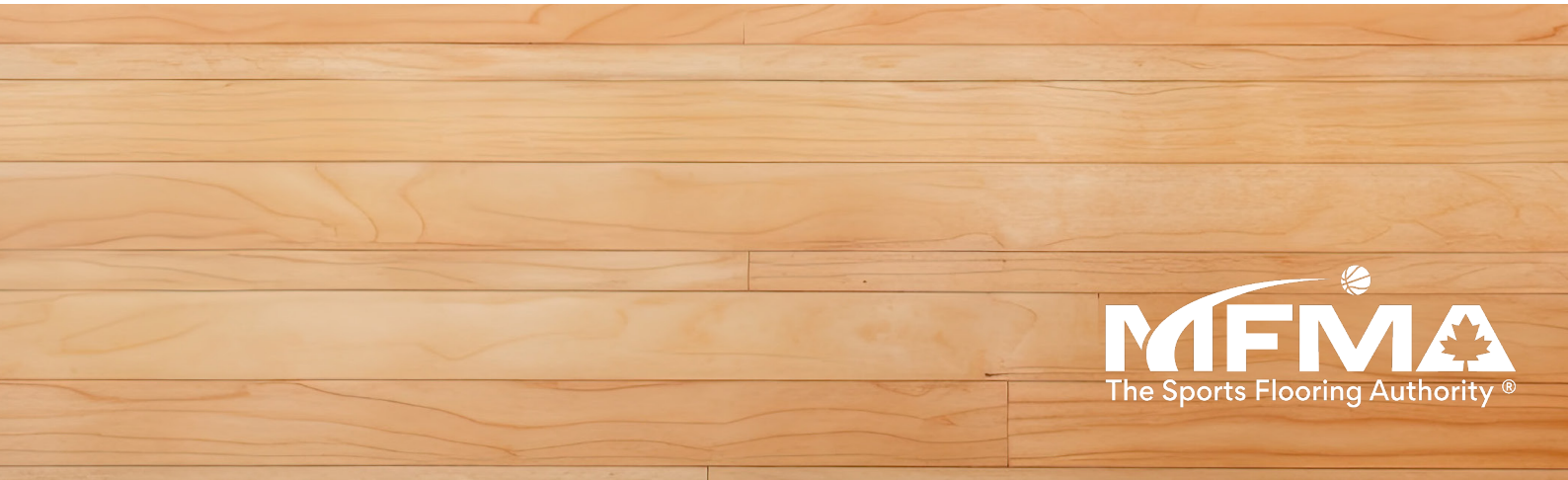
MFMA SUSTAINABILITY
Student Reading Sheet

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

www.maplefloor.org



The Sports Flooring Authority ®

Student Reading Sheet

Information about how materials, wood products, carbon, forests and climate relate
In Exercise 1, we learned about the carbon that continues to be stored in wood products. But where does this carbon come from? We've already discussed how materials are made and the various environmental impacts associated with them. Now, let's take a closer look at how materials, wood products, carbon, forests, and climate are all interconnected.

- Every living thing requires "energy" to survive. Even non-living things, such as objects like pencils and cell phones, require "energy" to be built. But what exactly is this "energy"?

- There are several ways that living and non-living things acquire energy, but the most prevalent source is the sun! The sun provides more than just sunlight; it provides energy. One way the sun does this is through photosynthesis, a process in which plants use carbon dioxide from the air and sunlight to produce food and oxygen.

- So, where does the carbon dioxide come from? Carbon is an element found in all living organisms. It moves through the oceans, the air, forests, and animals. When these organisms die, carbon is released back into the atmosphere. This is part of the natural carbon cycle.

- Another type of energy comes from fossil carbon, also known as fossil fuels. This is separate from the natural carbon cycle. Non-wood alternatives, such as synthetic materials, are petroleum- or fossil-fuel-based.

- While carbon exists in the atmosphere, it is attracted to oxygen (the air we breathe), forming carbon dioxide (Figure 1).

- Generally, the total amount of carbon on Earth remains stable. In fact, greenhouse gases (GHGs) are essential for life to exist on Earth. However, the amount of carbon in any given part of the planet can fluctuate depending on the movement of the carbon cycle. We can think of the cycle in terms of "sinks" (places where carbon is stored) and "flows" (the movement of carbon between these sinks).

    - Natural carbon systems are crucial for maintaining stable levels of GHGs that prevent excessive greenhouse gas concentrations, which can negatively impact the environment. Human activities, like the burning of fossil fuels, contribute large amounts of carbon dioxide and other GHGs to the atmosphere, pushing levels beyond what natural systems can regulate, thus contributing to global warming.

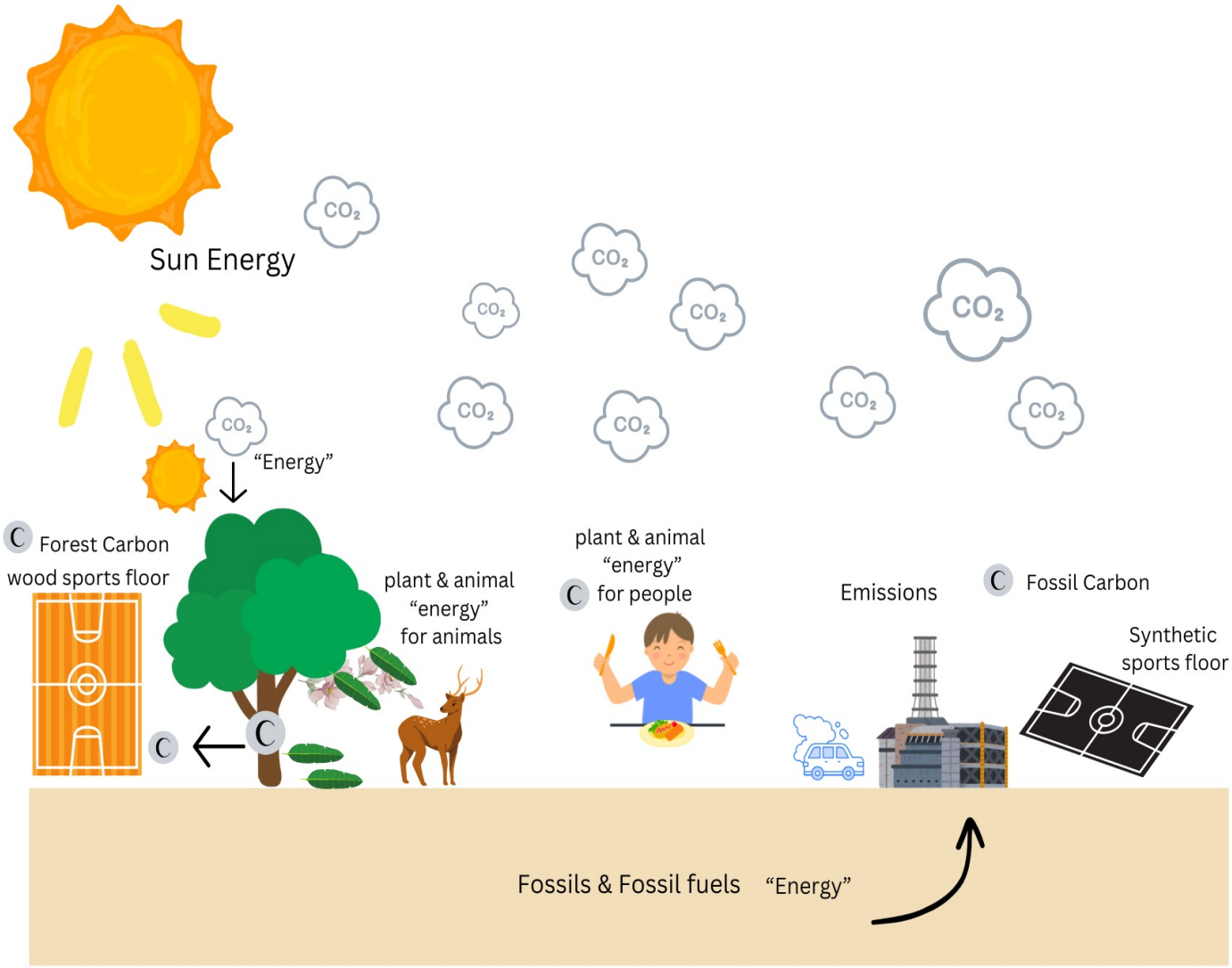


Figure 1. Different types of "energy." Comparison between fossil energy and plant energy from CO2

FOSSIL-BASED CARBON & FOREST CARBON

- The origin of carbon, whether from the forest or from fossil-based sources, affects the environmental impact of different products. Additionally, the amount of fossil carbon "energy" required to form, create, build, and produce certain products can have varying environmental consequences.

- Different materials (e.g., concrete, synthetic, hardwood) require different amounts of natural or fossil-based carbon to produce and manufacture into products. This results in varying levels of greenhouse gases (GHGs) being released into the atmosphere. This partly explains why the materials we select for products can impact the environment and influence a sustainable future.

- Carbon dioxide (CO_2) is just one of several greenhouse gases (GHGs), including methane (CH_2), nitrous oxide (N_2O), and water vapor. When we refer to any of these individually, we can call them GHGs.

- The burning of fossil fuels releases greenhouse gas (GHG) emissions, contributing to global warming and causing environmental impacts on people and the planet. Excessive amounts of fossil-based GHGs in the atmosphere are considered the primary driver of global warming.

- High levels of GHGs can contribute to respiratory diseases from smog and air pollution, and lead to the loss of ecosystems.

- While there are many efforts to find alternative energy sources, society remains heavily dependent on fossil carbon to meet power and product needs. If much of society still relies on fossil-based energy sources, how can we reduce our usage or decrease the amount of GHGs in the atmosphere?

- One solution is to use wood wisely, continue to manage our forests sustainably, and maximize carbon storage in the forest and carbon sequestration in wood products. As a society, we should consider the fossil carbon required to produce, maintain, manufacture, and dispose of the various materials we use.

THE CARBON CYCLE IN HARD MAPLE, SPORTS FLOORING EXAMPLE

To further understand how carbon flows through the atmosphere and into wood products, let's consider the example of sports flooring. By looking at the entire life cycle—from growth to disposal—we can see how carbon storage is important and beneficial to the environment. We'll focus on four stages: growth, harvest, processing, and disposal, recognizing that this is a closed-loop system for carbon storage. Here's how it works:

Growth: Through photosynthesis, trees like hard maple sequester carbon dioxide (CO_2) from the atmosphere and release oxygen, storing the carbon in their biomass. This process of capturing and converting CO_2 into a form that can be stored is known as carbon sequestration. While most people recognize that trees provide clean air by producing oxygen, they also play a critical role in capturing and storing carbon!

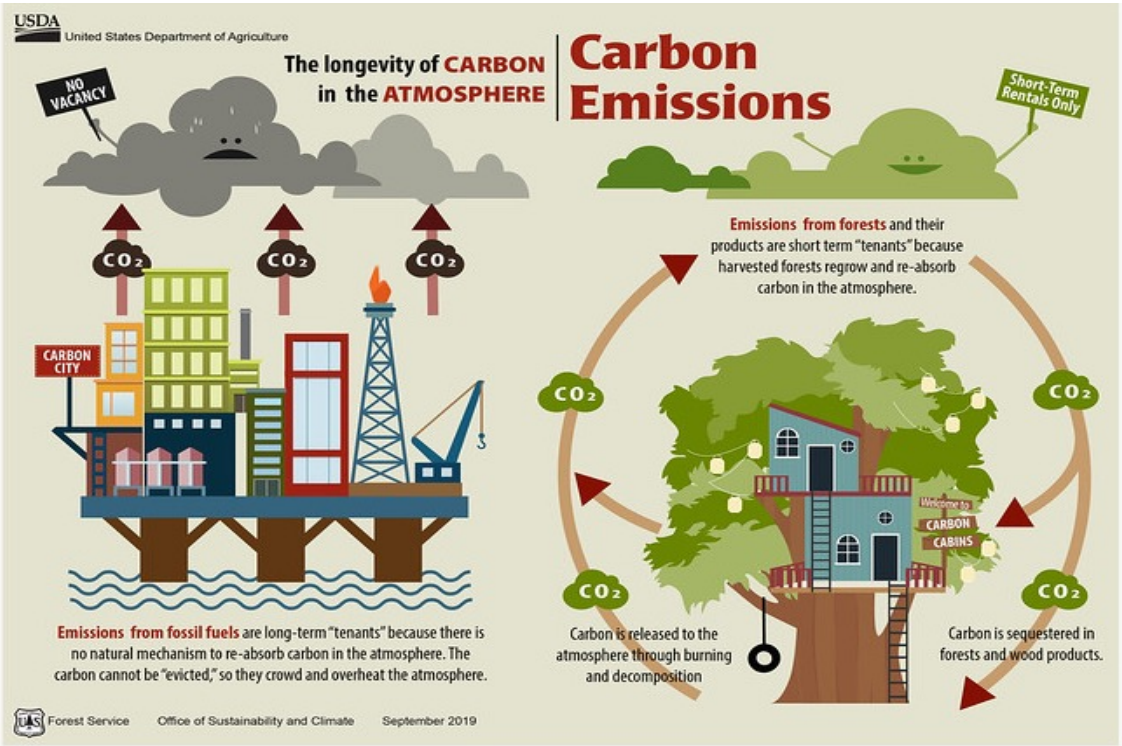
Harvest: Did you know that solid hardwood is made up of 50% carbon? When trees are harvested, their carbon remains stored in the wood. This means that the carbon sequestered by the forest remains "locked" in wood products (such as sports flooring) for many years, potentially even longer than the life of the building itself. The retention or long-term storage of sequestered carbon in natural sinks (like wood products) prevents its release back into the atmosphere, which helps mitigate the effects of global warming. This is known as carbon storage, and it's essential for reducing CO_2 levels in the atmosphere and preventing warming of the planet.

Processing: During the processing of harvested trees into products such as sports flooring, carbon remains stored in the material. Studies show that hardwood products release fewer GHGs during processing compared to alternative non-wood materials like synthetics. As a result, using hardwood products instead of synthetic alternatives helps "save" or "avoid" the release of additional GHGs into the atmosphere.

Disposal: Even during disposal (e.g., in landfills), carbon remains stored in hardwood products due to the slow decomposition rates of wood. While the carbon eventually may be released as the material decomposes, it remains stored for a significant amount of time, which contributes to the reduction of GHGs in the short term.

TABLE 1
Comparing the Environmental Impacts of Wood vs Alternative

Hardwood (maple gym floor)	Alternative materials
Hardwood is a renewable material that needs no fossil energy to grow, because it is grown from the sun.	Require fossil energy to create. Does not derive from renewable materials.
Hardwood often uses the least amount of fossil energy to produce as compared to other materials e.g. concrete, plastic. Some of the time, hardwood products are produced using fuel from plants (biofuels), which emit less GHG than fossil fuels.	Requires larger amounts of fossil energy to create.
Stores forest carbon and significantly delays or permanently prevents the release of GHG emissions, helps to maintain a balanced flow of carbon in the atmosphere.	Stores carbon that is fossil-based. This does not restore balance to the natural flow of carbon and minimize increases in GHGs in the atmosphere.
Harvested wood products such as gym floors create another carbon sink by storing more carbon than released (Figure 4).	Does not create a new carbon sink.
Hardwood is made from a natural material that is biodegradable, renewable, and intrinsically sustainable.	Alternative materials may not be made of natural materials, are not renewable or intrinsically sustainable and able to regrow.



This graphic illustrates the open cycle of fossil fuel emissions to the atmosphere and the biogenic, closed loop of forest carbon in the atmosphere. (USDA Forest Service graphic)

Figure 2. The natural carbon cycle with forest carbon compared to fossil carbon in the atmosphere

FORESTRY: CARBON SINKS & SUSTAINABLE FORESTRY

- Another way carbon is removed from the atmosphere is through carbon sinks and sustainable forestry.
- Many ecosystems act as natural carbon sinks, absorbing more carbon dioxide from the atmosphere than they release. Examples include oceans, forests, wetlands, and grasslands.
- Sustainably managed forests in the United States are a net carbon sink, meaning they absorb more carbon than they release.
- This natural flow of carbon helps maintain balance in the atmosphere. Understanding how forests sequester carbon and the dynamics of the natural carbon cycle allows us to make informed decisions about forest stewardship.
    - When we harvest trees for wood products, the carbon from the forest remains stored in the wood.
    - 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 CO2 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 CO2 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.
    - When trees die in a forest, they decay, releasing some carbon into the atmosphere and some into the soil.
    - Sustainable forestry ensures we have healthy forests that continue to store carbon while also producing wood products that store carbon.
- As a society, we rely on products and materials in our daily lives. Forests can provide many of these resources, while using less fossil energy than alternatives and storing carbon.

USE WOOD WISELY

- If forests are so important as carbon sinks, why do we cut down any trees? If we use more wood in more products, will we run out of forests to visit?

- Forests vary by type, location, and management objective. Different categories of forests each have distinct management goals. Management objectives depend on the landowner's goals. Examples include:
  - Public forests
  - Private forests
  - School forests
  - Urban forests
  - National forests
  - State forests
  - Working forests
  - Land trust forests
  - Experimental forests

- Understanding the differences in forest types helps explain why and how certain trees are cut, preserved, or managed. It also provides insight into the health of a species or ecosystem. Like other environmental practices, using forests for resources, recreation, economic gain, or carbon storage requires balance to achieve the most efficient outcomes. For example, to maximize carbon storage, forest management might involve ensuring a combination of older trees and new plantings.

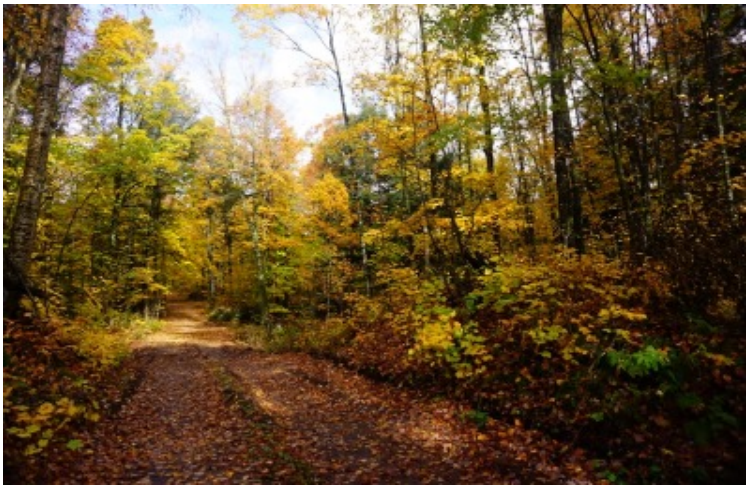
WORKING FORESTS

- The wood used in sports flooring comes from working forests that are sustainably managed.

  - Working forests provide a range of values and services to the public while maintaining the forest's natural character. These forests are not simply preserved in their natural state; instead, they are managed to provide economic, ecological, and social benefits in a sustainable manner. This requires a balance between the needs of the forest and the needs of people. For example, clean water, recreation, scenic beauty, plant and animal habitats, timber, and bio-based fuels are all valuable resources.

- The sports flooring industry relies on hardwood trees to produce thousands of floors each year. This reliance fosters a sense of stewardship to ensure that trees will be available for future generations—this is the essence of sustainability.

- Sustainably managed forests balance the needs of the environment, wildlife, and local communities, ensuring forest health for generations to come. Sustainable forestry means we allow forests to regrow more than we harvest, ensuring that forests will be available for future generations.



HARVESTING MAPLE & MAPLE SPECIES CHARACTERISTICS

- A **maple tree**, particularly the **hard maple**, is considered shade-tolerant, meaning it can thrive with less sunlight compared to other trees. Hard maple trees grow well under the canopy of larger, more mature trees. This trait shapes forest management strategies, as the growth and regeneration of hard maple require specific environmental conditions, including near-complete canopy cover.

- As a result, hard maple is harvested primarily through selective harvesting, where individual mature trees are chosen for removal, while ensuring that enough mature trees remain to maintain the surrounding canopy. Unlike clear-cutting, which removes most of the trees in an area, selective harvesting removes individual mature trees while preserving the overall structure of the forest. This approach helps maintain the canopy, creating conditions favorable for the growth of new hard maple saplings beneath the existing trees.

- Maple trees regenerate best when the forest canopy is opened to an intermediate degree, allowing sufficient light for seedlings and saplings. These trees grow best in a biodiverse forest with a mix of different tree ages. Shade tolerance also allows hard maple seedlings to grow slowly in low-light conditions. For successful regeneration, the existing canopy must not be fully opened all at once. Instead, forest management seeks to control light levels in the understory, promoting gradual regeneration of hard maple saplings and young trees.

- The forests where maple is sourced also prioritize wildlife habitat.

- Mature maple trees are harvested in rotations every 10-12 years from different stands throughout the forest to maintain healthy forest dynamics. Due to the species dynamics of maple, some mature hardwood trees are left standing in the forest as part of the canopy. These trees provide the necessary shade and protection for new seedlings while older trees are removed in stages. This process, known as selective cutting or “single-tree selection,” involves removing mature trees that have reached the end of their growth cycle but are not yet in the stage of natural mortality. After cutting, the forest is given time to regenerate, ensuring continued ecosystem health, supporting both carbon sequestration and biodiversity.

- By harvesting trees at their optimal point of maturity, their carbon storage potential is maximized throughout their lifecycle, from growth to harvest. When mature trees are harvested, the carbon remains stored in the wood. The timing of the harvest is crucial; removing a tree just before it reaches natural mortality prevents the carbon from being released back into the atmosphere through decomposition.

- This process allows a new generation of maple trees to grow under the shelter of the existing trees. This method is commonly used in forests that produce sports flooring to support the growth of shade-tolerant maple species in northern hardwood forests.

Maple trees are a particularly strong choice for carbon sequestration for several reasons, including their slow growth and long lifespan. Hard maple trees grow slowly but live for a long time, which allows them to store significant amounts of carbon over their lifetimes.

Once harvested, hard maple wood can be turned into durable products with long lifespans. As mentioned, sports flooring is one of the most notable products. Sports floors made from maple often outlast the buildings they occupy, providing significant, long-term carbon storage benefits. The durability of these products means that the carbon remains "locked" in the flooring for many years, potentially even longer than the life of the building itself.

So far, we have learned how greenhouse gases (GHGs) impact environmental health and climate, with a focus on one particular GHG—carbon—to understand how carbon flows from the forest to wood products. We've learned that increasing levels of GHGs are problematic because they contribute to respiratory diseases from smog and air pollution, as well as ecosystem loss. One solution to this problem is using wood wisely, due to its carbon storage capabilities and the reduction of fossil carbon energy and emissions.

Lesson Two

7 Characteristics of Hardwood that Help Maintain a Healthy & Sustainable Environment

1. **Biodiversity**
   The hardwood forests in which maple trees grow are biodiverse. Natural resources, such as hardwood, support biodiversity by playing a role in the food chain, providing habitats for various species, and contributing to natural nutrient cycling and pollination. Biodiversity is essential for maintaining balance and supporting life. The term is short for biological diversity, and it refers to all the different kinds of life found in one area—animals, plants, fungi, bacteria, and even people—that make up our natural world. All of these organisms work together in ecosystems to maintain balance and healthy environments.

2. **Natural Materials**
   Natural products, such as wood, do not contain harmful chemicals. In contrast, non-wood alternatives that contain synthetic materials can pollute waterways and ecosystems, both during use and after disposal. Utilizing natural wood products helps reduce our reliance on artificial, fossil fuel-based materials, and minimizes disruption to natural cycles and environmental health.

3. **Renewable**
   A renewable material is one made using energy from renewable sources like sunlight, wind, water, or plants. This means the energy used to create the material is sustainable and won't run out, unlike energy from fossil fuels like coal or oil.

4. **Sustainable**
   Hardwood can be considered sustainable because trees can be harvested repeatedly and still regrow (see Activity 1.2). If we use wood responsibly, when we cut trees to make products like sports floors, the forest can continue to thrive in the future.

5. **Biodegradable**
   Hardwood contributes to less waste and pollution because it breaks down naturally, is not toxic, and is beneficial for soil, plants, and animals. Different materials break down at different rates (also called decomposition). The type of material and its composition (such as strength and density) impact the rate at which greenhouse gases are released back into the atmosphere. For example, hardwood biodegrades slower than softwood due to its denser structure. Unlike other materials, such as plastic, which cannot biodegrade at all and instead break into tiny pieces under UV rays, hardwood is biodegradable. Because hardwoods are not mixed with harmful chemicals, they are also highly reusable and recyclable at the end of a product's lifespan.

6. **Durable (Janka scale) + Long life span.**
   The more durable a material, the more likely it is to last, reducing the need for the production of new materials that require additional fossil fuel energy. The Janka scale is used to measure the hardness of a given species of wood and its level of durability. To measure hardness, a steel ball is pressed into a piece of wood, and the force required to embed the ball is measured. (Consider printing and referencing the Janka scale for students.). v

   i. Note the Janka rating of maple (figure 3).

   ii. A hardwood's durability directly relates to its long-life span, meaning that the harder and more resistant a hardwood is to wear and tear, the longer it will last before needing significant repairs or replacement, making it a more long-lasting material compared to softer woods; essentially, the higher the durability, the longer the potential lifespan of the hardwood product.

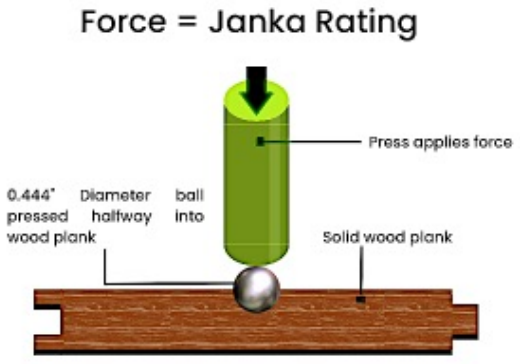


Figure 3. Illustration of Janka hardness test

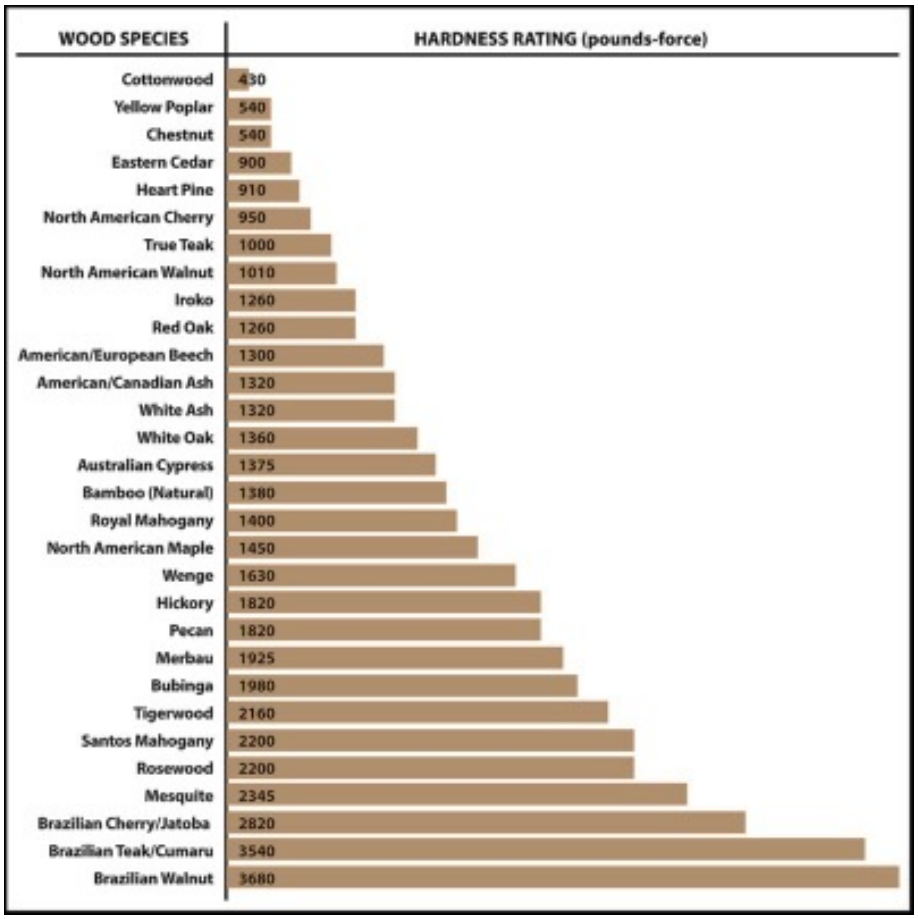


Figure 4. Comparison of different hardwood species Janka rating

The more durable a material, the more likely it is to last, reducing the need for the production of new materof tree and janka hardness scale rating. Students and 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

7. Versatile

Wood is an incredibly versatile material because nearly every part of a log can be utilized to create a wide variety of products, minimizing waste and promoting environmental sustainability. Each cut of a hardwood log usually is utilized for a specific wood product, for example, flooring is usually the second or third cut of a log, while the other cuts are used for paper, veneers, or other new innovative brand-new wood products!