Handouts/Worksheets:

Seagrass Sediment - Worksheet 1

Name(s) _____

Date_____

Section A

Introduction

You are working with a group of marine scientists to measure the amount of organic carbon in the sediment of two meadows in the Chesapeake Bay that are dominated by different species. Seagrasses are underwater plants that live in marine, salty, water. Like all ecosystems, like rainforests, they capture and store carbon in their sediments over long timescales.

Answer the following questions before beginning

1) Why are seagrass meadows important ecosystems?

2) What other ecosystems besides seagrass meadows might be good at carbon storage? List at least three examples. *Think about both aquatic and terrestrial habitats!*

3) What factors might affect the amount of carbon stored in seagrass sediments?

Form a hypothesis on which species will store more carbon

1) Write your hypotheses below.
    a) Why?

Measure the size of your core

When we measure carbon through sediment cores, we need to know how much sediment we take in a sample. Record the dimensions of your core below:

Core Radius:

Now, we can calculate the area of sediment we might sample using the equation for an area of a circle. Show your work:

remember the equation for an area of a circle* $A = \pi r^2$*

Record the amount of carbon

Take a sediment core from each bucket. Count the number of colored beads (carbon) and the number of neutral beads (sediment particles) and record them in your data table. Get the counts from the other groups' (replicates) cores and record them as well. Calculate the average carbon stock for each species.

Remember: Carbon Stock can be calculated from:

$$Carbon\ stock\ \left(\frac{Pieces\ Carbon}{cm^2}\right) = \frac{Carbon\ Grains}{All\ Grains}\ x\ \frac{1}{Core\ area\ (cm^2)}$$

Eelgrass Sediment Cores

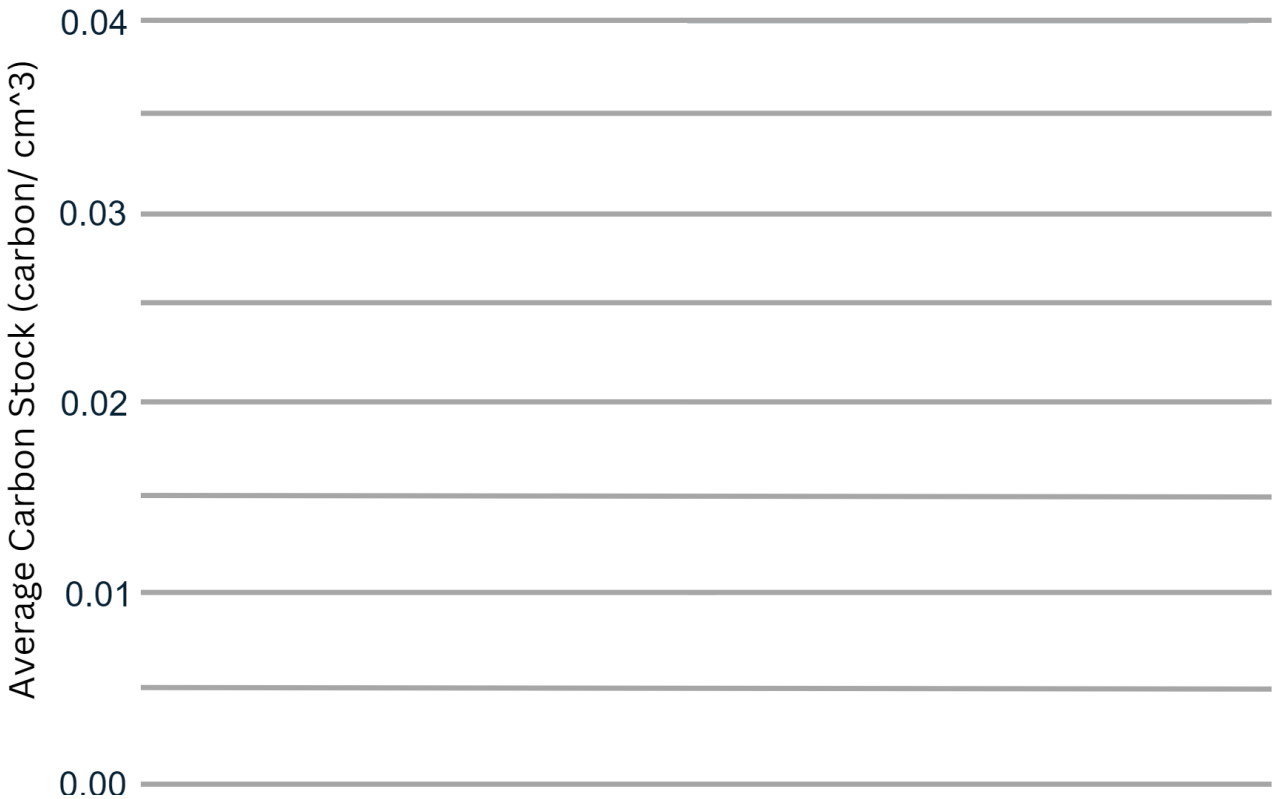
Replicate	Sediment Grains (pieces)	Carbon Grains (pieces)	All Grains (Pieces)	Proportion Carbon in Sample $(\frac{Grains\ Carbon}{All\ Grains})$	Carbon Stock $(\frac{Grains\ Carbon}{cm^2})$
1					
2					
3					
4					
5					
				Average:	

Widgeon Grass Sediment Cores

Replicate	Sediment Grains (pieces)	Carbon Grains (pieces)	All Grains (Pieces)	Proportion Carbon in Sample $(\frac{Grains\ Carbon}{All\ Grains})$	Carbon Stock $(\frac{Grains\ Carbon}{cm^2})$
1					
2					
3					
4					
5					
				Average:	

Graph the carbon stocks for each species. *Don't forget to fill in the legend if needed!*

1) What type of graph should we use, and why?



Answer the following questions

1) Which species had the larger carbon stock? What does this mean for a meadow of Eelgrass vs a meadow of Widgeon Grass?

2) What would happen if a meadow that had Eelgrass switched to one with Widgeon Grass?

Challenge Question:

3) Why might these species differ?

4) How can we protect seagrass meadows? Brainstorm a specific solution.

Seagrass Sediment - Worksheet 2

Name(s) _____

Date_____

Section B

Scaling Up in Space

Seagrass coverage in the Chesapeake Bay changes yearly. Scientists at the Virginia Institute of Marine Science use annual aerial images taken from planes to map how much seagrass there is per year. Use some of these values to see how Bay-wide carbon stocks might change over time depending on coverage and species identity.

*Note: **Many things impact carbon storage, including the age of a meadow and temperature, which will have changed between 1990 and 2020, but we can estimate the net change using our values***

2020

In 2020 Scientists found that there were 55,000 square meters of Eelgrass and 80,000 square meters of Widgeon Grass in the Chesapeake Bay. Our sediment stocks are per square cm. How can we make the units match? We can multiply our rate by the same number of square cm in a square meter, which is equal to 10,000!

Calculate an approximate carbon stock of each species and for all seagrass meadows in the Chesapeake Bay in 2020 using the coverage in square meters of each species as calculated in Section A.

Seagrass Carbon Stock in 2020

Species	Average carbon stock per square centimeter	Average carbon stock per square meter	The area of species is 2020	Carbon in all meadows in the Chesapeake Bay for this species

				Total carbon stock of all meadows in the Chesapeake Bay:

1990

In 1990 the area of species of seagrass in the Chesapeake was different: Eelgrass covered 1,010,000 square meters and Widgeon Grass covered 71,000 square meters.

Species	Average carbon stock per square centimeter	Average carbon stock per square meter	The area of species is 1990	Carbon in all meadows in the Chesapeake Bay for this species
				Total carbon stock of all meadows in the Chesapeake Bay:

Final Reflections

1) Was the average carbon storage of seagrass meadows higher in 2020 or in 1990? What is causing this?

Challenge Question:

1) What else might complicate this investigation?

Answer Keys:

Seagrass Sediment - Worksheet 1 ANSWERS

Name(s) _____

Date_____

Section A

Introduction

You are working with a group of marine scientists to measure the amount of organic carbon in the sediment of two meadows in the Chesapeake Bay that are dominated by different species. Seagrasses are underwater plants that live in marine, salty, water. Like all ecosystems, like rainforests, they capture and store carbon in their sediments over long timescales.

Answer the following questions before beginning

1) Why are seagrass meadows important ecosystems?

They provide a lot of services or benefits such as acting as nursery habits for fish, capturing carbon, and protecting shorelines.

2) What other ecosystems besides seagrass meadows might be good at carbon storage? List at least three examples. *Think about both aquatic and terrestrial habitats!*

rainforests, salt marshes, mangroves, redwood forest, swamp, etland, etc.

3) What factors might affect the amount of carbon stored in seagrass sediments?

The species of seagrass, height of leaves, temperature of water, pH of water, where the meadow is, depth of water, etc.

Form a hypothesis on which species will store more carbon

4) Write your hypotheses below.
    a) Why?

No right answer, but students should offer ideas on why they form the prediction they do. For example: Eelgrass will store more carbon because it is a bigger species!

Measure the size of your core

When we measure carbon through sediment cores, we need to know how much sediment we take in a sample. Record the dimensions of your core below:

****This lesson assumes a corer made of standard toilet paper tub (about 4 cm x 10 cm). If you use a different device, the answers will differ slightly****

Core Radius: 2 cm (half of the diameter!)

Now, we can calculate the area of sediment we might sample using the equation for an area of a circle. Show your work:

remember the equation for an area of a circle* $A = \pi r^2$*

A = 3.14*(2*2) = 12.56 cm^2

Record the amount of carbon

Take a sediment core from each bucket. Count the number of colored beads (carbon) and the number of neutral beads (sediment particles) and record them in your data table. Get the counts from the other groups' (replicates) and record them as well. Calculate the average carbon stock for each species.

Remember: Carbon Stock can be calculated from:

$$Carbon\ stock\ \left(\frac{Pieces\ Carbon}{cm^2}\right) = \frac{Carbon\ Grains}{All\ Grains}\ x\ \frac{1}{Core\ area\ (cm^2)}$$

****Every replicate sample will differ slightly!! These answers are just examples of what your student might get****

Eelgrass Sediment Cores

Replicate	Sediment Grains (pieces)	Carbon Grains (pieces)	All Grains (Pieces)	Proportion Carbon in Sample $\left(\frac{Grains\ Carbon}{All\ Grains}\right)$	Carbon Stock $\left(\frac{Grains\ Carbon}{cm^2}\right)$
1	120	49	169	$\frac{49}{169}$ = 0.29	$\left(0.29 * \frac{1}{12.56}\right)$ = 0.0231
2	130	40	170	0.31	0.0247
3	125	35	160	0.28	0.0223
4	110	30	140	0.27	0.0215
5	150	45	195	0.30	0.0239
				Average:	0.0231

Widgeon Grass Sediment Cores

Replicate	Sediment Grains (pieces)	Carbon Grains (pieces)	All Grains (Pieces)	Proportion Carbon in Sample $\left(\frac{Grains\ Carbon}{All\ Grains}\right)$	Carbon Stock $\left(\frac{Grains\ Carbon}{cm^2}\right)$
1	128	30	158	$\frac{30}{158} = 0.19$	$(0.19 * \frac{1}{12.56}) = 0.0151$
2	130	22	125	0.15	0.0119
3	125	23	148	0.16	0.0127
4	115	20	135	0.15	0.0119
5	135	25	160	0.16	0.0127
				Average:	0.01286

Graph the carbon stocks for each species as a bar plot.

1) What type of graph should we use, and why?

A bar plot! We are comparing the mean of two groups!

****These answers are just examples of what your student might get****

Answer the following questions

1. Which species had the larger carbon stock? What does this mean for a meadow of Eelgrass vs a meadow of Widgeon Grass?

Eelgrass has the larger stock! It means a meadow made out of Eelgrass will store more carbon in it's sediment than a meadow made from Widgeon Grass

2. What would happen if a meadow that had Eelgrass switched to one with Widgeon Grass?

It may lose its ability to hold on to as much carbon!

Challenge Question:

1) Why might these species differ?

They are different in height and width!

2) How can we protect seagrass meadows? Brainstorm a specific solution.

We could help fight climate change by replanting rainforests, stopping boats from destroying seagrass meadows, planting more seagrass, etc.

Optional Section B / Worksheet 2 ANSWERS

Scaling Up in Space

Seagrass coverage in the Chesapeake Bay changes yearly. Scientists at the Virginia Institute of Marine Science use annual aerial images taken from planes to map how much seagrass there is per year. Use some of these values to see how Bay-wide carbon stocks might change over time depending on coverage and species identity.

*Note: **Many things impact carbon storage, including the age of a meadow and temperature, which will have changed between 1990 and 2020, but we can estimate the net change using our values***

2020

In 2020 Scientists found that there were 55,000 square meters of Eelgrass and 80,000 square meters of Widgeon Grass in the Chesapeake Bay. Our sediment stocks are per square cm. How can we make the units match? We can multiply our rate by the same number of square cm in a square meter, which is equal to 10,000!

****These answers are just examples of what your student might get, which will differ slightly depending on the average carbon stock they calculate****

Seagrass Carbon Stock in 2020

Species	Average carbon stock per square centimeter	Average carbon stock per square meter	The area of species is 2020	Carbon in all meadows in the Chesapeake Bay for this species
Eelgrass	0.023	230	55,000	12,650,000
Widgeon Grass	0.013	130	80,000	10,400,000
				Total carbon stock of all meadows in the Chesapeake Bay: 23,050,000

1990

In 1990 the area of species of seagrass in the Chesapeake was different: Eelgrass covered 1,010,000 square meters and Widgeon Grass covered 71,000 square meters.

****These answers are just examples of what your student might get, which will differ slightly depending on the average carbon stock they calculate****

Seagrass Carbon Stock in 1990

Species	Average carbon stock per square centimeter	Average carbon stock per square meter	The area of species is 1990	Carbon stock of all meadows in the Chesapeake Bay for this species
	0.023	230	1,010,000	232,300,000

Eelgrass				
Widgeon Grass	0.013	130	71,000	9,230,000
				Total carbon stock of all meadows in the Chesapeake Bay: 241,530,000

Final Reflections

2) Was the average carbon storage of seagrass meadows higher in 2020 or in 1990? What is causing this?

Higher in 1990! More seagrass overall means more carbon stored! Could be up to 10X higher (may change slightly depending on your average carbon stock)

Challenge Question:

2) Why has the carbon stock changed?

Changes to the environment such as temperature, pH, depth, etc., has lead to changes in species coverage and overall seagrass cover!