, safety improvements, and other benefits to support your assessment of the lights. This step may take the form of a presentation as well.

Key Discussion Phrases

“You did great assessing those lights! Wasn’t it cool taking data on the lights around us? Now that we have created the inventory on our lights, we are going to find recommendations for the lights we want to change, write about what we think can be changed and how those changes will help, and fill out a cost analysis.”

“In our inventory and evaluation, we figured out which lights we wanted to change or replace. Now, we are going to select the replacement fixtures/bulbs we will recommend to our property manager or maintenance staff! The cost analysis will be done for the lights we want to make changes to or replace. The analysis will show how much money we spend now and how much money we would spend after we improve or replace the chosen lights. Finally, in our report, we will use all of our knowledge to write about our plan to improve or replace the chosen lights and how it would affect our community! In our writing, we will remember our Five Principles to recommend how the outdoor lighting can be improved to save energy and money and reduce light pollution.”

“Once we finish our lighting assessment, we will be able to make real change in our community. We will reduce light pollution and keep our community safe and healthy. We will save money and energy. This lighting assessment gives us the chance to document and raise awareness about light pollution. Furthermore, we will create change that helps the sky and every living thing near these lights! Are you excited to help improve our community?!”

“As we finish our lighting inventory and assessment and beyond, I hope you will all remember to Be a Knight for the Night. I hope we can all connect to this quote by Sarah Williams: “I have loved the stars too fondly to be fearful of the night.””

Demo Walk Through

This demo will walk your student(s) through the final portion of the lighting assessment. It will give examples of the replacement recommendation options, report and letter of change, and cost analysis. Refer to Lesson 7’s video for this demo. The documents you will need are available in Level 2 Downloadable Handout Packet plus the spreadsheet is available separately on the Online Training webpage of www.txnsf.org.

Extension of Learning and “Why is this important to me?”

- Talk with your students about the importance of changing lights for the better.
- While working on the lighting inventory and assessment, be sure to have students recall everything they have learned, especially the ecological and non-ecological effects of light pollution
- Continue to discuss with students the importance of light pollution, how light pollution affects all living things, and how they can reduce light pollution beyond the completion of the lighting inventory and assessment.

- Pose the question: what do you think will happen if light pollution continues to expand globally at this rate? Have a discussion about the importance and impact of your work!

Conclusion Survey to fill out as a class

Thank you so much for following along with this curriculum and the corresponding videos. Hopefully you found these materials useful and helpful! To learn more about light pollution and what you can do, continue to browse txnsf.org. Additionally, at txnsf.org, you will find flyers/handouts to hand out to family, friends, neighbors, etc. or to post online in order to raise more awareness about the amazing work you are doing and this cause you care about!