STEAM CURRICULUM
Aligned with National Learning Standards
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| Additional resources available on the EarthX website: |
| Film Resources |
| Tips for Young Filmmakers |
EarthX is dedicated to discovering, researching and innovating practices that impact and reshape our world through environmental education and awareness. To create a sustainable future, we must educate our students on the impact that our actions have on our world today. The goal of this curriculum is to create projects that guide students to understand our Earth, human impact and their role in creating a sustainable future.

The lessons are divided into four main areas of focus: Earth, Energy, Cities and Climate. Within each lesson, you will find the following components. Note that film, art and social studies activities may be integrated into the main content; therefore, not all lessons will include every section listed below.

- Grade Level/Focus Area/Discipline/Title of Lesson
- Objective/National Learning Standards/Driving Question
- Materials Needed
- Spinning the Cocoon (knowledge building)
- Metamorphosis (hands-on learning)
- Upcycle (an additional, more challenging component to the lesson)
- Kaleidoscope (social studies extension)
- eARTh (connected art project)
- Through the Lens (related film application)
- Kernel of Knowledge (on-topic fact to build real-world awareness)
- Community Garden (service-learning opportunity)
- Career Highlight (spotlight on an outstanding individual in a related career)
- Career Connections (related careers and their educational pathways)

The lessons are written with a specific focus but are also versatile in their makeup so that a teacher can easily adapt them to their teaching and learning outcomes. Lessons can be implemented in the classroom throughout the year, or to help observe and bring awareness in celebration of Earth Day. Educating students about the power they have to make a positive impact is vital, and it is our hope you can do that with these lessons.

In addition to the curriculum, EarthX has an educational division dedicated to showcasing films and emerging media that explore science, conservation, climate change and the environment while honoring the heroes working to protect our planet. With a mission to turn awareness into action through education, art and media, EarthXFilm provides learners with tools to understand, shape and drive a sustainable future.

Because film is a powerful resource in today’s technology-driven world, links to relevant, insightful and impactful film resources are included in many of the lessons. In addition, EarthXFilm will periodically provide additional links to new and upcoming films with suggested lesson connections. To view the many film and film-related resources offered through EarthX, including competitions, panels, discussions and more, visit https://www.earthxfilm.org/.

Note to Teachers: Please check your school district’s policies on screening films in the classroom; contact your campus administrator if you have questions about a specific resource. Also, we suggest checking any links prior to screening them for students. While the links contain recommended supplemental information, some feature advertising content that may or may not be suitable for classroom viewing. Many of the links and videos are not controlled by EarthX, so we are not responsible for any ads that pop up.
In this lesson, students will:
- observe and identify three forms of energy including light, thermal, and sound;
- explain the way folktales reflect beliefs of communities;
- observe and describe how thermal energy affects materials;
- ask questions and seek answers with a student-designed investigation of thermal energy in small groups; and
- create a series of three drawings based on their observations of thermal energy.

National Learning Standards:
Science: Kindergarten - K-PS3-1; K-PS3-2
1st - 1-PS4-3; K-2-ETS1-1; K-2-ETS1-2
Math: Kindergarten - K.MD.A.2
1st - 1.MD.C.4
Social Studies: 1st - I,c
Art: Kindergarten - Cr1.1.Ka; Cr2.3.Ka
1st - Cr1.1a
Begin the lesson by having students use their senses to explore energy in the forms of light, thermal and sound in the classroom, around the school building and outside. Take the students on an observation walk to these areas and tell them to use their eyes, ears and touch to make observations of these three forms of energy. As a group, stop and allow the students time to sit and draw some of their observations in a sketchbook.

When you return to the classroom or lab area, create a tree thinking map on the board together with the title “energy” and the three branches written as “light,” “thermal” and “sound.”

Ask students to share their observations from the walk and add them to the thinking map.

Next, demonstrate thermal energy with a simple heating soap demonstration. You will be placing a piece of white bar soap on a paper plate in the microwave and heating it for 90 seconds. Before showing the class this demonstration have them make predictions of how the soap will change and draw or write about these predictions in their journals. Then perform the demonstration and discuss the results with the class. If you do not have access to these materials you can also show your class a video of this demonstration. There are many options available on YouTube.

Review key vocabulary before continuing with the exploration.

- **Thermal** means relating to heat.
- **Investigation** is the action of testing and researching a question or inquiry.
- **Folktale** means an old story that has been passed down through generations of different cultures and groups of people through oral storytelling.”
Students will listen to the African folktale, *Why the Sun and Moon Live in the Sky*. This can be read aloud by the teacher or heard via an online audio link. In small groups, the students will discuss why this folktale was created and whether they think it is based on any facts.

Next, each group will design an investigation to test the heating effect of the sun on different materials and document their investigation in their journals. First, they will write down a question they have about how the sun’s thermal energy will change an object. They may use objects in the classroom or bring something from home. Then each group should plan how they will carry out the investigation. Student groups will draw a picture in their notebooks to show the steps of their investigation. Students will then carry out their investigation and make observations. Time should be allowed for students to modify their plans and retest if their first plan is unsuccessful.

Students should use thermometers to measure the temperature of the sun several times over a period of time when observing their object, and record temperatures and observations in their notebook. Instruct them to create drawings of how their object might be changing from the heat of the sun. Each time the students go out to check on their object, they will create a drawing to show the effects of the sun’s heat. They should have no less than three drawings upon completion of the experiment. Students will share their results with the class and conclude why they think the sun should stay in the sky.

**UPCYCLE**

Changes occurring as a result of heat have been observed and tested, but changes can also be made by cooling materials. How can the students change their investigation to not only evaluate the effect of applying thermal energy on an object but also of removing thermal energy? Students should redesign the investigations to observe and identify changes in materials caused by cooling. Then compare the changes in materials by both heating and cooling, and share those results with the class.

**THROUGH THE LENS**

Students should take photos of their drawings, then create a slideshow of their group’s drawings in sequence. Students should be able to share their slideshow with their peers and verbally explain what is happening in their drawings.
Take the observation drawings that the students created and display them as a group. Each student should have three drawings. If possible, glue each student’s drawings, in the order in which they were completed, onto a sheet of black paper. Invite the students to talk about their work and explain to their peers how their drawings reflect the effects of the sun’s heat on their object. Also, talk with the students about their use of the elements of art in their work.

Next, take the students outside on a nature walk and instruct them to collect a few objects along the way. These might include leaves, acorns, rocks, flowers, sticks, etc. When you get back to the classroom, give each student a sheet of sun sensitive paper (darker colored construction paper will work as well). Have the students lay their objects that they gathered on their walk onto their paper. Be sure to leave some space between each of the items.

Now, place the paper in a space where it will be in the path of direct sunlight. If possible, outside would be best, but next to a window that receives strong sunlight will also work. Leave the paper out for a day or two, depending on the type of material that is used. Sun sensitive paper will change much faster than construction paper. Allow the students to check the progress of their pieces each day. Ask them what they notice about the paper when they look at it. What is happening to the areas where the objects are placed?

Once the paper has faded significantly, allow the students to remove all the objects on the paper. Form a discussion around what is left on the paper. Why is the space where the objects were a different shade or color? How did thermal energy affect their art?
CAREER CONNECTION

**Physicist** - A physicist is a scientist who studies matter, energy, motion and force. To become a physicist, you need a bachelor’s degree in physics as well as a master’s degree. Ultimately, many physicists go on to complete their doctoral degree.

**Astronomer** - An astronomer is a scientific observer of celestial bodies or things of the sky including the sun, moon and stars. Most jobs in this field require a PhD in astronomy.

CAREER HIGHLIGHT

Sylvia Earle is an oceanographer who is advocating for our struggling oceans. She is highlighted in the film *High Seas Journey to Costa Rica Thermal Dome*, which was shown at EarthxFilm2018, where she is using her research to fight for the protection of this invaluable thermal energy source.
2ND GRADE
STEAM & SOCIAL STUDIES
In this lesson, students will:

- compose three dimensional solids with given properties or attributes;
- identify and demonstrate how to use, conserve, and dispose of natural resources and materials;
- identify and explain a problem and propose a task and solution for the problem;
- combine materials that, when put together, do things they otherwise could not by themselves;
- justify the selection of those materials based on their physical properties, while building a sustainable school model; and
- identify ways people can conserve and replenish natural resources.

Driving Question:
How can we design a sustainable school?

Materials Needed:
- Notebook to record plans/observations and summarize results, writing utensils, manila or colored construction paper, large collection of recycled materials available for model building (e.g., cardboard, plastic and paper products), glue, tape and fasteners, cameras or digital devices with cameras.

National Learning Standards:
- Science: K-2-ETS1-1; K-2-ETS1-2
- Math: 2.G.A.1
- Social Studies: III,g
- Art: Cr1.1.2a; Cr3.1.2a
Sustainability is about making a conscious effort to meet the needs of the present without compromising future generations. This is important to teach children at a young age. Sustainability goes beyond basic recycling to build thoughtfulness into our choices about how we treat our environment.

Use the following analogy to help students understand sustainability thinking. Break students into pairs and tell each pair to create a paper cylinder tube and a paper cone. Tell the students to study the two shapes and compare them using a Venn diagram in their journals. Then bring the group together and discuss their findings. Ask, “What do you notice about the two ends of each solid?” Record their answers on the board. They should notice that the cylinder has two openings that are the same size, and the cone has one end that is large and open, and the other end is small and/or closed. On their cylinder have them write “present” on one open end and “future” on the other open end. On the cone have them write “present” on the large open end and “future” on the small closed end.

Next, explain that sustainability thinking is like the cylinder. We want to ensure the choices we make in the present allow for an equal amount of choices or opportunities in the future. Then ask, “How is the cone different?” Explain that if we make poor choices and use up too many of our resources, then we limit choices and resources for the future. Tell students to talk with their partner about what they understand about sustainability.

Review key vocabulary before continuing with the exploration.

- **Sustainable** means capable of being maintained at a steady level without using up natural resources or causing severe damage to the environment.
- **Replenish** means to replace what is used.
- **Natural resource** is what people can use from the natural environment including land, water, soil, plants, and animals.

**KERNEL OF KNOWLEDGE**

The Texas-based company Austin Footwear Labs produces stylish shoes made from 50% recycled tire rubber, which makes for great footwear and also keeps tires out of landfills.
Show students the video *What is Sustainable Development?* by UNICEF. Begin a class discussion to generate ideas for how we can make more sustainable choices. Next, ask the students to think about how a school could be built to be sustainable. Allow students to call out things that they might see in a sustainable school and make a list of their ideas on the board.

Divide students into small groups and provide them materials to build a model of a sustainable school. Give students plenty of time to build and revise their designs. Remind them to create a school that will meet the needs of today’s students while not limiting resources for the future generations. As the students are creating their models, talk with them about their creative choices such as color and materials. Also, discuss principles of design with the students – particularly balance. Ask, “What does it mean for a work of art to be balanced?” Discuss some examples of visually pleasing and sustainable architecture using an article from the HuffPost titled *10 Most Sustainable Architectural Projects of 2016*. You can find additional examples on Pinterest if you would like to create your own slideshow.

Remind students that if they use natural resources in their model, then they should come up with a plan to replenish those resources. Encourage students to identify ways their new school can conserve resources. Students should take a photo of their new school model and put it in their notebooks with a written description of their school and why it is sustainable. If possible, display the models in the school so that others can view them.

**METAMORPHOSIS**

**UPCYCLE**

Students should take a digital photo of their school model and upload it to the app ChatterPix. Have them create a script of what they want to say about their sustainable school and its features. Then, they can record their own voice in the app and make the photo of their model talk. These videos can be shared with peers.

**THROUGH THE LENS**

Students should take digital pictures of their designs and write about it in their notebooks, including why their new school is sustainable. Digital photos and descriptions can be made into a class slideshow to share with their peers and on social medial.
A week prior to this lesson, ask students to bring in reusable materials that they might have thrown away such as food bags, lids, bottles, etc. Anything that is not perishable will work. Try to have extra materials that you have collected as well for students who might not be able to bring anything to class.

As you learned earlier in the lesson, a company called Austin Footwear Labs creates shoes that are made from 50% recycled tire rubber! Ask students to share ideas about other upcycled, or repurposed materials that could be used to make shoes.

Following the discussion, instruct students to make some sketches of ideas for shoes made from upcycled or repurposed material. Allow them to be creative as possible – there are no wrong ideas! Once they have made at least 5 different sketches, have them begin to create the shoe from the materials that they brought, or that you have available. When finished, they should share their work with the class and discuss the choices that they made and why their shoes would be successful.
CAREER CONNECTION

**Architect** - An architect is a person who designs buildings and, in many cases, also oversees their construction. This job requires at least a bachelor’s degree in architecture.

**Waste Management Professional** - Waste management professionals are involved with the disposal of waste. Often they are passionate about developing green environmental technologies and innovative disposal and recycling solutions. Jobs in waste management vary, but a high school diploma is required for disposal specialists and a bachelor’s degree in environmental management is required for higher level jobs.

CAREER HIGHLIGHT

Co-author of *Cradle to Cradle*, William McDonough is a leader in sustainable development and design. McDonough is working to remove the concept of “waste” from every aspect of human life. For McDonough, green building and innovation present viable solutions to current environmental crises while promoting economic growth. McDonough is the co-founder of the Make It Right Foundation and Cradle to Cradle Products Innovation Institute.
In this lesson, students will:

- explore and record how soils are formed by weathering of rock and the decomposition of plant and animal remains;
- collect data about materials found in multiple soil samples;
- summarize a data set with multiple categories using a frequency table, dot plot, pictograph or bar graph;
- identify and compare how people in different communities adapt to or modify the physical environment in which they live; and
- create a painting using soil as a medium.

National Learning Standards:
Science: 5-LS2-1; 5-ESS2-1
Math: 3.MD.B.3
Social Studies: III.h
Art: Cr2.1.3a; Re.7.2.3a; Re9.1.3a; Cn11.1.3a

GETTING DIRTY

Driving Question:
How does human development of communities affect soil development and composition?

Materials Needed:
Sketchbook, writing utensil, glass jars with lids, labels removed, several soil samples from around your community, water, rulers
Begin the lesson by having students brainstorm with a partner everything they know about soil. Have students discuss where their background knowledge comes from. As a class, generate a thinking map of ideas discussed with their partners.

Next, view this video on soil formation so students have a basic understanding of the process. After watching the video, have students work with a partner to create a flowchart in their notebooks about the process of soil formation. Then have each set of partners form a group with another set of partners and share their flowchart with each other. Have them discuss the similarities and differences they find.

Review key vocabulary before continuing with the exploration.

- **Soil** is a loose mixture of rock fragments, organic matter, water and air that can support plant growth.
- **Sediment** is the different types and sizes of rock material in soil.
- **Humus** is the decaying organic material from plants and animals that helps to create the soil mixture.

It takes **500 to 1,000 years** to create an inch of soil! Why so long? Soil is generally derived from rock, which has to be broken down by weathering and physical processes that take years and years to undergo.
Now it is time to explore and determine the composition of soil samples in your community. Divide students into small groups. The class will need a variety of soil samples to test. These samples can be collected ahead of time by the teacher or you can have students bring in soil samples from around the community or school. Each group will need one glass jar with a lid and a soil sample.

Students will fill their jar halfway with soil then fill the remainder of the jar with water. Once filled, students need to put the lid on tight and shake the jar vigorously. Jars should be labeled with group names and set somewhere they can remain untouched for two days. This activity will cause the soil to divide into soil layers, with the humus/organic material at the top, followed by the topsoil, subsoil, and finally any rock at the bottom.

When returning to the samples students should gently move them to a table where they can be observed. Each group should draw their sample in their notebooks and measure each layer they observe. Tell them to color and label each layer. Then students should create a table to collect data and compare all the group samples. This table should have group names on one axis and layers on the other axis. Next, each group can take turns observing all the samples and adding to their data table the measurements of the other soil layers by group. Students should write a summary of the data they collected in their notebooks. In a class discussion, summarize how the different soil samples from the community compare.

Ask the class these questions: What do the layers of soil samples tell us about our community? How might humans impact soil samples? (Some answers might include, how old the city/town is, how many people live there, what type of industries are in the area, etc.)

Now have students use computers to research any new developments in their communities. Have them list any new neighborhoods, business or community areas such as parks or nature preserves that are being created. If there is no new development in your community, have them create a plan for new development. Next, have each group create an image of a soil sample they might find in the areas of development. Ask, “How might they be the same or different as the current soil sample?” Combine groups and have each group justify their new created soil sample based on their development findings or creation.

As a wrap-up, have each student write in their notebooks a summary of the activity and the findings of their group. Be sure to have them write about the impact humans will have on soil formation in areas of development and form an opinion of whether the development is helpful or harmful for the environment.

METAMORPHOSIS

Students have observed the layers of soil and learned how soil is formed. Humus, or organic material, is a key component of the mixture of fertile soil. First, students should look at a development map of their community, which can be found on the county or city website. Next, they should identify which areas will have the greatest impact on humus or natural decaying material. Then, they will work in groups to determine how this will affect the quality of the soil formation in that area. Students should evaluate the benefits and risks to soil development.

Next, students can create a public service announcement video about human development in their community and how it is affecting their natural environment and soil development to inform the community. Videos can be shot using a camera, smart phone or tablet and edited with free software programs like iMovie.
Community Garden
As a class, research composting and how it benefits the environment and the community. Create a composter to turn food waste from the school cafeteria into compost for area gardens, or create a garden at your school! Visit this [website](#) for helpful tips on how to create a composter.

THROUGH THE LENS
Have students use a smartphone or other recording device to document the amount of cafeteria waste that could be used for composting. Create a documentary to show your principal to persuade them to allow students to create a composter at school.

Soil can be useful in a number of ways, including as a medium to make art! Before starting the project, talk with your students about cave paintings. These are some of the earliest forms of artwork known to man, and date back as far as 64,000 years ago. Many people, including Native Americans, use soil as an Earth-friendly medium to create art, for both decoration and as a form of communication. Some of the oldest cave paintings are found in modern-day France in what are known as the Lascaux caves. Visit this [site](#) with your students to see examples of these cave paintings and learn the history behind these extraordinary works.

Now that you have learned some of the history behind using soil as a medium, it’s time to make some soil paint of your own! You will need to following materials to make your paint:

- Various soil samples
- Metal sieve
- Elmer’s glue
- Water
- Small paper cups
- Popsicle sticks (or other stirring utensils)
- Paint brushes
- Thick paper (copy paper it is too thin; watercolor paper or some type of multimedia paper will work best).

Have the students collect various soil samples from around the school, or put a small portion of the samples that they gathered for the previous activity in separate plastic baggies. Make sure that the soil is completely dry before beginning. Sift the samples using the metal sieve to eliminate large lumps, rocks, etc. Put the sifted soil into paper cups, divided by type. Each type of soil will likely yield a different shade/color of paint.

Now, mix Elmer’s glue with a little water to form a runny paste. Add small amounts of this mixture to your soil samples until you have the consistency of paint. You can experiment with different consistencies. Thicker mixtures will be similar to using a tempera paint, while thinner versions will be more like watercolor. Once the students have created their paints, they can get started on their paintings. This would be a great project to work on creating different tones/shades as well as textures. Once they have finished, have the students discuss their art and the similarities and differences they experienced painting with soil as opposed to synthetic paints.
CAREER CONNECTION

Geologist - A geologist is a scientist that studies physical properties of the Earth, including rocks and soil. A bachelor’s degree is usually required, and advanced degrees are needed for more specialized positions.

Surveyor - A surveyor inspects land to determine its condition and value. Their evaluations are important to planning for human development. Most employers require a bachelor’s degree in surveying, mapping or geomatics (a branch of science that deals with the collection, analysis and interpretation of data relating to the Earth’s surface).

CAREER HIGHLIGHT

Dr. Sue Carstairs is the executive and medical director of the Ontario Turtle Conservation Centre in Peterborough, Ontario. She is an authorized wildlife custodian with more than 20 years of experience in wildlife medicine. Dr. Carstairs and her team help hundreds of injured turtles each year. Many of these turtles have been hit by cars and boats or impacted by other human development. Her work is highlighted in the film, Fix and Release, which was shown at EarthxFilm2018.
4th Grade
STEAM & Social Studies
In this lesson, students will:

- analyze scientific explanations of hurricanes by using evidence obtained through research and viewing videos to identify what forces within the storm cause damage,
- identify ways people have adapted and modified the environment in Texas over time and as a result of major storms, and
- design and build a model of a hurricane shelter that could be installed in a home for residents of South Texas.

Driving Question:
How could you design a hurricane shelter that would protect families and homes, and prevent community evacuations when storms are approaching?

Materials Needed:
Notebook, writing utensil, access to computers or devices to use the internet to do research about hurricanes, recycled building materials such as cardboard, plastics and paper, tape and glue.

National Learning Standards:
Science: 4-ESS2-1
Math: 4.OA.A.3
Social Studies: III.h
Art: Cr1.1.4a
Hurricanes are among nature’s most powerful storms. Damage from hurricanes can include storm-surge flooding, inland flooding from heavy rains, high winds, tornadoes, and high surf and rip current. Show the students footage of hurricanes like this video of Hurricane Harvey from CNN.

Next, have students do their own research to find out what forces within a hurricane cause damage and document these forces in their notebooks. Students should view footage of past Texas hurricanes. Remind them to use reliable sources and document where they find their information. After the research, lead a class discussion to share findings. Be sure to have students analyze the videos and use specific evidence from the videos to identify the damaging forces.

Review key vocabulary before continuing with the exploration.

- **Storm-surge flooding** is the rise in seawater level caused solely by a storm.
- **Inland flooding** occurs when powerful coastal storms move over land. As storms lose wind strength and move slowly, they drop massive amounts of rain in streams, rivers, and lakes that cause more flooding away from the coast.
- **Reliable** means consistently good in quality or performance, able to be trusted.
Look at photographs of Rockport, TX before and after Hurricane Harvey. As a class, identify ways people have adapted and modified the environment as a result of that hurricane. Brainstorm what people need to rebuild quickly after a damaging storm to carry on with everyday life, and have students justify their thinking. Next, propose the following question: “How can you design a structure that provides safety from a hurricane, prevents relocations and allows residents to resume everyday life as quickly as possible after a storm?”

Divide students into small groups to continue brainstorming and make their designs. Remind them to think about what island residents would need immediately after the storm. These things should also be protected and included in the design, if possible. After working on their designs, have each group partner with another group and share their designs. Encourage groups to pose questions about one another’s designs and allow for the opportunity to make modifications and adjustments. Finally, have the original groups build a scale model of their design out of recycled materials, and include a representation of their scale in their designs.

To begin a discussion about island communities, show students the trailer for Anote’s Ark, which was screened at EarthxFilm2018. After watching the video, brainstorm as a class what it would be like to live in an island community. Document the discussion in a thinking chart or on a whiteboard, and include what types of housing residents might use, where they get food, and what types of jobs and activities they do on a daily basis. Then, have students work in groups to analyze the model they built and whether it would still be helpful to island populations.

Have students create a news report about their new shelter and how it will benefit island communities. They should include details about their design and how it will protect the community. When creating the news report, they should write out a script and practice with their group before recording. Their videos can be shared with the class and on social media. As an example, view this report by Leilani Münter about Empowered by Light’s installation of solar panels at a Puerto Rico fire station after Hurricane Maria.
In addition to including necessities needed during a natural disaster, have students include some art in their designs as well! You can select multiple themes and have the groups draw from them or allow the groups to choose their own theme to draw and paint on their structure designs. When they present their shelters to the class, have them also discuss how they incorporated the theme in their shelters using the elements of art and principles of design.

**Community Garden**
- As a class, create disaster survival backpacks. Visit this [site](#) to find a list of supplies to have on hand in the event of a natural disaster. You can distribute these packs within your own community or send them to people who have recently been victims of a natural disaster.
**CAREER CONNECTION**

**Meteorologist** - A meteorologist is a scientist who studies the atmosphere, including weather and climate. This job requires a bachelor of science degree in meteorology.

**Oceanographer** - An oceanographer studies the physical geography of the oceans. This job requires a master of science or doctoral degree in oceanography.

**Solar Engineer** - Solar engineers create solar cells that collect and store energy from the sun. They design, plan and implement solar-energy projects for cities, businesses and homeowners. A bachelor’s degree in mechanical or electrical engineering is typically required for solar engineering positions, and in some areas additional certification and/or a license may be required.

**CAREER HIGHLIGHT**

Danni Washington is an advocate for oceans and science communication. She has a degree in marine science/biology and creates educational films to promote conservation and care for the world’s oceans. Danni is the first African-American woman to host her own science education TV show called *Untamed Science* and she is also the host of a STEM video series called *Xploration Nature Knows Best*. She is passionate about the ocean and science and wants to help inspire the next generations to connect with nature.
5TH GRADE
STEAM LESSON
In this lesson, students will:
• recognize how the changes made to an ecosystem affect the ecosystem and organisms within;
• identify how the height of buildings in highly urbanized areas affect the growth of plants at the ground level;
• construct a model that helps restore an ecosystem, even if it’s in a small way; and
• create a mural of native flowers and plants.

Driving Question:
How do human activities change an ecosystem, and what steps can be taken to minimize or repair human impact on that environment?

Materials Needed:
Notebook to record observations, writing utensil, sketch book, materials to create a 2D painting/drawing (will depend on chosen medium)

National Learning Standards:
Science: 5-ESS3-1; 3-5-ETS1-2
Art: Cr1.1.5a
Begin the lesson by looking at progressive aerial photos of your town or a town near you that is undergoing development. (These can be found on the county or city website.) If your town isn’t currently undergoing change, you might find old aerial maps of the area before it was highly developed at your local library archives to compare to current images from Google Earth. Tell students that of the 172 million acres in Texas, 128 million are involved in agriculture while much of the other land has been developed into cities and other urban areas. Show the side-by-side images to students and ask them to identify what has changed over time. Students might describe businesses or high-rise towers where there were once cotton fields or subdivisions where there were once piney woods.

Draw two columns on the board. As a class, discuss how this progress may have affected the biotic (living) and abiotic (nonliving) factors of the area and write them under the appropriate column. Students may discuss how a stream was diverted to avoid flooding in a business district or talk about how the number of birds declined due to not having trees to roost in or access to soil for the insects they eat. Students should be aware of how human impact has created destruction or modification of habitats of native species and thus decreased the biodiversity of the area.

Take the discussion further by bringing up species that go through Texas on their annual migrations such as Monarch butterflies or hawks. Ask students to brainstorm ideas for what might occur with these migrating species if the habitats they to stop in were to be modified or destroyed.

KERNEL OF KNOWLEDGE

Planting native plants and grasses such as the Texas state grass, Sideoats Grama, can help reduce the amount of water it takes to keep landscaping areas watered.
Students will research what plants and animals are native to the area as well as what species migrated through and what resources they used while migrating. Using this knowledge, students will design their own urban habitat restoration project. Students will evaluate areas such as their own home or a business rooftop and target a location for their project. At that location, they will create a plan to “restore” the area by reintroducing biotic and/or abiotic factors. Students might do something as complex as design a rooftop garden or “green roof” using native grasses or small trees on top of a business. They might also create something as simple as restoring some of the plants necessary to help monarchs migrate. Students should include justification for all aspects of their design and include how it might impact other native species.

**METAMORPHOSIS**

**UPCYCLE**

Unless you live in a more arid area of Texas, your city was probably home to many more trees than are currently present. Have students use temperature probes and probe software to collect data on the temperatures in various areas throughout town. They can visit places such as shopping centers, neighborhoods and parks. While collecting data with the probe, have them also note the features in the area. Ask, “Are there native trees, tall buildings, or a lack of shade and shelter?” Using information learned during the initial project and the data you collected, have students write a proposal to help areas of the city make a partial return to their original state by planning a strategic tree planting. How could this also help native species?

**THROUGH THE LENS**

Using Animoto, an app that allows you to easily make 30-second videos at no cost, have students create an informative video using material gathered from the class project. They can use photos taken from designing the urban habitat or record themselves speaking about the importance of planting native trees and grass. The Animoto app supports the selection of specific styles and music to which you add your photos or recordings. Follow this link for details on how to download and use the app.
Community Garden

Some city-owned land is either unused or underused. Have students work with your local parks and recreation department to create more green space in these unused areas. They can solicit volunteer labor to tidy up parks or lots owned by the city, then collect tree and plant donations from local arbors or nurseries to fill the parks and spaces. If there aren’t any local arbors or nurseries, try getting neighbors together to create a community produce garden. (North Texas has a growing season that starts in March.) Students can share the product of their labors with local food kitchens to help feed those in your city who are struggling. Some fruits and vegetables that grow in Texas are sweet potatoes, cucumber, honeydew, spinach, chile peppers and watermelon. Students might consider plants such as sunflowers that not only beautify the area, but also provide food through their seeds. If there aren’t enough volunteers to maintain a vegetable garden, consider planting natives such as pecan trees or bluebonnets, our Texas state tree and state flower. Be sure to have the students check the soil type in your area, as Texas is home to 1,300 types of soil!

Have students research what types of flowers are native to your area or state. Tell them to choose their favorite one, and if possible, print a picture of that plant/flower. Ask students to share which one they chose and give a bit of information about it, such as the season in which it grows, where it grows, how large it gets, where its name came from, etc.

Now, students will create a classroom mural of native flowers and plants! Roll a large piece of white butcher paper out on a table or the floor. Instruct students to draw a large version of the flower or plant that they chose as their favorite on the paper. Depending on your class size, you might have students go one at a time, or a small group at a time. Have everyone draw their portion in pencil first so that, as a class, you can critique the overall design before adding color.

Once everything has been drawn, allow each student to color their work. The medium for this portion is flexible. They could use paint, marker, watercolor, color pencil or even collage. After they have colored their portion, have them write one fact about their chosen flower or plant on a note card or small piece of paper and tape it next to their plant. When it is complete, hang it in the hallway or classroom. As a class, discuss how each of these flowers and plants are important to our ecosystem. Invite other classes to make one as well, and attach them in the hallway, creating a large-scale mural!
CAREER CONNECTION

Arborist - Arborists work with trees. They may trim, plant or otherwise maintain trees for both individuals and businesses. This career requires a high school diploma, and many arborists are certified through associations such as the International Society of Arboriculture.

Ecologist - Ecologists are scientists that specialize in studying ecosystems and how the organisms in them interact with each other. They may work to correct damage to an ecosystem or research an area to prevent damage from occurring. This career can range from needing an associate’s degree for general lab work to requiring a master’s degree for more advanced studies in ecosystem management.

Urban Planner - Urban planners look at land and develop plans for their use. They also plan out programs that encourage and aid in population growth. They may also work with existing towns to help revitalize them or help them grow. This career generally requires a master’s degree.

CAREER HIGHLIGHT

Leonardo DiCaprio is an actor turned conservation activist who founded the Leonardo DiCaprio Foundation. His foundation works on many projects, including one dedicated to protecting eco-regions and habitat restoration for threatened wildlife populations.
In this lesson, students will:
• recognize the detrimental effects of urbanization on wildlife diversity and formulate a plan to help offset those effects.

Driving Question:
How is genetic isolation damaging for populations? What solutions can be created to prevent genetic isolation from occurring in urban areas?

Materials Needed:
Sketchbook or science notebook, graph paper, computer, tablet or other technology for research, prototyping materials such as a 3D printer, dirt, clay, paint and glue

National Learning Standards:
Science: 3-5-ETS1-2; 5-LS2-1
Social Studies: VIII,a; X,c; X,d; X,g
Divide students into four “populations” of a species and assign each population to a corner of the room. Within each of the populations, assign a quarter of the students the “safety” gene. Explain to students that a sickness has hit the species, and in order for the species to continue successfully, they must procreate with one of the individuals with the safety gene within two mating seasons. Mating can be represented by students giving each other high fives. Individuals can only mate with one other individual per season. The different populations of species will be able to share genes because there are no barriers to mating. Guide students through two seasons of “mating” to see how many offspring will survive. In this simulation, there should be a majority of individuals with surviving offspring.

Repeat the simulation, but put rows of desks between populations and tell the students that they cannot breed with other populations due to geographic barriers. With geographic barriers in place, you should see fewer surviving offspring. Complete the simulation one more time but put the majority of the students with the safety gene in one population together with the geographic barriers in place. At the end of this final simulation, there should be very few successful matings.

Ask students what would happen if this were real populations of species and roads were built to prevent mating between populations. As a class, discuss how geographic barriers such as roads or the formation of new rivers can change a population of species to the point where they either become extinct or genetically different from the original population. Ask students for ideas of how barriers might be detrimental to species in other ways and compile a list on the board.

KERNEL OF KNOWLEDGE
In places like Wyoming, there are already several wildlife corridors that provide migration paths for pronghorn, elk and mule deer.
Students will identify one of the species in their area that has been disturbed or may be disturbed in the future by urban development. Students should either observe or research the organism in depth to discover its mating and migration patterns. After researching this information, students should determine what urbanization processes may disrupt the ability for different populations of the species to mate and migrate.

After determining the species’ patterns as well as possible disruptions to its patterns, students should develop ideas to help minimize such disruptions. After designing on paper, students should create prototypes to test. While students won’t be able to test their models on the actual organism, having a 3D model will allow them to see any underlying problems such as disruptions to the human environment or possible design flaws. Students will finish their project with a design report outlining details about the species, where problems may arise with urbanization, and the solutions that they have designed.

As students look at this from multiple points of view, they will vote on the prototype they believe will do the most good, and attempt to have it put into place. As a class, they will perfect the prototype, outline a budget and present their idea to the city council. Their presentation should include the benefits to the animals, as well as identify how this technology affects people of the city, anticipating how it could create potential problems and roadblocks to installation.

Students can document the process of creating their wildlife bridge/passageway using a smartphone or tablet. They can talk about the creative decisions that they made in their design as well as why creating these corridors is important. When they have finished recording, they can upload their video to Flipgrid or another app of your choosing.
• How does our government protect wildlife?

• Why should we create wildlife corridors in the United States and how they can benefit individuals and society?

• In what ways can students gain a voice in protecting various species through establishing wildlife corridors?

To start, allow students to research the U.S. Department of the Interior and its functions. Depending on the technology available in your class, they can do this on computers, tablets or phones. Check their understanding by having a short discussion on the topic. Be sure they understand that it is within the executive branch, and that its purpose is to protect America’s natural resources. Once they have a grasp of this agency, have them discuss endangered species and how wildlife corridors could help protect the wildlife around the country. Next, ask students what species could benefit from wildlife corridors.

Have students (individually or in a group) create a short video that evaluates how wildlife corridors could benefit society and how establishing more of these should be a priority of the government. Students may use free stock footage of wildlife from websites such as videezy or take photos or video of wildlife they see naturally in their surroundings such as squirrels, opossums, rabbits, reptiles and birds.

While the U.S. Department of the Interior is a government agency whose main goal is to protect the nation’s natural resources including its wildlife, it is important to note that it is restricted by a budget and legislation. Have students come up with ways to make their voice heard so that more wildlife corridors can be developed to protect wildlife. Have students post their videos to Flipgrid.
CAREER CONNECTION

**Ecologist** - An ecologist studies the interrelationships between organisms and their environments. For example, they may research how the creatures in forests, deserts, wetlands or other ecosystems interact with each other, as well as their environments. A degree in ecology or a related subject such as conservation biology, marine biology, zoology or environmental science is required for this career. A master’s or doctoral degree is recommended for teaching or research positions.

**Urban Planner** - Urban and regional planners develop land use plans and programs that help create communities, accommodate population growth, and revitalize physical facilities in towns, cities, counties and metropolitan areas. Most urban planners have earned a master’s degree in urban or regional planning, environmental planning, urban design or geography.

**Construction Worker** - A construction worker is a tradesperson, laborer or professional employed in the physical construction of the built environment and its infrastructure. A high school diploma or GED along with an apprenticeship, technical certificate, associate or bachelor’s degree can be required, depending on the position.

CAREER HIGHLIGHT

James Balog has become a global spokesman on the subject of climate change and human impact on the environment. He founded the Extreme Ice Survey (EIS), the most wide-ranging, ground-based, photographic study of glaciers ever conducted. His film, *The Human Element*, explores how humanity interacts with and affects the Earth.
5th Grade
STEAM & Social Studies
Driving Question:
What amount of carbon is saved by one individual household if they switch to green energy? How would the amount of carbon emission released change if an entire class switched to green energy?

Materials Needed:
Copy of utility bill or the average amount of KWH a student’s family uses monthly, calculator, paper or notebook, graph paper

In this lesson, students will:
• How can we use what we know about the carbon footprint of alternative energies to calculate the amount of carbon we can save by switching to them?

National Learning Standards:
Science: 5-ESS3-1
Math: 5.OA.1; 5.OA.2; 5.NBT.5; 5.NBT.6; 5.NBT.7
Social Studies: VII,h
Art: Cr1.2.5a; Cr2.3.5a; Re.7.1.5a
Ask students what sources of energy they are familiar with and write student responses on the board. Responses should include coal, nuclear, hydroelectric, solar, wind, and geothermal. Some energy sources, such as geothermal, might be new to students. Watch a quick video about the difference between renewable and nonrenewable energy. As a class, separate the list you compiled into renewable and nonrenewable energy. For each one, brainstorm pros and cons.

Ask students what they have heard about climate change and write student ideas on the board. Tell students that, according to some research done by NASA, it is theorized that carbon emissions contribute strongly to climate change. Carbon emissions from our chosen energy source is one way that almost all people of any age contribute to the increase of greenhouse gases. By choosing greener energy sources, we can all reduce our carbon emissions and contribute less to climate change. Look at the chart showing the amount of carbon per KWH below and discuss the different amounts with students and what they mean for the environment.

Ask students why they think some people choose nonrenewable over renewable energy. Talk to students about barriers to using green energy such as homeowners cost to install or people who rent being limited to only certain utility companies.
Students will obtain an energy bill or monthly kilowatt usage from their parents. If parents are unable or unwilling to share their energy consumption, students or teachers can call the utility company to ask for average consumption per household size or students can research the information online. Students will look at what renewable energy source is the most viable in their area. For example, if it is frequently stormy or if they live in a heavily forested area, solar might not be the best option. If they are far from water sources, hydroelectric is out. Students should use the carbon footprint of their chosen renewable source and calculate the total amount of carbon they would use based on their utility bill if they switched to that electricity source. Students will then calculate their energy carbon footprint if they used the same kilowatts with a nonrenewable source and compare them. Students will come together as a class to compile their calculations and compare the total amount of carbon emitted with renewable versus nonrenewable energy.

UPCYCLE

Students will use their chosen renewable energy source to research the cost of installing a renewable system on their home. Students will use the square footage of their home or their energy consumption to determine the size of the system needed and find online quotes or call companies to estimate the total cost. Students will then use their current cost of energy to determine if they can offset the cost of installation by not having to pay a utility bill. Students will create a yearlong budget for utilities with their current provider and another with monthly payments that would pay off a new renewable system to determine how many years it would take to break even on the cost of their system.

THROUGH THE LENS

Have student record themselves presenting their designs. They can then upload this to Flipgrid, or you can play their presentations for the class.

Have the students take pictures or short videos of examples of green energy that they find around their community. Combine each of the photos and videos into one presentation and present it to the rest of the school to inform them of how community is working to become greener. This would also kickstart a great conversation on steps that could be taken to utilize more renewable or green resources in the area.
Write on the board “Free Enterprise” and have students take turns writing words around it that come to mind. Some students will write words like “marketing,” “supply/demand,” “competition,” “consumer” and “profit.” Explain to students that the United States was not always this way. The Industrial Revolution brought more competition and allowed for business to grow, which in turn gave consumers choice. With the United States being a free enterprise economy, supply and demand drives consumers to buy certain goods.

Group students and give them different scenarios. Some sample ones are below. Be sure to explain that they are the typical consumer in these instances, and they are in the market for the largest savings.

1. You are in the market for a new computer. You are looking at two types that have the same exact features. One is an HP for $400 and the other is a Toshiba for $360. Which one would you, as a consumer, buy? Explain.

2. You are in the market for a vacuum. One you are viewing is similar to the other. It has the same power, the same detachable parts as the other, but is shaped a bit differently. One of the vacuums is $100 and the other is $90. As a typical consumer, which one would you purchase? Explain.

3. You are at the store and viewing hair shampoo. The two you have narrowed it down to have the same ingredients. One is $3.50 and the other is $5.25, as a typical consumer, which do you choose? Explain.

As students are deciding which products they would buy and with their group explaining their answers, ask questions like, “Does the price weigh heavily on the products you purchase?” “If there was only one product to buy and no choices, would price have much or any bearing on what you would purchase?”

When you’ve given students ample time (5-10 min), ask for volunteers from each group to write their reasoning on the board. Go through each with the class, clarifying any misunderstandings as some students may not have any concept of the importance of saving money for other purchases. If needed, explain budgeting and why consumers as a whole tend to lean toward lower prices.

As a wrap-up, pose the following question to your students: Knowing what you know now about carbon footprints, the costs of renewable versus nonrenewable, and about the condition of where we live in the United States, would you purchase solar panels if they went on sale for 60% off? Why?
Wind turbines can come in a variety of shapes, sizes and colors. Talk with your students about the importance of wind energy as an option for a renewable energy source. Now, show them some of the examples found on this site. As you look at the examples, ask the students what they notice about the designs. What colors are used? What shapes? Why did the designers make these choices? What principles of design do the students see in the turbines?

Now, have the students create some sketches of their own designs for wind turbines. To do this, they can work in pairs or on their own. Give them full creative freedom on this. Tell them there are no rules—anything goes. Their design should take into consideration the best way to harness energy in their town, as well as what would be aesthetically pleasing. Once they have worked through a number of ideas through sketches, have them either create a prototype of their turbine, or create a 2D artwork of their design.

When everyone is finished, the students should present their designs to the class. Each student or pair of students needs to discuss why their design would be a good fit for your area, as well as why they made the creative choices that they did.

Community Garden
As a class, discuss the different options that consumers have regarding renewable energy for their homes or businesses and write these on the board. Divide the students into groups of two, and assign each group one of the energy sources. Now, have them each create a drawing based on that energy source. It will only be a line drawing, so no color. Attach all of the pages together to create a coloring book. Make copies and sell the book! You could offer it to fellow teachers, students, and the community. Use the money to take steps to make your classroom and/or school greener.
CAREER CONNECTION

**Wind Power Engineer** - Engineers in the wind power industry are involved in the design and development of wind turbines. They also work in testing, production, and maintenance. Engineers may also supervise production, test manufactured products, and troubleshoot design or component problems. They also estimate the time and cost required to complete projects and look for ways to make production processes more efficient. Most positions require a bachelor’s degree in energy engineering, mechanical engineering, or a relevant field of engineering.

**Machinist** - Machinists set up and operate a variety of machine tools to produce precision parts and instruments. Some are precision instrument makers who fabricate, modify or repair mechanical instruments. A high school diploma or GED along with an apprenticeship or training certificate is required for most machinists.

**Quality Control Inspector** - These inspectors read and understand blueprints and specifications, monitor or observe operations to ensure that they meet production standards, recommend adjustments to the process or assembly and inspect, test, or measure materials or products being produced. Quality control inspectors need a high school diploma or GED, and receive up to one year of on-the-job training.

CAREER HIGHLIGHT

Leilani Münter is a race car driver, environmental activist, and self-proclaimed vegan hippie chick. She is an advocate for renewable energy, solar power and electric cars who actively works to offset her carbon footprint as a race car driver. Münter was featured in the film, *Racing Extinction* by Academy Award winning filmmaker Louis Psihoyos.
5th Grade
STEAM & SOCIAL STUDIES
In this lesson, students will:
- examine adaptations in plants to determine what makes them best suited to the local environment. They will use this knowledge to plan a garden that uses the least resources, while providing the best aesthetics.

National Learning Standards:
Science: 5-ESS1-1; 3-5-ETS1-1; 3-5-ETS1-2; 5-LS1-1; 5-LS2-1
Social Studies: VII,h
Art: Cr2.3.5a; Re.7.1.5a
Show students pictures or examples of various types of plant and tree leaves such as pine needles, waxy holly leaves, cactus spines, palm fronds or lobed oak leaves. Ask students to come up with ideas that explain the variances in leaf types and write their ideas on the board. Remind students of the term “adaptations,” and discuss how adaptations in organisms are specific to the living and nonliving features of their ecosystem.

Take the students for a walk outdoors and look for organisms that thrive in the surrounding environment. It can be something as complex as a tree species or something as simple as a weed. Ask students to draw what features they believe these species possess that allow them to be so successful. While outdoors, direct students to pay special attention to the soil in non-landscaped areas, and whether it is sandy, clay or a combination of both.

Back in the classroom, discuss the students’ drawings. Ask them to show and describe what they drew and share their ideas about what made those organisms successful. Some student ideas might include that they are able to conserve water due to their leaves, that they are able to grow in clay due to their hardy roots or that certain insects can eat tough leaves with their strong mandibles. Introduce the term “xeriscape” and explain to students that areas landscaped with xeriscaping techniques are considered greener and better for the environment because the plants require less water and are better adapted to the native area. Ask students to come up with ideas to further make landscaping green and compile ideas on the board.

According to Douglas W. Tallamy, non-native plants generate 29% less biodiversity than native ones.
Students will choose an outdoor area of the school that they would like to landscape (or re-landscape) with native plants. They will begin their design project by doing quick research on the climate in their area. They might visit the school’s weather station, if you have one, or read weather and climate reports online. Also, they will need to examine the soil in the area they choose for their landscaping project.

As a group, students will research and build models of native plants. They will use these models to design a landscaped area at their school, that is not only attractive, but also ecofriendly. Students should use research and models to determine how the chosen species will look during all seasons and adjust their landscaping plan accordingly. Groups should pay special attention to the amount of space each plant’s roots need to grow as well as whether the plant will provide shade covering to another plant they have chosen. Once groups decide on a final design, they will draw it using either graph paper or design software. Students should also complete a drawing of the way the area currently looks.

Using their drawings and research, student groups will prepare a presentation that outlines how the native plants will change that area. Students should discuss how the landscaping will change the path through which water travels, the amount of shade in the area, the aesthetics and the way habitats would change.

**UPCYCLE**

Students will design an experiment to explore the use of resources in their landscaping project compared to that of a non-native landscape. The students will use data recording skills and measurement tools to determine the amount of water used in both areas, as well as other resources such as mulch and fertilizer. They will use this data to present and propose a landscaping renovation to a local business. In their renovation plan, they should use mathematical calculations to generate a budget for installing the local plants, and the amount of money the business might save over time in watering and fertilizing costs.

It is important to note, that in our free-enterprise economy, businesses thrive on competition and turning a profit. By presenting the proposal to the local business, students should be sure to highlight the ability to promote their business as “green” and also how this saves them money. In their proposal, students should be able to describe how cutting costs are key to higher revenue but promoting that a business cares about the environment has the potential to increase consumer demand for their products and increase their profit.

**THROUGH THE LENS**

Once the students choose the area that they would like to re-landscape with native plants, have them document each step from choosing the location, to planting, to growing the flowers and plants. Using an app such as Framelapse, Lapse It or iMotion, create a time-lapse video of the process. Display the video at the front of the school so that visitors can visually experience the process when they come to the building.
eARTh

Once the students have discussed adaptations and the ways in which plants evolve to thrive in their environments, introduce them to the term “botanical artists.” These are artists who paint or draw botanical subjects such as plants and flowers. Using this website, show them examples of famous botanical artists. As you look at the examples, ask the students to talk about what they see in the artworks. How do the artists utilize color? What about line? What principles of design seem to be the most important in these works?

Now, tell the students that they will be creating their own flower or plant from their imagination. First, they will need to decide in what type of environment their plant will live. Next, they will create a sketch of the plant in the environment of their choosing. They can be as creative as they want with their plant, but it must have at least two different features, or adaptations, that it has grown in order to thrive in its environment. Once the students have produced some ideas in their sketchbooks, they can draw or paint their final version on paper. The medium can be open but it needs to have color.

When the students have finished, they should present their botanical art to the class and explain the adaptations that they chose to give their plant, as well as talk about the creative choices in their work.

Community Garden

As a class, let the students choose their favorite plant or flower. Then, give them a large sheet of paper on which to draw or paint their flower. It might be helpful to print out a photocopy of their chosen plant or flower. Each artwork should be colored, and the name of their chosen plant printed clearly at the top of the piece. With your students, find a nearby nursing home or hospital where they can donate their botanical art. Another option would be to have each student create their work on an 8”x8” square, mount that onto a black backing, and attach them to make one large piece.
CAREER CONNECTION

**Botanist** - A botanist researches, classifies and categorizes different kinds of plant life. They may study the effects of pollution on plants and work toward finding environmental protections for them. They can work in variety of settings – from teaching in a classroom to creating and growing new plants in a laboratory. This profession requires a bachelor’s degree in botany.

**Botanical Illustrator** - A botanical illustrator is a person who paints, sketches or otherwise illustrates botanical subjects, often for books or botanical journals. To become a botanical illustrator you can be self-taught, or earn a bachelor’s and/or master’s degree in two-dimensional (2D) art.

CAREER HIGHLIGHT

Margaret Mee was both a botanical artist and a conservationist who specialized in painting the flora of the Amazon rainforest. She also made a significant contribution to the worlds of science and conservation. Visit this [link](#) to see some examples of her amazing work and to read more about her.
5th Grade
STEAM & Social Studies

Waste & Recycling Zone
In this lesson, students will:
• explore items that commonly end up in the landfill and come up with creative ideas for how to use them individually or mix them with other products to create a durable post-consumer building material.

Driving Question:
How can materials that would otherwise end up in the landfill be used to build infrastructure? What are the benefits of blending reused materials with other materials versus only using them in their original state?

Materials Needed:
Tetra Pak containers or similar packaging, sample of ReWall, science journal or sketchbook, writing utensil, materials such as tire rubber, cardboard, plastic, etc., other materials such as water, glue or other substances to help create the new building material.

National Learning Standards:
Science: 5-ESS3-1; 3-5-ETS1-2; 5-PS1-2; 5-PS1-4
Social Studies: III,h; X,d
Show the students the Tetra Pak containers and the ReWall sample, and ask them what they think the materials have in common. If the students don’t mention it, explain that both are made from post-consumer products, although one is more of a homogenous mixture while the other clearly shows all of the materials that comprise it.

Show the class the How It’s Made video on Tetra Pak and the production video for ReWall so they can see how recycled products can be mixed to create new, useful products. Ask students for ideas of other materials that can be recycled and what they can be recycled into. Have them elaborate on whether the new product is a mix of other products or one single recycled material, as well as explain how the materials might have changed from their original forms. Compile on the board a list of recyclable or post-consumer materials and their potential uses in infrastructure.

KERNEL OF KNOWLEDGE

It will take a plastic bottle 450 years to biodegrade naturally.
Students will work in groups to identify a product they would like to create. It can be as simple as a food container or as advanced as a building material. Each group will use post-consumer materials as well as other items to create their product. The groups should take into consideration the unique qualifications of their product by answering questions such as, “Is this material safe for food products?” or “Is this product strong enough to stack in layers like you would bricks?” to help create a testable prototype. Students should document as they test different ratios and the outcome of each. Each group should record the percentage of each material in the final product as well as the steps they used to create the material. Students will present their final product and explain to classmates what materials and processes they used to create it.

**UPCYCLE**

Students will develop a marketing campaign for their new product. They will design an ad or film a commercial and sell three product prototypes to classmates. Consumers will test and review their product and may even improve upon the product to create competition in this new niche market.

Have students discuss how and why people have modified the environment since settling and moving west across the United States. It’s important to note that landfills were added to deal with waste build-up in cities. The long-term consequences, however, were not considered initially.

**THROUGH THE LENS**

Instruct students to create a short video segment on Flipgrid to respond to the following questions: Landfills are getting larger daily across the United States, even with recycling efforts in effect in many cities. How can citizens reduce the size of landfills beyond just recycling? Is there a way to lobby government officials to limit the use of certain plastic products such as straws? If so, how?
Talk with your students about the power of advertising images. Show some examples of ads for products with which they may be familiar and talk about what they see in the images. What grabs their attention first? Did you have to tell them what the ad was for, or did they already know? If so, how did they know? Ask students, “Who is the intended audience? How can you tell?”

If the students already created an ad for their product, then have them create another one. If they have not, then they will now create two advertisements. They can work alone, or in pairs or small groups. Tell them to refer back to the examples that you looked at as a class and think about why they were or were not successful. They should create initial sketches, and then complete their final drawings on a sheet of drawing paper. Make sure they add color and keep the principles of design at the forefront of their design decisions. If needed, review these with the students.

Once they have finished with both ads, they will present them to the class and the class will vote on their favorite of the two. They should explain to the designer their selection of that particular ad. When everyone has finished, display the ads in the school and invite everyone to vote on the product that they would most likely buy.

**Community Garden**

As a class, start collecting plastic bottles and jugs. Have the students bring them from home, and set out a box to collect them from the rest of the school as well. Don’t forget about the cafeteria! Research online to find creative ways to reuse these plastic containers. Create some of these as a class and sell them! You can use the money to purchase the class a set of reusable straws or metal water bottles, or decide as a class what you would like to purchase to eliminate the amount of plastic waste you produce at school.
CAREER CONNECTION

**Landfill Operator** - Landfill operators have a variety of duties, including disposing of solid waste materials at landfills, operating heavy equipment such as bulldozer, front-end loader and compactor, and transporting solid waste materials. This career requires a high school diploma or GED and completion of a landfill operator certification course.

**Recycling Sorter** - Recycling sorters have several responsibilities, including sorting materials such as metals, glass, wood, paper and plastics into appropriate containers for recycling, cleaning and inspecting. They also perform routine maintenance or minor repairs on recycling equipment. Employers prefer to hire recycling workers who have a high school diploma. Some on-the-job training is also required.

CAREER HIGHLIGHT

Tetra Pak was founded by Ruben Rausing and built on Erik Wallenberg’s innovation of a tetrahedron-shaped, plastic-coated paper carton from which the company’s name was derived.
6TH GRADE STEAM LESSON
In this lesson, students will:
- distinguish the difference between energy sources that are renewable and nonrenewable;
- understand the pros and cons of nonrenewable energy sources such as coal and oil versus green energy such as wind and solar;
- describe ways to reduce energy consumption in a sustainable way; and
- create a design for a wind turbine.

National Learning Standards:
Science: MS-PS3-3; MS-ESS3-3; MS-ETS1-1; MS-ETS1-2
Art: Cr2.1.6a; Cr2.3.6a
Before beginning this lesson, ask students to interview their parent or guardian to find out the source of energy used within their home. Depending on the location of your district, many students will probably have municipal energy.

During the next class period, show the website for one of the energy providers in your area and have students identify what method is used to produce their energy. Ask students to tell you what types of energy they’ve heard of before and write the list on the board. Some student responses might include solar, oil (petroleum) or wind. Define renewable and nonrenewable, and ask students to sort the energy list into those two categories. Complete the list by filling out any energy sources they haven’t come up with yet. Energy sources listed should include coal, oil, natural gas, nuclear power, biomass, wind, hydropower, geothermal and solar.

Break the students into pairs or small groups and assign each student group one energy source. Students will do quick research to find one pro and one con of their assigned energy source and present them to the class. Explain that, while some energy sources may be cleaner than others, all energy resources require some sort of energy to install the infrastructure required to run and maintain them. This infrastructure can be cost prohibitive when it comes to installing green energy. Sometimes reducing the amount of energy someone uses can be more cost effective AND nearly as green as using sustainable energy.

For this reason, it is important to also learn how to conserve energy. Many old buildings are not energy efficient, but can be with some slight modifications. As a class, investigate the classroom and the school to examine where energy waste may be present. Look for worn-out caulk and seals on windows or bathroom lights that are constantly left on. Touch walls or windows to check for transfer of heat or cold from the weather outside. Ask students to brainstorm ideas to help the school eliminate this energy waste and convert the building to conserve more energy.

Texas produces the most wind energy in all of the United States with over 20,000 megawatts (MW) per year. The next closest state is Iowa with almost 7,000 MW per year.
Students will brainstorm or research methods of energy conservation such as glass technology, insulation or subterranean building. Students will use their new knowledge, and review the methods of energy conservation discussed in class, to choose a room or building they are familiar with to convert with energy efficient upgrades. Students will create a scale model of the room or building and retrofit the space with recycled materials such as old clothes or milk cartons to reflect how they will update the energy efficiency of that area. While water conservation is also important, the focus should remain on energy unless water is being used to help maintain the space’s temperature.

Conserving energy is great, but what about completely changing the energy source you use to a cleaner, more sustainable version? The renewable energy field is constantly growing to enable more people to do this. Choose your favorite renewable energy source and use your knowledge, as well as design software, to create a renewable energy prototype such as a new style of turbine or a new way to harness energy or water.

Divide students into pairs or small groups, and have them take a trip around the inside and outside of the school. They should stop at each location where they see an example of energy waste. Using a smartphone or other recording device, have students take turns filming each other describing the evidence that indicates energy is being wasted. Make sure they also include suggestions for how to fix the issue and eliminate the energy waste. Once each group has finished, use an app such as Flipgrid to combine the clips and have the students present their video to the principal.
Wind turbines convert kinetic wind energy into mechanical power. Wind energy is an amazing source of energy for many reasons: it’s low cost, renewable, has enormous power and causes no pollution. In fact, one of the only complaints that people have regarding wind energy is the way that the turbines look!

Because this is a real issue for some people, artists and designers have begun creating more aesthetically pleasing wind turbines. They are beautifully designed pieces of art, and they not only help save the environment, but they add an aesthetic element to the space that they inhabit.

With your class, take a look at this article and discuss some of the different examples of artfully designed wind turbines. What do they have in common? How are they different? Encourage students to use proper vocabulary regarding the principles of design and elements of art when they discuss the examples.

Now, have students design their own wind turbine. They also need to think about the type of space that it would inhabit, such as an open field or somewhere more populated like atop a downtown office building. Be sure they brainstorm and create preliminary sketches before deciding on a final design. As they create their designs, remind them to keep these things in mind:

- What kind of space will it be placed in?
- How will it affect the space that it is in?
- What color(s) will it be?
- What shapes will it include?
- Will it create sound?

Encourage students to push their creativity. The final project can either be a detailed drawing of their turbine, or they can build an actual 3D model of their design. When they have finished, the students should present their ideas to the class.

Community Garden

Many resources for your community’s homeless population use volunteer labor to meet the needs of the individuals they serve. Many people are able to donate time but not necessarily money. Buildings such as food pantries and shelters, however, have operating expenses such as utilities that keep the building at a comfortable temperature.

Visit your community’s homeless resource buildings and use your knowledge of energy conservation methods and renewable energy sources to formulate a plan to reduce their operating expenses. Even a small reduction in energy costs can help them serve more people!
CAREER CONNECTION

Wind Turbine Technician - Wind turbine technicians specialize in the installation, maintenance and repair of wind turbines. This is a great career if you love heights! This career requires a high school diploma and technical school. Most of the time, technicians also complete an internship.

Community Market Coordinator - Community market coordinators set up the market, recruit vendors and help manage booths. They also help market patrons find the goods they are looking for. This career requires a high school diploma, plus experience in customer service and managing people comes in handy.

Civil Engineer - Civil engineers are responsible for almost all aspects of designing, building and maintaining a city. They work on infrastructure, including roads, bridges, buildings, sewer and water systems. Anything you see in your city is probably the result of the work of a civil engineer. This career requires a bachelor’s degree, although more advancement opportunities are available with a master’s degree.

Architect - Architects plan and design buildings. They may create something as small as a tiny house for the homeless to something as large as a stadium. This career requires a bachelor’s degree.

Drafter - Drafters use designs from engineers and architects to create technical drawings using design software. This career requires an associate’s degree.

CAREER HIGHLIGHT

Dan Corson incorporated solar power and art when he created his famous “Sonic Bloom” lighted sculptures outside of the Pacific Science Center in Seattle, WA. Not only do the giant flowers produce light at night, but they also demonstrate that even rainy environs such as Seattle can access solar energy.
6th Grade Steam & Social Studies
Driving Question:
How can knowledge of potential and kinetic energy help a community transit system go green?

Materials Needed:
Science notebook or sketchpad, writing utensil, magnets, small turbines, model vehicles, small gears, other prototyping materials such as glue, small balsa rods, etc., computer design program (in place of physical prototypes)

In this lesson, students will:
• use knowledge of kinetic and potential energy to brainstorm ideas to make a community transit system more sustainable.

National Learning Standards:
Science: MS-PS2-3; MS-PS3-1; MS-PS3-2; MS-PS3-5
Social Studies: VIII,a
Art: Cr1.1.6a; Cr2.1.6a; Cr2.3.6a; Pr5.1.6a
Begin by watching a quick video on potential versus kinetic energy with your students. After the video, tell students that everything has energy – either kinetic energy or stored as potential energy. Also, energy changes based on how it is acted upon by forces such as gravity. Ask students to brainstorm the ways forces change energy and write their ideas on the board. Some ideas that should be included are gravitational, frictional, magnetic and muscular force.

Explain that most energy we use to power homes or vehicles comes from the movement of gasses being captured by turbines or pistons. In gasoline powered engines, the combustion of gasoline produces a gas that is under pressure and moves pistons in the engine. As far back as steam locomotives, the steam energy produced from burning coal was able to move an entire train. To give an example of how a moving turbine converts energy from wind, water or gas, watch a short video. Discuss how turbines can be used for more than just energy production in homes. Ask students to brainstorm ideas for how air movement and turbines can be used to help capture energy to power vehicles such as trains and busses.

Kernel of Knowledge
Turn your engine off at red lights! Idling for 10 seconds consumes more fuel than re-starting your engine.
Student groups will get together to brainstorm ideas for how to create a city bus or train that runs, at least partially, on green energy. Students should create a concept that uses turbines and gears to either completely power a vehicle, or to power a vehicle after it has been started by a battery or other power source.

Before starting a prototype, students can draw a plan illustrating how to start the vehicle and also how turbines or pistons might be placed to capture energy. An example of student ideas might be placing turbines on top of a bus where the wind from the bus’s movement would cause it to spin, allowing the turbine to capture more energy for use by the bus’s engine. Students can build models of their energy producing system and attach them to model cars or put them on model wheels and chassis to test them on a downhill ramp. Students can make modifications to their prototypes to increase their concept’s potential for perpetual motion.

UPCYCLE

With students still in groups, ask them to identify the reasons why mass transit, like subways and buses, have become available in urban areas. They can write their reasons on sticky notes and place their group’s ideas on the board or share with the class as they are called on. Students should understand that there is a correlation between the population and how many public transit options are available. Next, ask students to brainstorm with their group ways to reduce carbon emissions by utilizing the ideas generated from the previous science lesson. Have them consider why it would be important to improve air quality in high-population areas and why society and government should care. Their group’s responses can be recorded on sticky notes or shared verbally.

THROUGH THE LENS

Have students work in small groups to create three-minute videos on Flipgrid that tell a story about green transit systems and why they are needed. The films can be narrative or documentary. Stage a screening of the films in the classroom with popcorn or another treat, and ask students to lead short Q&A sessions after their respective films to share what they learned from making their film and to promote class dialogue about ways to increase green transit systems.
Reducing our carbon footprint is important for many reasons, and the choices that we make regarding transportation have a huge impact on this. After discussing the importance of mass transit and carbon footprint reduction, have the students brainstorm other transportation methods that are greener. Some examples might include bicycle, scooter, skateboard, car pool or walking. Allow the students to call out their examples and write them down on the board.

Now, either in pairs or individually, tell the students that they are going to create an advertisement for a green form of transportation. They can either use one of the examples that were previously discussed, or they may invent their own. The sky’s the limit – there are no wrong answers. Allow them to be as creative as possible with this! To begin, they should create sketches of their ideas for green transportation. When they decide on their final product, they should create a drawing, or if possible, a prototype of their form of green transportation. When finished, have them record a commercial promoting their design. Have them pretend they are selling their product to a green transportation company, so they should address how their transportation is good for the environment as well as aesthetically pleasing. If you are not able to create a commercial, have the students make an advertising poster for their design highlighting the same points.
**CAREER CONNECTION**

**Transit or Light Rail Operator** - These operators drive public transit vehicles that operate on rail systems, including subway trains, trams and elevated trains. Operators are responsible for making sure that passengers get on and off vehicles safely. The education needed for this job includes a high school diploma or GED.

**Engineer in Renewable Energy** - This position is part of the growing sector of green jobs that involve environmentally conscious energy production. These individuals maximize the energy potential of clean energy sources including wind, solar, geothermal and hydropower. Renewable energy engineers monitor and develop alternative energy outputs. For this, you need a bachelor’s degree and various licenses.

**CAREER HIGHLIGHT**

Alfred Ely Beach was an American inventor who designed New York City’s earliest predecessor to the subway system that we know today. Created in the 1860’s, it was called the Beach Pneumatic Transit. Beach proposed the underground transportation system to help relieve traffic congestion in New York.
In this lesson, students will:

- compare the pros and cons of various energy sources. They will then create solutions to the detrimental air quality effects of some of the sources.

Driving Question:
How can items from nature be used to help improve air quality from polluting sources? How do various energy sources compare when it comes to air quality?

Materials Needed:
- Sketchbook or science notebook,
- ozone samples from around town,
- schoenbein paper, filter materials such as coffee filters, sand, gravel and charcoal, paraffin candles, carbon dioxide probe

National Learning Standards:
Science: MS-ETS1-1; MS-ETS1-2; MS-ETS1-4; MS-LS2-4; MS-ESS3-3
Social Studies: III,h; IX,d
Art: Cr1.2.6a; Pr5.1.6a; Cn10.1.6a
Prior to beginning this lesson, take ozone samples at various places around town or in surrounding towns. One sample should be near some type of energy producing source, whether it is green energy or nonrenewable energy. Identify a city near you that has a coal-fired power plant as well as an area producing wind energy and find them on the American Lung Associations (ALA) “State of the Air” map.

Ask students to name possible sources of energy production and write these sources on the board. Briefly discuss the pros and cons of each source such as availability, infrastructure required and sustainability. Ask students for ideas of other parameters which might be considered when choosing which energy sources a city uses. Show students the ALA air-quality data as well as the ozone tests for the two areas you selected, and ask them to hypothesize what causes the differences in air quality. Discuss how most renewable energy sources such as wind and solar emit almost no volatile organic compounds (VOCs) or measurable carbon, whereas as coal-generated plants, for example, do. Explain that other factors do come into play when it comes to air quality such as the location of the power plant.

Explain to students that many cities don’t necessarily have the budget to relocate a polluting power plant but can sometimes retrofit the facility with cleaners and scrubbers that help prevent the pollution from leaking out. These cleaners filter the air similar to the way that at-home water filters clean potable water further. As a class, read an article or watch a video that shows the materials used to make common water filters.

Even though coal use is declining in the United States, it is still the second-largest source of greenhouse gas emissions, according to the Energy Information Administration, and coal ash is one of the largest waste streams in the country.
In small groups, have students briefly research methods for water filtration and apply the data they found in their research to air quality. Students will use the information they researched to design at least three air filters on paper. While in the design phase, student groups must also consider the budget that would be required to make the filters on a larger scale. After designing their filters on paper, have each group create prototypes to test. Under the supervision of a parent or teacher, students can use paraffin candles in a vacuum with a CO2 monitor to test their prototypes. Students should record the amount of carbon dioxide that gets through their filter or another method to test the success of their filters. At the end of the prototyping phase, student groups should get together and share their results. As a class, they should discuss what were the most successful materials and design based on their results. Students should also discuss the potential costs associated with building such a filter. Based on this discussion, the students will work as a peer community to design and create a prototype of what might be the ultimate air filter.

METAMORPHOSIS

UPCYCLE

The students will use the information from the Metamorphosis section to build a cost analysis for building their ultimate air filter prototype on a scale large enough to function on a nearby polluting power plant. Students will interview officials at the power plant or research the dimensions needed and calculate the costs of building and implementing their filtration system. Student groups will then research the costs associated with installing green energy infrastructure such as a wind-powered plant and compare the costs associated with creating a new, green-energy plant with that of retrofitting existing polluting plants.
KALEIDOSCOPE

Facilitate a discussion with students exploring why technology drives the movement of people and economic sectors. Typically, where there are large concentrations of people a power plant is not far off. Discuss why this is so, including how people and businesses use power and how those uses have changed over time. Have students discuss how people have been impacted by climate. For example, the climate in Texas during the summer is hot while the climate in Alaska during winter is cold and without modern technology, like central air and heat people and businesses would not choose to reside in these places. However, energy sources allow individuals the ability to live and work anywhere because of the availability of air conditioning and heating. This creates an air-quality problem due to the power plants that are needed to provide energy to the population.

THROUGH THE LENS

After placing students into groups of 2-5, have them brainstorm how they as citizens can address the air quality issue, which should include a proposal to a local lawmaker. Have them create a video explaining their ideas and upload it to Flipgrid.

Some questions to post on the board while they are working include:
1. How can we limit emissions and improve air quality?
2. What options will bring the greatest results?
3. Will any options bring immediate results?
4. What are some ideas that may help businesses save money in the long-run?
5. How can we gain support for these ideas?
6. Are there dire consequences of not doing anything? If so, explain.

Remind students that their video should be clear and concise to get their point across. Providing a time limit may also help.
The Air Quality Index, or AQI, is the Environmental Protection Agency’s (EPA) index for reporting the daily air quality. The EPA calculates AQI for five major air pollutants regulated by the Clean Air Act: ground-level ozone, particle pollution (also known as particulate matter), carbon monoxide, sulfur dioxide and nitrogen dioxide. For each of these pollutants, the EPA has established national air-quality standards to protect public health. Visit this [link](#) to see the colors associated with each level. Review these levels and the colors associated with them with your class, and make a list of the things that would cause both the least and greatest effects to the air-quality index.

Now, introduce your class to the definition of a triptych. A triptych is a group of three artworks that are meant to be displayed or appreciated together. The three works are joined by a relationship in subject matter or technique used. Next, talk about what a monochromatic artwork is. This is a piece of art that is created using different tones and shades of one color or hue.

Once the class has an understanding of monochromatic and triptych art, the students will create a triptych based on three different color levels of the Air Quality Control Index. For each color that they choose, they must also choose something that might be the cause, or one of the causes, for that level of air quality. For example, if they choose green, they might draw a picture of someone riding a bicycle. If they choose red, they might draw a freeway packed with cars emitting smoke. Each individual piece needs to be monochromatic, so the green piece with the bicycled would all be painted in shades and tones of green, whereas the one depicting traffic pollution would be created in only shades and tones of red.

Once the students have finished their triptychs, they should present them to the class and discuss the content of each piece, how it relates to the color that they chose, and how they have successfully created a triptych using monochromatic techniques. Display the pieces so other students, administrators and visitors can view them. This would be a great exhibit to create for an Earth Day celebration!

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Community Garden

Many of the cleaners that we use regularly are hazardous to the environment. Have students research the common ingredients found in everyday cleaners and discuss why these are bad for our environment. Luckily, there are many environmentally friendly alternatives that can be easily and safely made. Visit this [link](#) for some recipes for green cleaners. Have students choose some to make as a class and give them to other teachers to use at school. The students can also take some home for use, as well as produce some for local community organizations and agencies.

Optional Community Garden film extension

As students make their biodegradable all-natural cleaning recipe, have them create a short (60-second) “How To” video of the process that can be shared with the class or on social media. Students should come up with a creative name for their product and video.
**CAREER CONNECTION**

**Emergency Management Specialist** - Emergency management specialists coordinate disaster response or crisis management activities, provide disaster preparedness training, and prepare emergency plans and procedures for natural (e.g., hurricanes, floods, earthquakes), wartime or technological (e.g., nuclear power plant emergencies, hazardous materials spills) disasters or hostage situations. This career requires a bachelor’s degree or higher, experience and specialized certifications.

**Economist** - Economists study the ways a society uses scarce resources such as land, labor, raw materials and machinery to produce goods and services. They analyze the costs and benefits of distributing and consuming these goods and services. A master’s degree is needed for this job.

**CAREER HIGHLIGHT**

In 1981, Hans Tholstrup and Larry Perkins became the first individuals to cross a continent in a solar-powered car that they built. Tholstrup is also the creator of the World Solar Challenge in Australia.
6TH GRADE
STEAM & SOCIAL STUDIES
In this lesson, students will:
• recognize the importance of urban trees, both to the oxygen/carbon cycle and heat islands.

National Learning Standards:
Science: MS-LS2-5; MS-ESS3-4
Social Studies: VIII,b
Art: Cr1.1.6a; Cr1.2.6a; Re.7.2.6a; Cn11.1.6a

Driving Question:
How does the number of trees in an urban area affect organisms, including humans, in that ecosystem?

Materials Needed:
Photos of a healthy versus stagnant pond or waterway, calculator, aerial views of town, access to Google Maps, a device for research, science notebook or sketchbook, writing utensil, temperature probe, online resources such as The Oxygen Project.
Ask students if they’ve ever been near a stagnant, still waterway such as a pond or lake and ask them to describe it. Students might describe the smell of decay, the lack of organisms in the water, or the stillness of the pond. If students have not had exposure to waterways, the instructor should show images and describe what it is like. On the inverse, ask them to describe a healthy pond or lake. A healthy waterway is teeming with fish, aquatic plants, and other life forms and is generally relatively clear near the surface. Ask students what makes a waterway healthy or unhealthy. Tell students that factors such as pollutants, the amount of motion in a waterway, sunlight and temperature all impact the amount of oxygen in the habitat. Pollutants kill organisms which decrease oxygen due to decaying matter. Decreased motion also depletes oxygen. Changes to sunlight and temperature can cause a decline in aquatic plants further reducing oxygen.

Just like an aquatic environment, terrestrial environments need oxygen to thrive and be happy. Write the formula for photosynthesis on the board and review with students. Students should know that plants take in carbon dioxide from the environment and release oxygen for organisms to breathe. While much of our oxygen is provided by aquatic species, a large amount is provided by trees. Ask students if they can guess how many people one tree can support with oxygen. Tell them that, according to the University of Georgia, one large tree can support up to four people. Divide the number of students in class by four to determine the number of trees needed to provide oxygen for the class.

Watch the United States Census Bureau’s population clock to show students how quickly the world population is growing, and ask them if they think we are planting trees at the same rate to provide oxygen for all of those people. Explain that, rather than planting more trees, we are losing our forests rapidly. Show students this National Geographic video on deforestation and discuss what students can do to prevent tree loss in order to help continue providing oxygen and lowering carbon dioxide levels in our environment.

Explain to students that humans have been changing their environment for centuries. Ask students to come up with examples of human environmental modification. After they provide examples, explain how progress is the driving force for many world economies and trees are not typically on the priority list for many businesses. For example, if a business wants to maximize space and create profits they will not save the trees that are on the lot where they build.

Lead students on a quick trip outside and take the temperature in the shade of a tree versus in the direct sunlight. Discuss how, in addition to providing oxygen and sequestering carbon, trees also provide canopy to prevent heat islands in urban areas. During summers in Texas when temperatures soar, this tree canopy can mean the difference between health and heat stroke for individuals who might have to walk to work despite dangerous heat levels.
Student groups will begin by researching tree types that would be well suited to the local environment. Students should consider the following when examining tree types: lifespan of the tree, mature size, spacing requirements, watering requirements and what biomass it might produce (pine needles, nuts, leaves, etc.). Students should also keep in mind that selecting diverse trees is better than having a monoculture.

Students will use this information as well as aerial maps of the city to decide which trees to plant and possible locations to plant them. Students can use programs such as Google Maps’ street view to design tree canopies over public park sidewalks or redesign street medians with trees with small roots. Students should plan and design at least three areas that were previously uncovered, and use either art paper or a computer drafting program to create before and after images of the chosen areas. Students will present these images, the type and number of trees they chose, and how these trees will affect the carbon and oxygen in town.

Student groups should take their plans for planting trees a step further by applying for urban tree grants such as the urban forest grant in Austin, Texas. Students should research which grants are available in their area and either apply for them or prepare a presentation for their city council urging them to apply for them. If there are no grants available in their area, students should brainstorm ways to raise funds themselves.

Document your process of painting your trees, from selecting the tree(s) to choosing the winning drawings to painting. Allow the students to provide commentary throughout the process and have each student speak about the importance of tree conservation and how this project will bring awareness to your cause.
As an extension, have students **watch** the original Lorax on their own (available on YouTube). Have them make connections from the lesson on deforestation to the movie. They can do this in a video response on Flipgrid or in an essay.

**KERNEL OF KNOWLEDGE**

Forest ecosystems store between 20 and 100 times more carbon per unit area than croplands.
eARTh

Trees play an integral role in our lives, from providing oxygen to breathe to creating shaded areas for temperature regulation. Unfortunately, as our cities grow and build, often trees are cut down and not replanted. This affects people across the globe. In response to this, some artists in India have started a project to raise awareness and offer solutions to this issue. They are painting trees to save them from being cut down because of development and road expansion. The images they paint on them vary, but they each have a deep meaning in Indian culture. Visit this link to see examples of these trees and read more about the artists’ goal.

Now, locate one or a few trees that you can paint around your school or community. Decide as a class the message that you would like to convey in the painting of your tree. It needs to focus on the importance of conservation and highlighting the value that trees provide. You could ask each student to create a sketch and then vote on the ones that the class feels truly reflects the message. If you are not allowed to paint the trees around your school or area, then you can wrap them in colorful yarn and hang drawings or important facts about tree conservation from the branches.
CAREER CONNECTION

**Horticulturist** - A horticulturist knows the science behind different plants, flowers and greenery. They conduct research in gardening and landscaping, plant propagation, crop production, plant breeding, genetic engineering, plant biochemistry and plant physiology. This generally requires an associate’s or bachelor’s degree.

**Landscape Architect** - Landscape architects design attractive and functional public parks, gardens, playgrounds, residential areas, college campuses and public spaces. They also plan the locations of buildings, roads, walkways, flowers, shrubs and trees within these environments. For this career, a bachelor’s degree and experience in the field is needed.

CAREER HIGHLIGHT

Theodor Suess Geisel, or Dr. Seuss, was a writer, poet and illustrator among other things. He was wildly creative and also highly invested in humans caring for both each other and the environment. In one of his most famous books, *The Lorax*, Dr. Seuss brings attention to the importance of trees and their conservation.
6th Grade
STEM & Social Studies
In this lesson, students will:
• recognize that, although thermal energy moves in a predictable pattern, energy transfer occurs at different rates depending on the type of material it is passing through.

Driving Question:
How do different building materials change the rate at which thermal energy is transferred?

Materials Needed:
Sketchbook or science notebook, clear materials such as plastic, Plexiglas, cellophane, graph paper, computer, tablet or other technology for research, prototyping materials such as Plexiglas, glass, glue

National Learning Standards:
Science: MS-PS3-3; MS-ETS1-2; MS-ETS1-3
Social Studies: VIII,a
Art: Cr2.1.6a
Set up a demonstration with two panes of the same transparent substance with a light above each one and a cup of ice underneath each one. Before beginning the demonstration, ask students to hypothesize what will happen to the ice and write their responses on the board. As the ice melts, students should record or photograph what is happening. Ideally, the ice should melt at the same rate. As a class, discuss why this occurred. Explain that thermal energy travels in a predictable way from an area of higher heat to an area of lower heat, therefore it should travel through the same substance at the same rate. Give the class definitions for convection, conduction and density.

Set up a second demonstration with three different transparent panes such as glass, plastic wrap and Plexiglas with a cup of ice under them. Each transparent pane should have its own light source equal distance away. With the light on, students should observe and draw or photograph the progression of the ice melting under the transparent panes. Ice should melt at different rates due to the amount of thermal energy able to pass through each transparent material. Ask students for their ideas on why the ice melted at different rates. Student ideas should include that thermal energy will travel through different conductors at different rates based on parameters such as density.

Examine the windows in your classroom or other areas of your school. Ask students how the windows may affect the temperatures indoors.

Discuss how the higher temperatures in Texas mean that we need more efficient windows in buildings to better manage temperatures and reduce the environmental and economic costs of cooling indoor spaces.

Artificial lighting accounts for 44% of electricity use in office buildings. Make it a habit to turn off the lights when you’re leaving any room for 15 minutes or more and use natural light when you can.
Using the classroom demonstration as a testing model, student groups will develop and test window prototypes that are best for energy conservation. Window prototypes should be transparent, but also energy efficient. Students should explore existing windows such as single pane glass, multi pane, and double hung windows to help contribute to their own ideas. Groups will complete brief drawings with a few lines denoting why they chose their specific design and material before creating and testing prototypes. Student groups will then choose their highest functioning prototype to present to the class. In their presentation, students will discuss the materials and design they chose as well as the results they concluded using the vocabulary terms learned in this unit.

UPCYCLE

Discuss with students the important role science has played in our society and its impact around the world. Ask them to research examples of technologies that are available all over the world. They may come up with examples like the iPhone, the internet or TV. Encourage them to think further back in time. For example, have them consider what U.S. farmers in the 1800s used to tend their crops and if the same technology was available in other countries then and now.

Explain that the resources we use are determined by the technology that is available, government policy and economic factors which can change over time. Batteries were not available until 1898 and are only recently being considered to power cars. The same concept applies to energy efficient windows, which were not available to the public until the energy crisis in the 1970s. This idea has grown into practice and is now the norm for many consumers and producers.

THROUGH THE LENS

Instead of having each student create their own individual sun-faded artwork, place a large piece of colored butcher paper outside and make it a group project. Using a time-lapse app, document the process and create a video unveiling the artwork at the very end.
As an extension or for extra credit, have students create a video to send to lawmakers that proposes a tax-cut for individuals and businesses that install energy efficient windows either on a new-build or as a replacement to conserve natural resources and minimize energy costs. Have them describe the design they created in the science lesson. They should emphasize how this scientific invention could help shape society in America and abroad. The video should provide several compelling reasons why the proposal will be beneficial to society, businesses and individuals.
The sun provides a powerful source of heat and energy for our planet. Art is among the many things which the sun has influenced. Using the sun as a source of artistic inspiration is one of the ways that art and science work together, and artist Michael Papadakis has found a beautiful way to harness that relationship. He uses different sizes of magnifying glasses to burn lines into wood to create beautiful pieces of art. Share his work and his process with your students using this link.

Now, your students will create their own sun art. There are a couple of ways to do this. Solar print paper will provide the most dramatic results. It is fairly inexpensive and can be found online or at many art and craft supply stores. If you are unable to find it, you can also use construction paper, which fades easily. Anything thicker, like card stock, will not work because it does not fade as easily.

Take your students outside to a sunny area. Using the solar print paper or construction paper, have them place various objects on the paper. You could use this project to focus on any of the elements or principles such as line, balance, movement, shape, etc. Also, the choice of object is up to you. Students may look for natural objects such as small leaves or rocks, or you can give them an assortment of small objects from which to choose. They will place the objects in a purposeful way on top of the paper and leave the paper outside for a few hours. The light from the sun will fade the paper and the spaces where the objects are placed will remain the original shade. Collect each of the pieces and discuss with your students why the paper faded the way that it did. Also, each student should be able to talk about their artwork using correct vocabulary and explain why they placed the objects where they did on their paper.
CAREER CONNECTION

Window Installer - Window installers fit pre-made windows into window openings and door frames of homes and buildings. Some installers work on residential or smaller commercial buildings, while others work on large commercial buildings. This job requires a high school diploma and on-the-job training.

Environmental Engineer - These engineers deal with the potential environmental impacts of geothermal plants. Although geothermal energy is an environmentally friendly source of electricity, environmental engineers must consider a site’s potential impact on local plants and wildlife. A bachelor’s and possibly a master’s degree is required for this career.

CAREER HIGHLIGHT

Harnessing solar energy is nothing new. In 1839 Alexandre Edmond Becquerel discovered the photovoltaic effect which explains how electricity can be generated from sunlight. Although it would be years before solar energy would begin powering spaces as large as homes, his ideas sparked breakthrough conversations and inventions.
In this lesson, students will:
• explore the amount of waste, both recyclable and non-recyclable produced by their family and school mates;
• recognize the effect that waste has both locally and globally;
• come up with multiple solutions to either reduce or better manage waste; and
• create a 2D or 3D piece of art from “trash.”

National Learning Standards:
Science: MS-PS1-3; MS-LS2-1; MS-ESS3-3; MS-ESS3-4; MS-ETS1-1
Art: Cr2.1.7a; Cr3.1.7a; Re.7.1.7a; Re.7.2.7a; Cn11.1.7a

Driving Question:
How does the amount of waste produced locally affect the environment and what are solutions to resolve these affects?

Materials Needed:
Notebook to record observations, writing utensil, camera to record waste and effects of waste (optional), materials such as cardboard to design product, sketch book, items collected from their families “trash” (explained in lesson), glue, wire, tape or other materials for creating a 3D piece from found objects
SPINNING THE COCOON

Prior to beginning this lesson, instruct students to either check their trash cans at home or think about the things they throw away in a day. Make a quick list of items that end up in the trash daily. Ask students if they have recycling bins or other alternate way of disposing of waste. Some students may note that their family throws away a lot of paper plates, others might say their family uses a lot of baby diapers.

At school, begin this lesson by taking your students on a “field trip” around the school to look at waste. Drop by the cafeteria and count the number of trash bins, go outside and look for signs of litter or waste receptacles, and even take a glance in the dumpster. Have students add to the list of items frequently thrown away. Note whether or not your school has a method for recycling and, if so, what items can be recycled. Do a search for the top 10 items found in landfills and the amount of time it will take them to decompose.

Read this page from the National Park Service about plastic straws with your students. Discuss with students the many ways that something as simple as a straw can have a detrimental effect on the environment. Emphasize the human impact on water and the way our input can change how species interact with the environment.

Take another walk around the school to observe species, or brainstorm and discuss species that may be impacted by waste in the immediate area. Students might see or suggest birds, fish, outdoor pets, raccoons, or insects such as honey bees and other pollinators.

Take the waste discussion further by discussing the effects on the environment if our current behavior continues. What might happen to an entire species? What happens if a species or multiple species are lost?

This will act as a segue into discussing species diversity and how waste disrupts food webs. One excellent local example of how a lack of species diversity can lead to catastrophic events is the cotton boll weevil almost eliminating cotton monocultures. Students can use the species list they compiled to create a quick food web and look at how species could be affected by waste. For example, if too many Styrofoam food trays from the cafeteria made it into the local pond, this could block light from getting to the plants, thus reducing the amount of oxygen in the water for the fish and decreasing their population.

THROUGH THE LENS

One of the most important ways to combat excessive waste is to educate people about its impact on the Earth. As students are answering the questions for their research projects, have them also interview their family members, friends or others in the community and ask them the same questions. The students should record the interviews and present them to the class. Once everyone has played their interviews, form a discussion around the following questions:

• How many people were able to answer the question correctly?
• How might we help to educate the community on the impact of waste?
• What are some alternatives that we can introduce to the community to help make eliminating waste easier?
Students or student groups should choose one of the items they noted in high concentration in either home or school waste receptacles. Make sure that at least one of the groups chooses to focus on plastic straws. For the first part of the project, students will investigate their item further and report on their findings. Student research for their report should be both online and discovered by exploring their neighborhood, waterways such as ponds and drainage, and, if possible, the local landfill. Be sure to discuss safety before students embark on their research. Some questions the students must respond to in their report include:

- Why do we use this particular item?
- What percentage of the total trash does our particular item take up? (For example, Styrofoam trays compose about 80% of our lunchroom trash.)
- How long does the item take to break down in a landfill?
- How often do we see items made of the same material as litter in our town or neighborhood?
- What species might this item have a detrimental effect on?
- How would it affect those species?
- How does that affect the food web the species is a part of?

Students will use this report as a guide on the second portion of the project. In this portion of the project, students will come up with a resolution for the negative effects. Students should understand why we use this item and then propose other tested solutions for the item. For example, students may test alternatives to the Styrofoam trays such as recycled cardboard. Students may also explore solutions that don’t involve waste production such as using stainless steel trays.

For each method they come up with, students should also explore the above questions and compare them to the original item. At the conclusion of their research and product testing, students will report their findings and their proposed solution for reducing or eliminating their particular waste item.

**UPCYCLE**

Design it better! Many companies are looking at alternate ways to build their products. For example, many tons of food-grade plastic wrap could be replaced in the landfill by using new Bee’s Wrap, a sustainable food wrap made out of beeswax. Use natural, recycled and/or compostable materials to design your own replacement product for the item you investigated. Test your prototypes and come up with a plan that would allow the best one to be engineered on a scale large enough for it to sustainably serve people with an earth-friendly alternative!
Activist art is a type of art that is created to bring awareness to an issue that affects society in some way. Because the environment is a huge concern, many activist artists create pieces that bring awareness and new perspectives to issues plaguing our planet.

Show your students some of the work on this [site](#) that deals with environmental issues. There are some amazing examples to pick from. Have an in-depth classroom conversation around three or four of them. Ask the students questions* such as:

- What do you see?
- Do you think this is a successful piece of activist art?
- Why or why not?
- Would you change anything?

*As the students are talking, remind them to use proper vocabulary relating to the elements of art and principles of design.

Now, instruct students to collect items from their trash at home throughout the week that they can bring to school. They should not bring anything that could spoil or rot, or any container or wrapper that has not been thoroughly rinsed.

After they have had time to collect their trash, they should make a sculpture or 2D work of art with it! Have them lay out all of the items that they were able to bring. They should begin to brainstorm their sculpture or 2D work by creating some sketches of their ideas. Invite them to trade items if they want.

Once they have finished, the students will present their projects to the class. If possible, display the pieces for their peers and teachers to view. Have them write an explanation of the piece, what it is comprised of, and what they learned about consumer waste in the process of creating their art.

Note: Earth Day is celebrated each year on April 22nd. This would be a great project to do for Earth Day to raise awareness of the amount of waste that families can produce in as little as a week.

**Community Garden**

There are a number of alternatives to using plastic straws. Visit this [link](#) with your students and discuss all of the options available for ecofriendly straws. Many of these options are very affordable! Work with your class to think of a way to raise money so that you can purchase some of these options, then, set up a booth at a local Earth Day event, or any community gathering, and hand the straws out to visitors. Be sure to include information regarding the level of harm plastic straws bring to the ecosystem and marine life. EarthX has launched a campaign to Strike Out Straws; at [earthxfilm.org](http://earthxfilm.org) students can take the pledge to reduce the burden of single use plastic straws on our environment.

**KERNEL OF KNOWLEDGE**

According to an article in *The Global Citizen*, the U.S. alone uses over 500 million straws each day.
CAREER CONNECTION

**Recycling Sorter** - Recycling sorters go through the mixed recycling from community or residential bins. They use a conveyor belt to remove, sort and clean materials. This career requires a high school diploma or GED.

**Recycling Coordinator** - Recycling coordinators work with cities and other entities to coordinate recycling programs and manage the employees within that program. They are also responsible for community outreach and education programs. This career requires a bachelor’s degree in a recycling related field.

**Waste Management Driver** - Waste management drivers use large trucks to collect trash and recycling from residences and other sources. They usually also perform general maintenance on their truck. This career requires a high school diploma or GED as well as a Class A or Class B driver’s license.

**Ecologist** - Ecologists are scientists that specialize in studying ecosystems and how the organisms in them interact with each other. They may work to correct damage to an ecosystem or research an area to prevent damage from occurring. This career can range from needing an associate’s degree for general lab work to requiring a master’s degree for more advanced studies in ecosystem management.

**Inventor** - Inventors create new products and build prototypes. They then apply for patents to secure their invention. This career requires a high school diploma or GED.

CAREER HIGHLIGHT

Jackie Nunez was traveling in the Caribbean when she realized just how detrimental the plastic straws in our drinks have been to the ocean. She has since founded The Last Plastic Straw, a movement dedicated to decreasing our plastic consumption, thus reducing the level of plastic pollution in our water.
7th Grade
STEAM & Social Studies
In this lesson, students will:
• recognize the effects of poor erosion control and come up with a comprehensive plan to help prevent erosion, deposition and watershed contamination.

National Learning Standards:
Science: MS-ESS3-3; MS-ESS3-4; MS-ETS1-1
Math: 7.G.6
Social Studies: III,h
Art: Cr2.3.7a

Driving Question:
How can changes be made in and around town to help control erosion, deposition and watershed contamination?

Materials Needed:
Examples of debris that might be found in watersheds such as plastic straws, Styrofoam, a bag of lawn fertilizer and pet waste, science notebook, sketchbook, writing utensil, ways to test prototypes such as access to a downspout or water pumps, prototyping materials such as filters, device for research
Show students examples of debris that might be found in watersheds and ask for ideas of what they may all have in common. Explain that all of these items are things that might eventually end up in local or even global waterways through rain and wind. Define watershed and tell students that items such as plastic bags and Styrofoam that don’t quite make it into trashcans are blown or washed through watersheds until they reach our local waterways. Excess lawn chemicals and pet waste travel in the same way and eventually contaminate our local watersheds.

In most parts of Texas, rapid population growth and development is occurring. Show students images of piles of earth and other materials displaced by construction and ask students what will happen if we get one of the heavy torrential downpours for which we are known. Students should be able to identify that the soil will be quickly washed away because there are no plant roots to hold it down. As a class, discuss where all of this eroded material goes and what effect it has on local waterways. Explain that this is fairly large-scale, and ask for examples of how erosion might be occurring in their own yard at home. Ask students what measures they think should be taken to prevent both small- and large-scale erosion and note their ideas on the board.

Further discuss the effects of watershed contamination, erosion and deposition on not only the local watershed, but also on the rivers and streams that eventually lead into the ocean.

Land along the Texas coast is sinking and the seas are rising, leading to rapid erosion. Annual erosion rates can run as high as 35 to 40 feet near the Louisiana border and 10 to 15 feet on South Padre Island and Galveston Island.
Students will create and design some mechanism to prevent and control erosion or to capture items and chemicals before they are deposited in the watershed. Students may test different plant and foliage types near downspouts to help maintain soil quality as well as provide a habitat for organisms. They may also choose to create a city plan and budget to install more waste receptacles to prevent more plastics from entering watersheds. Students will create a comprehensive report identifying the problem (erosion, deposition of chemicals, deposition of substances, etc.), how they have chosen to address it, and what their experimentation shows the outcome of their plan will be.

UPCYCLE

Discuss the following with students: While humans modify their environment in unnatural ways (e.g., building massive dams, deforestation and infrastructure) some modifications of the environment are natural. For instance, mountains erode over time from wind, water, snow and glaciers. Additionally, rivers can form canyons and deposit sediments downstream called deposition. Why then would a government want to put control measures on erosion and deposition?

Students can research this topic individually and share answers, or students can brainstorm and share out ideas in a group or class discussion. They should understand that erosion and deposition hurts human consumption. It causes damage to land that is privately and government owned as well as buildup in lakes that are created by dams. It also clogs up water filtration systems, causes rocks to slide into roads from mountains, and can result in devastating landslides.

THROUGH THE LENS

Share with students the following question: “How does Texas government go about controlling erosion and deposition?” Have students research this and explain in a Flipgrid video how the Texas government addresses erosion and deposition issues.
While erosion can have a negative impact on the earth, the effects from the energy of water can be quite beautiful on objects. Show your students some images of the effects of erosion on rocks. If you google this topic, a number of great images will come up. Have them look closely at the images, using an artist’s eye, and discuss what they see. One of the most stunning features is, often the varying lines that form from the erosion. Also, multiple types of textures might form or strong variations in value. Focus the discussion on the elements of art that are present in the images.

Next, perform an erosion experiment with your students. Give each student, or pair of students, three types of candy. They should be varying degrees of hardness. The students should take a close-up photograph of each. Next, provide the pairs with three small glass jars with lids. Fill them about three-quarters full with water and place one candy in each jar. The students will then take turns shaking the jars to see the effects that the force has on the candy. After a few minutes of shaking, the students should stop, take the candy out and take another close-up photograph. They should have at least four photos of each candy by the end. After some time, the candy may dissolve or completely break up.

Once they have finished, the students will review their photos and pay close attention to how the shape, size and color of the candy changed in each one. The students will now recreate these images in a painting or drawing. Using four small squares of white paper, have them recreate each stage on a separate square and mount them all on one big sheet of paper when they have finished. They should present their work to the class and talk about what they observed in the process, how their candy changed, and how this is reflected in their use of line, color, shape and size.
CAREER CONNECTION

Civil Engineer - Civil engineers plan, design, construct and maintain city infrastructure projects. They are responsible for nearly everything you see in the city, from roadways to sewer systems. Civil engineering requires a bachelor’s degree.

Water Quality Inspector - Water quality inspectors use their knowledge of water-quality standards and legislation to ensure the safety of our water and compliance with local and federal laws. Water quality inspectors require classes in earth and water science, as well as many certifications and experience in the field.

CAREER HIGHLIGHT

Prior to the scientific discoveries made by James Hutton in the mid-1700s, humans erroneously thought the world was much younger. Hutton formulated the theory of uniformitarianism, which said that processes such as erosion create uniform layers of rock and sediment which can give us invaluable information about the past.
In this lesson, students will:
- identify the damage caused by catastrophic events and design structures to better withstand the increase in natural disasters.

National Learning Standards:
Science: MS-ESS3-2; MS-ETS1-1; MS-ETS1-3
Social Studies: IX,d
Art: Cr3.1.7a; Re.7.2.7a

Driving Question:
How can we build houses to make them both eco-friendly and tornado safe?

Materials Needed:
Science journal, sketchbook, graph paper, writing utensil, away to simulate natural disasters, prototype building materials such as baling wire, glue, balsa wood or plaster
Ask students if they have ever been in a natural disaster or seen one in the news. Examples of recent catastrophic events include Hurricane Harvey along the Texas Gulf Coast or the tornadoes that struck Rockwall, TX. Write the list of natural disasters on the board and begin to discuss the effects they have. For each disaster type, ask students what effects it had on abiotic and biotic factors such as the water quality, air quality, biodiversity and food availability. To see to what extent these events affect an ecosystem, look at images or videos such as these satellite images and discuss what the students see.

Next, watch a video about the rebirth of an ecosystem after a disaster such as this one about Mount Saint Helens. After the video, talk with students about how nature has a way of repairing itself, even slowly, and list the steps it takes such as formation of soil, initial producers coming in, followed by primary consumers who eat those producers, and so on.

Talk about how natural disasters are a part of living on this planet, and may even be increasing in frequency. Even though nature has a way of repairing itself, ask students what happens to displaced organisms and what can we do to help organisms such as humans withstand disasters? Is it possible to create homes and business that can withstand things like tornadoes and floods while also making them greener?

Examine building techniques such as partially submerged ferrocement houses and discuss how they save energy, while also acting as a storm shelter from natural disasters such as tornadoes. What other designs could help with other catastrophic events such as flooding, while incorporating green components? Have the class watch this short video on creating a green storm-shelter at a school.

The Texas Health and Human Services Commission has spent more than $1.1 billion on Hurricane Harvey relief, most of which came from the United States Department of Agriculture’s (USDA) food assistance program, according to state budget officials.
METAMORPHOSIS

Student groups will choose a natural disaster that would affect their area such as a hurricane or tornado. With the effects of their chosen event in mind, students will begin to design and then prototype a building or structure meant to withstand the major elements of the disaster. Students may choose to include features such as wind resistant architecture or water storage and elimination systems for their structure. While incorporating these disaster resistant features, students should also keep in mind green components such as the amount of energy saved by using ground temperature or rainwater reclamation tanks during non-disaster periods. For a cool way to test tornado resistance, watch this video on building a tornado simulator. Students will build and test their prototype until they are satisfied with their design, then present the design with its disaster-resistant and green features to the class.

UPCYCLE

Explain to students that after natural disasters, the Federal Emergency Management Agency (FEMA), a government agency, works with the Red Cross to assist with clean-up and rebuilding efforts, and works to build a more sustainable area in case of future disasters. Ask, “How can we come up with solutions to deal with the waste that either was created by Hurricane Harvey or brought in by it?” Have students brainstorm as a class possible solutions and encourage them to write their congressman or senator to share their ideas. This can be at the national or state level, depending on teacher discretion.

THROUGH THE LENS

Have students answer the question in Upcycle through a Flipgrid video. This can become more than one video, so the class can debate and come up with ideas to help aid the clean-up effort. As part of their research for the video, students could interview representatives of businesses to find out how they would help in a disaster and/or if they are developing products that would reduce waste. For example, Budweiser uses one of its facilities to can drinking water for emergency distribution, Tide employees operate portable laundromats in disaster recovery areas, and Tetra Pak has developed water containers that will reduce waste.
Global and cultural issues are two factors that heavily influence many artists and their work. Often, their pieces are used as a way to communicate about or bring awareness to issues facing society. Natural disasters are part of life on Earth, that doesn’t, however, take away from the effects that these events have on both the land and the people that live there. These disasters can quickly turn into cultural and political issues that leave a lasting impact on society. There are many ways in which artists create works based on natural disasters, from finding the beauty in a storm to focusing on the pain and suffering caused. Richard Parrish is an artist from Montana who chooses to focus on the beauty that he sees from natural phenomenon. Share with your students this link and discuss the pieces that he has created to reflect various natural occurrences.

Parrish works in an abstract way to communicate what he sees in these disasters. Form a discussion around the way the artist uses color, line and shape to create his work rather than using traditional and representational images. Ask students, “What does it mean to create a piece of nonrepresentational art? How does this change the way that the viewer experiences the piece? Is it important to know what the work is based on when viewing it? Why or why not?”

Next, ask the students if they, or a family member, have ever been directly affected by a natural disaster. Have them write down some of the words that they think of regarding that experience. If they have not had such an experience, then give them an example and have them imagine how the people that lived in the area affected might have felt or feel.

The students should create nonrepresentational art based on the natural disaster about which they have been writing. Instruct them to think about questions such as, “What colors can best represent the feelings that I want to convey? What types of shape, line and value contrast would work to get my point across?” Be sure to review the principles of design – particularly balance and contrast. The medium is up to you. This could work as a 3D piece or a 2D artwork.

When the students have finished, they should present their work to the class. Instruct them to talk about the emotions that they were hoping to convey through the piece, and how they chose to represent those with color, line, texture, etc.

Community Garden
- When disaster strikes, people are amazing about coming together to help their fellow man. When you are miles away from those in need, it can seem difficult to help, but there are many organizations that need assistance.
- With your students, research different organizations that respond to the needs of victims of natural disasters such as the Red Cross, Feeding America and the Salvation Army. Often, they collect care packages to send to victims. Choose an organization to contact, and ask how you and your students can contribute to helping the people in need.
CAREER CONNECTION

Architect - Architects design, redesign and repair buildings and structures. Most architects use computer design software to come up with creative building concepts, as well as visualize renovations. They are responsible for ensuring not only a building’s general appearance, but also its safety and longevity. Architects must complete a minimum of a bachelor’s degree.

Urban Planner - Urban and regional planners develop land-use plans and programs that help create communities, accommodate population growth, and revitalize physical facilities in towns, cities, counties and metropolitan areas. Most urban planners hold a master’s degree in one of the following fields: urban or regional planning, environmental planning, urban design or geography.

CAREER HIGHLIGHT

Building green is nothing new for Ken Yeang, a Malaysian architect famous for integrating ecology into architecture. His sustainable creations and “subscrapers” have earned him great accolades including being named “One of the 50 People Who Could Save the Planet” by The Guardian.
In this lesson, students will:
- recognize that different ratios of organic compounds in soil aid in the breakdown and change of materials in compost.

National Learning Standards:
Science: MS-LS2-3; MS-LS2-5; MS-ESS2-1; MS-ESS3-3
Social Studies: III,h

Driving Question:
How do different composting methods affect how quickly substances decompose?

Materials Needed:
Example of previously composted materials, science notebook, food scraps, other biodegradable trash (e.g., grass clippings and paper), dirt, earthworms, containers for compost (e.g., large buckets with lids), outdoor areas for compost (if students want to test outdoors), soil test kit, supplemental reading resources such as this blog
As a class, create a list of things that are commonly thrown away such as paper, food scraps, plastic bottles and baby diapers. The student list may be quite extensive. As a class, sort all of the items into these three categories: can be easily broken down, can’t be easily broken down and unsure.

Look at all of the items that can be broken down and talk about what they have in common. Tell students we label them biodegradable and define biodegradable as the ability to quickly break down into more basic compounds such as carbon, hydrogen (water) and oxygen. Explain that, when thrown away, these items end up in the landfill where they can take even longer to break down and be exposed to volatile chemicals thus contaminating them. A more efficient and sustainable way to aid household waste in breaking down to more basic compounds is composting.

Show students the compost sample and explain that the soil they see was once food scraps, grass clippings and leaves. The breakdown of these materials leads to a soil rich in nutrients that are important for plant growth. In order to create compost, they need equal amounts of nitrogen sources such as veggie and fruit scraps or grass trimmings as well as carbon sources such as dried leaves or straw. Keeping the compost moist and aerating it frequently will allow the substances within to break down fairly rapidly.

KERNEL OF KNOWLEDGE

It takes 500 to 1,000 years to create an inch of soil! Why so long? Soil is generally derived from rock, which has to be broken down by weathering and physical processes over time.
Students will experiment with how quickly they can get waste materials to break down in compost. Students should have at least two compost buckets or piles. They should keep detailed records of how they manipulate the two compost samples that include the mass of carbon and nitrogen sources added, how often they turn the compost, the volume of water added, and whether or not they incorporated organisms such as earthworms. Ideally students should only change one variable such as the amount of water or how often they turn the compost. Students should check regularly to see if their compost is fully broken down. When it is, students can take an additional step and use a soil test kit to test nitrogen, phosphorus, potassium, and the Ph balance of their sample to check how fertile the is, in addition to the speed at which it broke down.

**UPCYCLE**

Most food will ideally rot eventually or be consumed by decomposers. But are all foods created equal? Students will use compost and vermiculture to test how quickly organic versus processed food waste is broken down. Students should use two vermiculture bins with the same amount of soil and worms. In one they will place organic food such as potatoes, fruits, vegetables, and organic pastas and oatmeal. In the other bin, students can put items such as processed chips and other pre-packaged, non-organic foods. Prior to officially beginning the exploration, students should write a hypothesis regarding what will happen to the food products and worms in each bin. Students should weigh all food before adding it and “feed” their worms with regularity. After adequate time has passed, students should use a screen to separate worm castings from leftover food byproducts and weight the mass of the remaining food products as well as count the number of worms in each bin. Students should use this data to determine if worms consume and break down organic foods or processed foods at faster rates and if the different food sources impacted the worms’ health.

**THROUGH THE LENS**

Have students create a short video using Flipgrid either individually or in a small group that answers the following question: How can composting reduce toxic runoff in waterways and improve life for Texans? The video should incorporate the ideas generated from the science lesson above. Remind them that the video should be clear and concise.
KALEIDOSCOPE

Explain to students that the Texas economy is largely based on agriculture. Have students identify ways Texans have modified the environment, specifically related to the waterways and pollution from farming practices, and have them research and analyze the results using their electronic device. Use the answers students find to promote a discussion. This can be done in partner talks or as a class.
Worms are hard workers when it comes to creating a compost pile, but did you know that they can also be artists? Borrow a few of the worms that were used in creating the compost pile for the science lesson and introduce your students to worm art! Give each student 1-3 worms to work with*, a medium sized sheet of white watercolor or mixed media paper, and some water-based paints. Be sure avoid oil-based or other forms of paint as they may harm the worms.

Once the students have their paper laid out and their paint ready (which should be in small bowls), have the student dip their worm in their chosen paint color and place it on the white paper. The worm will start to wiggle and move around create a beautiful line as it glides across the paper. If the student has multiple worms, have them dip them in different colors and place them on the paper at the same time. When finished, the worms should be rinsed with water and placed back in the dirt or compost pile.

Once all of the worm paintings are dry, hang them up and let the students see all of them. Form a discussion about line and color. Ask students, “Do the lines vary? Are there different thicknesses?” This can be a great kick start project for a more concentrated work based on line, or the students can take their worm’s art and add to it to make it a collaborative effort.

*If any of the students are just too grossed out to paint with the worm, have some gummy worms handy that they can dip in paint and drag across the paper themselves.
Organic Composting Specialist - Organic composting specialists work for waste departments to discover ways to more effectively break down waste materials into usable products. In addition to hands-on research, they manage other scientists and interns within composting programs. This career requires a bachelor’s degree in science, as well as personnel management skills.

Soil Scientist - Soil scientists examine and research the chemical and physical properties of soil from around the world. Not only do they determine soils viability for agricultural purposes, they also provide vital information about soil quality as it pertains to human health and biodiversity. A soil scientist requires a bachelor’s degree, but most have a master’s degree.

CAREER HIGHLIGHT

Joel Salatin, a self-proclaimed “lunatic farmer,” is famous for making nature work for him to create sustainable farms. One of his most intriguing projects uses animal rotation to compost various areas of the farm, thus preventing the need for fertilizer. By rotating different animals from pasture to pasture, manure is spread and composted to fertilize the fields with minimal interference from humans.
7TH GRADE STEM & SOCIAL STUDIES
ENERGY

ENERGIZING YOUR LAWN

Driving Question:
How can cultivated yards be changed to provide food for a community?

Materials Needed:
Science notebook, sketchbook, writing utensil, a device for research, small planting boxes or herb containers, seeds or seedlings

In this lesson, students will:
• use knowledge of food webs and the scarcity of food to create nontraditional food sources.

National Learning Standards:
Science: MS-ESS3-3; MS-ESS3-4; MS-ETS1-1
Social Studies: III.h
Art: Pr5.1.7a
Begin by asking students what makes life on Earth possible. Student responses will likely include our atmosphere and the sun. Explain that our proximity to the sun allows for the ideal climate for the biodiversity needed for all species to survive. Expand on the initial question by asking students what else the sun provides for us. In addition to energy for electricity, it also provides energy needed for plants to grow. After undergoing photosynthesis, plants use energy from the sun along with water and carbon dioxide to produce glucose, a sugar needed by humans and other organisms for energy. Explain that, because plants produce energy, we call them “producers.” Other organisms that consume plants are called “consumers.”

Show students an example of a food chain and ask them for strengths and weaknesses of the model. Explain that the model is great as a simplified version of how just a few organisms eat, but doesn’t explain the complexity of feeding relationships in an ecosystem. A better model is the food web, which uses arrows pointing toward the consumer to expound on the complexity of feeding relationships. Ask students to describe some of the producers they have actually seen growing such as a local corn field or tomatoes in their parent’s garden. Then, create a food web on the board showing feeding relationships, including humans, insects that also eat the food, and other organisms that might break down what is left of it after we have had our fill.

Tell students that the first grocery store in the United States opened in 1916, more than 100 years ago. Grocery stores didn’t open in other places such as Europe until the 1950s, so how did we get our food? The Farm Bureau estimates that less than 2% of the U.S. population is engaged in agriculture, feeding the other 98% of us. A large amount of our food is even grown in other countries. Regardless of it whether it is grown domestically or internationally, our food must travel many miles before it gets to our plates, but what does that mean?

Shipping food means that it is loaded onto carbon-producing vehicles and trucked long distances. During travel, it is exposed to vehicle exhaust and other contaminants. All of this occurs when we could be growing a significant amount ourselves. But where? In place of cultivated lawns! Discuss how cultivated lawns consume resources such as water, and also contribute to chemical pollution via overuse of fertilizers and other lawn chemicals. All of that, and no food to show for it.

Ask students to estimate the number of American citizens who don’t get enough to eat every day. Tell students that, according to Feeding America, a staggering 41 million people suffer from hunger in our nation. What can we do about this locally?
Students or student groups will begin by researching the Food Not Lawns Project. They will either use their own lawn or a lawn of their choosing as a basis for their project. Students will research and choose food crops such as pole beans, zucchini and tomatoes to grow in their project and note the space and light requirements, crop yields, potential pests and predators. Students will draw their design and create a timeline for food production. Based on estimated yields, students will also prepare a report of how many people one lawn can feed versus the number of people residing in the attached house. Groups can use ratios to create a scale model of their garden to test functionality, uncover problems that may hinder the ease of harvest, and check yields based on one plant versus many. Students will then create a food web of their new lawn including humans, potential pests and predators, and even decomposers such as earthworms in the soil.

Upcycle

One of the reasons farming has improved so much is because of what occurred during the Dust Bowl. Explain the Dust Bowl to students and how it affected the plains in the 1930s. It was called this because, due to drought and bad farming practices, there were severe dust storms in the Texas Panhandle, Oklahoma, Kansas, Colorado and New Mexico. Other areas were affected, but these states endured the worst consequences. Conditions were so horrible that people had to plug their windows and doors with rags, wear face masks and stay indoors. Some suffered major health issues, especially those with lung problems like asthma. Many people had to move because there was no food for them or their livestock to eat and therefore they couldn’t survive if they stayed. It would be helpful to show pictures of the Dust Bowl and a map of the affected area to students.

Have students research the Dust Bowl on their electronic devices. Have them determine what farmers were doing that contributed to the event and how the government has since put in place measures to prevent a disaster like this from happening again. You may check for understanding and foster a discussion or have students design an information poster that explains the Dust Bowl and what was learned from it.
Community Garden

Ever wonder what happens to all of the food that grocery stores don’t sell? Sadly, a huge percentage of it is thrown out – even when it is still perfectly fine to eat. Show your students this article and discuss how they feel about the information in it. Ask them, “What could be done about all of the food wasted? Where could it go?” With your students, create a proposal for a local grocery store to package the food that they plan to throw out so that you and your class can take it to a local community kitchen. The students can write out the proposal with posters to present, or record a video and send it to the store.

Food is a source of energy for all living things, but have you ever thought of food as a medium to create art? When artists use food to create their work, it becomes what is known as ephemeral art. This is a type of art that is meant to occur once, and it is temporary. With this type of art, the photograph or documentation of the piece becomes the part of the artwork that lives on. Introduce your students to this term, and show them the work of Nadia Luongo. She is an Italian artist who uses nontraditional mediums to create art. Visit this link to see images of her food art, as well as videos of her creating some of the pieces.

Now, it’s time for your students to make some food art of their own! There are several ways to approach this. You can bring in a specific type of food for them to use or leave it to them to bring in something. Think about taking them to the cafeteria the day of the project to see what food is going to be thrown out that you can repurpose for the art project.

Before the students begin, they need to create some sketches of their ideas. You could give them a theme, or let them choose what they would like to create with their food. It is important that it be something that they can complete in one class period, so they need to create a simple, clean drawing from which to work. Once they have their sketches done and have decided on a final drawing, they can begin creating their food art. As soon as they finish their piece, have them photograph it. They could also record the process of creating it and upload it to Flipgrid or another app of your choice. When everyone has finished, the students should share their work with the class. They need to be able to discuss the principles of design in their piece as well as the elements of art, particularly line and value. If you are able to print out the photos of the final artworks, you could display them in the hall or create an exhibit in the cafeteria.

KERNEL OF KNOWLEDGE

In North America, fruits and vegetables travel an average of 1,500 miles before reaching your plate. Buying fresh, local food eliminates long distances traveled and preserves flavor and nutrients.
CAREER CONNECTION

Farmers Market Vendor Coordinator - Vendor coordinators work with local farmers and food artisans to create a sensible market map, ensure product variety, check producer credentials, and promote the market to the community. Most market coordinator jobs require some college courses and advanced interpersonal, organizational and marketing skills.

Homestead Farmer - Homestead farmers create and implement a farm plan, which will vary greatly depending on region. Some raise meats, some produce, and many raise both. Homestead farmers must be well-versed in agriculture practices as well as animal husbandry. No formal education is required, but most take regular courses or spend a lot of time reading about their chosen specialization. Being willing to wake up early and work long hours is a must!

Produce Buyer - Farm-to-table restaurants specialize in preparing and serving food that is sourced locally. A produce buyer for such a restaurant is responsible for knowing what fruits and vegetables are available during each season, where to obtain them locally and then purchasing what the chef needs to create a menu. This career does not require a college degree, but buyers must have extensive knowledge of produce as well as math and negotiation skills.

CAREER HIGHLIGHT

Like many scientists before him, Bill Mollison got his ideas for permaculture from observing nature. He used his observations of marsupials in Australia to develop self-sufficient and sustainable agricultural production practices. The permaculture movement in the United States may be just now gaining steam, but he helped co-found the first ever Permaculture Institute in the 1970s.
8TH GRADE STEAM LESSON
In this lesson, students will:

- understand that climate is driven by interactions between the sun’s energy and our planet’s water and winds, and is not static;
- recognize the effect that changing biotic and abiotic factors have on species;
- create a plan to reduce human impact on climate conditions; and
- create a climate change coloring book

National Learning Standards:
Science: MS-ESS3-3; MS-ESS3-5; MS-ETS1-1; MS-ETS1-3
Art: Cr2.3.8a; Pr5.1.8a; Pr6.1.8a

Driving Question:
In what ways do humans impact climate, and how can we reduce that impact to maintain the correct abiotic and biotic factors for other species?

Materials Needed:
Notebook to record observations, pencil, sketchbook or sheets of paper stapled together
Watch a weather forecast or pull up a weather report on Weather Underground or similar website. Examine weather forecasts from previous days and compare it to the actual weather of the day. Ask students how weather is predicted with such accuracy. Show the students a weather map and explain to them that the heat energy from the sun creates convection currents causing warm and cool air movement. As warm air cools and sinks, it creates areas of high pressure. Inversely, as cool air warms and rises, the pressure is lowered. These areas of cool and warm air and high and low pressure as well as humidity, cloud cover and winds drive the weather.

Ask students the difference between weather and climate and write some of the responses on the board. Discuss responses and explain that weather is how the atmosphere is currently behaving whereas climate is how the weather behaves over a long period of time, typically examining data over about 30 years. Weather is generally a temporary condition, although disastrous weather such as hurricanes and tornadoes may cause long term results. Climate change over time has an effect on the long-term biotic (living) and abiotic (nonliving) factors in any given area. This change can either be detrimental, beneficial or neutral to the organisms living in that area. Additionally, due to the convection currents, climate change in one area can affect climate differently in another area.

Write the phrase “global warming” on the board and ask students to come up and write what they associate with that phrase on the board around it. Read over some of the responses as a class and discuss them. Remind students that greenhouse gases helping keep the Earth warm is known as “The Greenhouse Effect.” Climate can be affected by the amount of greenhouse gases (in particular carbon and methane) present in the environment because these gases act as a barrier preventing the sun’s heat energy from escaping. This is normal and necessary for life, but the increase in greenhouse gases is trapping more heat than in previous years. Tell students that global warming is the common name given to a theory supported by groups of scientists, including the Intergovernmental Panel on Climate Change, which shows that the overall climate of Earth is changing rapidly. As with all theories, there may be scientists who disagree or downplay the effects of this theory. However, what bad can come from trying to remedy this issue? At the very least, we leave the Earth a better place for future generations than we found it.

According to NASA, atmospheric carbon dioxide levels have increased from 280 parts per million to 400 parts per million in the last 150 years.
Students should research and identify one major greenhouse gas contributor such as methane from feedlots, carbon from vehicles or a combination of both from power plants. Students will identify the contributor and research its effects on the local ecosystem. Students will then come up with a viable plan to reduce its contribution to greenhouse gases.

Students might examine the viability of a partnership between farms just outside the suburbs to provide meat for residents rather than purchasing from factory farms, or they might create a proposal to the city for increased bike lanes to reduce reliance on carbon-emitting vehicles. Students should outline their plan in such detail that they would be able to enact their proposal with the correct funding and support. As a conclusion, students will also hypothesize on how reduction in carbon emissions might affect local species.

**UPCYCLE**

Reducing greenhouse gases can begin with reducing the current CO2 levels in the atmosphere. Choose a couple of plants to grow such as peas or algae, and use a CO2 and O2 probe to measure the level of respiration in each. Which plants use more CO2 from the air? Is it feasible to grow more of these plants? How would it affect the species in your local ecosystem to bring these plants in?
Climate change is an issue that scientists have been voicing concern over for years. However, since it is something that happens over a long period of time, it is often hard for people to understand the level of impact. Sometimes if we can’t actually see or experience the effects of something quickly, it is difficult to grasp the overall impact. When it comes to raising awareness for an issue, art is a powerful tool. People can relate to images in a way that they cannot relate to words.

In order to raise awareness to the issue of climate change, artist Brian Foo created a climate change coloring book. In it, he addresses issues relating to things such as fossil fuels, global warming and air pollution using images that the viewer colors. Because the act of coloring is slow, this forces the viewer to ponder the information, both in word and image form. Click on the link above and explore the book with your students. Discuss what issues he brings attention to in his work and invite students to talk about what they might change if they were to make such a book.

Now, have the students create their own climate change coloring book. There are many options for creating the actual book. You could get a large spiral bound sketch book and have each student contribute one or two pages to the book, or you could staple or bind a few blank pages together and have each student create their own book.

For their pages, students should include a fact about climate change and draw an image relating to that information. Make sure that students understand that they are making contour drawings so that the viewer has space to color in the parts of the image.

When the book, or books, are finished, display them so that other students and teachers can see them. If possible, make copies of the books, or a few of the pages, so that students can pass them out to other classes to color and learn about climate change.
CAREER CONNECTION

Climatologist/Meteorologist - Climatologists and meteorologists study weather patterns and how they affect the planet. They may also test the effects of various weather conditions on structures. These careers require a bachelor’s degree, but most in the field hold doctoral degrees.

Grant Writer - Grant writers use advanced writing and interpersonal skills to research funding, and to create and submit grant proposals. This career requires a bachelor’s degree.

Biochemist/Biophysicist - Biochemists and biophysicists study the chemicals and physical aspects of living things. They use their knowledge to try to maintain balance on the planet and investigate the effects of biogeochemical cycles. These careers require a doctorate degree.

CAREER HIGHLIGHT

James Hansen is a retired NASA atmospheric physicist who has been warning others about the dangers associated with climate change for well over 30 years. He has published many scholarly journals and articles and now uses his knowledge to educate others and testify in court cases related to climate change.
8TH GRADE
STEAM & SOCIAL STUDIES
In this lesson, students will:

- recognize that invasive species compete against native species for ecosystem resources and can lead to irrevocable change in those ecosystems if not controlled.

Driving Question:
How can we use knowledge of species interactions to help counteract the detrimental effects of invasive species?

Materials Needed:
Pictures of common invasive species such as Japanese honeysuckle, kudzu and cane toad, science notebook, writing utensil, device for research

National Learning Standards:
Science: MS-LS1-4; MS-LS1-5; MS-LS2-2; MS-LS2-4; MS-LS2-5; MS-ETS1-1; MS-ETS1-2; MS-ETS1-3
Social Studies: III,c; III,j; IX,d
Art: Cr1.2.8a; Pr6.1.8a; Cn10.1.8a
Begin by showing students images of invasive species and ask what they all have in common. Explain that all of these species, as well as many others, were introduced into an ecosystem. These particular species were so well adapted to the ecosystem, and had few natural predators in them, that they outcompeted native species and either reduced or eliminated them. These invasive species can completely change or destroy an ecosystem if not controlled.

Ask students how invasive species come to be in new ecosystems, and briefly discuss how the cane toad was introduced to Australia and how kudzu was brought in to try to help control erosion. Other organisms such as cogon grass and zebra mussels are brought in unintentionally. Show students an image of the zebra mussel and discuss how it was unintentionally introduced in the Great Lakes but has now made it as far south as Texas. It is wreaking havoc on our lakes and quickly invading more waterways. Campaigns have been launched to try to curb the spread, but as recently as July of 2018 the zebra mussel was discovered in new places such as Lake Grapevine in North Texas.

**KERNEL OF KNOWLEDGE**

In her five-year lifetime, a single quagga or zebra mussel will produce about five million eggs, 100,000 of which will reach adulthood. The offspring of a single mussel will in turn produce a total of a half-billion adult offspring.
Students will research the zebra mussel to discover what biotic and abiotic factors it needs to survive, and how that compares to the needs of native species. They will further research the life cycle, modes of transportation and detrimental effects of the zebra mussel. Students will use this information to come up with a plan for curbing their spread. Students may devise a way to interrupt their reproductive cycle, eliminate their ability to attach to substances or chemically divert them with pH changes. Together, the students will critique their method to check for problems it might cause for native species and identify possible adjustments to prevent those problems. Students will then prepare a presentation detailing their hypothesis of how their method would work, along with its strengths and drawbacks, to share with Texas Parks and Wildlife.

**THROUGH THE LENS**

Using Flipgrid or another recording app, have students record a presentation detailing their hypothesis to combat invasive species in the area. Send the presentation(s) to Texas Parks and Wildlife.

**UPCYCLE**

Students will further research zebra mussels to find a purpose for the populations currently existing in Texas. They may have brought Lake Erie back to life by filtering the water, but what other uses do they have? Is it possible to use them to feed hungry people within the community? Can their shells be used for building and infrastructure? Can the things that make them successful as a species be used to benefit humans?
The introduction of invasive species was not an issue in the Colonial Era or in the early years of our republic. They came, usually by accident, on ships. Have students research what types of non-native plants and animals were brought to America prior to 1900. Have them compile lists, and compare and contrast each in groups. Ask them why settlers might have brought these species over. Provide time for discussion and questions. Near the end of the lesson, point out that our national parks, which are managed by the federal government, are so concerned with some invasive species they require all watercraft to be inspected before they are allowed to dock. This is due to the phenomena and environmental crisis created from the introduction of the Zebra Mussel. Point out to students that in Glacier National Park, they are desperate to rid the lakes of invasive lake trout that a license is not required to fish. In Yellowstone National Park, lake trout are not allowed to be placed back into the water because it is a predator of the bull trout, which is an endangered native species. Ironically, the lake trout was introduced to bring people to the park after the railroad was built because they were easy to catch and had relatively high numbers.
Invasive species are a serious issue in many parts of the world – even in our own backyards. Once you have defined invasive species, show your students this video which further explains the process of invasive species in a new land and uses beautiful graphics to help tell the story.

After the video, ask students if they think they would have learned as much from the video without seeing the images. Why or why not? Look back at the images and freeze the video to focus on specific frames. Discuss the elements of art and the principles of design used in the selected frames.

Next, divide your students into groups of 3-4. Have them choose one invasive species to research. They should identify where the species originated, what it eats, who are its natural predators, where it was introduced, how it got there and its impact on the land it now inhabits. Once they have this information, they will create a comic book or graphic novel to illustrate the story. They can create their book from different perspectives such as that of a person who experiences the effects of the invasive species, from the perspective of a narrator, or even the invasive species itself. Encourage them to really push their creativity! Their drawings should be clean-lined and colored neatly – just as you would see in an illustration or comic book. You can staple together sheets of copy paper or research different ways of binding books to take it up a notch.

Once the students finish, give each group the chance to read one another’s stories and offer feedback. Also, display the books where other students and teachers can see them.

Community Garden
Create the books as directed in the eARTh section, but focus on invasive species that are directly affecting your area. Use only line drawings to create the images in the books so that they can be made into coloring books, and distribute them to local organizations, grocery stores, etc. Include suggestions on how to address the issue and prevent it from happening with other species.
Ecologist - An ecologist studies the interrelationships between organisms and their environments. For example, they may research how the creatures in forests, deserts, wetlands or other ecosystems interact with each other, as well as their environments. Ecologists must hold a bachelor’s or higher degree in ecology or a related science.

Research Biologist - Research biologists study interactions between species both in the lab and the field. They may study an organism as minute as microbes or as advanced as humans, and work to understand how these organisms might benefit or hurt each other. Most research biologists have a master’s degree.

CAREER HIGHLIGHT

Rachel Carson, author of *Silent Spring*, is perhaps the most famous conservationist and ecologist in the United States. Carson’s essays, based on her research, became some of the most loved and hated ecological writings of her time, inspiring change that brought species such as the bald eagle back from the brink of extinction.
8th Grade STEM & Social Studies
In this lesson, students will:
- recognize that the alignment of our planet, moon and sun, as well as convection currents in the ocean, cause the movement of the tides. They will understand how that movement can be captured as energy.

National Learning Standards:
Science: MS-ESS2-4; MS-ETS1-1; MS-ETS1-3
Social Studies: VI,g
Art: Cr1.1.8a; Cr2.1.8a; Cr2.3.8a; Pr4.1.8a; Pr6.1.8a; Cn10.1.8a
Show students an image of the solar system focusing on the Earth, our moon and the Sun. Ask students to identify what forces keep our solar system in a relatively predictable state of motion. Discuss how the gravitational pull of the Earth, moon and sun are all unique, but play a vital role in maintaining planetary alignment and distances.

Put water in a small bucket with a rope attached and ask students what will happen if you swing it very quickly over your head, and then demonstrate. Ideally, if you swing the bucket fast enough, gravity acts on the water to keep it in the bucket, regardless of it going upside down over your head. Tell students it is this force, as well as the oceans’ movement as result of thermal energy, that cause changes in daily tidal heights.

Next, pour water through a toy propeller and watch as it spins. Ask students of what the propeller movement reminds them. Discuss how water movement past the propeller is similar to wind blowing past a turbine. Explain that energy can be captured in a similar fashion.

Kernel of Knowledge

The first tidal project in Canada was built in Annapolis Nova Scotia where the highest tides in the world are harnessed to produce electricity. With a capacity of 20 megawatts, the plant can provide electricity to approximately 4,500 homes.
Students will design and prototype a device built to capture the energy of the changing tides. Students might develop a way to capture the ebb and flow via tanks, underwater turbines or any other method. Students should use flowing water to test the movement of their system and its efficiency. They should include materials that might be used in a full-scale device, decide how the device will be anchored, and how it will transmit energy to a power plant. Students will then research their design to determine how it might be detrimental to underwater ecosystems and create an environmental impact statement. Finally, students will present their prototype and environmental impact statement to classmates.

**UPCYCLE**

A lot of wind energy is produced via offshore turbines, so why not combine wind and tidal energy? Have the students design a concept that incorporates the tidal energy system they just created and a wind turbine system to make double use of oceanic infrastructure. Students should build prototypes and test them to see if the two systems can work independently, while still being attached to each other.

**THROUGH THE LENS**

Students can create a video on Flipgrid or a poster that explains the types of energy that were used during the 1800s. Have them explain why industry is beginning to return to wind power and looking at more renewable energy sources. The following questions may help get students started:

- How did the Lowell Mills in Massachusetts power their machines in the early 1800s?
- Where in the world was wind power more readily available than water power?
- When and why was wind power more efficient than water power?
- Why is there a push to go back to wind power?
Discuss with students how wind energy has been used since ancient times and was even used to help pump water for steam engines during the American Industrial Revolution. Have students conduct research to explain why our society has gone away from wind power in favor of other types of power sources.
For years, artists have used their work to bring awareness to social, political and environmental issues around the world. This type of art can be seen in neighborhoods, museums and everywhere in between. Land Art Generator is an organization that asks artists and designers to take these passions to the next level. They host annual design competitions focusing on creating models of renewable energy that add value to public spaces, inspire, educate and provide power to people around the world. Visit their website with your students and explore the different competitions and artistic designs that have been submitted.

As you look at the examples with your students, ask them to talk about what they see in the different designs, focusing their responses to include the principles of design. Look at the specifics for competitions that combine art, technology and science. Break the students into pairs or small groups, and have them create a design for one of the competitions. You can choose the competition or let the groups choose from the list on the site.

The focus of each of the projects is to create an aesthetically pleasing design that functions as a work of art as well as a source of renewable energy. Each group should create a variety of potential design sketches and then choose one to prototype. Have them present their design to the class in a 30-60 second video that makes the case for their design and states why their product is better for the environment. They must discuss both the design principles that were used to create a visually pleasing structure, as well as how it functions as a source of renewable energy. If the students meet the guidelines for the actual contest, have them send in an official entry.

Community Garden
- While it is essential to be friendly to our environment, it is equally as important to show others that they are important and beautiful. Start a “kindness campaign” in your class. Tell students to leave a post-it or other type of note on one person’s desk/locker/book, etc., each day. The note should point out something positive about that person, or include an inspirational quote or image. Start in your classroom and see if it will catch on throughout the entire school – and maybe into the community!
**CAREER CONNECTION**

**Renewable Energy Engineer** - Engineers working in renewable energy are part of a growing sector of green jobs that involve environmentally conscious production. These individuals maximize the potential of clean energy sources such as wind, solar, geothermal and hydropower. Renewable energy engineers monitor and develop alternative energy outputs. For this career, you need a bachelor’s degree and various licenses.

**Oceanographer** - Oceanographers study the formations, composition and history of the seafloor to provide vital information about the past and future. They use advanced technology to confirm and develop theories about land masses and other underwater features. Oceanography requires a bachelor’s degree, although most have a master’s or doctorate degree.

**CAREER HIGHLIGHT**

Brian Polagye is an associate professor and co-director of the Northwest National Marine Renewable Energy Center. There, he focuses on the environmental impact of renewable marine energy, including energy that can be created by rivers, tides and ocean currents.
8th Grade
STEAM & SOCIAL STUDIES
In this lesson, students will:
• recognize how the removal or addition of one species can alter an entire ecosystem.

Driving Question:
How does the addition or removal of one species affect an entire ecosystem?

Materials Needed:
Science journal, sketchbook, writing utensil, microhabitat materials such as two-liter bottles, terrariums, soil, water, plants and organisms, device for research and photography

National Learning Standards:
Science: MS-LS1-5; MS-LS2-1; MS-LS2-2; MS-LS2-3; MS-LS2-4; MS-LS2-5
Social Studies: II,f; III,h
Art: Cr1.1.8a; Cr2.1.8a; Cr2.2.8a
Watch the following video with students about how reintroducing wolves to Yellowstone affected the rivers in that ecosystem. Ask students to brainstorm other ways that introduced species could affect an ecosystem and write them on the board. The responses can be negative or positive. Next, ask students to focus specifically on humans and how we positively or negatively affect ecosystems, and write down their ideas. Explain that all species have their own niche, or specific place, within an ecosystem. If they leave this niche, then another species moves in. Because the new species may interact differently with other species in the ecosystem, this can cause a huge shift in the entire ecosystem. Ask students in what ways they think a new species moving in can affect an ecosystem. They may come up with competition for food or other resources, predation, or even the species itself being prey. Explain that these seemingly minute changes can impact future generations of all species in an ecosystem.

**KERNEL OF KNOWLEDGE**

There are now 41,415 species of animals and plants on the International Union for Conservation of Nature Red List, the foremost authority in threatened and endangered species. Of these, 16,306 species are threatened with extinction.

**THROUGH THE LENS**

Allow students to consider the Upcyle questions and have them research and create a video in Flipgrid to answer them. Be sure students understand that, as settlement moved westward in the mid-to-late 19th century, bison, a source of life for many Native American tribes, were killed off almost entirely.

When they relate this to a contemporary issue of biodiversity, they may mention migratory species such as the pronghorn, elk, mule deer and/or antelope. They may even mention bison and how, due to being in controlled environments such as Yellowstone National Park, these animals have ceased their former migration patterns. Places like Yellowstone create isolation and limit biodiversity. This is a result of continued settlement in surrounding areas that were formerly grazing land where bison could roam free. Have students identify potential solutions to this problem such as fencing, predator control, wildlife corridors and/or more conservation areas.
Students will design and create a living micro-ecosystem on which to ethically test various hypotheses. Students might choose to create an aquatic system in a terrarium or two-liter bottle, or a terrestrial system. In whatever system they chose, they should include plant life as well as some living organism such as insects or small fish. It is advised not to allow students to use birds or mammals due to ethical issues. Once established, students should take careful notes and photographs of the ecosystem over a predetermined length of time. Roughly a month is usually enough to see “norms” in such a small ecosystem. Students can take a few minutes at the beginning of each class to record population numbers and make notes about growth and resources. After a set amount of time, students will introduce a new species to the habitat and write a hypothesis about what they think will occur when the new species is introduced. It may be a new plant, bug or fish species. Students will continue to observe their ecosystem and record data similar to what they were recording prior to the addition of the new species, as well as data about how the new species interacts. After a predetermined length of time, students will write a final report detailing how the species that was introduced affected the ecosystem, and what implications this might have for a large-scale ecosystem.

Students can augment their written records with daily photos of the ecosystem throughout the experiment, and then edit together a visual journal of the changes. Voiceover or graphics explaining the process and timeline also may be added.

METAMORPHOSIS

UPCYCLE

Have students consider the following questions:

1. How did westward expansion change the biodiversity in America, and how does this relate to contemporary issues in the nation as we settle more land?
2. Evaluate solutions to the biodiversity problem currently found in and around Yellowstone National Park.
3. Would it be possible to have lawmakers address this issue and solve this problem? If so, how?
Introduce your students to the term appropriation in art. This involves the use of pre-existing objects or images with little or no transformation applied to them, often shifting the meaning of the initial object. Appropriation has taken many forms throughout art history. One of the most famous women artists to use ready-made objects for appropriation was Meret Oppenheim. Her body of work involved many themes, including the use of irony in the objects that she appropriated for her work. For example, one of her most famous pieces is a fur covered teacup, saucer and spoon. Although it is interesting to look at, it is no longer useful in its new form. Another of her pieces was an iron to which she attached nails causing it to shred anything that it “ironed.” Show your students examples of Oppenheim’s work and talk about how they are ironic. Also, discuss how the students define appropriation versus stealing. Are they different? Why or why not?

Now, instruct the students to brainstorm some everyday objects that they could appropriate and turn into a new and ironic works. The viewer should still be able to easily discern what the initial object was, as well as understand how the student has adjusted the object to no longer be useful as it was in its original form. Although the end result will be a somewhat useless object, it should still have the principles of design at the forefront of its conception. When finished, the students should display their appropriated sculptures and talk about the creative choices that they made in their work, as well as how they altered the purpose of the original object.

**Community Garden**

Often, especially after a natural disaster, people are forced from their homes into unfamiliar places where they have no family, friends or home. Ask your students to brainstorm ways that they might help people who have been displaced from their homes. Ideas might include collecting cans and staples for a food pantry, gathering clothes to donate to a local shelter or accumulating toiletries to send to disaster areas.

One nonprofit that builds homes for families in need is Habitat for Humanity. Contact your local organization and ask how you and your students can help build houses for those in need! Visit their website for more information and to contact your local Habitat for Humanity.
CAREER CONNECTION

Ecologist - An ecologist studies the interrelationships between organisms and their environments. For example, they may research how the creatures in forests, deserts, wetlands or other ecosystems interact with each other, as well as their environments. A career as an ecologist requires a bachelor’s or higher degree in ecology or a related science.

Environmental Advocate - Environmental advocates lobby on behalf of environmental groups and individuals to try to implement policies that conserve and protect our environment and ecosystems. Most environmental advocates have a bachelor’s degree in political science or communications.

CAREER HIGHLIGHT

Ecologist and conservationist Chris Morgan uses television and film to share information about one of the most feared and misunderstood terrestrial creatures. His work with bears crosses continents as he works to educate people and prevent the unnecessary reduction of bear populations, and promote recovery in places where bears previously inhabited.
In this lesson, students will:
- recognize the damage done to coral reefs resulting from human activities and climate change, and develop a plan to rehabilitate or recreate the ecosystem.

Driving Question:
How can humans help reverse the damage and ecosystem loss caused by the destruction of coral reefs?

Materials Needed:
Before and after images of coral reef systems, science notebook, sketchbook, prototype materials such as a 3D printer (ProtoCycler), clay or model supplies

National Learning Standards:
Science: MS-LS2-4; MS-LS2-5; MS-ETS1-1; MS-ETS1-2
Art: Cr2.3.8a; Pr5.1.8a
Begin by showing students before and after pictures of the Great Barrier Reef such as the ones in this article, and ask students what impact such changes could have. Discuss how the coral reef not only serves as a hotspot for oceanic biodiversity, but also acts as a barrier for coastlines to prevent damaging erosion. It is also vital to nutrient cycling, and provides economic benefits such as fishing and tourism to local areas. Coral reefs may have additional benefits such as housing organisms used in medications for humans or other products.

Tell students that most coral reefs are near the equator, just like rainforests. Their consistent temperature is what encourages their biodiversity. Based on this information, what can students deduce is occurring in reef systems such as the Great Barrier Reef to cause die-offs and bleaching? Explain that at least two global bleaching events have been associated with El Niño weather patterns, but that ocean temperatures are expected to continue to change, leaving reefs vulnerable. One way to help maintain oceanic biodiversity as well as the other benefits of the reef are to install artificial reefs. Thus far, artificial reefs have primarily been made by sinking old military equipment and similar vehicles as explained in this article. These artificial reefs help to protect coastlines and provide habitat for various aquatic organisms, just like natural reefs. Installing a natural substrate to encourage reef restoration and coral growth in various areas can also prevent changing ocean temperatures from causing further damage to existing reefs.

KERNEL OF KNOWLEDGE

The Great Barrier Reef generates more than $1.5 billion each year from fishing and tourism for the Australian economy.
METAMORPHOSIS

Have student groups brainstorm materials and a design for creating an artificial reef. They can use existing materials, or create and design their own, similar to the underwater sculptures. Students should study current natural reef systems for information on how reefs grow and what the organisms they require for life. Studying natural reefs might also give students ideas for design. After the design phase, students will select materials to create a prototype for their reef design. Students should analyze their prototype and consider factors such as how likely it would be to move with ocean currents and the durability of materials. Students will research options for where to place their artificial reef in the ocean and provide the reasoning for their choices.

UPCYCLE

Oceanic plastic is a hot topic right now. The ProtoCycler is a 3D printer that uses plastic such as water bottles to create 3D models without the use of virgin materials. Students should design an artificial reef prototype and then print it using the ProtoCycler. They will then use ratios to determine how much recycled plastic they could convert into a usable, artificial reef if the technology were available at scale.

THROUGH THE LENS

Instruct students to document the process of creating their coral reef dioramas. In their documentary, they should discuss why it is important to bring awareness to the dying off of the coral reefs, as well as steps that can help prevent further deterioration. For inspiration, have them watch Chasing Coral. (Netflix account required to stream the film.)
Explain to students that Americans are constantly redefining our national identity. Ask students to give examples of current social movements. Tell them that these movements each help to define America. Ask, “How does Americans’ commitment to the environment help define our national identity?” Have students create a foldable or poster that explains the environmental movement, including a brief history. Have them explain how the movement connects to the coral reef project above, and the message it sends to the rest of the world.
eARTh

Equipped with their new knowledge of coral reefs, have students create a diorama of a reef. The diorama should include different coral of various colors and textures, organisms that rely on the coral for life, and animals that rely on it for protection or food. Dioramas include both 3D and 2D elements, so allow the students to decide which ones they will create in 2D or 3D. If possible, have the students sculpt some of the forms from clay and paint and fire them. If not, they can use cardboard, paper, found objects or any other 3D material for the solid forms.

The students will need to research each element that would be present to create a complete environment. These can be as large or as small as you require. In addition to the diorama, the students should write at least one statistic regarding the dangers that coral reefs face on or near their artwork. Have them present their work to the class and, if possible, create an exhibit with the pieces for the public to view.

Community Garden
- Study the impact of litter on marine plant and animal habitats. Invite other clubs or school organizations to participate in a nearby beach cleanup.
- If there are no oceans near you, no problem! Nearby lakes and streams are just as important and require litter-free environments to thrive. Sort and quantify the litter retrieved, and present the findings at your school to encourage others not to litter local beaches, lakes and streams.
CAREER CONNECTION

**Marine Biologist** - Marine biologists specialize in species and ecosystem interactions in our oceans. Their examinations of both biotic and abiotic features are vital to the health of our oceans and seas. Marine biologists hold a minimum of a bachelor’s degree, and most have a master’s or doctorate degree.

**Chemical Engineer** - Chemical engineers develop compounds found in food, medications and other products. They are responsible for the creation of products such as new sunblock formulas that won’t harm coral reefs. Chemical engineering requires a bachelor’s degree as well as an internship.

CAREER HIGHLIGHT

Dr. Ruth Gates is best known as president of the International Society of Reef Studies and a contributor to the film Chasing Coral. Currently, she is the director of the Hawaii Institute of Marine Biology (HIMB) at the University of Hawaii at Manoa where she leads a team dedicated to the research and preservation of coral reefs.
HIGH SCHOOL
STEAM, BIOLOGY, WORLD GEOGRAPHY
In this lesson, students will:
- determine how pollutants such as excess nitrogen runoff or common household chemicals affect the growth of plants.

Driving Question:
How do pollutants from common farming and household activities affect the growth and/or reproduction of plants?

Materials Needed:
Science notebook, a fast-growing seed such as sunflower or bean sprouts, containers and soil for seeds, test material (Note: this is dependent on what chemical or environmental condition the students would like to test), oxygen probe, water-sampling containers, device with a camera

National Learning Standards:
Science: LS2-2; LS2-6; LS4-6
Social Studies: II,b; III,c; X,c
Art: Cr2.3.1Ia; Pr5.1.IIa; Cn10.1.1Ia; Cr1.1.IIa
Begin by asking students what humans need to survive. They should be able to recall that we need oxygen, water, food and some sort of shelter. Next, ask what plants and other species need to survive. Explain that these requirements are what allow all organisms on Earth to maintain homeostasis for their species or population. Define homeostasis, and ask students for ways that organisms maintain homeostasis. Some examples might be human beings sweating to stay cool or plants opening stomata to release excess gases. Continue the discussion by asking students what might happen if an organism’s environment changes so rapidly that their homeostatic mechanisms can’t keep up. Students might say that plants wilt if they don’t have enough water in their environment, humans may need IV infusions of fluids and electrolytes when they lose fluids during intense exercise, or even that an organism might die from rapid changes to its environment.

Explain that some environmental changes may cause an organism to be unable to reproduce or cause rapid cell growth leading to tumors. In other cases, the organism might benefit from the rapid environmental change. Ask for examples of environmental changes caused by both humans and nature and write answers on the board. Some examples of student responses might include changes in salinity, changing tidal patterns, introduction of chemicals via pollution, or increased plastic in the ocean. Discuss with students how each one of the items they suggest might have an effect on humans and other organisms, and whether these effects are positive, negative or both.

KERNEL OF KNOWLEDGE

According to the United States Environmental Protection Agency (EPA), about 40% of heavy metals, including lead, mercury and cadmium, in landfills come from electronic equipment such as discarded smart phone and computer components.
Students will work in either partners or groups. They will begin by growing their chosen plant from seeds. Students should have one control plant and one that they will feed differently as their variable plant. Prior to beginning their project, students should write a hypothesis about plant growth in both the control and variable plant. Students will feed, water and provide sunlight according to growth instructions for the control plant, and then decide what change they’d like to make for the variable plant. Students may choose to introduce excess fertilizer, occasionally add a household soap or cleaner to the plant, or even lower the amount of “sunlight” to represent tall buildings or other plants blocking the sun. Students should decide what ecological disruption they would like to represent.

Note: Special care should be taken if students are handling chemicals such as fertilizers, soaps or household cleaners.

As the plants grow, students should take specific growth measurements, as well as draw or photograph changes in their plants. They should also keep precise records of what substances and the amounts applied to each plant. Other than the one variable, all other applications such as the amount of water or light should be consistent between the two plants. At roughly 30 days, students should take final measurements and create a final report. The report should show graphs or charts of growth, and should include their original hypothesis, a report of findings, and whether they accepted or rejected their hypothesis in the end. Students should also include some scientific reasoning for why they think their results occurred.

UPCYCLE

Waterway pollution is increasingly becoming worse. Students will utilize a local waterway such as a stream, creek or lake for this project. Note that special care should be taken around waterways to prevent drowning or potential bites from snakes and other organisms. An initial water sample should be taken and sent to a local university or to the Noble Foundation for testing. Students also should take an initial dissolved oxygen reading. Have students photograph and document the conditions of aquatic plants such as duckweed or algae, and make notes about the characteristics of the surrounding area, such as whether there are farms, neighborhoods or industrialized zones.

Twice weekly over the course of a month, students should document any changes to the surrounding environment, as well as any other conditions that seem pertinent. They may document information such as a farm appearing to fertilize or spread pesticides, or higher levels of smog or other contaminants on certain days or weeks. If any large change occurs, such as an algae bloom or a plant die-off, students should carefully take another water sample to be sent for evaluation. At the conclusion of their investigation, students should create a report of any changes to the aquatic plants, including a hypothesis of what caused the change. Significant changes to a waterway typically occur in the early spring near agricultural operations, so it may be best to time this exploration accordingly.
Ask students to hypothesize whether they believe the air quality is better or worse in densely populated areas. Have students research and find a map of the world that illustrates the air quality. Then allow students to create a video that:

- explains their findings,
- describes whether or not their hypothesis was correct, and
- offers possible solutions for improving the air quality in these troubled areas.
eARTh

Poor water quality is an issue that affects people, plant life and wildlife all over the world. Discuss the statistics regarding poor water quality and the causes using the information found on [website](#) from the Pacific Institute. Write some of the reasons for poor water quality on the board and discuss the effects.

Talk with your students about the concept of an installation. An art installation is a complete experience where the viewer enters a space where they are surrounded by the art. It is usually the size of a room and encapsulates the viewer. Now, tell the students that they will create an installation based on poor water quality and the reasons behind it. Allow the students to brainstorm ways to communicate this idea through art. One idea might be to fill plastic bags with various colors of water or to have different objects floating in the bags. They should work in groups to create sketches of their ideas and share them with the class. Have the students vote on their favorite idea, and then begin creating the installation.

Once the installation is finished, have a public show to allow others to experience the work. Treat this as an installation that one would see in a museum. There should be wall placards or information about the pieces visible to viewers. If possible, work with teachers in other disciplines to create an educational experience for the public, such as an Earth Day celebration.

- **Community Garden**
  - Work with your fellow teachers to create a family education night focused on the importance of clean water, like the one discussed in the eARTh section. Charge a small fee and donate it to The Water Project. This charity provides access to clean drinking water to people in Africa. Visit their [website](#) to learn more about the organization and how you and your students can help.
CAREER CONNECTION

**Water Quality Chemist** - Under general supervision, a water quality chemist performs analysis of physical, chemical and bacteriological elements present in a treated and untreated water supply. Working at a water treatment laboratory, they maintain detailed records of their observations, and diagnose, troubleshoot, and coordinate the maintenance and repair of instruments and equipment. This career requires a bachelor’s degree and experience in the field.

**Microbiologist** - A microbiologist is a scientist who studies microscopic organisms, including bacteria, algae and fungi. Often, they study organisms that cause diseases and environmental damage, or that are of industrial or agricultural interest. A bachelor’s degree or higher is required for this career.

**Cartography** - A Cartographer creates maps that can be topographic or spatial in nature. They have a wide range of possible career paths that can include the Department of Agriculture and the US Forest Service. Often, they can take scientific data that provides geographic imagery to better understand trends and provide possible solutions to environmental problems. This career requires a bachelor’s degree.

CAREER HIGHLIGHT

Ryan Hreljac was only six years old when he first learned that many people in other countries don’t have clean water to drink. So he began doing extra chores to help raise money to install a well for his pen pal in a foreign country. That initial effort led to the formation of the Ryan’s Well Foundation, a nonprofit water charity that seeks to provide water to developing nations.
In this lesson, students will:

- use knowledge of calculating the perimeter and area of three-dimensional shapes to design a scale model of an energy-efficient tiny house.

**Driving Question:**
How can geometry help design an energy-efficient tiny house?

**Materials Needed:**
- Graph paper
- Drawing materials
- Calculator
- Prototyping materials such as balsa wood, glue, clay and Legos

**National Learning Standards:**
- Math: G-CO-12; G-GMD-4; G-MG-3
- Social Studies: I,a
- Art: Cr1.2.Ia; Cr2.1.IIa; Cr2.3.IIa

**SMALLER IS SAVVIER**
Draw basic shapes on the board such as rectangles, squares and triangles. Tell students you’d like to build one of the shapes out of wood and ask how you can determine the amount to buy. Students should be able to tell you to measure around the entire shape or determine the answer using two sides (length and width). Review with them the formula for finding the perimeter of rectangles and circles.

Next, tell students you want to cover one side of your rectangle with wood siding. As a class, discuss how you would use the area formula to determine what size board you would need to purchase and cut to cover your rectangle. Review with the class the formulas for calculating the area of a triangle, circle and square.

Tell students that these basic geometric concepts are what architects use to design and build a house. Recently, the idea of minimalist living in the form of tiny houses – homes generally under 1,000 square feet – has taken the country by storm. Not only do tiny houses use fewer building materials than larger homes, they also are more efficient and reduce one’s ecological footprint. Use this or any number of websites to show students the array of designs available for tiny houses. Discuss some of the design aspects that make these homes “green” such as natural lighting or lofts that are just high enough to sleep but reduce energy costs associated with heating and cooling.
Student groups will use their knowledge of area and perimeter to design and draw three-dimensional plans for tiny houses. Students must include exterior and interior schematics with measurements noted for height, width and area. Exterior schematics should include aspects such as window sizing and roof pitch. Interior designs should note areas for sleeping, food preparation, living and bathroom facilities. Encourage students to make their tiny house creative and innovative, not just a box. Students should also focus on ways to make their tiny house “green,” such as by incorporating lots of natural light.

Once their designs are complete, students should choose building materials and use their measurements to complete a rough building budget, excluding costs for plumbing and electrical. Students should keep in mind that the completed footprint of their tiny house should be under 1,000 square feet, but can include aspects such as lofts or rooftop living. Students will then use their knowledge of fractions and scale to build a small-scale model of their tiny house design to present to the class, along with the estimated build budget. During their presentation, students should also point out the green features in their project.

The tiny home movement is considered a type of counterculture to many as it goes against the norms of society. Modern American society tends to value large, expensive homes with several spaces inside to be used in various ways, such as a home office, or exercise, craft, game or theater room. Tiny houses, however, are about the bare necessities and emphasize the idea of “the smaller, the better.”

Have students research the counterculture movement of tiny homes and create a Flipgrid video that explains the movement, its history, its popularity and where to find tiny home builders in the area. If there are tiny homes nearby, students may want to ask if they can create a video tour of one. As they film, they should record narration pointing out efficiencies and comparing electricity and water usage (among other things) to that of their own homes.
eARTh

Using Google Sketchup, or another free design app, have students design their own tiny home. This project should focus heavily on the principles of design and creating aesthetically pleasing color schemes for their home. Lastly, they should focus on making their house as green as possible.

When they have finished, each student should present their design to the class and discuss the elements and principles present in their design. They should also talk about why they feel that it would be a successful space for someone to live, and what they included to make it more environmentally friendly.
CAREER CONNECTION

**Sociologist** - A sociologist studies human society and social behavior by examining the groups and institutions that people form, including social, religious, political and business organizations. Most positions require a master’s or doctoral degree.

**Concrete Truck Driver** - A concrete truck driver operates a truck equipped to deliver concrete mix to construction sites. They also receive the sand, gravel, cement and water used to mix the concrete. For this job, a high school diploma and on-the-job training are required.

CAREER HIGHLIGHT

Pietro Belluschi was an architect renowned for his skyscrapers that changed the skyline of Portland, OR. Today, he and his son Tony are best known for their design of a very famous tiny house, a tea room located behind their home.
In this lesson, students will:
- explore the effects of urban development on watersheds, and explore alternative materials that can help control erosion and prevent pollution.

**Driving Question:**
How does changing the composition of flat surfaces, such as parking lots, affect the absorption and filtration of rainwater before it reaches the watershed?

**Materials Needed:**
Science notebook, building and filtration materials such as rubber chips, filter paper, asphalt samples or other substances, a watershed model similar to EnviroScapes, water in a spray bottle, dyes to represent contaminants such as red drink mix for fertilizer or cocoa powder for animal waste, bucket or tub to collect “runoff”

**National Learning Standards:**
Science: LS2-5; LS2-7; ETS1-3
Social Studies: I.d; VII.e; VII.e
Art: Re.7.1.Ia; Cr1.2.IIa; Cr2.3.IIa; Re.7.2.IIa; Cn10.1.IIa; Cr1.1.IIIa; Pr6.1.IIIa
Begin by showing students a watershed model. Select students to spread the various “contaminants” around the cityscape. As the students are spreading contaminants, ask how many of them clean up the waste from their pet on a regular basis or how many know someone who fertilizes their lawn without following the application instructions.

Ask them to quickly research and identify their local watershed and drinking water source. Ask students what they think will happen when it begins to rain. Select one student to simulate rain while the other students note their observations. Discuss how everything that we put into the environment, including items such as chemicals, motor oil or animal waste, ends up in our watershed where it can be detrimental to flora and fauna, and even to us.

Draw two columns on the board and ask students what they think happens when it rains over a grassy area versus what happens over surfaces such as parking lots, sidewalks and driveways. Student responses should include the soil acting as a filter for water as well as grassy areas slowing down the flow of water into the watershed, thus preventing erosion. Tell students that contaminants such as motor oil from cars driving on roadways and other pollutants are easily washed into drains and straight into the watershed without filters such as soil to help control them.

Ask students for their ideas on how paving formerly green areas to create “improved” surfaces can affect wildlife, soil and even the aquifer, and write them on the board. Talk about how big differences can be made in these detrimental effects depending on design. Some design aspects might include having a natural progression into green space rather than a curb, using textured surfaces to slow water flow, or even using materials other than concrete to create improved surfaces. If time allows, watch the following video on the use of a new surface material being used in Yellowstone National Park.

KERNEL OF KNOWLEDGE

Each year, Americans generate approximately 300 million tire scraps. Luckily, today more than 90% of tires are recycled and reused annually.
Prior to beginning this project, students should examine the surrounding area focusing on parking lots and sidewalks. Have them make note of any erosion control or filtration systems the city or surrounding businesses use. Also have students note the amount of space transformed surfaces take up in their community versus the amount of green space. Assign students to groups, and using materials of their choice, have each group develop a design plan and prototype of an improved surface that will absorb water and possibly even filter it rather than allow it to flow freely.

As the students work on their improved surface material, they may periodically test prototypes by using drink mix and other materials to represent contaminants and the spray bottle to simulate rain over a water-capture device. Successful prototypes will allow water to pass through while still being strong enough for use, and even possibly acting as a filter for contaminants.

Have students create a Flipgrid video about how human activity has modified the landscape of the United States. The video should explain how we can reverse or change these negative effects. Ideas might include making parking lots flatter so to prevent oil and gas runoff into waterways.

Students should answer the following questions in their video:
• Why was the environment not given consideration initially when humans modified the landscape?
• Why are advocates building movements to reverse the effects on our environment?
• How can we avoid causing more damage?
Introduce the concept of how Americans have been modifying their environment since the settlement of this continent. Ask students to provide examples of ways in which we have changed our environment and how people from different cultures deal with their environment over time. Provide some examples, like how the Native American’s modified their physical environment to yield a higher crop number in the 1600’s. Another example would be the idea of Manifest Destiny and how American culture believed that the physical environment of the west should be willed to the setters wants and needs during the mid 1800’s. (The settlers felt a railroad to travel and trade on and a telegraph line that allowed communication across the continent was needed in the west, much to the detriment of the buffalo population and the Native tribes that were already living there). They may come up with modern ideas, such as the construction of parking lots and buildings, the creation of landfills, deforestation and the building of dams. Explain to students that these are some of the ways people make living in their surroundings more convenient. Help students recognize, however, that such actions typically have a negative effect on the environment.
Many materials that are not biodegradable have been used by artists in their works, as is the case with artist Chakaia Booker. Booker is a New York-based sculptor whose medium is discarded rubber from tires. Watch the following video with your students to learn more about her process and why she chooses to work with this unique material.

Now, brainstorm with your students about other materials that are abundant but not biodegradable. Some examples might include cable wires, computer hardware, plastic, metal cans, etc. Write the list for students to refer back to on the board. Now, introduce your students to the term assemblage. This is a technique for creating 3D art that involves incorporating everyday objects in a composition, much like Booker’s work. Once the students have a strong understanding of this technique, they can begin on their own assemblage project.

The work should consist of a non-biodegradable material of their choice. They can choose to include one or several different kinds of materials. The shape that they make is up to them, and can be representational or non-representational. But, it should include strong design elements such as balance, proportion, movement, etc. Once students have finished, they should present their work to the class and discuss the creative choices they made in their design. Exhibit the sculptures within the school. Each display should include a description of the work, as well as steps that people can take to alleviate the impact of these materials on the Earth.

**Community Garden**
- Adopt a local park, green space or street near your school, and coordinate with the parks management to plant and maintain a section of the designated area. Visit your space regularly as a class to pick up trash, and donate any non-biodegradable materials collected to the art class for sculptures.
CAREER CONNECTION

**Environmental Compliance Manager** - An environmental compliance manager tracks laws and regulations that might affect an organization’s policies or practices. They assist operations management in maintaining compliance with air quality, wastewater and storm-water permits, and help address issues. This position requires a bachelor’s degree and experience in the field.

**Environmental Technician** - An environmental technician, typically working under the direction of an environmental scientist, monitors the environment and investigates sources of pollution by performing laboratory and field tests. This job usually requires an associate’s degree, but some positions may require a bachelor’s degree.

CAREER HIGHLIGHT

Chris Jordan is an artist and filmmaker whose work highlights the severe damage plastics are doing to wildlife, even in areas hundreds of miles from human contact. His film, *Albatross*, depicts heart-wrenching truths about the detrimental effects human activity has on our oceans.
HIGH SCHOOL
STEAM, ENVIRONMENTAL SYSTEMS, GOVERNMENT
CHOOSEING TO CONSUME

Driving Questions:
How does the level of atmospheric carbon affect global climates?

How do the crops we grow as food affect the amount of carbon in the environment?

How can changing what food crops we choose to grow affect carbon’s effect on climate change?

Materials Needed:
Notebooks or computer to document data collection, test plants (store bought or grown), oxygen probes with data logging software, a controlled lab environment in which to grow plants

In this lesson, students will:
• explore how, over time, levels of atmospheric carbon correlate with global climate data. They will investigate how the plants we cultivate have an effect on carbon levels via photosynthesis and respiration, and use plant data to hypothesize how changes in agronomy could influence climate change.

National Learning Standards:
Science: LS2-7; ETS1-1; ETS1-3
Social Studies: VII.e; VIII.d
Art: Pr6.1.Ia; Re.71.1a; Re8.1.1a; Cn10.1.Ia; Cr1.2.11a; Cr1.1.11a; Cr3.1.11a
Prior to class or as a class, students should read NASA’s data on climate change found on their website. Define greenhouse gases as any atmospheric gas that absorbs and re-emits radiant energy from the sun. Students will assist in compiling a list of known greenhouse gases such as carbon and methane. As a class, discuss how an increase in these gases would affect the level of radiant energy absorbed and emitted in the Earth’s atmosphere. Analyze the charts and graphs depicting global climate and atmospheric carbon levels on the Exploring the Environment website.

Draw or present an image of the carbon cycle and analyze areas where carbon is emitted such as via the burning of fossil fuels. Also point out carbon “sinks” such as peat bogs and carbon-sequestering plants. Ask students to hypothesize how current human activities may be influencing global climate change through increased carbon levels, and brainstorm ideas on ways to reduce this greenhouse gas. Use this to transition into a discussion on photosynthesis and the different rates at which it occurs.

Review students’ prior knowledge on the basics of photosynthesis. Students should be able to recall, at minimum, that plants take in carbon dioxide and release oxygen in the presence of certain forms of light such as the sun or grow lamps. Write the basic formula for photosynthesis $6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$ on the board. As a class, discuss what occurs in plants in the absence of light. Students should be able to recall that, in the absence of light, plants consume oxygen and release carbon dioxide in the process of respiration.

Even though plants undergo respiration and are known to release carbon dioxide, they are still carbon sinks and reduce the amount of carbon in the atmosphere. Explain that plants perform photosynthesis and respiration at different rates. Use this resource to explore how differences between photosynthesis and respiration indicate the net carbon consumption of a plant. Discuss how changes to the size of leaves throughout a plant’s life cycle can change its net carbon consumption.

As a class use elodea leaves, sodium bicarbonate, an oxygen sensor and data-logging software to track data on photosynthesis and respiration rates, then calculate the net carbon consumption of the elodea leaf.

**Kernel of Knowledge**

Theories suggest that increased carbon in our atmosphere has led to our food crops containing increased amounts of sugar, replacing other healthy nutrients.
Students will research both typical and atypical food crops. As a group, they will choose three crops that would be considered a food-producing crop. The plants chosen must be plants that can be cultivated and experimented on by the students over an extended period of time (at minimum the vegetative and fruiting/harvesting stage of the plant), and that can be grown in a highly controlled lab environment with grow lights. The students can decide whether the plants will be grown from seed or if they will be purchased as seedlings.

Student groups will design an experiment that tests the following parameters pertaining to carbon regulation:

- What amount of carbon is sequestered by the plant via photosynthesis at various points in the plants growth cycle?
- What amount of carbon is emitted (or what amount of oxygen is consumed) by the plant during a simulated overnight respiration period during the same points in the growth cycle?
- Data should also be collected on the amount of resources such as water and fertilizer used to keep the plants alive.

The project design will be at the discretion of the students. Most will choose to clip leaves and use the harvested leaves and sodium bicarbonate solution in test tubes to measure the photosynthetic rate with an oxygen sensor over a period of time. They can then measure oxygen consumption of the same sample when deprived of light. Special care should be taken by students to ensure light intensity remains consistent during data collection throughout the entire project.

While this project should be student designed, you will facilitate by ensuring students are using data collection tools correctly, and collecting data at frequency intervals that allow them to determine rates of photosynthesis compared to rates of respiration at various points in the plant’s life cycle. You may also assist students with calculating actual CO2 consumption and release based on the data collected.

Students should use the data they collected to determine which food crops are better carbon sinks. They will summarize the results of their research, outlining which food crops they recommend planting to help reduce atmospheric carbon and to what extent the crops may have an effect based on net carbon consumption alone. Students should also use the additional data they collected on water use and crop yield to render a more detailed conclusion.
When compost is properly worked, it emits small amounts of CO2. If, however, waste is buried in a landfill, it produces methane. If the methane is not recaptured and used, it can be just as bad for the environment as carbon dioxide. Students should determine the amount of CO2 released by composting materials and investigate if the crop yield is better than using chemical fertilizers. As an extension, students may also try growing hydroponic or aquaponic plants, or select another growth medium, to determine their crop yield and net carbon consumption.
This video project may be done in small groups or individually and can be offered as extra credit. Have students create a short video that:

- explains NASA’s purpose,
- identifies the branch of government to which the agency reports,
- provides an example of a technology NASA has released publicly that has improved consumer products,
- provides an explanation of research NASA has provided publicly relating to climate change,
- explains how society can reduce carbon emissions, and
- shares ways citizens can convince government officials to enact laws that reduce carbon emissions in the Earth’s atmosphere.

Students may come up with varying responses in their video but should understand that NASA is an independent executive agency created by Congress that reports directly to the President. Its purpose is to conduct space exploration and develop aeronautics technologies for the benefit of mankind. NASA has released several important technologies such as memory foam and invisible braces, which have allowed consumers access to a variety of innovative products. The agency has also provided the public evidence that climate change is a real phenomenon.

For inspiration, students can watch the films *An Inconvenient Truth* and *An Inconvenient Sequel: Truth to Power*. When finished, have them upload their videos to Flipgrid.
Activist art brings awareness to an issue that affects a large group of people. Often, it is driven by political or environmental issues. With your students watch some of the videos below that feature artists who use their work to advocate for causes about which they feel strongly.

Aida Sulova: An artist who paints on public trash cans to bring awareness to the serious issue of waste plaguing Kyrgyzstan.

Paulo Grangeon: This artist worked with the World Wildlife Fund to create an installation that brings awareness to the dwindling numbers of pandas in the world.

Chris Jordan: This artist creates photographs that show the massive amounts of debris that humans generate.

As you view these examples with your students, ask them to point out whether the artists have been successful in conveying their message to the viewer. Though many of these images would traditionally not be considered “beautiful,” have the students discuss the ways in which the artist has used the elements of art and principles of design to create aesthetically pleasing works that carry a deeper message.

Now, either individually or in pairs/small groups, instruct the students to choose an environmental issue about which they feel strongly and create a piece of art based on that issue. The art should be large-scale and may take some time to fully execute. They need to produce multiple preliminary sketches and ideas before deciding upon their final design. When finished, the students should present their work to the class, discuss their creative process and explain why they chose their subject. They should be able to provide an in-depth knowledge on the issue and field questions from their peers.

Community Garden
With your students, visit the website for the World Wildlife Fund (WWF). The WWF provides opportunities to “adopt” an endangered animal. As a class, choose an animal that you would like to adopt and create signs and posters with images of the animal on them to post around the school and community. Work to raise money to adopt your animal and advocate throughout your community for people to adopt additional animals available through the organization. The class may opt to create a video promo on behalf of the animal using stock footage and graphics to discuss the impact to the environment were the animal to go extinct.
CAREER CONNECTION

**Applied Climatologist** - Climatologists are scientists who study long-term trends in climate. Depending on the position, this career requires anywhere from a bachelor’s to a doctoral degree.

**Sustainability Consultant** - Sustainability consultants help corporations plan and execute their sustainability and corporate social responsibility efforts – from energy efficiency to employee well-being and engagement. Education requirements for this job vary from on-the-job training and experience to a master’s or doctorate degree.

CAREER HIGHLIGHT

Michael Pollan is a writer whose essays on food have inspired millions to rethink what they cook and consume. Several of his books relating to food science have been made into documentaries, including *Cooked*, a four-part Netflix documentary on different natural elements and their relationship to modern cooking methods.
## Kindergarten

### Kindergarten Next Generation Science Standards Connections

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<thead>
<tr>
<th>Standard</th>
<th>Description</th>
<th>Connections</th>
</tr>
</thead>
<tbody>
<tr>
<td>K-PS3-1</td>
<td>Make observations to determine the effect of sunlight on Earth’s surface.</td>
<td>You Are My Sunshine (Energy)</td>
</tr>
<tr>
<td>K-PS3-2</td>
<td>Use tools and materials to design and build a structure that will reduce the warming effect of sunlight on an area.</td>
<td>You Are My Sunshine (Energy)</td>
</tr>
</tbody>
</table>

### Kindergarten Math Common Core State Standards Connections

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<tr>
<th>Standard</th>
<th>Description</th>
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</tr>
</thead>
<tbody>
<tr>
<td>K.MD.A.2</td>
<td>Directly compare two objects with measurable attribute in common, to see which object has “more of” / “less of” the attribute and describe the difference.</td>
<td>You Are My Sunshine (Energy)</td>
</tr>
</tbody>
</table>

### Kindergarten National Core Arts Standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
<th>Connections</th>
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</thead>
<tbody>
<tr>
<td>VA: Cr1.1.Ka</td>
<td>Engage in exploration and imaginative play with materials.</td>
<td>You Are My Sunshine (Energy)</td>
</tr>
<tr>
<td>VA: Cr2.3.Ka</td>
<td>Create art that represents natural and constructed environments.</td>
<td>You Are My Sunshine (Energy)</td>
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## 1st Grade

### 1st Grade Next Generation Science Standards Connections

<table>
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<tr>
<th>Standard</th>
<th>Description</th>
<th>Connections</th>
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</thead>
<tbody>
<tr>
<td>1-PS4-3</td>
<td>Plan and conduct investigation to determine the effect of placing objects made with different materials in the path of a beam of light.</td>
<td>You Are My Sunshine (Energy)</td>
</tr>
</tbody>
</table>
### K-2-ETS1-1
Ask questions, make observations, and gather information about a situation people want to change to define a simple problem than can be solved through the development of a new or improved object or tool.

You Are My Sunshine (Energy)

### K-2-ETS1-2
Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

You Are My Sunshine (Energy)

### 1st Grade Math Common Core State Standards

<table>
<thead>
<tr>
<th>1.MD.C.4</th>
<th>Organize, represent, and interpret data with up to three categories; ask and answer questions about the total number of data points, how many in each category, and how many more or less are in one category than another.</th>
</tr>
</thead>
</table>

You Are My Sunshine (Energy)

### 1st Grade National Council for the Social Studies Curriculum Standards

<table>
<thead>
<tr>
<th>NCSS: I,c</th>
<th>Culture Social studies programs should include experiences that provide for the study of culture and cultural diversity, so that the learner can describe ways in which language, stories, folktales, music, and artistic creations serve as expressions of culture and influence behavior of people living in a particular culture.</th>
</tr>
</thead>
</table>

You Are My Sunshine (Energy)

### 1st Grade National Core Arts Standards

<table>
<thead>
<tr>
<th>VA: Cr1.1a</th>
<th>Engage collaboratively in exploration and imaginative play with materials.</th>
</tr>
</thead>
</table>

You Are My Sunshine (Energy)
### 2nd Grade Next Generation Science Standards Connections

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
<th>Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>K-2-ETS1-1</td>
<td>Ask questions, make observations, and gather information about a situation people want to change to define a simple problem than can be solved through the development of a new or improved object or tool.</td>
<td>We Built This School (Cities)</td>
</tr>
<tr>
<td>K-2-ETS1-2</td>
<td>Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.</td>
<td>We Built This School (Cities)</td>
</tr>
</tbody>
</table>

### 2nd Grade Math Common Core State Standards Connections

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
<th>Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.G.A.1</td>
<td>Recognize and draw shapes having specified attributes, such as a given number of angles or a given number of equal faces. Identify triangles, quadrilaterals, pentagons, hexagons, and cubes.</td>
<td>We Built This School (Cities)</td>
</tr>
</tbody>
</table>

### 2nd Grade National Council for the Social Studies Curriculum Standards

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<tr>
<th>Standard</th>
<th>Description</th>
<th>Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCSS: III,g</td>
<td>Describe how people create places that reflect ideas, personality, culture, and wants and needs as they design homes, playgrounds, classrooms, and the like.</td>
<td>We Built This School (Cities)</td>
</tr>
</tbody>
</table>

### 2nd Grade National Core Arts Standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
<th>Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>VA: Cr1.1.2a</td>
<td>Brainstorm collaboratively multiple approaches to an art or design problem.</td>
<td>We Built This School (Cities)</td>
</tr>
</tbody>
</table>
### 3rd Grade Next Generation Science Standards Connection

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
<th>Resource</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-LS2-1</td>
<td>Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.</td>
<td>Getting Dirty (Earth)</td>
</tr>
<tr>
<td>5-ESS2-1</td>
<td>Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.</td>
<td>Getting Dirty (Earth)</td>
</tr>
</tbody>
</table>

### 3rd Grade Math Common Core State Standards Connections

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
<th>Resource</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.MD.B.3</td>
<td>Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one- and two-step “how many more” and “how many less” problems using information presented in scaled bar graphs.</td>
<td>Getting Dirty (Earth)</td>
</tr>
</tbody>
</table>

### 3rd Grade National Council for the Social Studies Curriculum Standards

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<thead>
<tr>
<th>Standard</th>
<th>Description</th>
<th>Resource</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCSS: III, h.</td>
<td>Social studies programs should include experiences that provide for the study of people, places, and environments, so that the learner can: examine the interaction of human beings and their physical environment, the use of land, building of cities, and ecosystem changes in selected locales and regions.</td>
<td>Getting Dirty (Earth)</td>
</tr>
</tbody>
</table>
### 3rd Grade National Core Arts Standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
<th>Resource</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cr2.1.3a</td>
<td>Create personally satisfying artwork using a variety of artistic processes and materials.</td>
<td>Getting Dirty (Earth)</td>
</tr>
<tr>
<td>Re.7.2.3a</td>
<td>Determine messages communicated by an image.</td>
<td>Getting Dirty (Earth)</td>
</tr>
<tr>
<td>Re9.1.3a</td>
<td>Evaluate an artwork based on given criteria.</td>
<td>Getting Dirty (Earth)</td>
</tr>
<tr>
<td>Cn11.1.3a</td>
<td>Recognize that responses to art change depending on knowledge of the time and place in which it was made.</td>
<td>Getting Dirty (Earth)</td>
</tr>
</tbody>
</table>

### 4th Grade

#### 4th Grade Next Generation Science Standards Connections

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<tr>
<th>Standard</th>
<th>Description</th>
<th>Resource</th>
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<tbody>
<tr>
<td>4-ESS2-1</td>
<td>Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.</td>
<td>Rock Me Like a Hurricane (Climate)</td>
</tr>
</tbody>
</table>

#### 4th Grade Math Common Core State Standards Connections

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
<th>Resource</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.OA.A.3</td>
<td>Solve multistep word problems posed with whole numbers and having whole-number answers using the four operations, including word problems in which remainders must be interpreted. Represent these problems using equations with a letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation strategies including rounding.</td>
<td>Rock Me Like a Hurricane (Climate)</td>
</tr>
</tbody>
</table>
### 4th Grade National Council for the Social Studies Curriculum Standards

| NCSS: III,h | Examine the interaction of human beings and their physical environment, the use of land, building of cities, and ecosystem changes in selected locales and regions. | Rock Me Like a Hurricane (Climate) |

### 4th Grade National Core Arts Standards

| Cr1.1.4a | Brainstorm multiple approaches to a creative art or design problem. | Rock Me Like a Hurricane (Climate) |

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### 5th GRADE

### 5th Grade Next Generation Science Standards Connections

<p>| 5-ESS1-1 | Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky. | Locally Grown (Earth) |
| 5-ESS3-1 | Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment. | Let It Be (Cities), Saving Some Green (Climate), Trash to Cash (Energy) |
| 3-5-ETS1-1 | Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. | Locally Grown (Earth) |
| 3-5-ETS1-2 | Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. | Let It Be (Cities), Diversity Makes Us Stronger (Cities), Locally Grown (Earth), Trash to Cash (Energy) |</p>
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Resource</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-LS1-1</td>
<td>Support an argument that plants get the materials they need for growth chiefly from air and water.</td>
<td>Locally Grown (Earth)</td>
</tr>
<tr>
<td>5-LS2-1</td>
<td>Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.</td>
<td>Diversity Makes Us Stronger (Cities), Locally Grown (Earth)</td>
</tr>
<tr>
<td>5-PS1-3</td>
<td>Make observations and measurements to identify materials based on their properties.</td>
<td>Trash to Cash (Energy)</td>
</tr>
<tr>
<td>5-PS1-4</td>
<td>Conduct an investigation to determine whether the mixing of two or more substances results in new substances.</td>
<td>Trash to Cash (Energy)</td>
</tr>
</tbody>
</table>

5th Grade Math Common Core State Standards Connections

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Resource</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.OA.1</td>
<td>Use parentheses, brackets, or braces in numerical expressions, and evaluate expressions with these symbols.</td>
<td>Saving Some Green (Climate)</td>
</tr>
<tr>
<td>5.OA.2</td>
<td>Write simple expressions that record calculations with numbers, and interpret numerical expressions without evaluating them.</td>
<td>Saving Some Green (Climate)</td>
</tr>
<tr>
<td>5.NBT.5</td>
<td>Fluently multiply multi-digit whole numbers using the standard algorithm.</td>
<td>Saving Some Green (Climate)</td>
</tr>
<tr>
<td>5.NBT.6</td>
<td>Find whole-number quotients of whole numbers with up to four-digit dividends and two-digit divisors, using strategies based on place value, the properties of operations, and/or the relationship between multiplication and division. Illustrate and explain the calculation by using equations, rectangular arrays, and/or area models.</td>
<td>Saving Some Green (Climate)</td>
</tr>
<tr>
<td>5.NBT.7</td>
<td>Add, subtract, multiply, and divide decimals to hundredths, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and</td>
<td>Saving Some Green (Climate)</td>
</tr>
</tbody>
</table>
### 5th Grade National Council for the Social Studies Curriculum

<table>
<thead>
<tr>
<th>NCSS: III,h</th>
<th>Examine the interaction of human beings and their physical environment, the use of land, building of cities, and ecosystem changes in selected locales and regions.</th>
<th>Trash to Cash (Energy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCSS: VII,h</td>
<td>Describe the relationship of price to supply and demand.</td>
<td>Saving Some Green (Climate), Locally Grown (Earth)</td>
</tr>
<tr>
<td>NCSS: VIII,a</td>
<td>Identify and describe examples in which science and technology have changed the lives of people, such as in homemaking, childcare, work, transportation, and communication.</td>
<td>Diversity Makes Us Stronger (Cities)</td>
</tr>
<tr>
<td>NCSS: X,c</td>
<td>Locate, access, organize, and apply information about an issue of public concern from multiple points of view.</td>
<td>Diversity Makes Us Stronger (Cities)</td>
</tr>
<tr>
<td>NCSS: X,d</td>
<td>Identify and practice selected forms of civic discussion and participation consistent with the ideals of citizens in a democratic republic.</td>
<td>Diversity Makes Us Stronger (Cities), Trash to Cash (Energy)</td>
</tr>
<tr>
<td>NCSS: X,g</td>
<td>Examine the influence of public opinion on personal decision-making and government policy on public issues.</td>
<td>Diversity Makes Us Stronger (Cities)</td>
</tr>
</tbody>
</table>

### 5th Grade National Core Arts Standards

| VA: Cr1.1.5a | Combine ideas to generate an innovative idea for art-making. | Let it Be (Cities) |
### 6th Grade Next Generation Science Standards Connections

<table>
<thead>
<tr>
<th>MS-PS2-3</th>
<th>Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.</th>
<th>Potentially Perpetual (Cities)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS-PS3-1</td>
<td>Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.</td>
<td>Potentially Perpetual (Cities)</td>
</tr>
<tr>
<td>MS-PS3-2</td>
<td>Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.</td>
<td>Potentially Perpetual (Cities)</td>
</tr>
<tr>
<td>MS-PS3-3</td>
<td>Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.</td>
<td>The Answer is Blowing in the Wind (Energy), Windows to Efficiency (Energy)</td>
</tr>
<tr>
<td>Standard</td>
<td>Description</td>
<td>Resource</td>
</tr>
<tr>
<td>----------</td>
<td>-------------</td>
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</tr>
<tr>
<td>MS-PS3-5</td>
<td>Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.</td>
<td>Potentially Perpetual (Cities)</td>
</tr>
<tr>
<td>MS-ESS3-3</td>
<td>Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.</td>
<td>The Answer is Blowing in the Wind (Energy), In the Zone (Climate)</td>
</tr>
<tr>
<td>MS-ETS1-1</td>
<td>Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.</td>
<td>The Answer is Blowing in the Wind (Energy), In the Zone (Climate)</td>
</tr>
<tr>
<td>MS-ETS1-2</td>
<td>Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.</td>
<td>The Answer is Blowing in the Wind (Energy), In the Zone (Climate), Windows to Efficiency (Energy)</td>
</tr>
<tr>
<td>MS-ETS1-3</td>
<td>Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.</td>
<td>Windows to Efficiency (Energy)</td>
</tr>
<tr>
<td>MS-ETS1-4</td>
<td>Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.</td>
<td>In the Zone (Climate)</td>
</tr>
<tr>
<td>Standard</td>
<td>Description</td>
<td>Curriculum Area</td>
</tr>
<tr>
<td>----------</td>
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</tr>
<tr>
<td>MS-LS2-4</td>
<td>Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.</td>
<td>In the ‘Zone (Climate)</td>
</tr>
<tr>
<td>MS-LS2-5</td>
<td>Evaluate competing design solutions for maintaining biodiversity and ecosystem services.</td>
<td>Guarant-treed Oxygen (Earth)</td>
</tr>
<tr>
<td>MS-ESS3-3</td>
<td>Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.</td>
<td>In the ‘Zone (Climate)</td>
</tr>
<tr>
<td>MS-ESS3-4</td>
<td>Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth’s systems.</td>
<td>Guarant-treed Oxygen (Earth)</td>
</tr>
</tbody>
</table>

**6th Grade National Council for the Social Studies Curriculum Standards**

| NCSS: III,h | Examine the interaction of human beings and their physical environment, the use of land, building of cities, and ecosystem changes in selected locales and regions. | In the ‘Zone (Climate), Guarant-treed Oxygen (Earth) |
| NCSS: VIII,a | Identify and describe examples in which science and technology have changed the lives of people, such as in homemaking, childcare, work, transportation, and communication. | Potentially Perpetual (Cities), Windows to Efficiency (Energy) |
| NCSS: VIII,b | Identify and describe examples in which science and technology have led to changes in the physical environment, such as the building of dams and levees, offshore oil drilling, medicine from rain forests, and loss of rain forests due to extraction of resources or alternative uses. | Guarant-treed Oxygen (Earth) |
### 6th Grade National Core Arts Standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>VA: Cr1.1.6a</td>
<td>Combine concepts collaboratively to generate innovative ideas for creating art.</td>
<td>Potentially Perpetual (Cities), Guarant-treed Oxygen (Earth)</td>
</tr>
<tr>
<td>VA: Cr1.2.6a</td>
<td>Formulate an artistic investigation of personally relevant content for creating art.</td>
<td>In the 'Zone (Climate), Guarant-treed Oxygen (Earth)</td>
</tr>
<tr>
<td>VA: Cr2.1.6a</td>
<td>Demonstrate openness in trying new ideas, materials, methods, and approaches in making works of art and design.</td>
<td>The Answer is Blowing in the Wind (Energy), Potentially Perpetual (Cities), Windows to Efficiency (Energy)</td>
</tr>
<tr>
<td>VA: Cr2.3.6a</td>
<td>Design or redesign objects, places, or systems that meet the identified needs of diverse users.</td>
<td>The Answer is Blowing in the Wind (Energy), Potentially Perpetual (Cities)</td>
</tr>
<tr>
<td>VA: Pr5.1.6a</td>
<td>Individually or collaboratively, develop a visual plan for displaying works of art, analyzing exhibit space, the needs of the viewer, and the layout of the exhibit.</td>
<td>Potentially Perpetual (Cities), In the 'Zone (Climate)</td>
</tr>
<tr>
<td>VA: Re.7.2.6a</td>
<td>Analyze ways that visual components and cultural associations suggested by images influence ideas, emotions, and actions.</td>
<td>Guarant-treed Oxygen (Earth)</td>
</tr>
<tr>
<td>VA: Cn10.1.6a</td>
<td>Generate a collection of ideas reflecting current interests and concerns that could be investigated in artmaking.</td>
<td>In the ‘Zone (Climate)</td>
</tr>
<tr>
<td>VA: Cn11.1.6a</td>
<td>Analyze how art reflects changing times, traditions, resources, and cultural uses.</td>
<td>Guarant-treed Oxygen (Earth)</td>
</tr>
</tbody>
</table>

### 7th Grade Next Generation Science Standards Connections

<p>| MS-PS1-3 | Gather and make sense of information to describe that synthetic materials come from natural resources and impact society. | Be the Change (Earth) |
| MS-LS2-1 | Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. | Be the Change (Earth) |
| MS-LS2-3 | Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. | Rot On (Earth) |
| MS-LS2-5 | Evaluate competing design solutions for maintaining biodiversity and ecosystem services. | Rot On (Earth) |
| MS-ESS2-1 | Develop a model to describe the cycling of Earth’s materials and the flow of energy that drives this process. | Rot On (Earth) |</p>
<table>
<thead>
<tr>
<th>MS-ESS3-2</th>
<th>Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.</th>
<th>Sustainably Sound (Climate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS-ESS3-3</td>
<td>Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.</td>
<td>Be the Change (Earth), Get Your Deposit Back (Cities), Rot On! (Earth), Energizing Your Lawn (Energy)</td>
</tr>
<tr>
<td>MS-ESS3-4</td>
<td>Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.</td>
<td>Be the Change (Earth), Get Your Deposit Back (Cities), Energizing Your Lawn (Energy)</td>
</tr>
<tr>
<td>MS-ETS1-1</td>
<td>Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.</td>
<td>Be the Change (Earth), Get Your Deposit Back (Cities), Sustainably Sound (Climate), Energizing Your Lawn (Energy)</td>
</tr>
<tr>
<td>MS-ETS1-3</td>
<td>Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.</td>
<td>Sustainably Sound (Climate)</td>
</tr>
</tbody>
</table>

**7th Grade Math Common Core State Standards Connections**

| 7.RP.1 | Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units. | Energizing Your Lawn (Energy) |
| 7.G.1 | Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale. | Energizing Your Lawn (Energy) |
| 7.G.4 | Know the formulas for the area and circumference of a circle and use them to solve problems; give an informal derivation of the relationship between the circumference and area of a circle. | Energizing Your Lawn (Energy) |
| 7.G.6 | Solve real-world and mathematical problems involving area, volume and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms. | Get your Deposit Back (Cities), Energizing Your Lawn (Energy) |

### 7th Grade National Council for the Social Studies Curriculum Standards

| NCSS: III,h | Examine the interaction of human beings and their physical environment, the use of land, building of cities, and ecosystem changes in selected locales and regions. | Get Your Deposit Back (Cities), Rot On! (Earth), Energizing Your Lawn (Energy) |
| NCSS: IX,d | Explore causes, consequences, and possible solutions to persistent, contemporary, and emerging global issues, such as pollution and endangered species. | Sustainably Sound (Climate) |

### 7th Grade National Core Arts Standards

| VA: Cr2.1.7a | Demonstrate persistence in developing skills with various materials, methods, and approaches in creating works of art or design. | Be the Change (Earth) |
| VA: Cr2.3.7a | Apply visual organizational strategies to design and produce a work of art, design, or media that clearly communicates information or ideas. | Get Your Deposit Back (Cities) |
| VA: Cr3.1.7a | Reflect on and explain important information about personal artwork in an artist statement or another format. | Be the Change (Earth), Sustainably Sound (Climate) |
| VA: Pr5.1.7a | Based on criteria, analyze and evaluate methods for preparing and presenting art. | Energizing you Lawn (Energy) |
| VA: Re.7.1.7a | Explain how the method of display, the location, and the experience of an artwork influence how it is perceived and valued. | Be the Change (Earth) |
| VA: Re.7.2.7a | Analyze multiple ways that images influence specific audiences. | Be the Change (Earth), Sustainably Sound (Climate) |
| VA: Cn11.1.7a | Analyze how response to art is influenced by understanding the time and place in which it was created, the available resources, and cultural uses. | Be the Change (Earth) |

**8th Grade**

**8th Grade Next Generation Science Standards Connections**

<p>| MS-LS1-4 | Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively. | Mussel-ey Invaders (Cities) |</p>
<table>
<thead>
<tr>
<th>MS-LS1-5</th>
<th>Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.</th>
<th>Mussel-ey Invaders (Cities), Back to the Future (Earth)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS-LS2-1</td>
<td>Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.</td>
<td>Back to the Future (Earth)</td>
</tr>
<tr>
<td>MS-LS2-2</td>
<td>Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.</td>
<td>Mussel-ey Invaders (Cities), Back to the Future (Earth)</td>
</tr>
<tr>
<td>MS-LS2-3</td>
<td>Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.</td>
<td>Back to the Future (Earth)</td>
</tr>
<tr>
<td>MS-LS2-4</td>
<td>Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.</td>
<td>Mussel-ey Invaders (Cities), Back to the Future (Earth), Reef-Lief (Energy)</td>
</tr>
<tr>
<td>MS-LS2-5</td>
<td>Evaluate competing design solutions for maintaining biodiversity and ecosystem services.</td>
<td>Mussel-ey Invaders (Cities), Back to the Future (Earth), Reef-Lief (Energy)</td>
</tr>
<tr>
<td>MS-ESS2-4</td>
<td>Develop a model to describe the cycling of water through Earth’s systems driven by energy from the sun and the force of gravity.</td>
<td>Lunar Energy (Climate)</td>
</tr>
<tr>
<td>MS-ESS3-3</td>
<td>Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.</td>
<td>The Temps They are A’Changin (Climate)</td>
</tr>
<tr>
<td>Standard</td>
<td>Description</td>
<td>Examples</td>
</tr>
<tr>
<td>----------</td>
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</tr>
<tr>
<td>MS-ESS3-5</td>
<td>Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.</td>
<td>The Temps They are A’Changin (Climate)</td>
</tr>
<tr>
<td>MS-ETS1-1</td>
<td>Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.</td>
<td>The Temps They are A’Changin (Climate), Mussel-ey Invaders (Cities), Lunar Energy (Climate), Reef-Lief (Energy)</td>
</tr>
<tr>
<td>MS-ETS1-2</td>
<td>Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.</td>
<td>Mussel-ey Invaders (Cities), Reef-Lief (Energy)</td>
</tr>
<tr>
<td>MS-ETS1-3</td>
<td>Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.</td>
<td>The Temps They are A’Changin (Climate), Mussel-ey Invaders (Cities), Lunar Energy (Climate)</td>
</tr>
</tbody>
</table>

8th Grade National Council for the Social Studies Curriculum Standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCSS: II,f</td>
<td>Use knowledge of facts and concepts drawn from history, along with elements of historical inquiry, to inform decision-making about and action-taking on public issues.</td>
<td>Back to the Future (Earth)</td>
</tr>
<tr>
<td>NCSS: III,c</td>
<td>Use appropriate resources, data sources, and geographic tools such as atlases, data bases, grid systems, charts, graphs, and maps to generate, manipulate, and interpret information.</td>
<td>Mussel-ey Invaders (Cities)</td>
</tr>
</tbody>
</table>
### NCSS Standards

<table>
<thead>
<tr>
<th>NCSS: III,h</th>
<th>Examine the interaction of human beings and their physical environment, the use of land, building of cities, and ecosystem changes in selected locales and regions.</th>
<th>Back to the Future (Earth)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCSS: III,j</td>
<td>Observe and speculate about social and economic effects of environmental changes and crises resulting from phenomena such as floods, storms, and drought.</td>
<td>Mussel-ey Invaders (Cities)</td>
</tr>
<tr>
<td>NCSS: VI,g</td>
<td>Explore the role of technology in communications, transportation, information-processing, weapons development, or other areas as it contributes to or helps resolve conflicts.</td>
<td>Lunar Energy (Climate)</td>
</tr>
<tr>
<td>NCSS: IX,d</td>
<td>Explore causes, consequences, and possible solutions to persistent, contemporary, and emerging global issues, such as pollution and endangered species.</td>
<td>Mussel-ey Invaders (Cities)</td>
</tr>
</tbody>
</table>

### 8th Grade National Core Arts Standards

<table>
<thead>
<tr>
<th>VA: Cr1.1.8a</th>
<th>Document early stages of the creative process visually and/or verbally in traditional or new media.</th>
<th>Lunar Energy (Climate), Back to the Future (Earth)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VA: Cr1.2.8a</td>
<td>Collaboratively shape an artistic investigation of an aspect of present-day life using a contemporary practice of art and design.</td>
<td>Mussel-ey Invaders (Cities)</td>
</tr>
<tr>
<td>VA: Cr2.1.8a</td>
<td>Demonstrate willingness to experiment, innovate, and take risks to pursue ideas, forms, and meanings that emerge in the process of artmaking or designing.</td>
<td>Lunar Energy (Climate), Back to the Future (Earth)</td>
</tr>
<tr>
<td>VA: Cr2.2.8a</td>
<td>Demonstrate awareness of practices, issues, and ethics of appropriation, fair use, copyright, open source, and creative commons as they apply to creating works of art and design.</td>
<td>Back to the Future (Earth)</td>
</tr>
</tbody>
</table>
### NATIONAL STANDARDS INDEX

<table>
<thead>
<tr>
<th>VA: Cr2.3.8a</th>
<th>Select, organize, and design images and words to make visually clear and compelling presentations.</th>
<th>Temps, They are A’Changin (Climate), Lunar Energy (Climate), Reef-lief (Energy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VA: Pr4.1.8a</td>
<td>Develop and apply criteria for evaluating a collection of artwork for presentation.</td>
<td>Lunar Energy (Climate)</td>
</tr>
<tr>
<td>VA: Pr5.1.8a</td>
<td>Collaboratively prepare and present selected theme based artwork for display, and formulate exhibition narratives for the viewer.</td>
<td>Temps, They are A’Changin (Climate), Reef-lief (Energy)</td>
</tr>
<tr>
<td>VA: Pr6.1.8a</td>
<td>Analyze why and how an exhibition or collection may influence ideas, beliefs, and experiences.</td>
<td>Temps, They are A’Changin (Climate), Mussel-ey Invaders (Cities), Lunar Energy (Climate)</td>
</tr>
<tr>
<td>VA: Cn10.1.8a</td>
<td>Make art collaboratively to reflect on and reinforce positive aspects of group identity.</td>
<td>Mussel-ey Invaders (Cities), Lunar Energy (Climate)</td>
</tr>
</tbody>
</table>

### HIGH SCHOOL (9-12)

**HS Next Generation Science Standards Connections**

| HS-LS2-2 | Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. | Growing Pains (Earth) |
| HS-LS2-5 | Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere. | Shedding the Traditional (Cities) |
| HS-LS2-6 | Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and | Growing Pains (Earth) |
| HS-LS2-7 | Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. | Shedding the Traditional (Cities), Choosing to Consume (Climate) |
| HS-LS4-6 | Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity. | Growing Pains (Earth) |
| HS-ETS1-1 | Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. | Choosing to Consume (Climate) |
| HS-ETS1-3 | Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts. | Shedding the Traditional (Cities), Choosing to Consume (Climate) |

**HS Math Common Core State Standards Connections**

<p>| G-CO-12 | Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). | Smaller is Savvier (Energy) |
| G-GMD-4 | Identify the shapes of two-dimensional cross-sections of three dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects. | Smaller is Savvier (Energy) |
| G-MG-3 | Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios). | Smaller is Savvier (Energy) |</p>
<table>
<thead>
<tr>
<th>HS National Council for the Social Studies Curriculum Standards</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>NCSS: II,b</td>
<td>Demonstrate an ability to use correctly vocabulary associated with time such as past, present, future, and long ago; read and construct simple timelines; identify examples of change; and recognize examples of cause and effect relationships.</td>
</tr>
<tr>
<td>NCSS: III,c</td>
<td>Use appropriate resources, data sources, and geographic tools such as atlases, data bases, grid systems, charts, graphs, and maps to generate, manipulate, and interpret information.</td>
</tr>
<tr>
<td>NCSS: X,c</td>
<td>Locate, access, organize, and apply information about an issue of public concern from multiple points of view.</td>
</tr>
<tr>
<td>NCSS: I,a</td>
<td>Explore and describe similarities and differences in the ways groups, societies, and cultures address similar human needs and concerns.</td>
</tr>
<tr>
<td>NCSS: I,d</td>
<td>Compare ways in which people from different cultures think about and deal with their physical environment and social conditions.</td>
</tr>
<tr>
<td>NCSS: VII,e</td>
<td>Suggest ways to monitor science and technology in order to protect the physical environmental, individual rights, and the common good.</td>
</tr>
<tr>
<td>NCSS: VIII,d</td>
<td>Identify examples of laws and policies that govern scientific and technological applications, such as the Endangered Species Act and environmental protection policies.</td>
</tr>
<tr>
<td>NCSS: VII,e</td>
<td>Suggest ways to monitor science and technology in order to protect the physical environmental, individual rights, and the common good.</td>
</tr>
<tr>
<td>NCSS: VIII,d</td>
<td>Identify examples of laws and policies that govern scientific and technological applications, such as the Endangered Species Act and environmental protection policies.</td>
</tr>
</tbody>
</table>
### HS Proficient National Core Arts Standards

| VA: Cr1.2.Ia | Shape an artistic investigation of an aspect of present-day life using a contemporary practice of art or design. | Smaller is Savvier (Energy) |
| VA: Pr6.1.Ia | Analyze and describe the impact that an exhibition or collection has on personal awareness of social, cultural, or political beliefs and understandings. | Choosing to Consume (Climate) |
| VA: Re.7.1.Ia | Hypthesize ways in which art influences perception and understanding of human experiences. | Choosing to Consume (Climate), Shedding the Traditional (Cities) |
| VA: Re8.1.Ia | Interpret an artwork or collection of works, supported by relevant and sufficient evidence found in the work and its various contexts. | Choosing to Consume (Climate) |
| VA: Cn10.1.Ia | Document the process of developing ideas from early stages to fully elaborated ideas. | Choosing to Consume (Climate) |

### HS Accomplished National Core Arts Standards

| VA: Cr1.2.IIa | Choose from a range of materials and methods of traditional and contemporary artistic practices to plan works of art and design. | Shedding the Traditional (Cities), Choosing to Consume (Climate) |
| VA: Cr2.1.IIa | Through experimentation, practice, and persistence, demonstrate acquisition of skills and knowledge in a chosen art form. | Smaller is Savvier (Energy) |
| VA: Cr2.3.IIa | Redesign an object, system, place, or design in response to contemporary issue. | Growing Pains (Earth), Smaller is Savvier (Energy), Shedding the Traditional (Cities) |
| VA: Pr5.1.IIa | Evaluate, select, and apply methods or processes appropriate to display artwork in a specific place. | Growing Pains (Earth) |
| VA: Re.7.2.IIa | Evaluate the effectiveness of an image or images to influence ideas, feelings, and behaviors of specific audiences. | Shedding the Traditional (Cities) |
| VA: Cn10.1.IIa | Utilize inquiry methods of observation, research, and experimentation to explore unfamiliar subjects through artmaking. | Growing Pains (Earth), Shedding the Traditional (Cities) |

**HS Advanced Grade National Core Arts Standards**

| VA: Cr1.1.IIIa | Visualize and hypothesize to generate plans for ideas and directions for creating art and design that can affect social change. | Growing Pains (Earth), Shedding the Traditional (Cities), Choosing to Consume (Climate) |
| VA: Cr3.1.IIIa | Reflect on, reengage, revise, and refine works of art or design considering relevant traditional and contemporary criteria as well as personal artistic vision. | Choosing to Consume (Climate) |
| VA: Pr6.1.IIIa | Curate a collection of objects, artifacts, or artwork to impact the viewer’s understanding of social, cultural, and/or political experiences. | Shedding the Traditional (Cities) |
**Christina Beck** is a biology and AP Environmental Science teacher at Pilot Point High School where she has been teaching for three years. She holds a master’s degree in science education and curriculum from the University of Texas at Arlington and specializes in using inquiry-based learning to actively engage students in science education. Beck is passionate about sustainable farming, alternative energy, creating urban farmers and involving more kids in agriculture. She strongly believes that a majority of children’s learning takes place outside of the classroom in real-life, hands-on experiences. She uses this philosophy to create lessons that promote community involvement — acting locally to affect the global community in a positive way. When she is not teaching or writing curriculum, Beck works in her Denton, TX apiary and urban farm with her husband, children, chickens and miniature cows.

**Marian Martin** is an elementary classroom teacher at Hattie Dyer Elementary School in Krum, TX. She holds a bachelor’s degree in interdisciplinary studies from the University of North Texas with a focus on early childhood through 4th grade. With more than 10 years of experience in elementary education, Martin was named “Elementary Teacher of the Year” for Krum ISD in 2017. She believes that children should have learning opportunities that are engaging and challenging, and has been an advocate for purposeful technology integration in the classroom. In her classroom, flexible groups work collaboratively on STEAM-related learning experiences across all the content areas, including reading, language arts, math, social studies and science to better prepare students for future careers. Martin lives happily in North Texas with her family where she and her husband try to keep up with all of their children’s activities.

**Morgan Nevarez** is an 8th grade social studies teacher at Fossil Hill Middle School in Keller ISD in Keller, TX. She holds a master of arts degree in teaching with an emphasis in history. Nevarez has a passion for learning and loves teaching a variety of social studies subjects at different levels. She has held various teaching positions at the high school and college level, including at Alvord High School and Weatherford College, and has taught courses in United States history, economics, sociology and government. She also has a passion for motivating students to think critically and to make inquiries that look beyond the obvious. She enjoys spending quality time with her family, and her favorite pastime is visiting state and national parks. She feels that these treasures help foster a love and curiosity for environmental conservation for future generations.

**Krissi Oden** has been a high school visual arts teacher since 2014. She will begin working toward her PhD in art education at the University of North Texas in the fall of 2018 and will focus on curriculum. She holds a master’s degree in art history and museum education from the University of North Texas and a second master’s in art education from Texas Woman’s University. She has more than 12 years of experience in art education with a philosophy that focuses on a Constructivist approach to teaching and learning. Oden’s goal as a teacher is to empower students to celebrate their uniqueness, and to build upon their own experiences and cultures as they learn and grow. She believes that learning extends beyond the classroom, and has led the design of this curriculum with the goal of highlighting the world as a place of constant learning, understanding and critical inquiry. Oden is a native Texan and lives in Denton, TX where she loves spending time with her family, and working on her painting and photography.