



ELEMENTARY LESSON – COST-BENEFIT ANALYSIS OF PLAY STRUCTURES

Companion lesson to Healthy Markets = Healthy Forests

HEALTHY MARKETS = HEALTHY FORESTS

Cost-Benefit Analysis of Play Structures

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Target Grade Levels: 2-5

- For K-2 students, go through the reading material from Activity 1 as a whole class in more of a discussion format. Modify Activity 2 to focus on only 4-5 areas instead of all that are included.

Appropriate for Middle School and High School with modifications in Extending the Lesson

Curricular Categories

Economics, Forestry, Wood Products, Sustainability

Time Frame 1.5 – 2 hours; 2 class periods

- Introduction & Activity 1: 45-60 minutes; 1 class period
- Activity 2 & Conclusion: 45-60 minutes; 1 class period

Materials

- Healthy Markets = Healthy Forests
 - Introduction: Start of video and first segment about the Madison Children’s Museum with Brenda Baker and introduction of Brian Brashaw. Stop at 4:09.
 - Activity 1: Multiple segments from How Healthy Markets Sustain Forests (see plans for Activity 1 for specific segments)
- Student Sheet: Cost-Benefit Analysis of Play Structures
- Activity 1 Reading_K-5_Carbon Cycle_Cost-Benefit Analysis
- Assessment of Learning: Cost-Benefit Analysis Assessment

Key Words

- Benefit cost, cost-benefit analysis, atmosphere, carbon cycle, carbon dioxide, climate change, climate solutions, decompose, fossil fuels, nanocellulose, photosynthesis, sugar, working forest, closed loop, net zero



Learning Objectives

Students will be able to:

- Define what benefits and costs are.
- Describe how carbon moves through the carbon cycle and how trees and forest products store carbon and are climate solutions.
- Conduct a cost-benefit analysis of a forest product.

Activity Summary

This lesson will start using the Into the Outdoors episode, *Healthy Markets = Healthy Forests* and other resources to help students examine the benefits and costs of building a playground using wood from black locust trees. Students will apply what they learn in the introduction and first activity to complete a cost-benefit analysis of wood play structures versus metal play structures in a second activity. The lesson will wrap up with students using evidence from the lesson to compose a recommendation about which type of structure would be best for their school.

Vocabulary

- **Benefit:** something that is good or helpful that comes from making a decision
- **Cost:** the money or resources needed by the decision; what can be lost from making a decision
- **Cost-benefit analysis:** tool that helps you decide what action you want to take by looking at costs and benefits
- **Biodegrade:** can break down through natural process that don't harm the Earth
- **Atmosphere:** air that surrounds Earth
- **Carbon cycle:** process that moves carbon atoms between plants, animals, the atmosphere, oceans, and soil. The total amount of carbon on Earth is always the same. Carbon makes life on earth possible.
- **Carbon dioxide:** a gas molecule made of oxygen and carbon found in earth's atmosphere.
- **Climate change:** long-term changes in temperatures and weather patterns; climate change can be caused by natural activities like volcanic eruptions; since the 1800s human activities, like the burning of fossil fuels, have been the main cause of climate change
- **Climate solutions:** actions people can take to slow down climate change
- **Decompose:** break down through natural processes that don't harm the Earth
- **Fossil fuels:** fuels like coal, oil and natural gas (methane) found in Earth's crust; they are made from decomposing plants and animals and take millions of years to form; they are made up of carbon so when they are burned they release carbon dioxide into the atmosphere
- **Nanocellulose:** tiny/microscopic material made from cellulose that is 1,000 times thinner than a human hair.
- **Photosynthesis:** chemical reaction that turns carbon dioxide and water into sugar and oxygen
- **Sugar:** molecule made of carbon, hydrogen and oxygen
- **Working forest:** forest lands that are taken care of for habitat, all species and other purposes that include making forest products; Managing forest so it is healthier after a harvest than before



- Closed loop: every part of the tree gets used so there is no waste
- Net zero: no waste is produced

Background Information

Much of this information is also included in the Carbon Cycle Student Sheet.

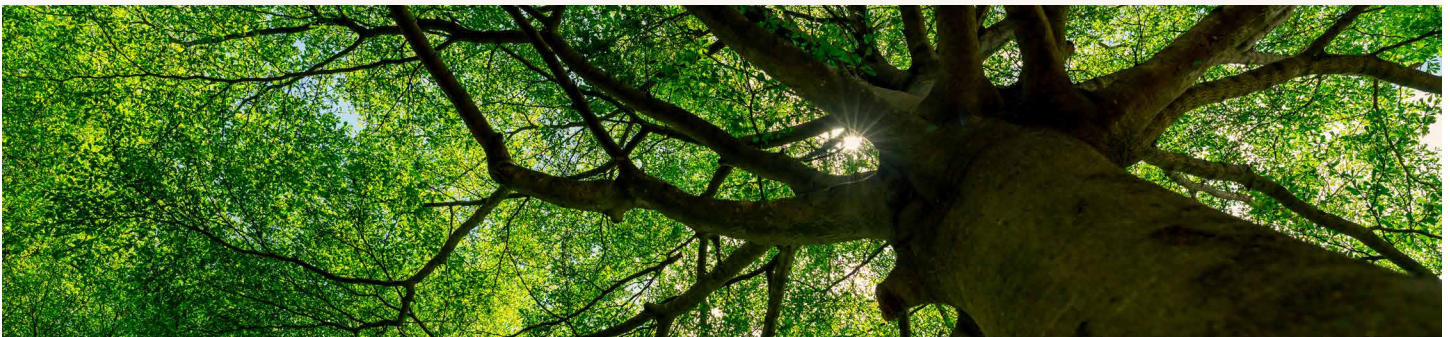
Carbon Cycle & Climate Change

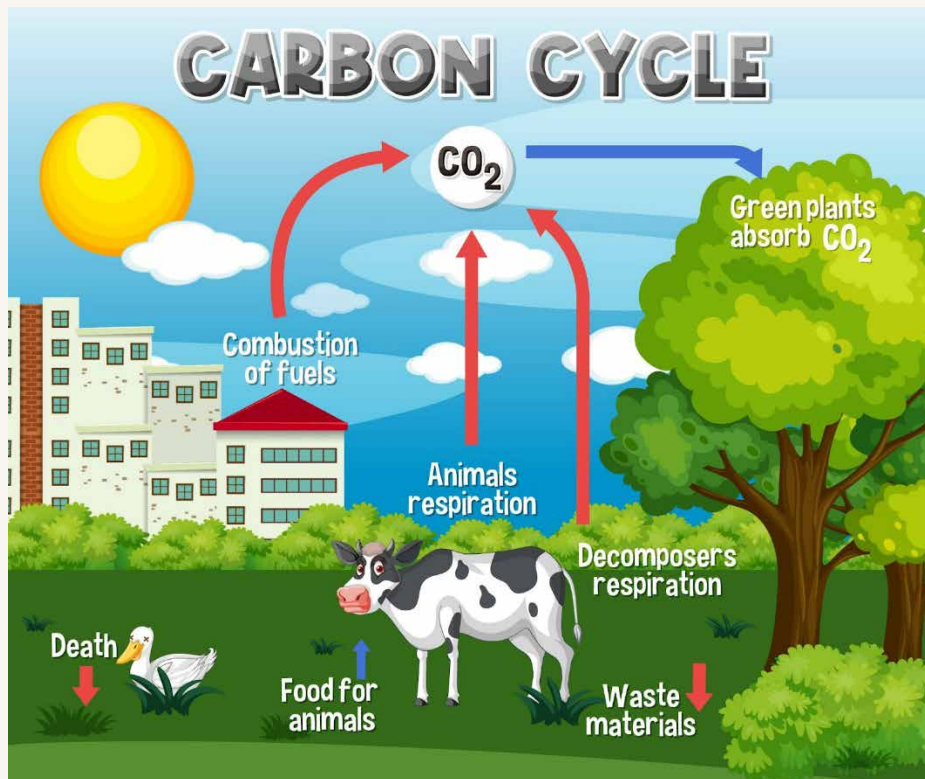
Carbon is part of the oceans, air, rocks, soil, and all living things. The total amount of carbon on Earth never changes but it is constantly cycling through the ecosystem. During photosynthesis carbon moves from the atmosphere to trees and plants when they take in carbon dioxide and turn it into sugars. Carbon may be stored in the roots and trunks of trees for years and is even stored in forest products like wood. The carbon remains in these forest products until it is burned (released to the atmosphere as carbon dioxide) or decomposes (moves into the ground). Carbon moves from trees and plants to animals through the food web when animals eat the plants and can also move from animal to animal in this way. Carbon also moves from living organisms into the atmosphere through respiration (breathing).

When plants and animals die, carbon moves into the ground through decomposition. Some decomposing plants and animals get buried and their carbon becomes fossil fuels over millions of years. When fossil fuels are burned, carbon quickly enters the atmosphere as carbon dioxide gas. Oceans take some carbon from the atmosphere. The ocean holds more carbon than any other part of Earth's biosphere. (Not shown in image.)

Generally, the amount of carbon in the atmosphere is decreased through marine sediments (carbonate) settling on the seafloor and the accumulation of plant biomass on land and in the ocean. The amount of carbon in the atmosphere is increased through the burning of fossil fuels and deforestation as well as through other processes.

Carbon dioxide is a greenhouse gas that regulates Earth's temperature and allows Earth to support life. For thousands of years the amount of carbon dioxide in the atmosphere stayed at close to the same level. When humans started consuming large amounts of coal during the Industrial Revolution





and other fossil fuels (petroleum and natural gas) following, it significantly increased the amount of carbon dioxide in Earth's atmosphere. The increased level of carbon dioxide in Earth's atmosphere is the leading cause of climate change.

Image by brgfx on Freepik –

https://www.freepik.com/free-vector/carbon-cycle-diagram-science-education_41852850.htm

Learning Procedure

Introduction: How Healthy Markets Sustain Forests Episodes

- Pass out the student sheet Cost-Benefits of Playgrounds_Introduction and Activity 1. Instruct students to look at the first page of their student sheet and not turn the paper over.
- Tell students that they are going to watch a short video clip about a new playground that was added at the Madison Children's Museum. Tell them that as they watch the video, they should write down the benefits of using Black Locust as the main building material for the playground. Explain that a benefit is something good or helpful that comes from making a decision.
- Watch the How Healthy Markets Sustain Forests episode introduction and segment about the Madison Children's Museum with Brenda Baker and through the first part of the segment with Brian Brashaw, stopping at 4:09.
- Ask students to share the benefits they recorded on their student sheet. Benefits highlighted in the segment include:



- Spending more time in nature, provides real connection to nature, encourages being outdoors
- Local material (don't need to transport a long ways), sustainable material (comes from nature and can biodegrade, return to nature without harmful impacts)
- Long lasting
- Black locust is an invasive species; when it is cut/removed from a forest it helps native plants grow
- Helping forests helps combat climate change
- Provides educational experience for students
- Using wood helps the market for sustainable forest products which helps forest managers make good decisions about forests, so the forests stay healthy
- Sustainable products from the forest can make our lives better
- Ask students if they can think of other benefits of building a playground from the wood from black locust trees. Have students add these benefits to their student sheet.
- Tell students that when we make decisions, there are costs too. Explain that a cost is the money or other resources that are given up from making a decision or what can be lost from making a decision. Ask students to think of what the costs of building a playground from black locust would be. If they struggle to come up with ideas, prompt them with the following questions:
 - Where do the trees come from? Who cuts them? What does that cost?
 - Is the wood durable enough for a playground? Will the wood last as long as other materials that are not wood?
 - How easy is black locust wood to work with? Can the playground take any shape or does the size and shape of the tree influence what can be built?
 - How much does it cost to hire someone to design a black locust playground?
 - How much does it cost to hire people to build a black locust playground?
 - Are there still parts that cannot be made from wood? (hint...slides)
- The Wood Database Wood Filter is a great resource to help you with this discussion about Black Locust. <https://www.wood-database.com/black-locust/> Some properties (information used with permission from Eric Meier, Wood Database) of black locust include:
 - Very durable, with good weathering characteristics. Frequently used as fence posts for its outdoor longevity
 - Usually straight grained, but its high density and hardness can make it more difficult to machine (cut) than some other hardwoods; it glues and finishes well
 - Prices should be moderate if it grows in your area
 - Widespread (even considered invasive in some areas)
 - Very hard, strong wood, comparable to hickory as the strongest and stiffest wood from the U.S. but more stable and rot resistant than hickory
 - Though uncommon, some people have allergy symptoms when working with (cutting/sanding) black locust
- Tell students to record the costs of a black locust playground on their student sheet.



Activity 1: Cost-Benefit Analysis of Playgrounds

Explain to students that all realistic decisions have both costs and benefits. Often, the best decisions are the ones that have the most benefits and the fewest costs. Comparing the benefits of a decision to the costs of the decision is called a cost-benefit analysis. Doing a cost-benefit analysis can help people make decisions that best meet their needs.

Tell students that they are going to watch some additional video clips to further understand the benefits and costs of using black locust (or other wood) to build a play structure.

Pass out a copy of the Activity 1 Reading Sheet: *Carbon Cycle, Climate Change, Trees and Forest Products* to each student. As a class, read about the carbon cycle, climate change, trees and forest products. Make sure students understand the vocabulary words in bold print. Show students the Carbon Cycle diagram included in the Background Information to help them understand how carbon moves in the cycle.

Restart the episode at 4:35 and play it until 5:55. This segment covers a little bit about the carbon cycle and climate change, along with other benefits of using wood. Ask students what additional benefits or costs of using black locust to build a playground could be added to their student sheet.

If time permits, show the segment featuring Peter Connor from Nicolet Hardwoods (**7:36-10:30**) and discuss the following vocabulary words: **working forest, closed loop, net zero**. Ask students to explain how these concepts could be applied to the black locust playground. Does using black locust contribute to a working forest? (*Since black locust is considered invasive in some forests, the removal of it to use as a product can play an important role in a working forests.*) Could using black locust help this be a closed loop or net zero system? (*Using what some consider to be an invasive species as a wood product helps close the loop; if there is waste from the black locust trees students could suggest it be used for woodchips for the surface beneath the playground.*) If you utilize this segment, have students add benefits and costs from your discussion to their student sheet.

Show the segment featuring Jen Youngblood, Forest Supervisor for the Chequamegon and Nicolet National Forests (**10:48-12:59**). Discuss how a working forest supports wildlife and recreational use of the forests. Ask students how using wood to build a playground (whether it is black locust or another wood) can be a benefit? (*managing forests and using products help create spaces for plants that support wildlife to grow, this can also support cultural or recreational activities*). Have students add this information to their student sheet.

If time permits, show the remaining segments to further support student understanding of working forests and have students add benefits and costs to their student sheets.



- Warren Suchovsky, Private Landowner and logger - Suchovsky Logging Inc (13:30-18:07)
- Matt Dallman, The Nature Conservancy (18:07-20:56)
- Julie Ballweg, Forest Products Lab (21:05-end)

If you are limited on time, you can move on to Activity 2.

Activity 2: Cost-benefit Analysis of Wooden Play Structures versus Metal Play Structures

Tell students that they are going to participate in a **cost-benefit analysis** to determine the type of play structure they would recommend the school purchase/build (be sure they know this is a simulation and that the school is not actually getting a new play structure). They should use what they have learned throughout the lesson and information on their activity sheet to help them complete the cost-benefit analysis. You may decide if you want students to complete this activity independently, with a partner, or as a small group.

Once everyone has finished completing the Cost-benefit analysis table, have them share their ideas with other students, pairs or groups. Tell students they are welcome to make changes to their student sheets if their peers have come up with additional information they had not thought about.

Ask students to look at their Cost-benefit Analysis of Wood versus Metal Play Structures. Ask them to think about the following questions:

- Based on the information in the table, what structure would they recommend and why?
- What are the costs of choosing this structure?
- What are the benefits of choosing this structure?
- How do the benefits of choosing this structure outweigh the costs of choosing this structure?

Conclusion: Assessment

Have students complete the Written Assessment of Learning Writing Prompt independently. *Based on what you learned in this lesson...*

- What type of play structure would you recommend the school to purchase / build?
- What are the costs of choosing this structure?
- What are the benefits of choosing this structure?
- How do the benefits of choosing this structure outweigh the costs of choosing this structure?

Tell students that they must use at least one piece of evidence from the episode in their response. Tell them they should write at least one sentence per point (at least 4 sentences). Remind students to use capital letters, end marks, and commas correctly and to do their best to spell words correctly.



Extending the Lesson (Optional)

Early Elementary School Recommendations

The following LEAF lessons may be used for early elementary learners:

LEAF K-1st Grade Forestry Lesson Guide, Lesson 4: Forest Products Time Machine

- Students learn about historical uses of forest resources. Students begin by sharing ways we use the forest while playing a game of Hot Pine Cone. Next, the class explores forest resources used to create products of the past, while relating them to present-day goods. To conclude, students examine forest products and draw a picture of one they use every day. <https://www.uwsp.edu/wp-content/uploads/2023/11/leaf-k-1-lesson-4-forest-product-time-machine.pdf>

LEAF K-1st Grade Forestry Lesson Guide, Lesson 5: Animals Need Forests Too

- Students explore what the forest provides for its animal residents. Cooperatively, students create a forest ecosystem with their classmates, and enter the forest as animals in search of food, water, shelter, and space.

LEAF 2nd-3rd Grade Forestry Lesson Guide, Lesson 4: Forests Are Important to Me!

- Students explore and graph their personal forest values. Using a checklist, they discover how many of the forest products they use are made right here in Wisconsin and map them. As a conclusion, students create a collage and write about why they value forests. <https://www.uwsp.edu/wp-content/uploads/2023/11/leaf-2-3-lesson-4-forests-are-important-to-me.pdf>

LEAF 2nd-3rd Grade Forestry Lesson Guide, Lesson 5: Decisions, Decisions

- Students learn about forest management by making a plan for a schoolyard. Using a card game similar to Old Maid, students learn about some of the people involved in managing forests. As a conclusion, they act out the roles of people involved in forest management and sing a song about what forests can be managed for. <https://www.uwsp.edu/wp-content/uploads/2023/11/leaf-2-3-lesson-5-decisions-decisions.pdf>

Upper Elementary School Recommendations:

Have students design the playground they think the school should build.

LEAF 5th-6th Grade Forestry Lesson Guide, Lesson 4: Ecosystem Extravaganza

- Students learn about ecosystem functions and the types of organisms found in ecosystems. Students complete a diagram of photosynthesis and use calculations to follow the flow of energy through producers and consumers. Students read to learn about the water cycle and carbon cycle and create their own diagrams of the processes. <https://www.uwsp.edu/wp-content/uploads/2023/11/leaf-5-6-lesson-4-ecosystem-extravaganza.pdf>

LEAF 5th-6th Grade Forestry Lesson Guide, Lesson 6

- Students explore events in Wisconsin's history that led to modern forestry. They learn about forest management techniques and read a "choose your own adventure" type story about management to learn what can happen if various management decisions are made. <https://www.uwsp.edu/wp-content/uploads/2023/11/leaf-5-6-lesson-6-what-is-management.pdf>



Middle/High School Recommendations:

Complete the same activities in the elementary lesson or the Middle School and/or High School lessons that go along with this episode. In addition, the following LEAF lessons support topics explored in the episode.

LEAF 7th-8th Grade Forestry Lesson Guide, Lesson 4: Many Forests, Many Values, Many Reasons

- Games, story analysis, and brainstorming help students categorize and assess people's forest values. Groups answer questions about Wisconsin's past and present forest use to get an idea of how forests shape the economy, culture, society, and environment. Students have a chance to demonstrate creatively what they've learned about values by completing an independent or small-group project and presenting it in class. <https://www.uwsp.edu/wp-content/uploads/2023/11/leaf-7-8-lesson-5-many-forests-many-values-many-reasons.pdf>

LEAF 7th-8th Grade Forestry Lesson Guide, Lesson 6: Making Broader Connections

- Students make connections between forests of Wisconsin and forests worldwide. Students discover how forestry and forest products affect the economy, society, and environment of Wisconsin by tracing the life cycle of a forest product. <https://www.uwsp.edu/wp-content/uploads/2023/11/leaf-7-8-lesson-6-making-broader-connections.pdf>

LEAF 9th-12th Grade Forestry Lesson Guide, Lesson 4: The Forest Marketplace

- Students participate in activities that illustrate economic factors influencing the supply of and demand for forest products. Students first learn how veneer is produced and used. They create a circular flow market diagram, define economic terms, and interpret supply-and-demand graphs. Students work in small groups and use data tables and statistics to describe the general supply of and demand for forest resources in different regions of Wisconsin. They use graphs to further describe the supply-and-demand characteristics of the Midwest and United States. In summary, students compare and contrast the economies of different nations, analyze the relative cost of production in each, and work together to describe the economic relationship between Wisconsin's forest resources and those of the rest of the world. <https://www.uwsp.edu/wp-content/uploads/2023/11/leaf-9-12-lesson-4-the-forest-marketplace.pdf>

Student Pages

See additional documents that will need to be included:

- Student Sheet: Cost-Benefit Analysis of Play Structures
- Activity 1 Reading_K-5_Carbon Cycle_Cost-Benefit Analysis
- Assessment of Learning: Cost-Benefit Analysis Assessment

Standards

WISCONSIN STANDARDS FOR SCIENCE

- SCI.SEP6.A.e-i Students use evidence and ideas in construction evidence-based accounts of natural phenomenon.



- SCI.SEP8.e-i Students use developmentally appropriate texts to obtain scientific and technical information. Students communicate information with others in oral or written formats.
- SCI.ESS2.E.e-i Living things can affect the physical characteristics of their environment.
- SCI.ESS3.A.e-i Energy and fuels humans use are derived from natural sources, and their use affects the environment. Some resources are renewable over time and others are not.
- SCI.ESS3.C.e-i Things people do can infect the environment but they can make choices to reduce their impact.
- SCI.ETS2.B.e-i Every human-made product is designed by applying some knowledge of the natural world and is built by using natural materials. Taking natural materials to make things impacts the environment.

WISCONSIN STANDARDS FOR SOCIAL STUDIES

- SS.Econ1.a.3 Use economic reasoning to compare and contrast the costs and benefits of a decision.
- SS.Econ4.a.3 Trace the chain of supply for a needed product (e.g., food, shelter).
- SS.Geog3.a.i Classify a provided set of resources as renewable or nonrenewable, and analyze the implications of both at the local, national, and global level.
- SS.Geog4.a.i Compare the positive and negative effects of human actions on our physical environment over time.
- SS.Geog5.b.i Examine how human actions modify the physical environment when using natural resources (renewable and nonrenewable).

WISCONSIN STANDARDS FOR ENVIRONMENTAL LITERACY AND SUSTAINABILITY

- ELS.EX3.B.e-i Examine the relationships among resource use, environmental quality, and human health and well-being.

WISCONSIN STANDARDS FOR ENGLISH LANGUAGE ARTS

- ELA.RF.3-5 Read grade-level text with purpose and understanding.
- ELA.R.3-5.1 Locate and refer to relevant details and evidence when explaining what a text says explicitly/implicitly and make logical inferences.
- ELA.R.3-5.2 Summarize texts.
- ELA.W.K-5.1 Compose reflective writing.
- ELA.W.K-5.2 Write informative texts. Use facts, definitions and details to develop points.
- ELA.W.K-5.7 Conduct short inquiry projects that build knowledge about a topic.
- ELA.W.K-5.9 Recall and use facts from information texts to support reflection and inquiry.
- ELA.SL.K-5.2 Determine the main ideas and supporting details of a text read aloud.
- ELA.L.K-5.6 Appropriate use of capitalization, commas, end punctuation and correct spelling.



HEALTHY MARKETS = HEALTHY FORESTS

COST-BENEFIT ANALYSIS OF PLAY STRUCTURES

Carbon Cycle, Climate Change, Trees and Forest Products –
Activity 1 Reading



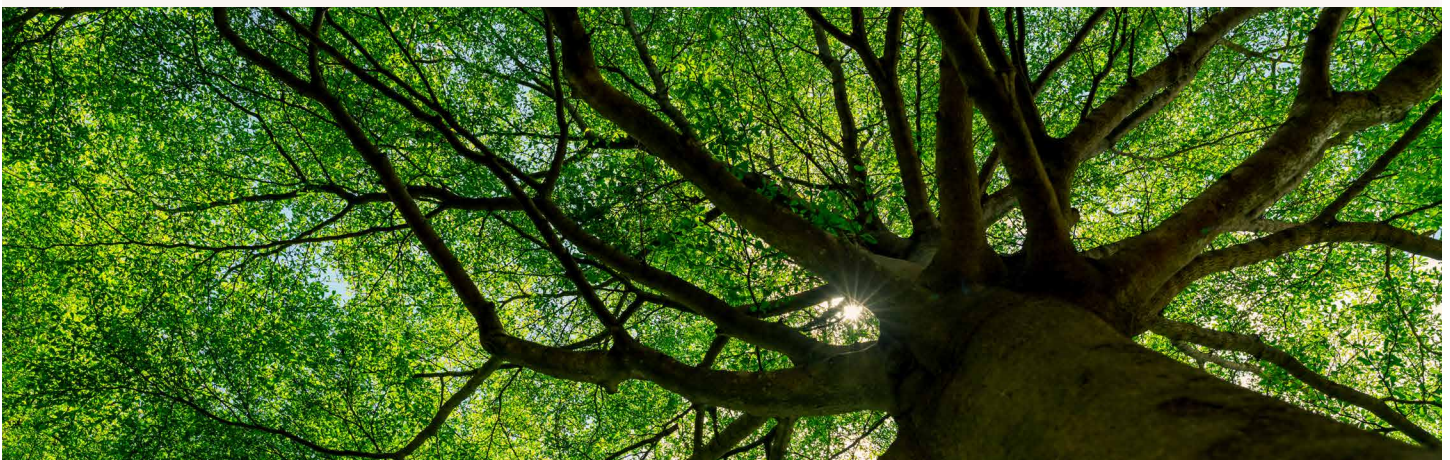
Carbon is part of the oceans, air, rocks, soil, and all living things. The total amount of carbon on Earth never changes but it is always moving from one place to another in the **carbon cycle**. Plants take in **carbon dioxide**-a gas in Earth's **atmosphere** (the air that surrounds Earth). In plant cells **photosynthesis** takes place. Photosynthesis is a [chemical] reaction that turns carbon dioxide and water into **sugar** (a molecule made of carbon, hydrogen and oxygen) and oxygen (the gas people and animals breathe). The carbon is stored in the roots and trunks of trees as they grow.



IMAGE BY DILOK

When a tree is cut down, the carbon from the tree is stored in the products that are made from the tree (like wood, paper, cardboard, etc.). The carbon stays in the products until they burn-which releases carbon [dioxide] into the air, or **decompose** - get broken down by organisms in the soil/ground. If the tree is not cut down, the carbon stays in the tree until the tree burns or decomposes.

When animals eat fruit, leaves, or the tree itself, carbon moves from the tree to the animal. Carbon also moves from animal to animal when one animal eats another animal. Carbon moves from animals, including humans, to the atmosphere when they breathe. When plants and animals die, carbon moves into the ground through decomposition. Some decomposing plants and animals get buried and their carbon becomes **fossil fuels** over millions of years. When fossil fuels are burned, carbon quickly enters the atmosphere as carbon dioxide gas. Oceans take some carbon from the air atmosphere. Oceans hold more carbon than any other part of Earth ecosystem.





Carbon dioxide in Earth's atmosphere absorbs heat from the sun. This helps Earth be the right temperature for plants, animals, and people to live on it. For thousands of years the amount of carbon dioxide in Earth's atmosphere was close to the same amount. When humans discovered how to burn coal, oil and gas to produce more energy, the carbon stored in the fossil fuels was put into the air faster than usual. This has caused there to be more carbon dioxide in Earth's atmosphere now than there has been in thousands of years. The extra carbon dioxide in Earth's atmosphere is causing the average temperature of Earth to get warmer which is causing Earth's climate to change. **Climate change** is something many people worry about because it leads to more extreme weather, more ice melting at the north and south pole and higher sea levels. These impacts and other impacts from climate change can make it more difficult for many plants, animals and people to live where they always have lived.

People are looking for **climate solutions** - ways to slow down climate change and get extra carbon dioxide out of Earth's atmosphere. Trees and forest products are climate solutions because trees and anything made from trees (like wood, paper, and even things made with the tiniest parts of trees – **nanocellulose**) store carbon and keep it from entering Earth's atmosphere.



Image by OceanProd



COSTS OF A BLACK LOCUST PLAYGROUND
(or questions I have about the costs)

ACTIVITY 2: COST-BENEFIT ANALYSIS WOOD PLAY STRUCTURE VERSUS METAL PLAY STRUCTURE

All realistic decisions have both costs and benefits. Often, the best decisions are the ones that have the most benefits and the fewest costs. Comparing the benefits of a decision to the costs of the decision is called a cost-benefit analysis. Doing a **cost-benefit analysis** can help people make decisions that best meet their needs.





INSTRUCTIONS: Use what you learned in Activity 1 and the table below to complete a **cost-benefit analysis** to determine the type of play structure you would recommend the school purchase or build. Note-this is a simulation, the school does not currently have plans to install new play structures.

*Wooden Structure
Image by Robert Schneider
Metal/Plastic Structure
Image by Alona Dudaieva*

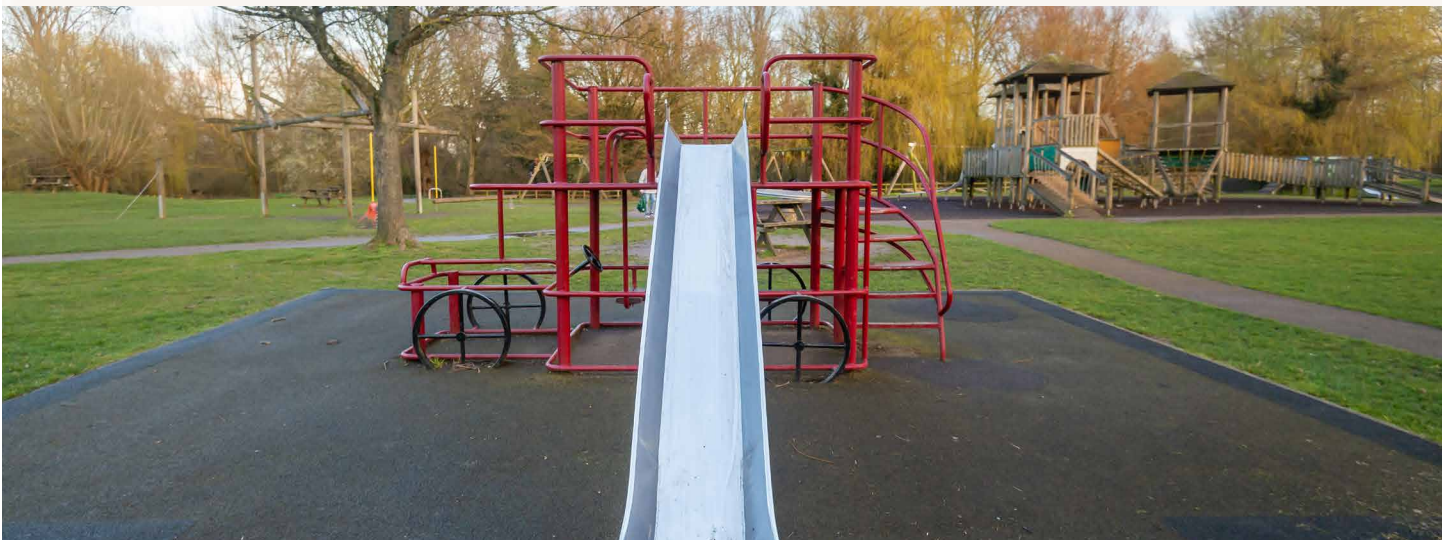


CHARACTERISTICS	WOOD PLAY STRUCTURE	METAL PLAY STRUCTURE
Durability	-Very durable play structure -Can splinter or rot over time if not maintained	-Most durable play structure
Price	-A little more expensive than metal to purchase and install	-Less expensive than wood to purchase and install
Weather Resistance	-Holds up in all weather conditions if well maintained -Does not get as hot or cold	-Holds up in all weather conditions -Can get very hot or very cold
Maintenance / Care	-Needs to be stained and cared for to be durable and weather resistant	-Easy to take care of -Need to prevent rusting
Safety	-Safest play structure	-Safe but can get hot
Looks	-Can be stained if colors are desired -Natural look that can help people feel connected to nature or the environment	-Can choose many different colors -Looks industrial
Special Features	-Can choose a lot of features -Easy to add customized features -Easy to add on to after installed	-Can choose a lot of features -Difficult to add customized features -Difficult to add on to after installed



ACTIVITY 2: COST-BENEFIT ANALYSIS WOOD PLAY STRUCTURE VERSUS METAL PLAY STRUCTURE

WOOD PLAY STRUCTURE	METAL PLAY STRUCTURE
<p style="text-align: center;">BENEFITS</p>	<p style="text-align: center;">BENEFITS</p>





COSTS

COSTS

