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Feeling Blue

Background Information Sheet

Vocabulary Words:

- **Carbon sequestration –** The process of capturing carbon dioxide from the atmosphere.
- **Carbon storage –** The long-term confinement of carbon in plant materials or sediment.
- **Blue carbon -** Carbon captured and stored in coastal ecosystems (salt marsh, mangrove, sea grass).
- **Anaerobic processes** – metabolic processes that microorganisms must use when there is no oxygen.

Places of Interest:

- Galveston Bay
- Coastal wetlands

Background Information:

Coastal ecosystems, including tidal wetlands, mangroves, and seagrass beds sequester a significant amount of the carbon, which is referred to as '**Blue Carbon**.' These coastal ecosystems remove Carbon Dioxide (CO_2) from the atmosphere 10 times faster per hectare than terrestrial forested ecosystems. The pathway for **carbon sequestration** starts with fixation of CO_2 into vegetative leaves, stems, and roots via photosynthesis. When the vegetation dies the plant tissue is buried in the soil where microorganisms use the tissue as a food source. In wetlands, however, small sediment grain size prevents gas exchange. As such, wetland soils tend to have low oxygen concentration, forcing microorganisms to use **anaerobic processes**. Because anaerobic processes generate less energy for the organism, the breakdown of plant tissue is slow compared to soils were aerobic metabolic pathways are used.

Wetland soil can store carbon for centuries if wetlands remain in tact. Wetland degradation, however, results in emission of nearly half a billion tons of CO_2 annually. Every year, salt marsh and seagrass collectively sequester 13 tons of CO_2 per hectare. Whereas, the 13 tons of CO_2 per hectare stored in wetland and seagrass bed soils is small compared to the 16 billion tons we need

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to mitigate, one hectare is about the size of half of an American football field, therefore, preservation and restoration of wetlands along all coastlines could be part of the larger solution to mitigate climate change. Moreover, wetlands provide additional ecosystem services such as improving water quality, erosion control, attenuation of coastal flooding, and habitat for wildlife including important commercial fisheries species.

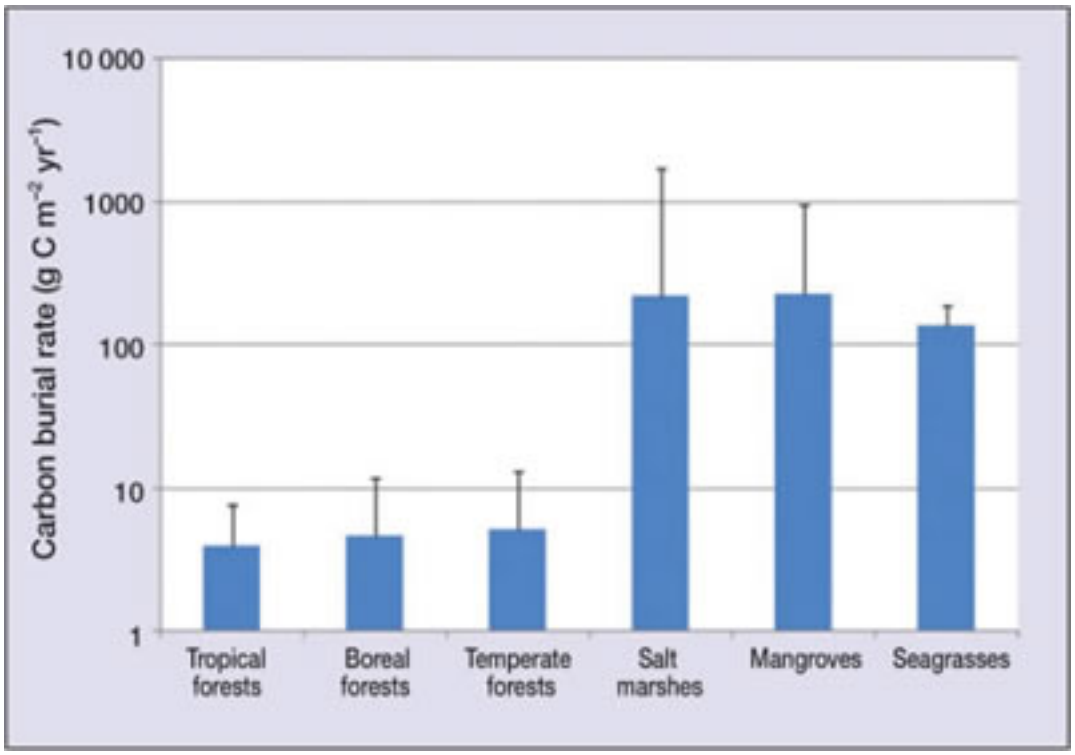

Figure 1. Carbon Storage Abilities of Different Habitat Types (image from: http://www.habitat.noaa.gov/coastalbluecarbon.html).

Feeling Blue
Introductory Lesson

This activity meets the following:

TEKS	NOAA Ocean Literacy Principles	GBEP State of the Bay Priorities
Science Grade 7 7.5 (A)(C) 7.6(A) 7.8	3 6	1 7

Objectives:

- Students will be able to understand the carbon cycle.
- The sequestration and storage abilities of coastal wetland ecosystems will be understood.
- The role of blue carbon in coastal ecosystems will be demonstrated.

Synopsis:
In this activity, students will act out the carbon cycle in coastal wetland ecosystems by each playing a role in the carbon cycle. Students will learn how coastal wetland ecosystems sequester, utilize, and store carbon.

Time: 60 minutes

Materials:

- 12 large Styrofoam balls labeled "C"
- 24 medium/small Styrofoam balls labeled "O"
- 10 small Styrofoam balls labeled "H"
- Toothpicks
- String
- Bucket labeled "atmosphere"
- Reusable bags (one for each student)
- 1 Blue Carbon Worksheet

Procedure:

1. Go over the background sheet and show the students the video "Blue Carbon: Two Ocean Minutes with Jim Toomey".
2. Have the students create 12 CO_2 compounds by using toothpicks to attach two Styrofoam balls labeled "O" to each large Styrofoam ball labeled "C". Have them place the CO_2 compounds in the bucket labeled "atmosphere".
3. Divide students into the following roles (you can rearrange based on class size):
    a. 4 leaves
    b. 2 stems
    c. 6 roots
    d. 1 soil
    e. 2 microbes
    f. 1 recorder/narrator
    g. 4 extras
4. Have the students arrange themselves using Figure 2 as a guide. Have them use string or their arms to connect with each other together. Give each student a reusable bag to hold molecules and compounds in.
5. Use the Blue Carbon Worksheet to act out the carbon cycle in a coastal wetland plant.

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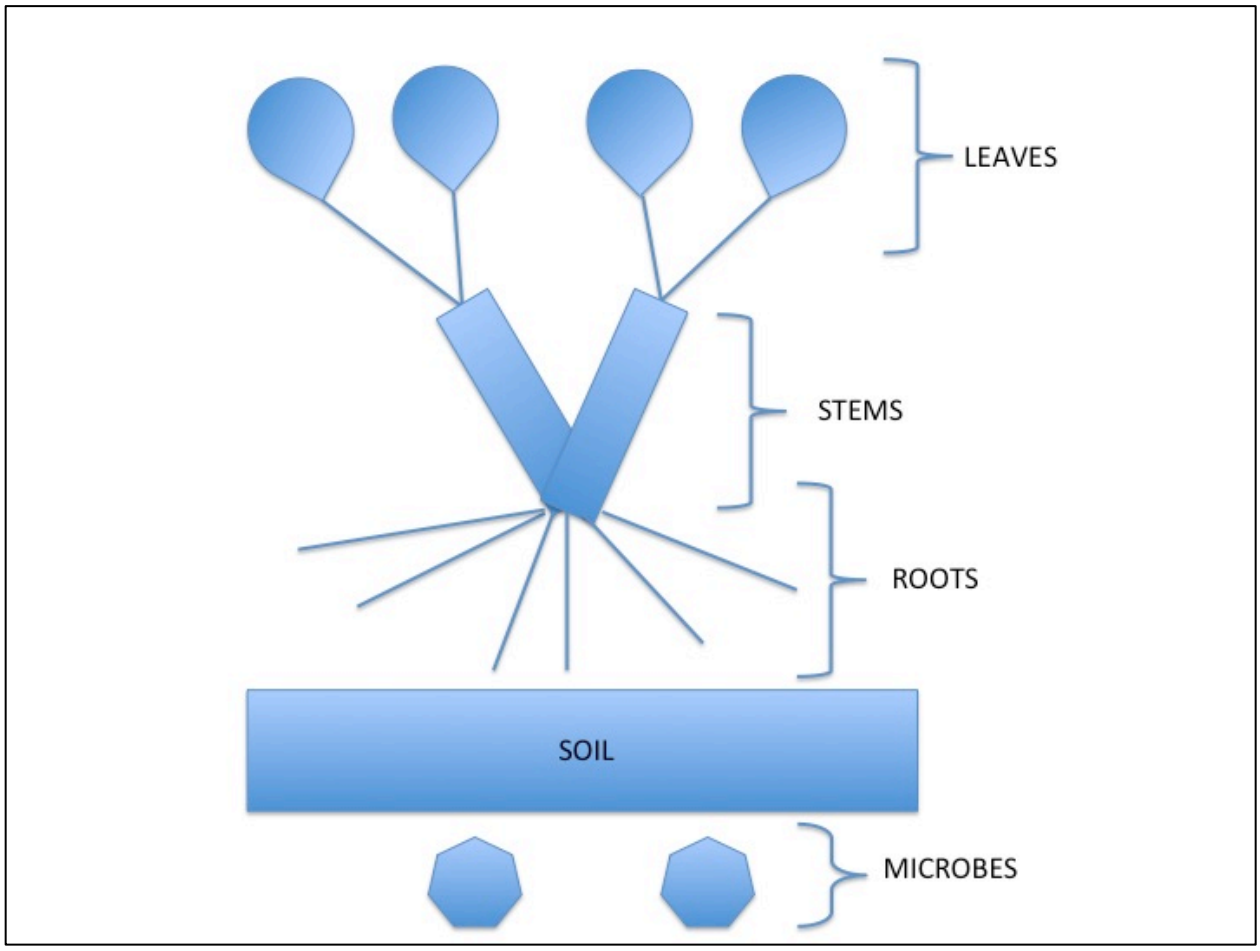

Figure 2. Guide on how to arrange students to act out being a coastal wetland plant.

Blue Carbon Worksheet

1. Each leaf must gather 3 compounds of CO_2.

2. Each leaf must remove the oxygen molecules from the CO_2 and release them into the atmosphere (place in the "atmosphere" bucket).

3. Each leaf must pass 2 carbon molecules down to the stems. Each stem must pass 3 molecules of carbon to the roots.
    a. How many carbon molecules are stored in the leaves? _____
    b. How many carbon molecules are stored in the stems? _____
    c. How many carbon molecules are stored in the roots? _____

4. Two leaves drop off the plant during the winter. One leaf falls in the water and is buried in the anoxic soil. This leaf must give their carbon molecule to the soil. The other leaf lands on the ground above the water. This leaf must give their carbon molecule to a microbe. The microbe eats the leaf and releases CO_2 into the atmosphere (place in the "atmosphere" bucket).

5. Two plant roots die and are eaten by a microbe. These plant roots must give all their carbon to the microbes. Since these microbes live in anoxic conditions, they do not use oxygen during respiration. Instead, they use hydrogen. Have the microbes add 4 hydrogen molecules to each carbon molecule they "eat" and release CH_4, or methane back into the atmosphere (place in the "atmosphere" bucket).
    a. How many CO_2 compounds has the plant released? _____
    b. How many CH_4 compounds has the plant released? _____
    c. How many carbon molecules remain in the leaves? _____
    d. How many carbon molecules remain in the stems? _____
    e. How many carbon molecules remain in the roots _____
    f. How many carbon molecules are stored in the soil? _____

6. Spring has arrived and the plant begins to grow again. Two new leaves sprout on the plant and four new roots sprout. Repeat steps 1-3 again.

7. Carbon is released in to the soil from internal transport between the roots and the soil. Have five of the roots give all their carbon to the soil.

8. Answer the following questions about the carbon cycle in this coastal wetland plant:
    a. How many carbon molecules were stored in the leaves? _____
    b. How many carbon molecules were stored in the stems? _____
    c. How many carbon molecules were stored in the roots? _____
    d. How many CO_2 compounds were **sequestered?** _____
    e. How many carbon molecules were **stored** in the soil? _____
    f. How many CO_2 compounds did the plant release? _____
    g. How many CH_4 compounds did the plant release? _____

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