Herbaceous Biomass & Carbon Analysis

Purpose

- To provide students with an opportunity observe and understand patterns and trends in their field measurement data.

Overview

Students will work with a individually or with a partner to explore the field data. Students will consider a variety of questions that directly address the data and will discuss how these findings relate to further explorations of the local carbon cycle.

Student Outcomes

Students will be able to:

- Examine their field data and how it was used to calculate shrub/sapling biomass and carbon storage
- Students will work with a partner or small group to answer a variety of application type questions help them analyze and interpret their data
- Students will communicate their understanding of the field data analysis in a class discussion

Questions

Unit (Examples)

- Student research questions
- Example: How do carbon stocks at our sample site relate to our study of the global carbon cycle?

Content

- What is the current carbon stock of herbaceous vegetation in our sample site?

Science Concepts

Grades 9-12

Scientific Inquiry

- Design and conduct a scientific investigation
- Use appropriate tools and techniques to gather, analyze, and interpret data
- Use mathematics in all aspects of scientific inquiry

NGSS (Black-covered directly, gray-addressed, but not directly covered)

- *Disciplinary Core Ideas*
  - Gr.6-8: ESS3.A
  - Gr.9-12: ESS3.A
- *Science and Engineering Practices*
  - Developing and using models
  - Analyzing and interpreting data
  - Using mathematics and computational thinking
  - Constructing explanations

Time/Frequency

35 minutes

Level

Secondary (Middle & High School)

Materials and Tools

- Copies of *Herbaceous Biomass Analysis Questions*
- *Optional:* At least one computer with Excel, or a smiliar spreadsheet program.
- *Optional:* Analyzed data spreadsheet downloaded from GLOBE

Prerequisites

- Understanding of unit concepts: how is carbon stored in vegetation, allometry, biomass units

Preparation

- Gather all materials.
- Write essential, unit, and content questions somewhere visible in the classroom.
- *(Optional)* Download your data with completed analysis from GLOBE (http://datasearch.globe.gov). Instructions on page 3.

Background

For scientific background of the concepts addressed in this activity see the introductory lesson *BiomassUnits.*

What To Do and How To Do It

ENGAGE **Grouping:** Class **Time:** 5 Minutes

- Using field investigation data sheets and all handouts concerning biomass, fieldwork, and the schoolyard have students consider the research or unit question written on the board: example - How does our sample site's carbon stock relate to our study of the global carbon cycle?

EXPLORE **Grouping:** Individual or Pairs **Time:** 20 Minutes

- Students use the Herbaceous Biomass Analysis questions to eplore their data.
  - **NOTE:** The questions are fairly basic, but this is a great opportunity to get students thinking about what they have learned and what it means. These questions also prepare students to answer the broader essential and unit questions or their own research questions.

EXPLAIN **Grouping:** Class or Pairs **Time:** 10 Minutes

- Discuss student responses to the initial questions, using the white board to document the range of student responses and to clarify concepts and skills.

ELABORATE **Grouping:** Individual or Pairs **Time:** Varies

- If your students collected tree and/or shrub/sapling data and have not yet investigated that data using the associated analysis questions, do so now.

EVALUATE **Grouping:** Individual **Time:** 35 Minutes

- Students thoughtfully respond to *Field Wrap-up Questions* (on the GLOBE Carbon Cycle webpage in the Resources section), which are designed as a formative assessment.
- Collect and read, or hold a class discussion to discover errors in thinking that need to be addressed before a summative assessment such as the *Field Unit Assessment* (also on the GLOBE Carbon Cycle webpage in the Resources section).

Assessment

- *Field Unit Assessment* (written questions)

Extensions

- Emphasize the inquiry cycle, and to encourage students to develop their own researchable question based on the field data. Offer students time to pursue their own question, providing access to additional resources, including the library and internet. (See *Pose Research Questions, Data Interpretation, and Identify New Research Questions* in the Resources section of the GLOBE Carbon Cycle webpage.)
- Work with the *Biomass Accumulation Model* to estimate biomass and carbon storage for your location. How do model results compare to field results?

How To Download Data From GLOBE

Once your data are entered on the GLOBE website (for help with this, see the *Carbon Cycle eTrainings* and the *Data Entry* guide on the Carbon Cycle webpage), **the calculations to convert your raw data to biomass and carbon storage values will be completed for you.**

To download your data, complete with carbon and biomass estimates:

1. Go to http://datasearch.globe.gov (*Can also be found from globe.gov by clicking 'GLOBE Data' - 'Retrieve Data')*
2. Read through the instructions to familiarize yourself with this tool.
3. Under Data Filters, click 'Select Protocols'
4. Scroll down to find the Biosphere section, click 'Carbon Cycle', and click 'Add Protocols'
5. Select a data range that includes the date in which you collected data.
6. Under Site Filters, click 'School or Teacher', and select your school.
7. If you have multiple Carbon Cycle field sites, select the individual site in which you are interested under 'Site Name'
8. Click the green 'Apply Filter' button in the top left.
9. Click 'Obtain Measurement Data' *(Note, data will be downloaded for the whole list you see, if your school is not the only one listed, refine your filters).*
10. The button will update, and you can click 'Download Measurement Data' to download a .csv, which can be opened in a spreadsheet tool such as Excel.

** Note, you can also use the GLOBE Visualization System (vis.globe.gov) to view your and other school's Carbon Cycle data on a map. Use the Layers feature to choose Biospere, then Carbon Cycle, and then select the Protocol(s) in which you have interest. Widen your data range (top-center) to see all available data.*

Name: Date:

Herbaceous Biomass Analysis Questions

Understanding the data

Using the herbaceous biomass data from your *Herbaceous Biomass Data Sheet*, explore the biomass and carbon of your sample site. Your previous work on biomass units may also be helpful in understanding the data.

1. Record plot summary data. Remember to include units.

Average Herbaceous Biomass	Herbaceous Carbon Stock

2. Describe or show the calculations for the relationship between biomass and carbon storage.)

3. What types of herbaceous vegetation were present in your sample site? (Species or common names or general types- grasses, crops, forbs, etc.)

4. Look at the Carbon Lookup Tables (Table 1 and Table 2) on the last page of this worksheet. Choose two other types to compare to the carbon stock of the herbaceous vegetation on your plot. What types did you choose? Are the carbon stocks similar or different to your calculated values? What about these plants might cause the similarities/differences you observe?

5. You measured the carbon stored in the *aboveground* part of the herbaceous vegetation. How do you think this compares to the carbon stored in the *belowground* portion of the plant? Why?

6. What is one additional thing you notice about the data?

7. Name one thing that interests or surprises you about the data.

8. What questions do you have about the data? Be thoughtful.

Table 1. Carbon Storage Look-up Table for Agricultural Crops. From Li et al. 1992 and Changshen Li, pers comm. 2012)				
Crop Name	Carbon Storage (g C/m^2)		Crop Name	Carbon Storage (g C/m^2)
Alfalfa	561.4		Oats	1043.5
Artichoke	688.2		Onion	960
Banana	800		Papaya	2000
Barley	832		Peanut	375.7
Beans	293.3		Potato	857.1
Beet	1152		Radish	408.1
Berries	320		Rapeseeds	563.4
Broccoli	400		Rice, Deepwater	342.9
Cabbage	280		Rice, Paddy	823.8
Cassava	923.1		Rice, Rainfed	933.3
Cattail	1400		Rice, Upland	444.4
Celery	400		Rye	304.8
Corn	1030.9		Safflower	650
Corn, Silage	900		Sedge	2000
Cotton	450		Sedge, Boreal	148
Cover Crop	400		Sorghum	685.7
Flax	150		Soybean	351.2
Flowers	182.7		Strawberry	730.9
Grape	70		Sugarcane	1776
Grass, Annual	444.4		Sunflower	240.1
Grass, Perennial	933.3		Tobacco	192
Green Onion	400		Tomato	461.3
Hay	1100		Tule	1080
Lettuce	142.8		Wheat, Spring	780
Millet	212.9		Wheat, Winter	761
Mustard	440			

Table 2. Carbon Storage Look-up Table for Residential and Native Grasses		
Grass Type	Carbon Storage (g C/m^2)	Source*
Residential Lawn	82	Jo and McPherson, 1995
Tall Grass Prairie	212	Derner at al. 2011