VALUE OF A TREE

Full Lesson Plan

Activity Plan

Project Skills or Goals or Objectives:
Understand the relationship between woody biomass, jet fuel, and carbon.
Analyze the decision to harvest or preserve a tree.
Life Skills:
STEM, Environmental Awareness, Data Literacy
Audience:
3rd – 12th grade
Number of Participants: 35 max
Program Length:
2-3 hours
Supplies Needed:
Class Worksheets
Reference Charts
PowerPoint slides
Clipboards
Pens/Pencils
Carbon Cycle Game
VOAT lesson kit
Do Ahead:
Prepare equipment
Set up carbon cycle game
Sources:
See “Resources” section
Developed by:
Justin Hougham and Upham Woods research naturalists
Funded by:
WEEB 2016 Forestry Grant (Grant no. 2016 – 0009).

BACKGROUND

This lesson will introduce students to the concept of renewable fuel source from biomass. They will learn about where woody biomass originates and how it is used in jet planes. They will compare the amount of fuel that can be harvested from biomass to the amount of carbon that a tree has sequestered. Students will then debate the merits of harvesting the tree for timber and fuel versus leaving it standing to sequester carbon and provide habitat. This lesson is possible thanks to a Wisconsin Environmental Education Board 2016 Forestry Grant (Grant no. 2016 – 0009).

LESSON OBJECTIVES

After completions of this activity, participants will be able to:

- Understand the renewable resource that is woody biomass
- Understand the Carbon Cycle and the major processes within it (photosynthesis, combustion)
- Understand the effects that carbon has within our atmosphere
- Use tools and basic math to determine the size and biomass potential of a tree
- Debate the best usage of a tree
- Achieve several of the Department of Energy’s Energy Literacy Principles (for complete list see Resources)

Carbon Cycle Game Materials

- Print outs (7 stations signs, 7 Movement directions)
- 7 dice
- Recorder sheets for each student

VOAT lesson kit

- (2) 100' Yard Tapes
- (2 – 3) DBH Tapes
- (2) Forestry Clinometers
- (2) Homemade Clinometers
- (2) Increment Borers
- (2) Calculators
- Celestron Handheld Microscope and Microsoft Surface Pro

TABLE OF CONTENTS

1. INTRODUCTION

- Introduce yourself and then introduce the VOAT project using PowerPoint Slide 2.
- Tell the students that they will be making concept maps, exploring the carbon cycle, using forestry tools to measure trees, and calculating the available biomass in a few trees on site. Tell them their goal for the project is to ultimately fly a plane from Lambeau Field to Soldier Field.
- Thank them for participating in the online assessment- this will help us better understand how to teach these important concepts better.

2. USING TECHNOLOGY TO SEE TREES IN NEW WAYS (Hook) 10 minutes

a. Observing the tree without using technology

- Divide students into groups of 3 – 4 students, allowing each group to choose a target tree they would like to learn more about. Have the students look at the tree closely; what does the bark look like? Observe the different patterns in the leaves or the stems. How do branches and twigs grow out? Students can write down their observations or vocalize them, recording or remembering questions they would like to explore further.

b. Observing the tree using technology

- Connect the Celestron Handheld Microscope to the Microsoft Surface Pro. Access the Celestron MicroCapture Pro app to be able to utilize the microscope. Allow the students to explore their tree with the handheld microscope, observing the bark, stems, branches, twigs and leaves/needles. How are the patterns from their first observations different from their second observations (with the microscope)? How are the patterns or observations the same?
- Have the students describe one thing they did not know about trees before exploring with the microscope.
- Explain to the students that, building upon what they have already learned and observed about their tree, they will get the opportunity to learn about the tree's true full potential.
- Equipment:
  - **Microsoft Surface Pro**

    Apps on the Surface Pro that provide a hook to the lesson to have students start thinking about trees in a new way.

    - Corinth Micro plant- provides a visual value of a tree, with definitions of the parts of a tree. Ability to zoom in from a full tree level to microscopic leaf structures. Select the "Dream Walk" button at different levels to discover more detail. For instance, if 'Dream Walk' is selected at the tree level, students can learn more about the crown, branches, and roots, and what each structure provides the tree.
    - iBird Guide: identify birds that are seen or heard during the activity. What birds are using the student trees as habitat? This could help determine the habitat potential of the given tree.
    - Nature Detective: keep track of the different trees, animals, flowers, insects and birds observed during the time outdoors. Could be used with this lesson to determine the wildlife habitat potential of the given trees in the area.
    - Students could also use the surface pros to access the online assessment.

- **Celestron Handheld Microscope**

  The microscope can also be used in conjunction with the increment borer later in the lesson to count the tree's growth rings, and examine the microscopic structure of the core sample.

3. CONCEPT MAPPING THE VALUE OF A TREE [PowerPoint Slide 3] <u>20 minutes</u>

- Split the students into pairs or small groups. Ask them to create a concept map of their perceived value of a tree, being sure to include the new thing they just learned about trees from the "hook" of the lesson. If needed, explain the idea of a concept map using a simplified version. Examples of good simplified versions include "your sibling' or 'your teddy bear' to flesh out such ideas as 'what does your teddy bear provide you?' i.e. comfort, warmth etc. This will help students with the idea of what trees provide them. Give students 10 minutes to complete this activity. Monitor and engage students during this process.
- Allow up to 10 minutes for a group share out and go over briefly the words on the instructor's concept map (PowerPoint slide 5). Introduce the terms and explain to the students that they will learn more about these things during the lesson. Inform students that they are now tasked with the great responsibility of determining if a tree is more beneficial to be left alive to sequester carbon dioxide and provide habitat or to be turned into products including lumber and jet fuel.

4. CARBON CYCLE BACKGROUND <u>10 minutes</u>

- Students first need to understand the Carbon Cycle. Images 2 and 5 in the appendix and PowerPoint slides 6-8 are good representations of the Carbon Cycle with respect to the forestry industry. It is important to know that plants are made of cellulose- a long, linked chain of sugar molecules that give plant walls their strength. Limitations of these images include: missing plant respiration representations, and that the arrows of the overall cycle are not to scale. Go over the flow of these images with the students, highlighting these points: The presence of cycles within cycles, the fact that plants trap carbon dioxide via photosynthesis and convert it to plant biomass (sugars within the plant), if plants and animals are buried quickly after death they can turn into fossil fuels, and finally the point that forests are one of the largest carbon sinks on the plant, second only to the ocean.
- Some topics that may need some additional explanation include:
  - Photosynthesis, aka "How do plants make food?" [slide 6, image 2]
    - Explain the very basic process of photosynthesis. Light + CO2 + Water = O2 + Sugar (a carbon molecule). Ask where the carbon compounds are stored by the plant, and where the carbon compounds go if they are covered in soil?
  - Fossil Fuels: How are they formed? [slide 7, image 3]

- Briefly explain how different fossil fuels are formed by using the infographic as a tool. The main take away from this topic is that 1) fossil fuels take a very long time to form and 2) different recipes of organic matter, heat and pressure form different fossil fuels.

5. CARBON CYCLE GAME [slides 9-10] <u>10-15 minutes</u>

- Give all the students Carbon Cycle Game Recorder sheets and pens/pencils. Explain that different sources and sinks of carbon are located around the room. Students should choose a station to start with and record that station on the first line of their Recorder Sheet. Have students roll the dice at each station to determine where they should go next, recording each roll of the dice on their Recorder Sheet. Once their sheet is filled up, have students return to their seats until everyone is done.
- Students can create a bar graph of how many times they went to each station on the back of their Recorder Sheet. This will help them visualize how much time carbon 'spends' moving around the cycle or 'stuck' at different carbon sinks. Discuss what stations the students were 'stuck' at the most.
  - **Carbon Sink**

    Explain to the students what a carbon sink is; something can be described as a carbon sink when it takes in more carbon than it gives off over a period of time. In the forestry industry, trees are considered a carbon sink. Younger forests need more carbon because they are growing at a quicker rate than older forests. Refer to Image 6 for more details. Notes about the graphic: the horizontal axis represents decades, and the vertical axis represents hectares (1 hectare = 2.4 acres or almost 2 football fields). If students are having difficulty with this concept, explain that trees needs a good root system established before they can focus on upward growth. Refer to image 10 for the fact that 27% of a tree is underground. Because younger forests sink more carbon, a rotational system for harvesting tree plantations is beneficial for the long term storage of carbon in the soil.
  - **Carbon in the Atmosphere: Greenhouse gas effect**

    Now that students know a little bit more about carbon, they can begin to understand carbon's role in the atmosphere. Referring to PowerPoint slide 11, explain how the greenhouse effect works. Note that too little greenhouse effect would let our planet get too cold for life to thrive, and too much, well we're currently running that planetary experiment, evidenced by stronger storms, phenology changes etc.

    Refer to images 7 - 9, and 12 – 14 and slides 12 - 15 for more information about carbon dioxide's effect on the planet and how humans may be a factor in the increase of atmospheric carbon.

6. ASSESSMENT: STUDENTS' UNDERSTANDING OF ENERGY 5 minutes

- Assess the student's understanding of the concept of energy. What is energy? Energy is the ability to do work. Gauge the students' grasp of the usage of energy by asking them one way in which they used energy today. Examples might include: getting here, eating, cooking, etc.
- Ask the students if energy can always be observed. No, it is present, but not always visible, however, with close inspection there can be evidence of energy all around us. Challenge the students to inspect the room for signs of energy. Continue their assessment with asking what sources of energy their household/school uses. Are the sources renewable or nonrenewable? Renewable energy sources are those that can be used without running out, while nonrenewable sources have a limited supply and cannot be recreated. Renewable energy sources include solar, wind, geothermal and hydropower, while nonrenewable sources include coal, oil and natural gas.
- Wouldn't it be cool if we could get our energy from something we see all around us? We can! We can use trees and their biomass to produce the energy we need.

7. VALUE OF A TREE [slide 16] 15 minutes

- Before going too deep into the concept of biomass, circle back to the function and values of a tree that students created in their concept maps. Is there anything they would like to add now that they know a little more about what trees may be able to provide us?
- Explain that timber value is the main reason for harvesting a tree, but there are many uses for trees, including a recent push for renewable biofuels. Currently the U.S. forest products industry produces $200 billion in sales a year and employs about 1 million workers [9]. Industrial round wood is all wood used for any purpose other than energy [10], including pulpwood, fence posts, telephone poles, building materials etc. Explain to students that not all parts of a tree are usable for these products. Image 10 is helpful to explain how much is usable and how much is discarded. Normally, the tops and limbs of the trees – called slash- are left on the ground and later burned, releasing their stored carbon into the atmosphere. Instead of burning the slash piles, new initiatives have begun collecting it and turning it into other products such as aviation fuel, among other things.
    - **Biomass**

      The focus of this lesson will be on the renewable energy source that students often understand the least- biomass. It is simple enough for most students to acknowledge that the sun, wind, water and even the Earth are sources of energy. However, many do not think that energy can be stored in living things. Biomass can be defined as the material taken from living, or recently living organisms.

When talking about turning woody biomass into a fuel source, it is important to note that we are referring to only the parts of a tree that remain after logging- the slash.

- **Biomass to Biofuels** [slide 17 – 20]

  Biofuels refer to the energy made from renewable plant and animal materials. A simplified definition may explain a biofuel as burning the leftover biomass to create power. The biofuels this lesson is talking about are a bit more technical than that, however. Image 11 can be used to explain the process of turning woody biomass into usable jet fuel.

  The steps include:

  1. Plants are made of cellulose, which is just long chains of sugar molecules
  2. The woody biomass is broken down until just the sugars remain
  3. Scientists use microbes and fungi to break down the sugars, releasing energy. The energy byproducts can be a usable fuel source.

8. EVALUATING A TREE 30 - 40 minutes

For the sake of this activity, we will see how much jet fuel is required to transport the Green Bay Packers via 747 jet from Lambeau Field to Soldier Field to play against the Chicago Bears - roughly 175-mile trip. [Slide 22]

Break the students into groups of 3 – 4. Provide each group with a clipboard, pen/pencils and copies of the “What is the Value of this Tree” worksheet. Take the students outside to the designated trees and assign each group a tree to work with. Explain that they will be taking measurements of the tree to determine how much fuel can be harnessed from their single tree, and determine how many trees that size may be needed to fuel the jet for the trip.

- **Measuring Height**

  Tools from the VOAT kit you will need to use include: 100’ measuring tape, forestry clinometer, homemade clinometer and calculator. Step by step, visual instructions for the trigonometry method are also included in the VOAT kit lesson package.

  There are multiple ways to measure the height of a tree.

  1. Person method: have a volunteer stand next to the tree. Tell them that they are about 2 meters tall and have the other students guess how many versions of the volunteer, stacked head to toe it would take to be the same height as the tree. This method works well for younger students or those who may not understand the math behind the other method.

2. Trigonometry method: Have a student stand 50’ or more away from the chosen tree, far enough away that they can easily see the top of the tree. Record how far away they are from the tree. Have them measure the angle it takes for them to see the top of the tree with either the homemade clinometer or the forestry clinometer. Explain that they now have the angle and the adjacent side of a triangle. Using the tangent calculation (Tan (Angle) = Opposite / Adjacent.) have the students solve for the opposite side. Add the distance from the ground to the measure person’s eye to get the fully accurate height of the tree.

- **Measuring Circumference**

  The easiest way to determine the circumference of a tree is to use the Diameter at Breast Height (DBH) tape. One side of the tape provides the diameter of the tree at breast height, while the other side of the tape provides the circumference based on the diameter.

Have students follow the steps on the worksheet, filling in the values they collect. Using the “How much Carbon is in a Tree” chart, with the values for height and circumference, students can determine how much carbon their tree has sequestered. Remember that only the top 23% - or the slash- of the tree has the potential to be used for biofuel production. From the amount of carbon in their tree’s top 23%, they determine how much biofuel potential the tree has. They then calculate how far their one tree’s biofuel potential can fly a plane. Have the students identify the numbers of trees identical to theirs that would be needed to complete the full 175-mile flight. If possible at the location, have students walk out a plot of the total number of trees they will need.

- **Measuring Age**

  Explain that a tree grows outward every year from the center in concentric rings. When a tree is cut down, or a large branch is cut from a tree, its age can be determined by counting the number of rings. This is fun; however, no trees will be cut down during this activity. Instead, an increment borer can be used to drill a small hole into the tree, pulling a core sample out, and counting the number of rings that way. Once students have measured the height of their tree, have them guess how old they think their tree is just by its outward physical characteristics. How can they tell what age it is? Have them assist in pulling the core sample from the tree, comparing how old the tree is to their estimates.

  When finished, gently slide the core sample back into the tree, sealing up the hole. Taking a core sample will not hurt the tree overall, it is able to heal over the core sample if it is returned to the tree.

9. CONCLUSION

- **Discussion of the Best Use of a Tree** 10 minutes

  In their groups, have the students come to a decision about the best use of their tree, and why they chose what to do. Have each group state their opinion about their tree to the class, and allow for discussion between groups. There is no right answer about what should be done with trees, the point is to get the students to realize the full potential of trees.

- Circle back to the concept map the students created at the beginning of the lesson. Are there any values of a tree they didn't know about before this lesson that they want to add to their maps? What did they find most interesting about this lesson?

- Ask the students why the information they gathered today was important
  - In a few short years, they will be the ones responsible for policy and decision making.
  - What jobs might renewable energies and biofuel productions impact? How might it affect their personal lives?
  - What are the benefits of negatives of using biomass derived from trees versus corn?

10. EXTENSIONS

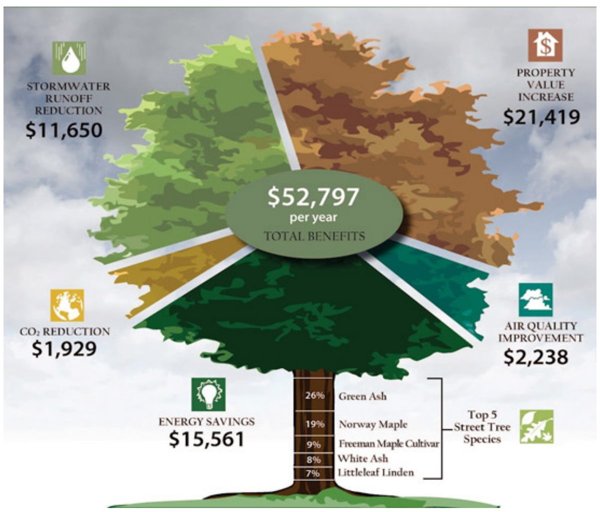
- **Debate the Value and Use of Trees**

  Assign each group to represent a different role in a debate. Some example roles could include:
  - The Timber Industry – interested in using slash and other woody biomass to build things such as tables, plywood, particleboard and other building materials and household items. Goal is to cut down all the trees to maximize profit.
  - The Biofuel Industry – interested in using slash and other woody biomass to create new biofuels to power jets, cars and city busses. Interested in obtaining as much slash as possible to maximize profits.
  - Conservationist- interested in keeping trees standing to provide habitat for wildlife, and sequester carbon. Goal is to sequester the greatest amount of carbon to attempt to reverse the amount of CO_2 in the atmosphere.
  - Tree Farm Owner- interested in harvesting the trees on their property, selling them to the Timber and Biofuel industry, but still maintain good habitat and environmental quality of the trees on the property. Goal is to make the most money from selling the trees, while also caring about the environment and wildlife.

Provide time for the groups to research facts to support their assigned positions. To assist in forming their positions, groups can fill out the Value of a Tree: The Great Debate and Debate Role Frames handouts. Once the students are ready to present, set up a debate in the classroom space. Allow the groups to present their positions, debating whether a tree should be left standing to provide habitat for wildlife and sequester carbon, versus harvesting the tree for biomass potential and biofuel production. There is no right answer, the goal is for the students to realize that a tree can have many different values.

11. RESOURCES a. Images

1.



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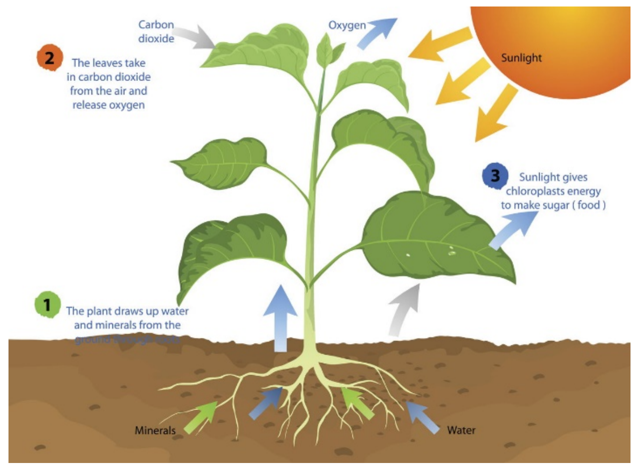

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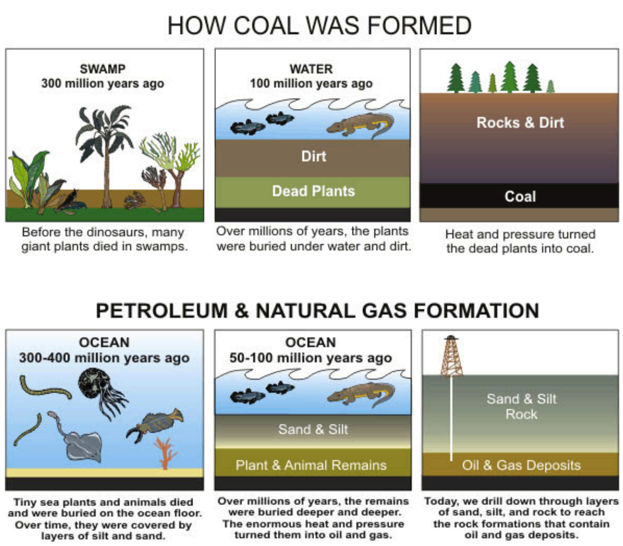

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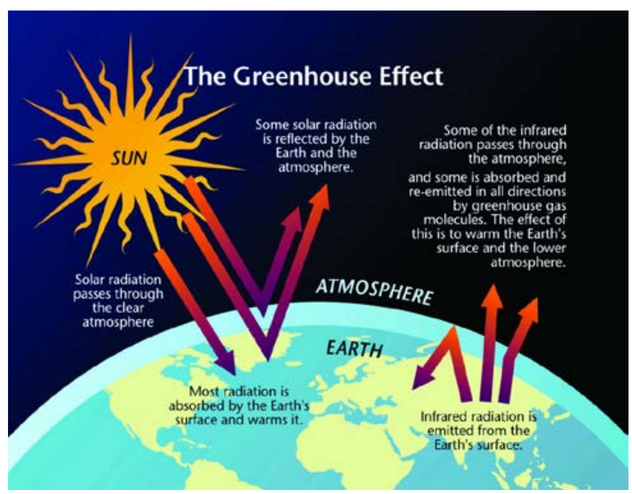

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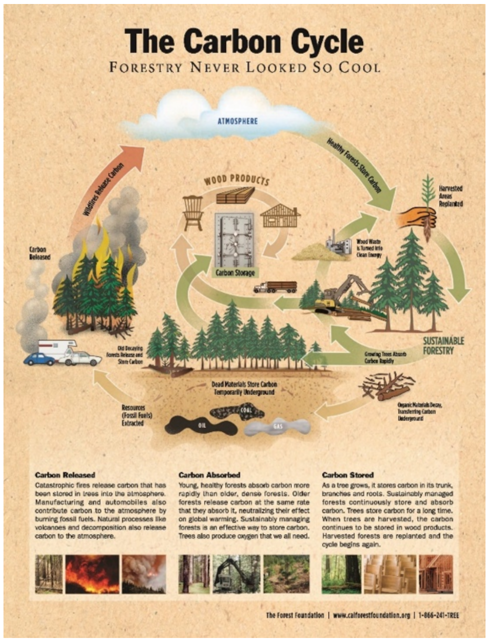
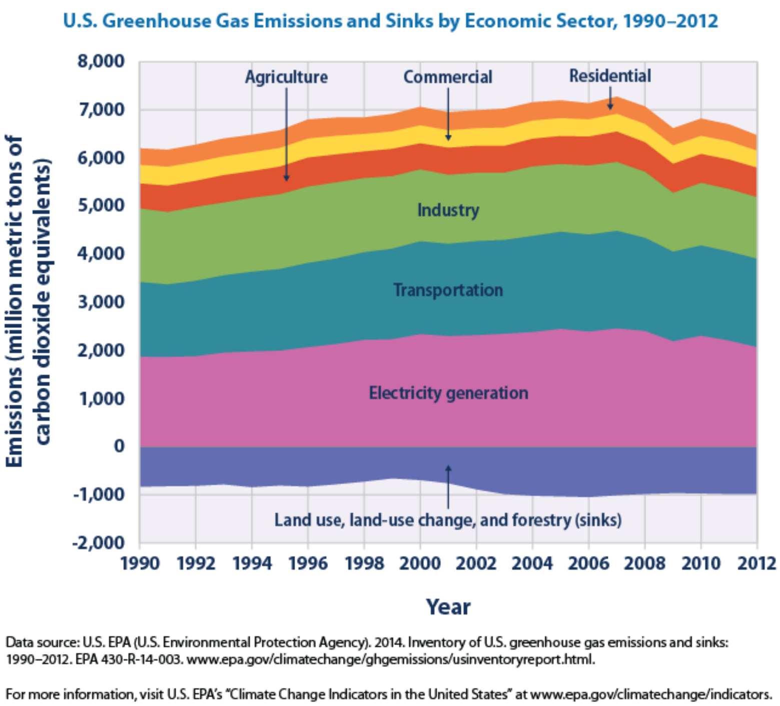


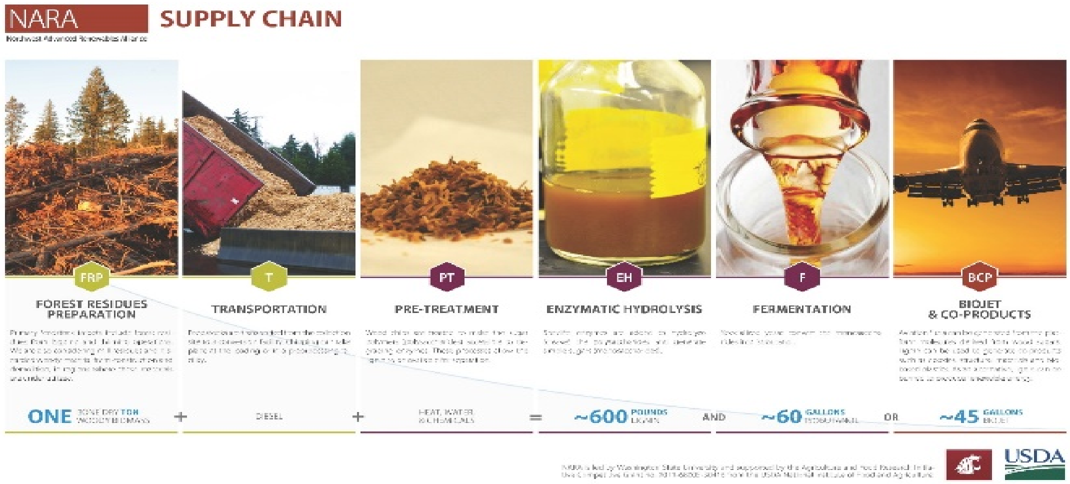
The Carbon Cycle
Forestry Never Looked So Cool
ATMOSPHERE
WOOD PRODUCTS
SUSTAINABLE FORESTRY
Carbon Released
Carbon Absorbed
Carbon Stored

6.



U.S. Greenhouse Gas Emissions and Sinks by Economic Sector, 1990–2012
Emissions (million metric tons of carbon dioxide equivalents)
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
-1,000
-2,000
Agriculture
Commercial
Residential
Industry
Transportation
Electricity generation
Land use, land-use change, and forestry (sinks)
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012
Year
Data source: U.S. EPA (U.S. Environmental Protection Agency). 2014. Inventory of U.S. greenhouse gas emissions and sinks: 1990–2012. EPA 430-R-14-003. www.epa.gov/climatechange/ghgemissions/usinventoryreport.html.
For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at www.epa.gov/climatechange/indicators.

7.



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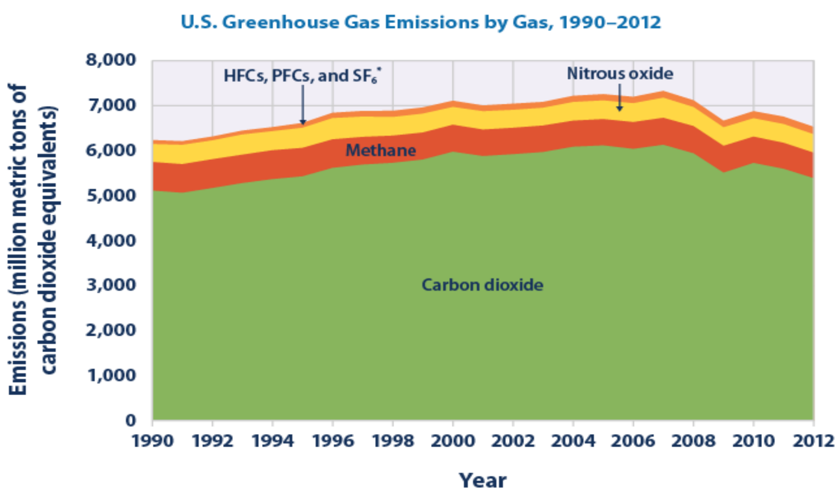

* HFCs are hydrofluorocarbons, PFCs are perfluorocarbons, and SF_6 is sulfur hexafluoride.

Data source: U.S. EPA (U.S. Environmental Protection Agency). 2014. Inventory of U.S. greenhouse gas emissions and sinks: 1990–2012. EPA 430-R-14-003. www.epa.gov/climatechange/ghgemissions/usinventoryreport.html.

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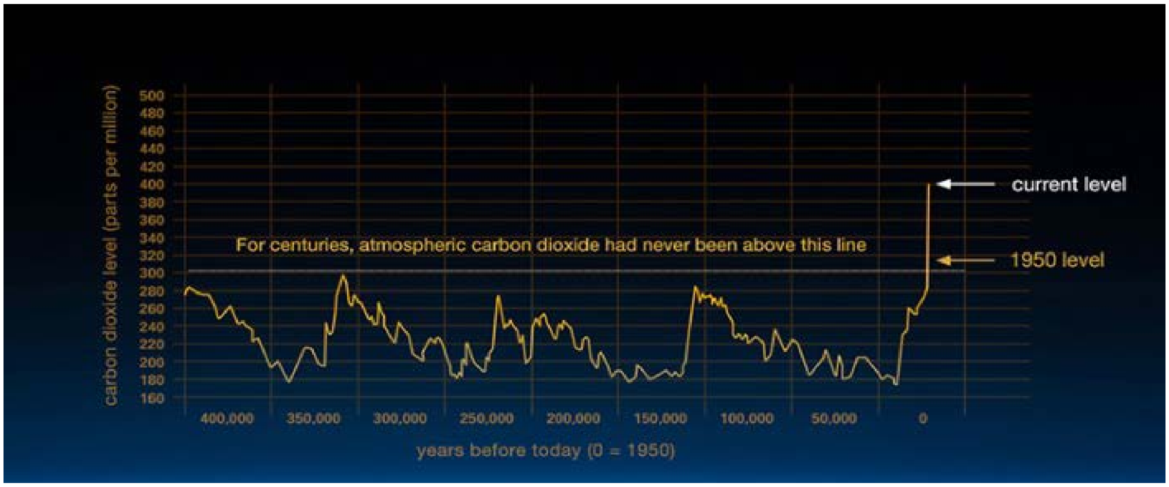
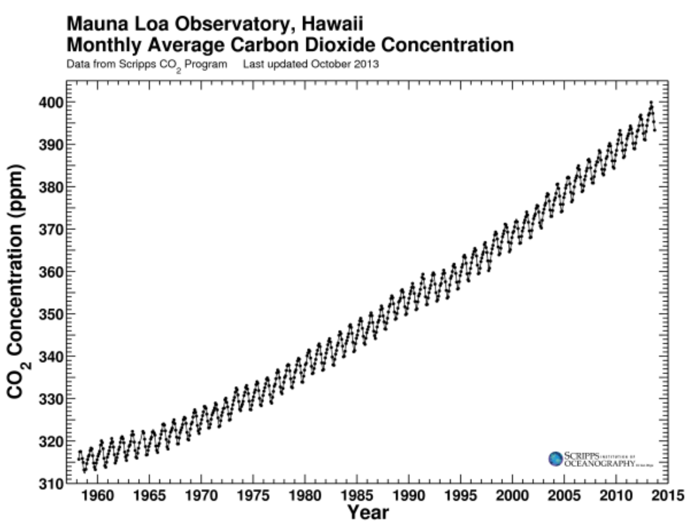
9.


carbon dioxide level (parts per million)
500
480
460
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
current level
1950 level
For centuries, atmospheric carbon dioxide had never been above this line
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
years before today (0 = 1950)

10.


Mauna Loa Observatory, Hawaii
Monthly Average Carbon Dioxide Concentration
Data from Scripps CO_2 Program Last updated October 2013
CO_2 Concentration (ppm)
400
390
380
370
360
350
340
330
320
310
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
Year
SCRIPPS OCEANOGRAPHY

b. Worksheets and Charts

HOW MUCH CARBON IS IN A TREE? (kg)

Tree Height (m)	Circumference at Breast Height (m) 0.25	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.25	2.5	2.75	3.0	3.25	3.5	3.75	4.0	4.25	4.5
2.0	10	14	19	26	36	48	61	77	95	115	138	162	189	217	248	281	316	353
4.0	11	18	28	43	62	86	113	145	181	221	266	315	368	425	486	552	622	696
6.0	13	22	38	60	89	124	165	213	267	327	394	467	547	633	725	823	928	1,040
8.0	14	26	48	77	115	162	217	281	353	433	522	620	726	840	963	1,095	1,235	1,383
10	15	31	57	94	142	200	269	349	439	539	651	773	905	1,048	1,202	1,366	1,541	1,727
12	16	35	67	111	168	238	321	416	525	645	779	925	1,048	1,256	1,440	1,638	1,848	2,070
14	17	39	76	128	195	276	373	484	610	751	907	1,078	1,263	1,464	1,679	1,909	2,154	2,414
16	18	43	86	145	221	315	425	552	696	857	1,035	1,231	1,443	1,672	1,917	2,180	2,460	2,757
18	19	48	95	162	248	353	477	620	782	963	1,164	1,383	1,622	1,879	2,156	2,452	2,767	3,101
20	20	52	105	179	274	391	529	688	868	1,069	1,292	1,536	1,801	2,087	2,394	2,723	3,073	3,444
22	21	56	114	196	301	429	581	756	954	1,175	1,420	1,688	1,980	2,295	2,633	2,994	3,379	3,787
24	22	60	124	213	327	467	633	823	1,040	1,281	1,549	1,841	2,159	2,503	2,872	3,266	3,686	4,131
26	23	64	133	230	354	505	685	891	1,126	1,387	1,677	1,994	2,338	2,710	3,110	3,537	3,992	4,474
28	24	69	143	247	380	544	737	959	1,211	1,493	1,805	2,146	2,517	2,918	3,349	3,809	4,298	4,818
30	25	73	152	264	407	582	789	1,027	1,297	1,599	1,933	2,299	2,697	3,126	3,587	4,080	4,605	5,161
32	26	77	162	281	433	620	840	1,095	1,383	1,705	2,062	2,452	2,876	3,334	3,826	4,351	4,911	5,505
34	27	81	172	294	460	658	892	1,163	1,469	1,811	2,190	2,604	3,055	3,541	4,064	4,623	5,217	5,848
36	28	86	181	315	486	696	944	1,231	1,555	1,917	2,318	2,757	3,234	3,749	4,303	4,894	5,524	6,192
38	29	90	191	332	513	734	996	1,298	1,641	2,023	2,446	2,910	3,413	3,957	4,541	5,166	5,830	6,535
40	31	94	200	349	539	773	1,048	1,366	1,727	2,129	2,575	3,062	3,592	4,165	4,780	5,437	6,137	6,879
42	32	98	210	366	566	811	1,100	1,434	1,813	2,235	2,703	3,215	3,772	4,373	5,018	5,708	6,443	7,222
44	33	103	219	382	592	849	1,152	1,502	1,898	2,341	2,813	3,368	3,951	4.580	5,257	5,980	6,749	7,565
46	34	107	229	399	619	887	1,204	1,507	1,984	2,448	2,960	3,520	4,130	4,788	5,495	6,251	7,056	7,909
48	35	111	238	416	645	925	1,256	1,638	2,070	2,554	3,088	3,673	4,309	4,996	5,734	6,522	7,362	8,252

Reproduced from Project Learning Tree's Exploring Environmental Issues: Focus on Forests.
Estimates based on the formula M_c (mass of carbon in the tree) = 0.5 x M_w (mass of the wood), where M_w = 0.55 x V (volume of tree) x D_w (density of wood); V = 0.0567 + 0.5074 x $(CBH/\varpi)^2$ x H. It assumes that D_w = 0.6 g/cm³, and that water makes up 45 percent of the tree's mass
http://www.plt.org./focus-on-forests-activity-8---climate-change-and-forests

How Far Can I Fly in a Boeing 747? Chart

Amount of carbon (kg)	Distance flown (mi)	Amount of CO_2 sequestered (kg)
0-500	0-11	1,833
501-1,000	12-22	3,666
1,001-1,500	23-33	5,499
1,501-2,000	34-44	7,333
2,001-2,500	45-55	9,166
2,501-3,000	56-66	10,999
3,001-3,500	67-77	12,832
3,501-4,000	78-88	14,665
4,001-4,500	89-99	16,498
4,501-5,000	100-110	18,331
5,001-5,500	111-121	20,165
5,501-6,000	122-132	21,998
6,001-6,500	133-143	23,381
6,501-7,000	144-155	25,664
7,001-7,500	156-166	27,497
7,501-8,000	167-177	29,330
8,001-8,500	178-188	31,164

Boeing. 2014. 747 Family: 747-8 Intercontinental fun facts.
www.boeing.com/boeing/commercial/747family/pf/pf_facts.page

Reproduced from Project Learning Tree's Exploring Environmental Issues: Focus on Forests.
Estimates based on the formula M_c (mass of carbon in the tree) = 0.5 x M_w (mass of the wood), where M_w = 0.55 x V (volume of tree) x D_w (density of wood); V = 0.0567 + 0.5074 x $(CBH/\varpi)^2$ x H. It assumes that D_w = 0.6 g/cm³, and that water makes up 45 percent of the tree's mass
http://www.plt.org./focus-on-forests-activity-8---climate-change-and-forests

c. Additional Resources

- How-To Videos about using the tools—both types of clinometers, DBH tape and the increment borer tool—are available on YouTube.
- The videos can be found by searching YouTube for "Upham Woods Value of a Tree"

d. Standards Alignment

- Next Generation Science Standards

CC – Curriculum Connections
MS-PS Matter and its Interactions – CC
MS-PS1-3
MS-LS From Molecules to Organisms: Structures and Processes – CC
MS-LS1-6
Ecosystems: Interactions, Energy, and Dynamics - CC
MS-LS2-3
MS-ESS Earth and Human Activity – CC
MS-ESS3-3
MS-ESS3-4
MS-ESS3-5
HS-LS From Molecules to Organisms: Structures and Processes – CC
HS-LS1-5
HS-LS1-6
HS-LS1-7
Ecosystems: Interactions, Energy, and Dynamics - CC
HS-LS2-3
HS-LS2-4
HS-LS2-5
HS-ESS Earth and Human Activity – CC
HS-ESS3-2
HS-ESS3-3
HS-ESS3-6

- Common Core State Standards

RST.6-8.1
RST.6-8.2
RST.11-12.1
6.EE.B.6
6.EE.C.9
MP.4
HSN.Q.A.1
SL.8.5
SL.11-12.5

- Wisconsin's Model Academic Standards:

Agriculture, Food and Natural Resources
ESS4.a.4.m: Identify alternative energy sources
ESS4.a.5.h: Compare and contrast the use and environmental impact of the burning of fossil fuels (conventional energy sources).

ESS4.a.6.h: Compare and contrast the use and environmental impact of alternative energy sources.
ESS4.b.3.m: Explain the importance of surveying and mapping for environmental service systems.
ESS4.b.4.m: Demonstrate proper use and maintenance of hand tools.
ESS4.b.5.h: Explain and demonstrate surveying principles with identification of forestry equipment.
NR1.a.3.m: Differentiate between renewable and nonrenewable natural resources.
NR1.b.6.m: Describe morphological characteristics

- Department of Energy's Energy Literacy Principles

The strongest alignments are shown in bold
1.1 Energy is a physical quantity that follows precise natural laws.
1.4 Energy available to do useful work decreases as it is transferred from system to system.
1.5 Energy comes in different forms and can be divided into categories.
2.3 Earth's weather and climate are mostly driven by energy from the Sun.
2.6 Greenhouse gases affect energy flow through the Earth system.
2.7 The effects of changes in Earth's energy system are often not immediately apparent.
3.1 The Sun is the major source of energy for organisms and the ecosystems of which they are a part.
3.4 Energy flows through food webs in one direction, from producers to consumers and decomposers.
3.5 Ecosystems are affected by changes in the availability of energy and matter.
3.6 Humans are part of Earth's ecosystems and influence energy flow through these systems.
4.1 Humans transfer and transform energy from the environment into forms useful for human endeavors.
4.2 Human use of energy is subject to limits and constraints.
4.3 Fossil and biofuels are organic matter that contain energy captured from sunlight.
4.4 Humans transport energy from place to place.
4.5 Humans generate electricity in multiple ways.
4.6 Humans intentionally store energy for later use in a number of different ways.
4.7 Different sources of energy and the different ways energy can be transformed, transported, and stored each have different benefits and drawbacks.
5.1 Decisions concerning the use of energy resources are made at many levels.
5.2 Energy infrastructure has inertia.
5.3 Energy decisions can be made using a systems-based approach.
5.4 Energy decisions are influenced by economic factors.
5.5 Energy decisions are influenced by political factors.
5.6 Energy decisions are influenced by environmental factors.
5.7 Energy decisions are influenced by social factors.
6.3 Human demand for energy is increasing.
6.4 Earth has limited energy resources.
6.5 Social and technological innovations affects the amount of energy used by human society.
6.6 Behavior and design affect the amount of energy used by human society.
6.7 Products and services carry with them embedded energy.
6.8 Amount of energy used can be calculated and monitored.
7.1 Economic security is impacted by energy choices.
7.2 National security is impacted by energy choices.
7.3 Environmental quality is impacted by energy choices.
7.4 Increasing demand for and limited supplies of fossil fuels affects quality of life.
7.5 Access to energy resources affects quality of life.

7.6 Some populations are more vulnerable to impacts of energy choices than others.

12. REFERENCES

Brooklyn Botanical Garden All-Region Guides, *Tree Care Primer*, 2007, pg12.

How to make a clinometer, http://www.wikihow.com/Make-a-Clinometer.

IPCC Fourth Assessment Report, 2007. http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_synthesis_report.htm.

United States Global Change Research Program, "Global Climate Change Impacts in the United States," Cambridge University Press, 2009, www.globalchange.gov/usimpacts.

Naomi Oreskes, "The Scientific Consensus on Climate Change," Science 3 December 2004: Vol. 306 no. 5702 p. 1686 DOI: 10.1126/science.1103618.

John Wiley & Sons, Inc., *4th Edition Forest Mensuration*, 2003, pg252.

Lippke, B., Gustafson, R., Venditti, R., Volk, T., Oneil, E., Leonard, J., Puettmann, M., and Steele, P. Sustainable Biofuel Contributions to Carbon Mitigation and Energy Independence, Forests 2011; 2,861-874, http://www.mdpi.com/1999-4907/2/4/861.

Tonon, G., S. Dezi, M. Ventura, and F. Scandellari. 2011. The Effect of Forest Management on Soil Organic Carbon. In: *Sustaining Soil Productivity in Response to Global Climate Change: Science, Policy, and Ethics.* Eds. T. J. Sauer, J. M. Norman and M. V. K. Sivakumar. Wiley-Blackwell. Oxford, UK. p. 225–238. Source within Knight. E. J., *Harvest intensity and competing vegetation control have little effect on soil carbon and nitrogen pools in a Pacific Northwest Douglas-fir Plantation*. Partial M.S. completion at University of Washington 2013.

U.S. EPA – Risk Management Sustainable Technology, Life Cycle Perspective, http://www.epa.gov/nrmrl/std/lifecycle.html. Last updated 8/13/2013.

U.S. EPA – Agriculture – Forestry, http://www.epa.gov/agriculture/forestry.html. Last updated 8/13/2013.

UNFAO 2013 Global Forest Production Facts and Figures http://www.fao.org/3/a-i6669e.pdf

Images

1. Daigneau, Elizabeth. Governing: Infrastructure & Environment, *iTree Calculates the Economic Worth of Urban Canopies Down to the Dollar.* August 2013. http://www.governing.com/topics/transportation-infrastructure/gov-itree-calculates-trees-economic-worth.html.

2. “All you need to know about photosynthesis and respiration”. BiologyWise. https://biologywise.com/photosynthesis-cellular-respiration.

3. “Formation of Fossil Fuels”. EarthLabs: Living in a Carbon World. https://serc.carleton.edu/eslabs/carbon/1d.html

4. NASA. “A Blanket around the Earth”. Global Climate Change: Vital Signs of the Planet. http://climate.nasa.gov/causes/.

5. “The Carbon Cycle”. California Forestry Association. CalForests.org. http://calforests.org/resources/community-benefit/

6. EPA, Climate Change Indicators in the United States, U.S. Greenhouse Gas Emissions by Economic Sector 1990-2012, http://www.epa.gov/climatechange/science/indicators/ghg/us-ghg-emissions.html.

7. Northwest Advanced Renewables Alliance, NARA, Infographic, http://nararenewables.org/docs/one-pager/supplychain.pdf

8. EPA, Climate Change Indicators in the United States, U.S. Greenhouse Gas Emissions by Gas 1990-2012, http://www.epa.gov/climatechange/science/indicators/ghg/us-ghg-emissions.html.

9. NASA, Images of Change, http://climate.nasa.gov/state_of_flux#Carbondioxidepollution.jpg

10. “Monthly Average Carbon Dioxide Concentration. Mauna Loa Observatory. Scripps Institute for Oceanography.

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Northwest Advanced Renewables Alliance (NARA), http://www.nararenewables.org/
Department of Energy’s Energy Literacy Principles, http://energy.gov/eere/education/downloads/7-energy-literacy-principles

Lesson adapted from *The Value of a Tree: Comparing Carbon Sequestration to Forest Products.* Schon. J., Hougham. R.J., Eitel. K., Hollenhorst. S. Science Scope Magazine, March 2014: 37(7) 27-35