ACTIVITY 12

The Carbon Puzzle

In this group activity, students assess a series of facts to understand how to manage plantation forests to maximize the removal of atmospheric carbon as they practice cooperative learning and graph interpretation skills.

Subjects
Agriculture, Biology, Environmental Science, Mathematics

Skills
Communicating, Data Analysis, Group Participation, Interpreting Graphs, Organizing Information, Problem Solving, Synthesizing, Systems Thinking

Materials
Student pages, presentation, and answer key (see Activity Webpage link below); scissors

Time Considerations
One or two 50-minute periods

Related Activities
Students should have an understanding of climate change (Activity 2), carbon cycle (Activity 7), and life cycle assessment (Activity 10). This activity helps reinforce and apply these ideas. It can be a culminating activity to the unit, or can be followed by the other activities in this section (Activities 13 and 14).

Research Connection
Scientists are conducting studies to better understand the amount of carbon that is stored in forests and forest products. They are synthesizing research about forest management, the carbon cycle, forest carbon sequestration, and life cycle assessment to understand how forests and wood products can mitigate climate change.

Activity Webpage
Find online materials for this activity at https://sfcc.plt.org/section5/activity12

Objectives

By the end of this activity, students will be able to

- explain the role forests can play in reducing atmospheric carbon through various carbon pools: live trees, dead wood, wood products, and forest products substitution, and
- identify skills that enhance cooperative group work.

Assessment

- Ask students to write a one-page summary that explains the role forests and wood products can play in reducing atmospheric carbon. Students could respond to this prompt by explaining how the carbon pools change over time, resulting in more sequestered carbon.

Background

Across the globe, scientists are investigating how to sequester and store more ***carbon dioxide*** in ***carbon sinks*** such as forests. They are also seeking to understand how to reduce the amount of carbon ***emissions*** by improving efficiency or using less carbon-intensive products. These two lines of actions are related and, in fact, can work together. For example, researchers with the Consortium for Research on Renewable Industrial Materials (CORRIM) have tracked and analyzed carbon across multiple ***carbon pools***. This research ties together several key concepts conveyed in this module: carbon cycles, carbon sequestration, and ***life cycle assessments*** to explore how forests can be managed to reduce atmospheric carbon dioxide.

Carbon Pools

A well-known ***climate change*** solution involves reducing the amount of carbon dioxide in the ***atmosphere*** through ***carbon sequestration*** in forests (see Section 3 for more background information). Trees remove atmospheric carbon dioxide and store it in their trunks, leaves, and roots as they grow. Because young, growing trees accumulate ***biomass*** at a faster rate than older trees, they also sequester carbon at a faster rate. Mature trees continue to sequester carbon, of course, but this is balanced by the decay of branches and trees that die. So at the forest scale, additional carbon is not removed from the atmosphere by a mature forest. It does, however, store a lot of carbon in the living trees, dead wood, and soil. The carbon in the dead wood will eventually move to the atmosphere and the soil.

Additional information related to the carbon cycle can be found in the **Section 3 Overview** and **Activities 7** and **8**, and information on life cycle assessment can be found in the **Section 4 Overview** and **Activity 10**.

If trees are ***harvested*** for wood products, such as paper or lumber, the carbon in the wood becomes part of these and other products. Paper is a ***short-lived wood product***; the carbon

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a carbon-intensive product. When using wood, which sequesters carbon, instead of products that cause more carbon to be put into the atmosphere, huge reductions in atmospheric carbon can result. These reductions are referred to as ***carbon savings*** in this activity.

In this activity, students seek to answer this question: How can we best manage planted pine forests and wood products to reduce atmospheric carbon dioxide? The activity will engage students in a discussion about the storage of carbon in live trees, dead wood in the forest, short-lived wood products, long-lived wood products, and forest product substitution. Research shows that reductions in atmospheric carbon dioxide can be maximized by harvesting forests on short rotation cycles so that a constant supply of solid wood products is available to be substituted for carbon-intensive products (Lippke et al., 2010; Perez-Garcia et al., 2005). This research was conducted in the Northwest, where trees are harvested after 45 years for lumber. However, in the Southeast, loblolly pine trees can be harvested for ***lumber*** within 25 to 35 years.

Using wood products, which sequester carbon, instead of carbon-intensive products is one way that consumers can reduce atmospheric carbon dioxide.

in these products returns to the atmosphere or soil when they decay or are burned. Lumber, on the other hand, is a ***long-lived wood product***. Depending on how the lumber is used, carbon can stay stored in wood for many years. When forest carbon and wood products are assessed together, sequestration is maximized by growing trees quickly, harvesting before growth slows down, and storing the wood in long-lived products.

Concrete requires cement, and the production of cement generates carbon dioxide from the combustion of fossil fuels and the process of converting calcium carbonate to lime. Currently, our society uses a lot of concrete in building construction around the world.

Forest product substitution is the practice of using wood instead of carbon-intensive nonwood products. For example, lumber can be used instead of other construction materials, such as concrete or steel, to build houses and buildings. Life cycle assessments have shown that producing concrete releases a great deal of carbon dioxide—making it a carbon-intensive product.

These concepts are introduced in this activity in two ways—through a cooperative learning exercise format known as Six Bits and through a graph that combines all the carbon pools.

Students may recall that ***deforestation*** is one factor that contributes to the increase in atmospheric carbon and may confuse that with forest harvesting. The difference is that a pine ***plantation*** is replanted—this piece of land is always sequestering carbon by growing trees. Deforestation refers to permanently removing forest from the landscape and converting the land into a land-use type that sequesters less carbon (farms or housing, for example). With sustainable ***forest management*** for wood products, forests can be planted, grown, and harvested forever, which enables carbon to be stored both in the growing forest and in long-lived wood products.

Six Bits

In Part A of this activity, students solve a puzzle about how forests, trees, and wood products help remove carbon from the atmosphere. The forests described in this activity are planted pine forests, just like the many southeastern forests that are managed for pulp or timber production. These forests are different from ***naturally regenerated*** or old-growth forests, as the trees in planted pine forests are generally the same age (because they are grown on the same rotation schedule and grow best in full sunlight) and are planted in rows. All privately owned forests are managed according to a landowner's stewardship, economic, or personal objectives.

The Six Bits activity is accomplished by separating the mystery to be solved into small "bits" of information. Students are organized into groups of six where each student is given one of six cards with bits of facts. Card 1 contains the question, and students are asked to work together to answer that question. If students are comfortable working in groups and tackling challenges, they will quickly realize that when they share information on their cards they can collectively determine how it fits together and solve the puzzle. Less adept students, however, may wait to be given more information. You can decide how much to reveal to your students, based on their abilities.

The only rule for the activity, which is written on each card, is that students are not allowed to *show* or *give* their cards to another student. They should, however, verbally share the information on the cards. This guarantees that everyone will be actively engaged in reporting and listening to the information. Note that some students misinterpret this rule to mean that they are not allowed to *reveal* the information on their cards. You can help them understand they are supposed to talk and work together; they can read their cards, but they cannot abdicate responsibility by giving all the cards to one person!

Students who have had practice working in cooperative groups may, on their own, designate a group leader (or perhaps the person with easy access to paper and pencil will become the leader), who will begin to ask group members to identify concepts and report any related facts. You can help students by asking them to choose a leader and a secretary; writing the question on the board to focus everyone on the problem; and suggesting they first ask for all the bits of information related to carbon in trees, then forests, and then carbon in wood products. You may need to explain the concept of substitution (when wood is used instead of a product that has greater carbon emissions during production). It is possible, however, for groups to complete the exercise without additional direction.

Through this activity, students learn not only about forests and carbon but also about the power of cooperation in learning and problem solving. Since each group of six receives the same instructions, the activity wrap-up includes a discussion question about why some groups worked well and others may have stumbled. The importance of identifying a leader, along with leadership and teamwork skills, can be discussed. The Six Bits process models an important societal skill by illustrating how cooperative actions help solve problems and how everyone has valuable knowledge to contribute. In conducting

In this activity, students work cooperatively to solve a puzzle related to climate change and forests. The teachers pictured here are experiencing the activity at a teacher symposium on climate change.

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Systems Thinking Connection

IN THIS ACTIVITY students use a behavior-over-time-graph (BOTG) to explore the relationship between forest management and ***carbon storage***. A BOTG is a common ***systems thinking*** tool to help students understand how different ***stocks*** (or pools) of a ***system*** interact. The key insight here from a systems perspective is that the matter (e.g., the carbon, oxygen, nitrogen) in a forest does not disappear when trees are harvested. Rather, it is incorporated into other stocks.

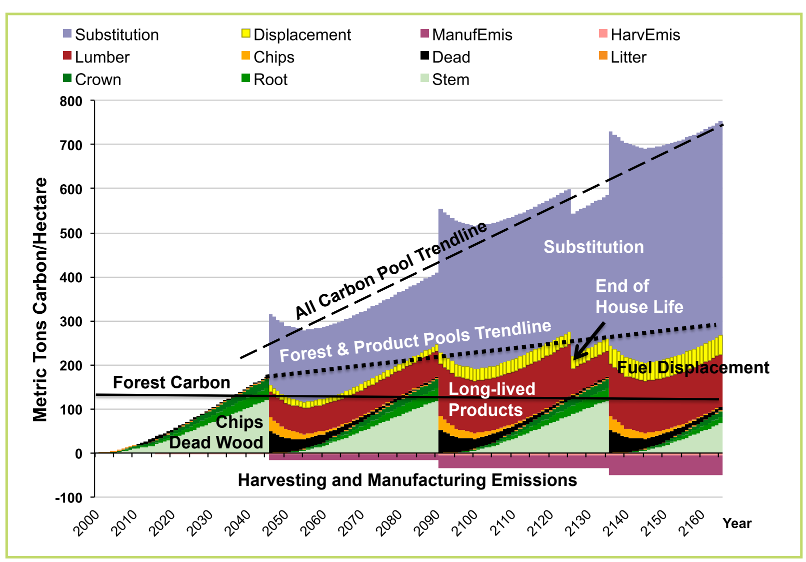
As children, we are taught to throw trash away. Systems thinking helps reveal that in reality there is no "away" for these things. The Earth is a materially closed system, meaning that except for the occasional meteorite (added material) and some space junk (orbiting and thus temporarily-removed-material), it has the same amount of carbon, nitrogen, and phosphorous today that it had when it was formed roughly 4 billion years ago.

Instructors may want to emphasize the different time scales at which the various stocks are formed. The carbon in the wood stocks (e.g., forest, short- and long-lived wood products) cycles in decades. The carbon saved by not manufacturing energy-intensive concrete, however, will continue to reside in the geological portion of the ***carbon cycle***, where it has been for millions of years.

this activity with your students, you may point out that collaboration works on more than just the classroom level—it may also help people think through issues such as climate change. You may wish to notice if single-sex groups work differently than groups of both males and females, and ask the students why that might be. How does understanding these group dynamics affect how we solve problems?

Combining Carbon Pools in a Graph

To reinforce the answer to the Six Bits puzzle, Part B presents a graph that combines carbon pool data over the course of 150 years (figures 1 and 2). The carbon included in the graph is measured from forests, dead wood, short-lived wood products, long-lived wood products, and carbon saved. As you can imagine, this graph is complex and provides a great opportunity to sharpen graph-reading and interpretation skills. The Tracking Carbon presentation provides a step-by-step explanation of the graph and each carbon pool and how they combine to build the final figure in the teacher notes for each slide. You can use this presentation to guide students through the complex graph and enable them to answer questions as they complete the student page.



LIPPKE ET AL., 2010

Figure 1. The information presented in this activity is based on research that explores how forests, wood products, and wood substitution can reduce atmospheric carbon dioxide (Lippke et al. 2010).

Teaching This Content

This activity helps you summarize the concepts in this module by demonstrating how all of us can contribute to healthy, sustainable forests and communities. Engaging in small group discussions through the Six Bits activity helps your students practice important communication and critical-thinking skills. How might understanding forest management in a changing climate improve your students' abilities to address climate change? By becoming more proficient at understanding and exploring complexity, students will be better able to address complex issues related to climate change through their comprehension of stocks and flows.

This activity supports teachers in developing key knowledge and skills among their students. Part A promotes students' cooperative and communication skills, and Part B gives them practice with scientific instructional representations (i.e., graph). When we pilot tested this activity with teachers, they told us that the puzzle should come first. Even though students may be confused, this is a good way to use curiosity to sustain their attention and interest so they can make sense of the graph.

Getting Ready

The Activity 12 webpage provides **Teacher Tools** that you can use to become more familiar with this activity's background and procedure (https://sfcc.plt.org/section5/activity12).

This activity synthesizes information from Sections 3 and 4. It will be beneficial if students have already become familiar with the carbon cycle (Activity 7), carbon sequestration (Activity 8), and life cycle assessment (Activity 10).

Download the Tracking Carbon presentation from the Activity 12 webpage. If you feel you would like more guidance for Part B before using it with your students, an additional narrated version of the Tracking Carbon presentation can be found on the Activity 12 webpage. Make copies of the Six Bits student page, one for each group of six students. Cut each page along dotted lines to form sets of six cards for each group.

Doing the Activity

Part A: Six Bits

1. Remind students of the carbon cycle (see **Activity 7: Carbon on the Move**) and prompt them to list the different ways carbon enters

TEACHERS SAY ...

This was one of the best activities for pulling a lot of the information together.

—Biology Teacher, Kentucky

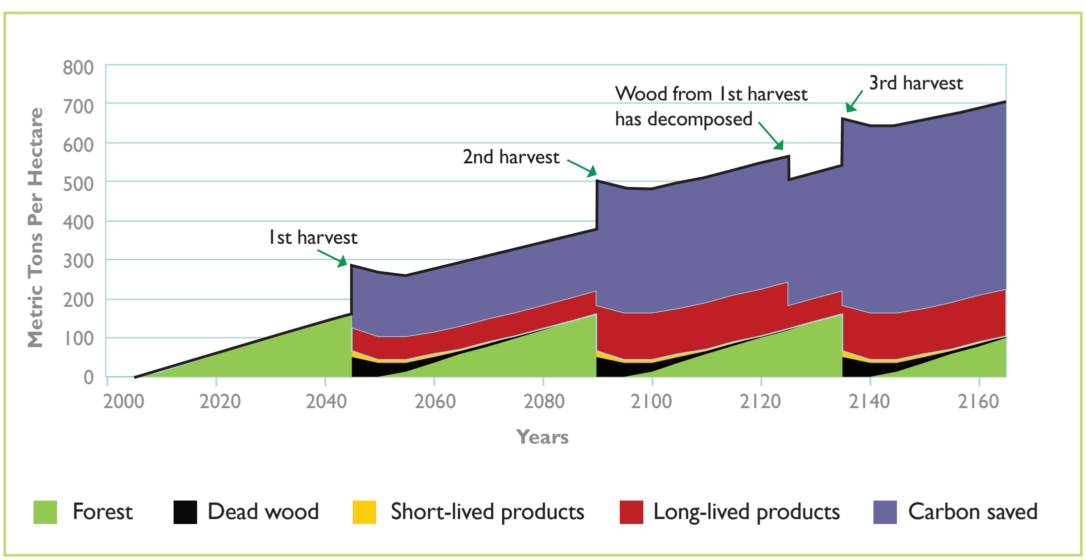


Figure 2. The Tracking Carbon presentation walks students through creating a simpler version of the carbon pools graph.

and leaves the atmosphere. Remind them of life cycle assessment (see Section 4) and ask them where the carbon goes when a tree is used to build a house. Briefly discuss the concepts of forest product substitution and carbon savings; students will learn more about these concepts as they solve the Six Bits puzzle. The introductory slides of the Tracking Carbon presentation provide a brief overview of carbon, the carbon cycle, and the role of carbon in climate change. These slides may be useful if you have not completed Activity 7 with your students.

2. Divide the class into groups of six students. If the class is not evenly divisible, make a few groups with less than six students rather than groups with more than six students.

3. Explain to students that they are going to work in small groups to solve a puzzle related to climate change and forests. Each group will get the same set of six different cards, and each student will get one (or more) of the six cards. One of the cards has the question that the group must answer. Explain to students that every group member has different "bits" of information that are essential to answering the question, so everyone will need to participate. The goal is for students to figure out the information they need, in the order they need it, so that everyone can participate and help answer the question. This teaching strategy engages everyone and reduces the problem of freeloaders in group tasks. You can also challenge groups to see who can finish the puzzle first. Instruct students in the following rules of Six Bits:

- Students are not allowed to *show* their cards to anyone else.
- Students are not allowed to *look* at the cards of other students.
- Students should tell other group members the clues on their card when they are relevant or necessary for solving the puzzle.
- Each group is responsible for answering the question posed on Card 1.

4. Distribute one set of Six Bits cards to each group. Each student should receive one card, face down. Ask students not to look at their cards until instructed to do so. For groups with less than six students, distribute all the cards, but ask for volunteers or select students to receive more than one card so that the group still has all the information needed to solve the puzzle.

5. When everyone has received their cards, ask students to read their cards silently and then work together to share clues and answer the question. Remind them that only one student has the question and the first step will be for that student to read the question to the group. Or, you might ask a student with Card 1 to read the question aloud and write it on the board. Every group is solving the same puzzle, but they will likely use different strategies to do so. Invite them to pay attention to *how* they solve the problem. Provide as little or as much guidance as you wish, depending

TEACHERS SAY …

The activity was great. I would not be able to use it without first using Carbon on the Move and Counting Carbon. The Six Bits activity was very engaging. This would benefit my AP class as a review just prior to the exam.

—AP Environmental Science Teacher, Florida

Alternative Six Bits Method

If you'd like to provide more structure and guidance to help students with the Six Bits exercise, try this alternative method.

1. Write the question on the board and underline the three main terms: planted pine forest, wood products, and atmospheric carbon dioxide.
2. Ask students to silently read the statements on their card and to categorize them using the three main terms.
3. Next, have students go through each term one at a time and share within their group the statements they included in that category.
4. Then ask students to look at the remaining statements, share them, and help each other build a better understanding of managing a forest for carbon.
5. One or more students should take notes so the group can clarify what they understand about each main term.
6. Then students can synthesize what they have learned to answer the question.

on how comfortable your students are with ambiguity and cooperative tasks (see the Alternative Six Bits Method box on this page).

6. Circulate throughout the room, answering questions and noting how leadership develops, what causes difficulty, and the order in which groups finish. Ask students to let you know when their group solves the puzzle.

7. Once all the groups have solved the puzzle, ask students the question posed by the activity: How can we best manage planted pine forests and wood products to reduce atmospheric carbon dioxide?

8. Have each group of students share their answers to the question. Students should have discovered that reductions in atmospheric carbon dioxide can be maximized by harvesting forests on short rotation cycles of 25 to 35 years so that a constant supply of solid wood products is available to be substituted for carbon-intensive products.

9. Broaden the discussion to talk about how students solved the puzzle, using these questions as a guide.

- Who took a leadership role in your group? What skills and resources did that person have?
  Leadership may manifest itself in many ways during a Six Bits activity. It could be that a person with the insight to ask everyone else questions is the one who gets the ball rolling to solve the puzzle. It could be the person who has a pencil and is able to take notes.
- Did everyone participate equally? What prevented or encouraged equal participation?
  For example, it could be the gender ratio in a group either favors or hinders group cooperation. Personality may also play a role with more talkative individuals participating more. Did they invite quieter students to contribute?
- How effectively did the group function? What might have improved efficiency? You may ask the group that finished first how they solved the problem so quickly.
- What skills were used to complete this task as a group?
- What different strategies helped some groups solve the puzzle?

10. Discuss with students the advantages of group collaboration. You may ask if they enjoyed depending on each other for information, or whether they were frustrated because they couldn't work by themselves. Most real-world situations require cooperation between parties with different interests, including climate change and forest management issues. Learning how to effectively utilize the skills and knowledge of all participants is in the best interests of everyone.

Part B: Combining Carbon Pools in a Graph

1. Explain to students that the answer to the Six Bits puzzle can also be displayed visually, through a graph that combines carbon pool data over 150 years. Use the Tracking Carbon presentation to guide students through the data regarding each carbon pool and how those data can be combined to provide a more complete view of carbon sequestration. The teacher notes included in the presentation provide an explanation for each carbon pool as well as for how to build the final figure.

2. Once you have gone through the presentation with the students, display the last slide, which shows the combined data from all carbon pools, and ask students to answer the questions on the Combining Carbon Pools student page. An answer key is available on the Activity 12 webpage.

3. Review the correct responses as a class to ensure student understanding.

In addition to the **Tracking Carbon** presentation that you can use with students, the Activity 12 webpage includes a narrated Teacher's Guide to help you better understand how to explain the graph.

4. Systems Reflection: How does studying a behavior-over-time-graph help promote systems thinking?
Behavior-over-time-graphs are tools to help people understand systems as dynamic rather than static. By providing a picture of how multiple variables in a system are changing over time, they allow people to better understand the patterns involved in those changes and the relationships between the variables over a certain period of time.

5. Summarize Part A and Part B of this activity by reminding students of the role of carbon pools and fluxes within an ecosystem and by synthesizing information about forest management, the carbon cycle, carbon sequestration, and life cycle assessment. How can plantation forests be managed to maximize productivity in a changing climate? How might the concepts of carbon pools and fluxes play a role in consumer decisions when considering climate change mitigation? Should we use policy to influence markets to encourage people to use wood products?

Modifications

You may wish to simplify this activity, particularly if your students struggle with understanding and interpreting data through graphs. In this case, you may wish to complete just Part A of this activity. The first half of the Tracking Carbon presentation will still be useful if you choose to do this modification. If students are struggling to solve the Six Bits puzzle, consider a "Team Six Bits" activity. To do this, divide your class into six groups and give each group of students one of the Six Bits cards. Then, students can work as a class to solve the puzzle.

Enrichment

Have students read the CORRIM fact sheet (available at http://www.corrim.org/pubs/factsheets/fs_05.pdf), which includes other carbon pools not covered in this activity. You can then lead a class discussion using the following steps:

- Ask students what those other pools represent and how each new pool affects the numbers regarding carbon sequestration.
- Help students discuss the strategies that can be used to reduce atmospheric carbon by asking them to categorize the carbon pools discussed in this activity. First, as a class, list possible carbon pools. Then ask students to place the various carbon pools into groups based on whatever criteria they like.
- Have the students describe their chosen groupings in class. Possible groupings include human-made (short-lived and long-lived wood products) versus natural (forest, dead wood). The substitution pool may not fit well with the other groups. It's fine to leave it on its own. Other groupings may be based on the length of time the pool is intact with short-lived pools (dead wood and short-lived products) in one pool and long-lived pools (forests, long-lived wood products) in another. If students do not mention this distinction on their own, be sure to emphasize it for them.
- Wrap up the discussion by reminding the students that the substitution pool involves carbon that has not been in the atmosphere for millions of years.
- Ask students to graph the carbon pools in a cornfield or a forest that is cleared for urban development. They should be able to select the pools and graph them to indicate relative amounts.

Additional Resources

CORRIM Presentations
Consortium for Research on Renewable Industrial Materials (CORRIM)
www.corrim.org/presentations/index.asp
This portion of the CORRIM website provides several videos and presentations related to assessments of carbon storage, life cycles, and product substitution.

Forests for the Next Century
http://rethinkforests.com/
This website has information and several videos related to forest health, climate change, and carbon sequestration in wood products.

Forest Management Solutions for Mitigating Climate Change in the United States
Robert W. Malmsheimer et al., 2008
www.ntc.blm.gov/krc/uploads/399/Forest%20Management%20Solutions%20 for%20Mitigating%20Climate%20Change.pdf
This *Journal of Forestry* article contains an executive summary and chapters related to preventing greenhouse gas emissions through wood substitution and biomass substitution, as well as information about reducing atmospheric greenhouse gases through sequestration in forests and storage in wood products.

Maximizing Forest Contributions to Carbon Mitigation
Consortium for Research on Renewable Industrial Materials (CORRIM), 2009
http://www.corrim.org/pubs/factsheets/fs_05.pdf
This fact sheet summarizes CORRIM research findings for life cycle assessment studies related to carbon in forests, forest products, and wood product substitution.

Towers of Steel? Look Again
Henry Fountain, The New York Times, September 23, 2013
http://www.nytimes.com/2013/09/24/science/appeal-of-timber-high-rises-wid-ens.html?pagewanted=all
This newspaper article reports on how some architectural firms are exploring the use of timber, rather than steel and concrete, to build skyscrapers that sequester carbon.

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Lippke B., Wilson, J., Meil, J., & Taylor, A. M. (2010). Characterizing the importance of carbon stored in wood products. Wood and Fiber Science, 42 CORRIM Special Issue: 5–14. Retrieved from http://www.corrim.org/pubs/reports/2010/swst_vol42/5.pdf

Perez-Garcia, J., Lippke, B., Comnick, J., & Manriquez, C. (2005). An assessment of carbon pools, storage, and wood products market substitution using life-cycle analysis results. *Wood and Fiber Science, 37 Corrim Special Issue:* 140–148. Retrieved from http://soilslab.cfr.washingtonedu/Publications/Perez-Garcia.pdf

Six Bits

Instructions: For each group of six students in your class, make one copy of this sheet. Cut the six cards along the dotted lines. Distribute a set of cards for each group—one card per person for each group of six. Remind students that they cannot show their cards to each other, but they should share the information verbally.

Card 1

Do not show this card to anyone in your group. You may read the information on the card to your group.

- How can we best manage planted pine forests and wood products to reduce atmospheric carbon dioxide?
- Fertilizer application helps trees grow faster.
- Forest product substitution is the practice of using wood instead of other products.
- Lumber is a long-lived, solid wood product; the carbon can stay stored in wood for many years, depending on how the lumber is used.

Card 2

Do not show this card to anyone in your group. You may read the information on the card to your group.

- Substituting wood products for more carbon-intensive products leads to additional reductions in atmospheric carbon dioxide.
- For buyers to choose lumber over concrete, lumber must be available and sold at a competitive cost.
- Growing trees faster is one way to sequester more carbon.
- After trees are harvested, carbon in the wood can be stored in forest products, such as paper and lumber.

Card 3

Do not show this card to anyone in your group. You may read the information on the card to your group.

- Forest product substitution is a carbon pool.
- Trees that grow on pine plantations are harvested for forest products.
- The average useful lifespan of a wood house is 80 years.
- Harvest cycles of 25 to 35 years provide a steady supply of solid wood products.

Card 4

Do not show this card to anyone in your group. You may read the information on the card to your group.

- As trees grow, they remove atmospheric carbon dioxide and store it in their trunks, leaves, and roots.
- Recycling paper is one way to keep carbon out of the atmosphere.
- Lumber can be used instead of other construction materials, such as concrete or steel, to build houses and buildings.
- Young, growing pine trees up to about 25 years old sequester significantly more carbon than mature trees.

Card 5

Do not show this card to anyone in your group. You may read the information on the card to your group.

- Forest carbon (stored in trunks, leaves, and roots) is an important carbon pool.
- Concrete and steel production release a great deal of carbon dioxide—making these products carbon-intensive.
- For landowners to manage their forests for lumber, there must be a market to sell their wood.
- Mature southern pine trees over 40 years old maintain the carbon they have sequestered, but do not add a lot of additional carbon.

Card 6

Do not show this card to anyone in your group. You may read the information on the card to your group.

- Paper is a short-lived wood product; the carbon in these products returns to the atmosphere when they decay or are burned.
- When only considering the forest carbon pool, carbon storage is maximized by maintaining old, mature trees.
- Life cycle assessments of concrete and wood reveal that concrete contributes significantly more atmospheric carbon than wood.
- Forest products (such as lumber and paper) are an important carbon pool.

Combining Carbon Pools (1 of 2)

NAME DATE

Based on the discussion about the carbon pools and using the graph of data from those pools (see page 2 of this handout), answer the following questions.

1. Where does the carbon come from when trees grow?

2. When the forest is cut (years 2045, 2090, and 2135), which carbon pools decrease immediately? Which carbon pools increase immediately? For each carbon pool, explain why it increases or decreases.

3. What happens immediately to the total carbon (represented by the black line that follows the top edge of the colored area on the graph) during the years that trees are harvested? Explain why in terms of your answer to Question 2.

4. What happens to the total carbon sequestered during the decade after each harvest year (2045–2055, 2090–2100, and 2135–2145)? Explain this behavior in terms of the carbon pools.

5. What happens to the total carbon sequestered at year 2125? Which carbon pool is responsible for this behavior? Explain why this carbon pool changes during this year.

6. Describe the carbon-saved pool. Why is this the biggest component on the graph? If it is so much bigger than the forest pool, can we obtain these benefits without the forest carbon pool?

7. Which carbon pools tend to grow over time and which ones are cyclical, rising and falling over time? What insights about carbon sequestration does this provide?

Combining Carbon Pools (2 of 2)

Forest + Dead Wood + Short-lived Products + Long-lived Products + Carbon Saved Pool