MFMA SUSTAINABILITY
Teachers Resources

USING SPORTS TO UNDERSTAND SUSTAINABLE FORESTRY & THE ENVIRONMENTAL BENEFITS OF HARDWOOD

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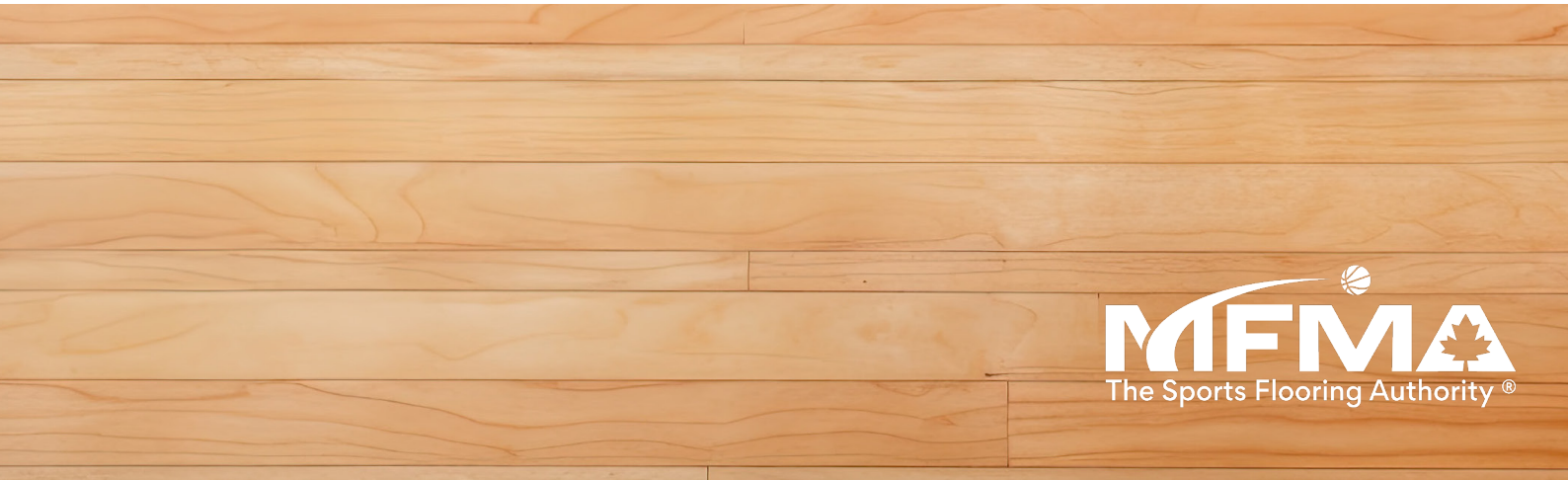


MFMA
The Sports Flooring Authority ®

Teachers Resources

This lesson is designed for a broad audience and does not focus on specific examples related to different regions. However, teachers are encouraged to incorporate place-based examples to help students connect local frameworks of thinking with the concepts and enduring understandings of the STEM project. Activities 1.1–1.2 allow teachers to select the state where their school is located, giving students a local understanding of forest sustainability.

This STEM project consists of two lessons taught on separate days, with the second day requiring access to a school forest, urban forest, or local forest. If it is not feasible for teachers to visit a forest, Lesson 1 can be used as a standalone activity, without the need for a forest visit on Day 2. For schools visiting an urban forest, it is important to emphasize students' connection to forests in their state and local surroundings.

The history of a place, its culture, and the systemic environmental issues its people face are key factors that shape a student's ability to relate to educational material. The more teachers can contextualize the lesson plan in relation to local environmental issues, the more successful the lesson will be

Lesson Plan Estimated-Completion Times

Lesson 1 Background – 30 minutes
Lesson 1, Activity – 1.5 hours
Lesson 1, Exercise 1 Calculating carbon storage – 2 hours
Classroom Discussion Questions & Deeper Understandings – 1.75 hours
Lesson 1, Activities 1.1-1.2: Forest Sustainability Calculators – 45 minutes
Lesson 1, Activity 1.3: Carbon dioxide equivalencies – 1.25 hours
Lesson 1 Summary – 25 minutes
Lesson 2 Overview – 1 hour
Lesson 2 Background Lucky Number 7: 7 Reasons wood is a sustainable material – 1.25 hours
Lesson 2, Activity 2 – 1.75 hours
Lesson 2, Summary & Careers – 45 minutes

Lesson 1

Additional background

For **Lesson 1**, students will review their reading pages about the different carbon inputs, comparing wood with alternative materials. Specifically, students will learn about the environmental and health reasons for considering materials, including the natural qualities of hardwood. These qualities include being grown from renewable resources (the sun) and requiring fewer fossil-based fuels to produce than synthetic floors, which are byproducts of petroleum (fossil fuels) and require much higher energy levels to produce. Teachers are encouraged to review and emphasize this before moving into the carbon storage exercise and discussion questions.

Teachers should pre-teach some of the basic concepts on the lesson plan such as carbon sinks, the carbon cycle, photosynthesis, greenhouse gases, and their impact on the environment. This information is found throughout the Teacher Guide, Student Reading Page, and the Lesson Plans.

1. **Basketball rebound:**
   Measures the basketball's rebound response off the sports floor system compared to the ball's rebound off concrete. At 100% rebound, the basketball returns to a height equal to its rebound off concrete. Hardwood provides a consistent level of bounce.

2. **Shock absorption:**
   Measures the flooring system's ability to absorb impact forces generated by the athlete. When an athlete impacts a sports surface, the force is translated into two resultant forces: one absorbed by the floor and the other absorbed by the athlete. Shock absorption is a major contributor to playability and comfort, making a floor more or less comfortable to use.

3. **Vertical deflection:**
   Measures the ability of a floor to adjust as an athlete jumps or falls on the court. Vertical deflection is thought to be related to foot stability because it measures the floor's downward movement when an athlete lands on the surface.

4. **Area of Deflection:**
   The measurement of how energy is dispersed through a sports floor system is called area deflection—how energy produced by movement, like running, jumping, or bouncing a ball, is dispersed throughout the floor. Hardwood floors generally provide a greater area of deflection than alternatives.

5. **Surface friction:**
   Measures an athletic flooring finish's ability to control the sliding of athletes on a sports surface. Hardwood provides a consistent amount of grip.

ACTIVITY 1: MATERIALS PREP

In **Activity 1**, students will perform a dribble test and jump test to begin understanding the qualitative and quantitative data associated with different materials, which they will later relate to environmental impacts. To maximize time, teachers are encouraged to prep the dribble test both in the gym and outside on the second surface. Teachers can use either chalk or poster paper with markers and a measuring tape to mark a height of up to 6.5 feet, accommodating taller students. The chalk or poster paper should be placed in an area where students have enough room to stand nearby, bounce the ball, and note the quantitative data (ball rebound height).

ACTIVITY 1: ICE-BREAKER QUESTIONS PREP

During **Activity 1**, teachers will engage students with ice-breaker questions after arriving at the school gym. Below are some suggested answers (in **bold/***italics*) to guide the discussion.

- **What sports and activities are played on this floor?** *Dancing, cheerleading, besides sports, do we also hold events in here such as Back to School Night, School Dances?*
- **What material is this floor made out of?** *Wood, specifically Hardwood.*
- **Where does wood come from?** *Trees, usually forests that are cared and managed.*
- **While we can use this floor for many different reasons, can you think of any sports that must use this surface to play? What sports require to play on this surface?** *Basketball. Basketball still prefers the use of hardwood at the collegiate and professional level (NCAA, NBA, WNBA).*
- **Are all basketball courts made out of the same wood?** *Not all, but most are made out of northern hard maple.*
- **How does the material we use for surfaces in sports and activities affect how objects move? Or how our bodies feel?** *Let's find out!*

ACTIVITY 1: DISCUSSION PREP

Below are some suggested answers (in **bold/***italics*) to guide the discussion at the end of **Activity 1**.

- **Why do you think the gym is made out of wood?** *If students are at a loss, nudge them in direction, is the wood stronger, Is the wood easier to get and build with, is it the best for the environment?*
- **How does the use of different materials impact the environment?** *Using wood can have a lower environmental footprint than other materials such as concrete, or synthetic floors.*
- **What are other materials that sports are played on?** *Asphalt/concrete, ice, synthetic-based floors, grass.*
- **How did it feel to jump on the wood? How did the ball bounce on the wood? Was it easier or harder? Did it feel nicer or not as nice?**

- **What type of tree do we think this comes from? Are they hardwood or softwood?** *Hardwood tree. Acer saccharum (sugar maple/hard maple/rock maple). Maple lumber comes principally from middle Atlantic and lake states. Maple grows to heights of 120 ft, with a diameter of 3 ft. Hard maple the predominant tree used for sports flooring in the U.S. grows in our local home state!*

- **How many trees does it take to make this court?** *It depends. Somewhere between 70-216 trees. More on this on Day 2.*

- **How are things like a house or floor made?** *Do we use tools, such as equipment like hammers and saws, or digital tools like Ipad's and computers? We use many things. Do those things ever run out of battery or need to be plugged in? What gives them the power to keep working to build or make things? Electricity, the sun, fossil-fuel based energy. Power from the sun, or wind, or coal-based power.*

Students, do you remember the process of photosynthesis, where trees grow with power of the sun and carbon dioxide? What happens to that carbon dioxide? Is it in this floor?
In the rest of lesson one and in lesson two students will learn more about answers to the questions above!

EXERCISE 1 PREP

Exercise 1 may require minimal preparation by teachers to ensure the activity can be conducted smoothly in the school gym. This might include moving bleachers or chairs to allow students to sit down and ensuring that there is a way to demonstrate the material, such as using a projector, chalkboard, or whiteboard.

Before guiding students through **Exercise 1**, review the "Deeper Understandings" section of **Lesson 1** to revisit key concepts on carbon storage, photosynthesis, how trees sequester carbon, and how carbon flows from forests to wood products. Emphasize how this process contributes to lowering environmental impact and reducing greenhouse gases (GHGs).

Sharing **Figure 1** with the students may be beneficial in providing a visual depiction of photosynthesis, carbon storage in trees, and the percentage of carbon in hardwood.

The final answer should be expressed in metric tons. Explain why metric tons are used to measure carbon: metric tons provide a standardized and internationally recognized unit for large quantities of carbon dioxide. Using this standard measurement (metric ton) allows us to compare the environmental impacts (emissions) more accurately.

An exact answer key will not be provided for each specific school floor, as gym sizes, floor dimensions, and measurements can vary. Teachers should refer to the example provided, which is based on measurements for a regulation-size basketball court with boundary lines

a. Example using the regulation size of a basketball court:
- 50 feet wide x 94 feet long x 0.0791 feet height/thick=371.77 cubic feet
- Convert cubic feet to cubic meter: 371.77 x 0.028=10.4 cubic meters of gym flooring/volume of wood in gym.
- Example final calculation: 10.4 m3 x 650kg/m3 x .5 x 3.67 = 12,404 kg
- Converting to metric tons= 12,404 kg/ 1000=12 metric tons co2 stored.

DEEPER UNDERSTANDINGS CLASSROOM DISCUSSION QUESTIONS PREP

It is recommended that teachers review the recommended resources shared at the end of this document and become familiar with the student reading pages, which provide background on deeper understanding topics. In particular, graphics developed by the U.S. Forest Service, which can be found here, are highly informative. Teachers should review the header topics in the "Deeper Understandings" section before presenting the questions to students. Start by sharing Figure 3 and work through the bullet points. To wrap up the "Deeper Understandings" section, revisit the discussion questions written on the board at the start of the session.

Discussion Questions:

1. This floor contains carbon—where does the carbon come from? Vinyl also contains carbon—where does that carbon come from?

2. If trees had to be cut down to produce this floor, does that mean the forest is gone forever?

3. Why are we concerned with carbon in the atmosphere, and why are we excited about carbon sinks in forests and wood products?

Review with Students at the End of the "Deeper Understandings" Session:

So far, we've learned about how greenhouse gases impact environmental health and climate, focusing on one of the key GHGs—carbon. We've explored how carbon flows from forests to wood products, contributing to the reduction of environmental impact and GHGs. We've also learned that the increasing amount of GHGs is problematic because it can contribute to respiratory diseases from smog and air pollution, as well as lead to the loss of ecosystems. One solution to this problem is using wood wisely, which helps with carbon storage and reduces the need for fossil fuel-based energy and emissions.

Students may have additional questions or inquire about how much CO_2 is left in the atmosphere due to the tree being cut down; how much CO_2 a mature maple tree takes in a year or how much its replacement takes in; and how many years it would take for the replacement tree to catch up. These topics are covered in the student reading page and teachers can remind students of this. Information reviewed below:

- In one year, a mature live tree can absorb more than 48 pounds of carbon dioxide, which is permanently stored in its fibers until the tree dies/decomposes, or is harvested.
- Young trees (seedlings) that replace harvested mature trees, absorb carbon dioxide more quickly than mature trees, but mature trees store more carbon over time. Established or mature forests are made up of middle-aged trees, which have large root systems and store large amounts of carbon. While some large trees will occasionally die, they are quickly replaced by seedlings, as a result, the overall net productivity is positive and carbon capture is enhanced.
- During their first few years, seedlings primarily focus on root development and establishing themselves, meaning they absorb less CO_2 than mature trees.
- According to the US Forest Service, while harvesting a forest does release some carbon dioxide, the overall impact is often a net carbon sink because forests can regrow and capture more carbon than is released during harvesting. The amount of CO_2 released depends heavily on management practices, the type of forest, and how the harvested wood is utilized. The immediate carbon release from harvesting itself is relatively small compared to the carbon stored in the harvested biomass, which can be balanced out by using the wood for long-lived products like building materials.
- When trees burn, carbon is released directly into the atmosphere, increasing CO_2 levels.

ADDITIONAL BACKGROUND ON CARBON FLOWS

Information below provided by the California Academy of Sciences.

Carbon is an important element for life on earth and can be found in all four major spheres of the planet: biosphere, atmosphere, hydrosphere, and lithosphere (the rigid, rocky outer layer of the earth). Carbon is found in both the living and non-living parts of the planet, as a component in organisms, atmospheric gases, water, and rocks. The carbon moves from one sphere to another in an ongoing process known as the **carbon cycle**. The carbon cycle influences crucial life processes such as photosynthesis and respiration, contributes to fossil fuel formation, and impacts the earth's climate.

Besides the relatively small additions of carbon from meteorites, the total carbon on Earth is stable. But, the amount of carbon in any given sphere of the planet can increase or decrease depending on the fluctuations of the carbon cycle. The cycle can be thought of in terms of **reservoirs** (places where carbon is stored) and **flows** (the movement between reservoirs). The **atmosphere** (the gases surrounding the Earth), the **biosphere** (the parts of the land, sea, and atmosphere in which life exists), the **hydrosphere** (all of Earth's water), and the **lithosphere** (rocky outer layer of the Earth) are the reservoirs and the processes by which carbon moves from one reservoir to another are the flows. Although carbon is relatively common on earth, pure carbon is not. Carbon is usually bound to other elements in compounds. Thus, the carbon cycle, includes many carbon-containing compounds, such as carbon dioxide, sugars, and methane.

Carbon cycles both quickly and slowly

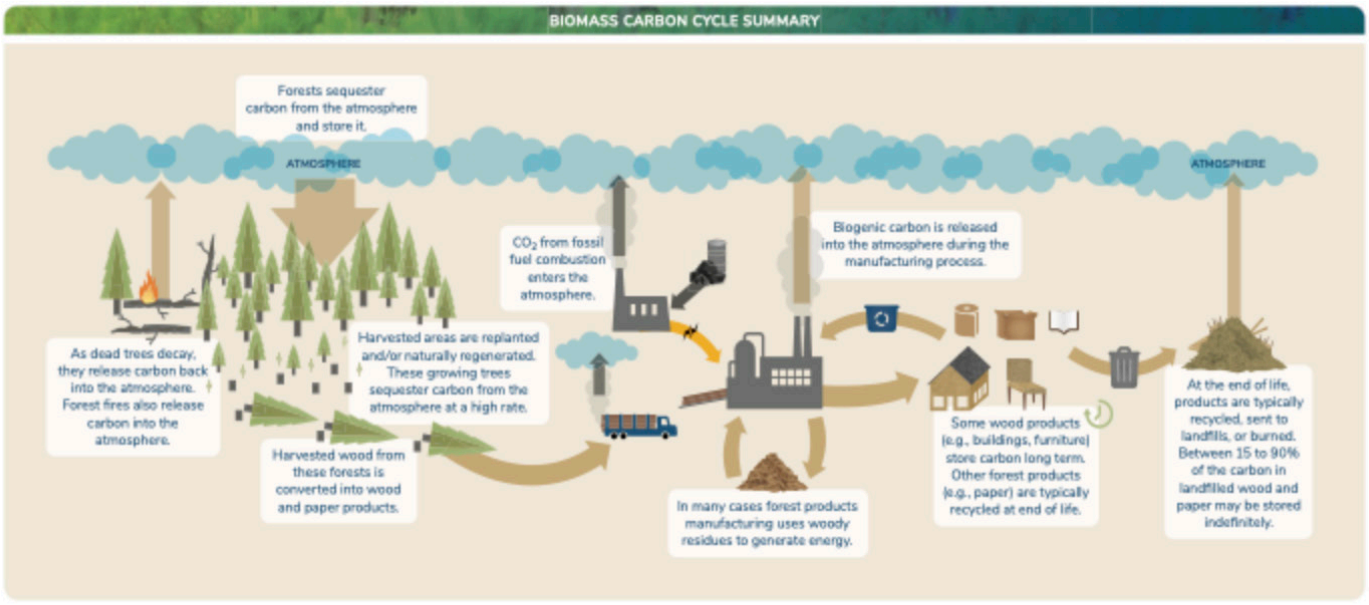
The many processes that move carbon from one place to another happen on different time scales. Some of them happen on short time scales, such as photosynthesis, which moves carbon from the atmosphere into the biosphere as plants extract carbon from the atmosphere. Some carbon cycle processes happen over much longer time scales. For example, when marine organisms with calcium carbonate skeletons and shells die, some of their remains sink towards the ocean floor. There, the carbon that was stored in their bodies becomes part of the carbon-rich sediment and is eventually carried along, via plate tectonic movement, to subduction zones where it is converted into metamorphic rock. These two examples show the extreme variety of processes that take place in the carbon cycle.

In general, the **short-term carbon cycle** encompasses photosynthesis, respiration, and predator-prey transfer of carbon. On land, there is a flow of carbon from the atmosphere to plants with photosynthesis and then a flow back to the atmosphere with plant and animal respiration and decomposition. For aquatic plants, photosynthesis involves taking carbon from carbon dioxide dissolved in the water around them. Carbon dioxide is also constantly moving between the atmosphere and water via diffusion. The long-term carbon cycle involves more of the lithospheric processes. It includes the weathering and erosion of carbon-containing rocks, the accumulation of carbon-rich plant and animal material in sediments, and the slow movement of those sediments through the rock cycle.

Humans affect the carbon cycle

There are natural fluctuations in the carbon cycle, but humans have been changing the carbon flows on earth at an unnatural rate. The major human-induced changes result in increased carbon dioxide in the atmosphere. The largest source of this change is burning fossil fuels, but other actions such as deforestation and cement manufacturing also contribute to this change in the carbon cycle. Because

carbon dioxide and methane are greenhouse gases that help to control the temperature of the planet, the human-induced increase in atmospheric carbon levels is resulting in a host of climatic changes on our planet. As discussed above, the natural carbon cycle is important to learn because it is crucial to many of earth's processes, but an understanding of the carbon cycle is especially important at this time in human history because of the dramatic and consequential alterations we are making to the cycle.



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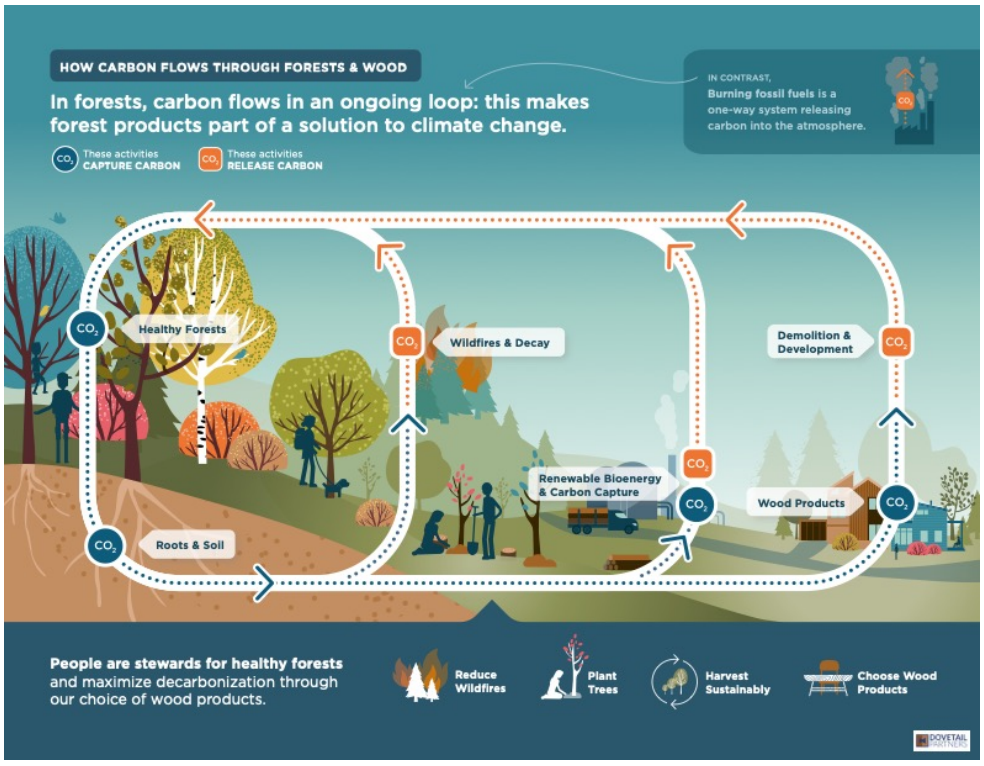

Activity1.1-1.3: ONLINE DATA CALCULATION TOOLS PREP

Teachers shall share with students that the calculator tools are built upon real data either collected or compiled by the U.S. Forest Service, and The Environmental Protection Agency, to help share information with the public. Teachers are recommended to reference the careers page to share with students the relevance of online data calculation tools with environmental studies and forest sciences careers based in Research and Analytics, GIS analyst, Forester, LiDar specialist, CAD Designer, Process Data Scientist, Web Designer, and Software Designer.

Link for UC Berkeley report (2009) on emissions: Reference the UC Berkeley report here:
http://escholarship.org/uc/item/6z37f2jr#page-3

Converting 1600 g Vehicle Miles traveled by school bus to carbon storage in gym floor.

Step 1: Start by converting grams to tons. 1,000,000 tons/1,600= 1 ton is = 625 VMT

Step 2: Multiply the amount of carbon dioxide stored in gym floor by 625= Answer
Answer will be expressed as total VMT by school bus that are equivalent to the carbon stored.

Lesson 2

Activity 2 Prep

Provide the context to students that this lesson will explore through forest while focusing on wood products and the characteristics that make wood a sustainable material.

This activity will take some preparation and customization to each forest that students visit. Teachers will coordinate with the forest staff at the field site to prepare a tree species identification sheet, and identify key areas of the forest that students will visit to see (tree stump, biodiversity, fallen logs or limbs, a mature tree).

While going through the 7 characteristics activity, teachers are recommended to review the descriptions in the background information to provide students with the context and meanings behind each characteristic after they interact with the activity. During the activity, teachers should aim to keep students within close enough proximity to rejoin the group for a group discussion and travel together to any new areas of the forest.

Sensory exercise break: Fostering a connection to nature. Teachers will describe to students that when you feel connected to a person, place, or thing, you care for it, and appreciate it in your life. There is physical connection and emotional connection. Ask students if they feel connected to the trees and nature around them. Lead them through a sensory exploration, asking what students hear, see, feel, smell, touch– encourage an intended and positive reference to nature, living systems or processes. Encourage colors, shapes, patterns, names of plants and animals, sounds of bugs and bees. Ask students to raise hands to share some of the sensory experience.

Durability and Hardwood Tree ID resources:
Characteristic 6 requires students to identify a specific tree species and consider the durability in reference to type of tree and janka hardness scale rating. Teachers are recommended to reference the following materials provided by LEAF:

1. Printable Tree ID Key: Tree ID Key
2. Winter Tree ID Key: Winter Tree ID Key
3. Urban Tree ID Key: Urban Tree ID Key

TABLE 1 FOREST PRODUCT CAREERS

- Environmental Studies **- Natural Resources** **- Carbon Accounting** **- Forestry** **- Wood Science** **- Administration**	**Business & Operations**	**Marketing & Sales**	**Engineering & Sustainability Careers**
• Logger • Tree Faller • Forester or Urban Forester • Sawmill operator • Wood Scientist • Furniture maker, cabinet maker, craftsman • GIS analyst • LiDar Specialist • Forest Ecologist • Forestry Researcher • Hardwood manufacturer • Hardwood flooring manufacturer • Carbon accounting • LCA practionner	• Director of Operations • Territory Manager • Purchasing/Procurement Manager • Supply Chain Analyst • Cost Estimator/Purchaser • Quality Control Manager	• Marketing Manager • Sales Manager • Technical Sales Representative • E-Commerce Content Creator • Website Coordinator • Online Marketing Specialist	• Fiber and Materials Strategy Lead • Process Data Scientist • Manufacturing Systems Specialist • Process Engineer • CAD Designer • Sports sustainability lead • Director of Sustainability • Sustainable bio-materials • Renewable materials researcher

STUDENT ASSESSMENT ANSWER KEY

1. **What are the 7 characteristics of hardwood that make it a sustainable material?**
   A. Biodiversity, natural material, renewable, sustainable, biodegradable, durable + long life span, and versatile

2. **Which of 7 characteristics of hardwood relates to the Janka Hardness scale? What is the Janka hardness scale?**
   A. Durability. The Janka hardness scale is a way to measure the hardness of a given species of wood and its level of durability. To measure the hardness, a steel ball is pressed into a piece of wood, and the force re quired is measured.

3. **What are two of the reasons why hard maple is the preferred tree species to produce the sports flooring wood product?**
   A. It is relatively dense, making it both strong and durable. It is also a sustainable choice, because it regrows naturally when managed with sound care.

4. **What is the difference between renewable and sustainable?**
   A. Renewable means that it comes from renewable sources, such as grown by power of the sun. Sustainable means it will readily replenish and repeatedly grow back after being cut.

5. **Why are we concerned with GHGs and carbon dioxide in the atmosphere?**
   A. Because fossil-derived carbon is separate from the natural carbon cycle and as a result causes more carbon dioxide in the atmosphere than the earth is used to, putting the Earth out of balance and causing global warming, environmental impacts to people and the planet. GHGs in the atmosphere have impacts on the environment because increases are considered the primary factor in global warming. Large amounts of GHGs can contribute to raspatory disease from smog and air pollution for people, and cause the loss of ecosystems.

6. **Where does the carbon in vinyl or concrete gym floors come from?**
   A. Fossil-carbon

7. **If we cut down trees wisely to produce wood products like gym floors, does that mean the forest is gone forever? How do we make sure the forest is not gone forever?**
   A. No. Sustainable forestry practices and striking a balance is important, using forests for resources, recreation, economic gain, or carbon storage requires balance to establish the most efficient result. For example, with a goal of maximizing the amount of stored carbon, management might include ensuring a combination of older trees and newer plantings offers.

8. **What is a carbon sink? What are two examples of natural carbon sinks?**
   A. Reservoir that absorbs and stores more carbon dioxide (CO_2) from the atmosphere than it releases, helping to offset greenhouse gas emissions and mitigate climate change. Natural carbon sinks are ecosystems or processes that play a significant role in the Earth's carbon cycle

9. **What are working forests? Why do they need to be managed sustainably? What does sustainable forestry mean?**
   A. Forests that are actively managed and designed to provide a suite of uses and values to the public, while maintaining the forest's wild character. These forests are not simply preserved in a natural state; instead, they are maintained to provide economic, ecological, and social benefits in a sustainable manner. This requires a balance between the needs of the forest and needs of people. For example, pure water, recreation, scenic beauty, plant and animal habitat, and timber and natural gas.

10 What are GHGs? What kind of impacts can GHGs have on human health and the environment?

A. Carbon dioxide (CO_2) gas is just one of several greenhouse gases (GHGs) i.e. methane (CH4), nitrous oxide (N2O), and water vapor. When we refer to any of these individually, we can call them GHGs. The burning of fossil fuels causes greenhouse gas (GHG) emissions, global warming, and can cause environmental impacts to people and the planet including increasing contributing to raspatory disease from smog and air pollution for people, and cause the loss of ecosystems. GHGs in the atmosphere have impacts on the environment because increases are considered the primary factor in global warming.

11. How is carbon sequestration and carbon storage related? How do they relate to photosynthesis and the carbon stored in the gym floor?

A. The terms carbon sequestration and carbon storage are closely related but refer to different aspects of managing carbon in ecosystems, such as forests. Through photosynthesis, trees sequester carbon and release oxygen. The process of capturing and removing carbon dioxide (CO_2) from the atmosphere and converting it into a form that can be stored is sequestration, while the retention or long-term holding of sequestered carbon in natural reservoirs to prevent its release back into the atmosphere is carbon storage. Some of the forest carbon sequestered by trees remains stored in wood products such as a gym floor. Harvested wood products are important for creating another reservoir of stored carbon.

12. Are there more harvests or growth rates on maple species in your state? What does this say about sustainable forestry?

A. There is more growth than harvests, which generally indicates a sustainable forestry practice, and a next generation of healthy forests.

13. What does it mean to feel connected to nature? And connected to the trees or forests in your local surroundings and in the State where you're from?

A. No "right" answer.

14. As fossil fuels continue to be utilized in everyday life, what is one solution we can use to minimize our dependance on fossil based non-renewable resources and also reduce the amount of fossil fuel burning that creates environmental impact? Name three reasons why hardwood is more beneficial to the environment than alternative materials.

A. Using trees wisely! Sustainably harvesting trees to produce wood products that can replace products that require more fossil fuels to create. We need to continue to manage our forests sustainably, maximizing carbon storage in the forest and carbon sequestration that continues to store in wood products. Consider as a society, how much fossil-carbon is required to produce, maintain, and dispose materials. We also learned that one solution is to use wood, which is created from renewable resources, and with less fossil-based energy, which has the ability to retain carbon to delay or permanently reduce GHGs due to carbon storage. Reasons why hardwood is more beneficial for the environment: 1) renewable resource, that grows from power of the sun and not fossil-based energy sources; 2) hardwood uses less GHG emissions throughout its lifespan, reducing GHG in the environment; 3) Hardwood is made from a natural material that is biodegradable, renewable, and intrinsically sustainable.

RECOMMENDED SOURCES

Carbon Storage in Harvested Wood Products (HWP) | UNECE. (n.d.). https://unece.org/forests/carbon-storage-harvested-wood-products-hwp

Carbon Cycle Role-Play | California Academy of Sciences. (n.d.). California Academy of Sciences. https://www.calacademy.org/educators/lesson-plans/carbon-cycle-role-play

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Ramsey, N. (2022, August 30). Activity 7: Carbon on the move - Southeastern Forests and climate change. Southeastern Forests and Climate Change. https://sfcc.plt.org/section3/activity7/

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