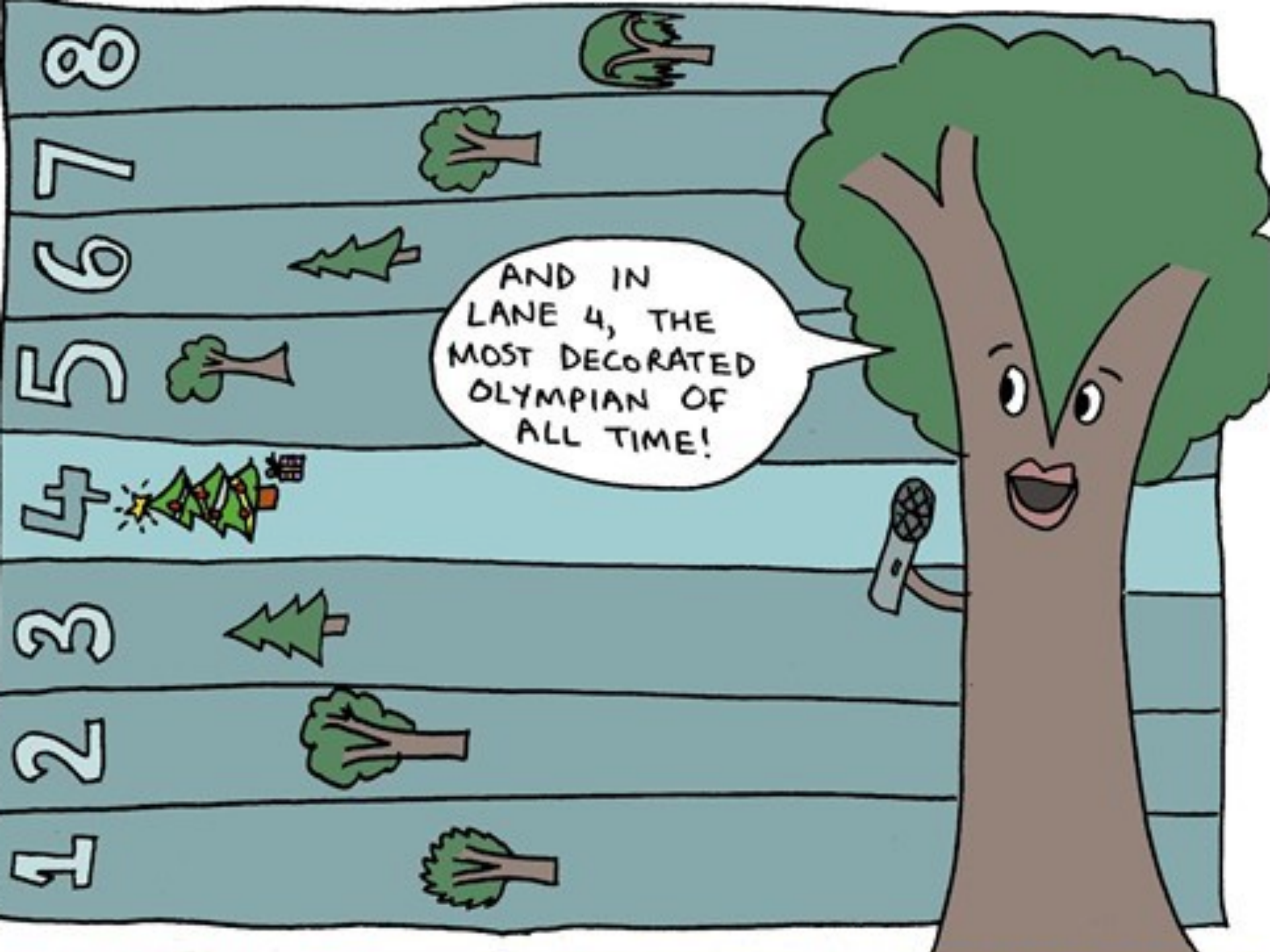
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AND IN LANE 4, THE MOST DECORATED OLYMPIAN OF ALL TIME!

Introduction

- Barb Wheeler
- Senior at Grand Valley State University (Michigan)
- Majoring in Integrated Science and Education with a minor in Elementary Certification
- I enjoy learning about our environment and ways in which we can be a more sustainable society.
- Why did I create this lesson plan?

Trees, Carbon, and You… What can you do? (5E Lesson Plan)

By: Barb Wheeler

Engage
(Questions to Think About)

- Can I grow enough trees to offset my carbon footprint?
- How many?
- Does the type of tree matter?
- What activity in your everyday life produces the greatest amount of carbon?

Explore 1 (Carbon Footprint)

- We need to figure out how much CO_2 we use in our everyday lives
- Fill out the Carbon Footprint worksheet
- This is a rough estimate, but it's a fairly easy worksheet fill out
- You can definitely find more accurate carbon footprint calculators online depending on how in depth you'd like to go
- How many pounds of CO_2 do you use in a year?

Explore 2
(Calculating Carbon Sequestration)

- Next, we're going to look at information about how much carbon certain trees sequester when they're planted in an urban setting
- The information we'll be looking at is from the U.S. Department of Energy- Energy Information Administration (1998)

URBAN FORESTRY CARBON SEQUESTRATION WORKSHEET

(Calculate each reporting year on a separate worksheet; photocopy if more than one sheet is required)

Reporting year: 19___

A. Species Characteristics (Refer to Table 1)			B. Tree Age	C. Number of Age 0 Trees Planted	D. Survival Factor (Refer to Table 2)	E. Number of Surviving Trees (C x D)	F. Annual Sequestration Rate (lbs./tree) (Refer to Table 2)	G. Carbon Sequestered (lbs) (E x F)
Name	Tree Type (H or C)	Growth Rate (S, M, or F)						
Total Pounds of Carbon Sequestered								

Table 2: Survival Factors and Annual Carbon Sequestration Rates for Common Urban Trees

Tree Age (yrs)	Survival Factors by Growth Rate			Annual Sequestration Rates by Tree Type and Growth Rate (lbs. carbon/tree/year)					
				Hardwood			Conifer		
	Slow	Moderate	Fast	Slow	Moderate	Fast	Slow	Moderate	Fast
0	0.873	0.873	0.873	1.3	1.9	2.7	0.7	1.0	1.4
1	0.798	0.798	0.798	1.6	2.7	4.0	0.9	1.5	2.2
2	0.736	0.736	0.736	2.0	3.5	5.4	1.1	2.0	3.1
3	0.706	0.706	0.706	2.4	4.3	6.9	1.4	2.5	4.1
4	0.678	0.678	0.678	2.8	5.2	8.5	1.6	3.1	5.2
5	0.658	0.658	0.658	3.2	6.1	10.1	1.9	3.7	6.4
6	0.639	0.639	0.644	3.7	7.1	11.8	2.2	4.4	7.6
7	0.621	0.621	0.630	4.1	8.1	13.6	2.5	5.1	8.9
8	0.603	0.603	0.616	4.6	9.1	15.5	2.8	5.8	10.2
9	0.585	0.589	0.602	5.0	10.2	17.4	3.1	6.6	11.7
10	0.568	0.576	0.589	5.5	11.2	19.3	3.5	7.4	13.2
11	0.552	0.564	0.576	6.0	12.3	21.3	3.8	8.2	14.7
12	0.536	0.551	0.563	6.5	13.5	23.3	4.2	9.1	16.3
13	0.524	0.539	0.551	7.0	14.6	25.4	4.6	9.9	17.9
14	0.512	0.527	0.539	7.5	15.8	27.5	4.9	10.8	19.6
15	0.501	0.516	0.527	8.1	16.9	29.7	5.3	11.8	21.4
16	0.490	0.504	0.516	8.6	18.1	31.9	5.7	12.7	23.2
17	0.479	0.493	0.505	9.1	19.4	34.1	6.1	13.7	25.0
18	0.469	0.483	0.495	9.7	20.6	36.3	6.6	14.7	26.9
19	0.459	0.472	0.484	10.2	21.9	38.6	7.0	15.7	28.8
20	0.448	0.462	0.474	10.8	23.2	41.0	7.4	16.7	30.8
21	0.439	0.452	0.464	11.4	24.4	43.3	7.9	17.8	32.8
22	0.429	0.442	0.454	12.0	25.8	45.7	8.3	18.9	34.9
23	0.419	0.433	0.445	12.5	27.1	48.1	8.8	20.0	37.0
24	0.410	0.424	0.435	13.1	28.4	50.6	9.2	21.1	39.1
25	0.401	0.415	0.426	13.7	29.8	53.1	9.7	22.2	41.3
26	0.392	0.406	0.417	14.3	31.2	55.6	10.2	23.4	43.5
27	0.384	0.398	0.409	15.0	32.5	58.1	10.7	24.6	45.7
28	0.375	0.389	0.400	15.6	33.9	60.7	11.2	25.8	48.0
29	0.367	0.381	0.392	16.2	35.3	63.3	11.7	27.0	50.3
30	0.359	0.373	0.383	16.8	36.8	65.9	12.2	28.2	52.7
31	0.352	0.365	0.375	17.5	38.2	68.5	12.7	29.5	55.1
32	0.344	0.358	0.367	18.1	39.7	71.2	13.3	30.7	57.5
33	0.337	0.350	0.360	18.7	41.1	73.8	13.8	32.0	59.9
34	0.330	0.343	0.349	19.4	42.6	76.5	14.3	33.3	62.4
35	0.323	0.336	0.339	20.0	44.1	79.3	14.9	34.7	64.9

Table 2: Survival Factors and Annual Carbon Sequestration Rates for Common Urban Trees (Cont'd)

Tree Age (yrs)	Survival Factors by Growth Rate			Annual Sequestration Rates by Tree Type and Growth Rate (lbs. carbon/tree/year)					
				Hardwood			Conifer		
	Slow	Moderate	Fast	Slow	Moderate	Fast	Slow	Moderate	Fast
36	0.316	0.329	0.329	20.7	45.6	82.0	15.5	36.0	67.5
37	0.310	0.322	0.320	21.4	47.1	84.8	16.0	37.3	70.1
38	0.303	0.315	0.310	22.0	48.6	87.6	16.6	38.7	72.7
39	0.297	0.308	0.301	22.7	50.2	90.4	17.2	40.1	75.3
40	0.291	0.302	0.293	23.4	51.7	93.2	17.7	41.5	78.0
41	0.285	0.296	0.284	24.1	53.3	96.1	18.3	42.9	80.7
42	0.279	0.289	0.276	24.8	54.8	99.0	18.9	44.3	83.4
43	0.273	0.283	0.268	25.4	56.4	101.9	19.5	45.8	86.2
44	0.267	0.277	0.260	26.1	58.0	104.8	20.1	47.2	89.0
45	0.261	0.269	0.253	26.8	59.6	107.7	20.7	48.7	91.8
46	0.256	0.261	0.245	27.6	61.2	110.7	21.3	50.2	94.7
47	0.251	0.254	0.238	28.3	62.8	113.6	22.0	51.7	97.5
48	0.245	0.247	0.231	29.0	64.5	116.6	22.6	53.2	100.4
49	0.240	0.239	0.225	29.7	66.1	119.6	23.2	54.8	103.4
50	0.235	0.232	0.218	30.4	67.8	122.7	23.9	56.3	106.3
51	0.230	0.226	0.212	31.1	69.4	125.7	24.5	57.9	109.3
52	0.225	0.219	0.206	31.9	71.1	128.8	25.2	59.4	112.3
53	0.221	0.213	0.199	32.6	72.8	131.8	25.8	61.0	115.4
54	0.216	0.207	0.193	33.4	74.5	134.9	26.5	62.6	118.4
55	0.211	0.201	0.188	34.1	76.2	138.0	27.2	64.2	121.5
56	0.207	0.195	0.182	34.8	77.9	141.2	27.8	65.9	124.6
57	0.203	0.189	0.177	35.6	79.6	144.3	28.5	67.5	127.8
58	0.198	0.184	0.171	36.3	81.3	147.5	29.2	69.2	130.9
59	0.194	0.178	0.166	37.1	83.0	150.6	29.9	70.8	134.1

Table 1. Common Urban Tree Species

Species	Type	Growth Rate	Species	Type	Growth Rate
Ailanthus, *Ailanthus altissima*	H	F	Maple, bigleaf, *Acer macrophyllum*	H	S
Alder, European, Alnus glutinosa	H	F	Maple, Norway, *Acer platanoides*	H	M
Ash, green, Fraxinus pennsylvanica	H	F	Maple, red, *Acer rubrum*	H	M
Ash, mountain, American,*Sorbus americana*	H	M	Maple, silver, *Acer saccharinum*	H	M
Ash, white, *Fraxinus americana*	H	F	Maple, sugar, *Acer saccharum*	H	S
Aspen, bigtooth, *Populus grandidentata*	H	M	Mulberry, red, *Morus rubra*	H	F
Aspen, quaking, *Populus tremuloides*	H	F	Oak, black, *Quercus velutina*	H	M
Baldcypress, *Taxodium distichum*	C	F	Oak, blue, *Quercus douglasii*	H	M
Basswood, American, *Tilia americana*,	H	F	Oak, bur, *Quercus macrocarpa*	H	S
Beech, American, *Fagus grandifolia*	H	S	Oak, California black, *Quercus kelloggii*	H	S
Birch, paper (white), *Betula papyrifera*	H	M	Oak, California White, *Quercus lobata*	H	M
Birch, river, *Betula nigra*	H	M	Oak, canyon live, *Quercus chrysolepsis*	H	S
Birch, yellow, *Betula alleghaniensis*	H	S	Oak, chestnut, *Quercus prinus*	H	S
Boxelder, *Acer negundo*	H	F	Oak, Chinkapin, *Quercus muehlenbergii*	H	M
Buckeye, Ohio, *Aesculus glabra*	H	S	Oak, Laurel, *Quercus laurifolia*	H	F
Catalpa, northern, *Catalpa speciosa*	H	F	Oak, live, *Quercus virginiana*	H	F
Cedar-red, eastern, *Juniperus virginiana*	C	M	Oak, northern red, *Quercus rubra*	H	F
Cedar-white, northern, *Thuja occidentalis*	C	M	Oak, overcup , *Quercus lyrata*	H	S
Cherry, black, *Prunus serotina*	H	F	Oak, pin, *Quercus palustris*	H	F
Cherry, pin, *Prunus pennsylvanica*	H	M	Oak, scarlet, *Quercus coccinea*	H	F
Cottonwood, eastern, *Populus deltoides*	H	M	Oak, swamp white, *Quercus bicolor*	H	M
Crabapple, *Malus* spp.	H	M	Oak, water, *Quercus nigra*	H	M
Cucumbertree, *Magnolia acuminata*	H	F	Oak, white, *Quercus alba*	H	S
Dogwood, flowering, *Cornus florida*	H	S	Oak, willow, *Quercus phellos*	H	M
Elm, American, *Ulmus americana*	H	F	Pecan, *Carya illinoensis*	H	S
Elm, Chinese, *Ulmus parvifolia*	H	M	Pine, European black, *Pinus nigra*	C	S
Elm, rock, *Ulmus thomasii*	H	S	Pine, jack, *Pinus banksiana*	C	F
Elm, September, *Ulmus serotina*	H	F	Pine, loblolly, *Pinus taeda*	C	F
Elm, Siberian, *Ulmus pumila*	H	F	Pine, longleaf, *Pinus palustris*	C	F
Elm, slippery, *Ulmus rubra*	H	M	Pine, ponderosa, *Pinus ponderosa*	C	F
Fir, balsam, *Abies balsamea*	C	S	Pine, red, *Pinus resinosa*	C	F
Fir, Douglas, Pseudotsuga menziesii	C	F	Pine, Scotch, *Pinus sylvestris*	C	S
Ginkgo, *Ginkgo biloba*	H	S	Pine, shortleaf, *Pinus echinata*	C	F
Hackberry, *Celtis occidentalis*	H	F	Pine, slash, *Pinus elliottii*	C	F
Hawthorne, *Crataegus* spp.	H	M	Pine, Virginia, *Pinus virginiana*	C	M
Hemlock, eastern, *Tsuga canadensis*	C	M	Pine, white eastern, *Pinus strobus*	C	F
Hickory, bitternut, *Carya cordiformis*	H	S	Poplar, yellow, *Liriodendron tulipifera*	H	F
Hickory, mockernut, *Carya tomentosa*	H	M	Redbud, eastern, *Cercis canadensis*	H	M
Hickory, shagbark, *Carya ovata*	H	S	Sassafras, *Sassafras albidum*	H	M
Hickory, shellbark, Carya laciniosa	H	S	Spruce, black, *Picea mariana*	C	S
Hickory, pignut, *Carya glabra*	H	M	Spruce, blue, *Picea pungens*	C	M
Holly, American, *Ilex opaca*	H	S	Spruce, Norway, *Picea abies*	C	M
Honeylocust, *Gleditsia triacanthos*	H	F	Spruce, red, *Picea rubens*	C	S
Hophornbeam, eastern, *Ostrya virginiana*	H	S	Spruce, white, *Picea glauca*	C	M
Horsechestnut, common, *Aesculus hippocastanum*	H	F	Sugarberry, *Celtis laevigata*	H	F
Kentucky coffeetree, *Gymnocladus dioicus*	C	F	Sweetgum, *Liquidambar styraciflua*	H	F
Linden, little-leaf, *Tilia cordata*	H	F	Sycamore, *Platanus occidentalis*	H	F
Locust, black, *Robinia pseudoacacia*	H	F	Tamarack, *Larix laricina*	C	F
London plane tree *Platanus_X_acerifolia*	H	F	Walnut, black, *Juglans nigra*	H	F
Magnolia, southern, *Magnolia grandifolia*	H	M	Willow, black, *Salix nigra*	H	F

Type: H = Hardwood, C = Conifer Growth Rate: S = Slow, M = Moderate, F = Fast

Carbon Seq. of Local Michigan Trees

Tree Name, Tree Type, and Growth Rate:

- American Basswood: Hard and Fast
- American Beech: Hard and Slow
- American Elm: Hard and Fast
- Black Cherry: Hard and Fast
- Boxelder: Hard and Fast
- Bur Oak: Hard and Slow
- Eastern Cottonwood: Hard and Moderate
- Hackberry: Hard and Fast
- Honey Locust: Hard and Fast
- Northern Red Oak: Hard and Fast
- Northern White Cedar: Conifer and Moderate
- Paper Birch: Hard and Moderate
- Pin Oak: Hard and Fast
- Red Maple: Hard and Moderate
- Shagbark Hickory: Hard and Slow
- Silver Maple: Hard and Moderate
- Sugar Maple: Hard and Slow
- Quaking Aspen: Hard and Fast
- Yellow Poplar: Hard and Fast
- White Ash: Hard and Fast
- Yellow Birch: Hard and Slow

Example:

Box Elder

How to Fill out the Sequestration Worksheet

- A. Species Characteristics:

  Name- Box Elder

  Tree Type- Hard

  Growth Rate- Fast

How to Fill out the Sequestration Worksheet Cont'd

- B. Tree Age

(How long it's been planted after starting at the standard size)

Let me explain…

"The tables included for estimating sequestration were designed for reporters who have planted ordinary, nursery- raised trees, typically sold in 15-gallon containers or balled and burlapped. Such "standard" trees are usually approximately one inch in diameter at 4.5 feet above the ground when planted. For the purposes of this method, age is measured from the time the tree is planted. Therefore, standard- sized trees are designated as age 0 when planted."

How to Fill out the Sequestration Worksheet Cont'd

- B. Tree Age (How long it's been planted after starting at the standard size): 3 years
- C. Number of Age 0 Trees Planted: 10
- D. Survival Factor: 0.706
- E. Number of Surviving Trees (C x D): 7.06
- F. Annual Sequestration Rate: 6.9 lbs. carbon/tree/year
- G. Carbon Sequestered (E x F): 48.7 lbs

Fill out one more row…

So that we're all on the same page…

- A. Northern White Cedar, Conifer (C), Moderate (M)
- B. 8 years
- C. 15 trees

Continue filling out the rest of the row using Table 2…

I added a few trees for you and filled out the table to save time…

Add up column G (Total lbs of Carbon Sequestered)

Then multiply that value by 3.67 and STOP! ☺

How Much?

- Did you all get around 1,435 lbs of CO2 sequestered?
- Let's go back to our Carbon Footprint and examine our numbers further…
- Divide your carbon footprint by the amount of pounds of CO2 sequestered

Explain
(Analyze Data)

- How many sets of trees do you need to offset your carbon footprint?
- How many actual trees would that be? (# of sets x 45 trees) i.e. – I needed 1.4 sets of trees or about 63 trees to offset my carbon footprint
- Keep in mind that this was just a random assortment of trees that I chose. There are many variables (tree type/age/amount) that determine how much carbon a tree will sequester.

Explain
(Answer our Engage Questions)

- Can I grow enough trees to offset my carbon footprint?

It's definitely possible if you utilize your resources and have space to plant trees; it also takes dedication

- How many?

It depends on age/type of trees you want to use

- Does the kind of tree matter?

Yes, preferably trees that grow in your local area (we looked at MI trees); Hardwood with a fast growth rate sequester the most carbon

Explain
(What does this all mean?)

Purpose of this lesson:

- Shows students how important trees truly are to both humans and our environment
- Helps students see how humans impact our environment (carbon footprint)
- It gives students a possible solution (planting trees) in order to help our environment
- Expands students awareness of using techniques to slow climate change
- Ultimately, students should be thinking about the environment we live in and the ways humans can give back

Elaborate

- Begin a tree planting project; simply plant trees in your school yard or community. (Get students outside!)
- Observe and collect data for tree growth over time
- Research deforestation
- Calculate the amount of trees needed to offset your entire school's carbon footprint. How much space would be needed to do so?
- Look into other ways you can reduce your carbon footprint (recycle, use less water/electricity, etc.)

Evaluate

- Ask your students questions about the activities they've completed (i.e. give them a scenario about planting the "best" (sequester the most carbon) trees to cancel their school's carbon footprint)
- Ask students to explain the purpose of this lesson
- Ask students how they will incorporate what they've learned into their daily lives

Final Thought…

In regards to caring for our environment…

Instead of asking ourselves, “Why?”

We should ask ourselves, “Why not?”

Sources

- Carbon Footprint

http://www.teachengineering.org/view_lesson.php?url=collection/cub_/lessons/cub_whatkindoffootprint/cub_footprint_lesson1.xml

- Michigan Trees

http://www.outdoor-michigan.com/Trees.htm

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- Tree Jokes

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