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# Watching Seagrasses Breathe—Primary Productivity Online Lab

# Part 1: Introduction to Primary Productivity

You are working with a group of marine scientists to measure the Gross Primary Production (GPP) of seagrasses in the Chesapeake Bay. Seagrasses are underwater plants that live in marine, salty, water. Like all plants, they use photosynthesis to use carbon dioxide to produce sugars and release oxygen, but they also respire and use oxygen and release carbon dioxide. You know that to measure GPP, you must first measure the Net Primary Production (NPP) and Respiration of the seagrass meadow.

# Pre-Lab:

1. Will the amount of dissolved oxygen increase or decrease with respiration? What about with photosynthesis?

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1. What equation will you need to calculate GPP from NPP and respiration?

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# Form a hypothesis:

1. Do you think the seagrasses will have a higher rate of respiration or NPP? Why?

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1. Do you think the seagrasses will have a positive or negative rate of GPP? Why?

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# Record the rates of Respiration and NPP in the data tables.

Look at the 1-hour incubations (light and dark) for your group and write down the replicate number. Count the number of bubbles at the start and end of your two incubations and record the starting and ending number of bubbles in your data table. Get the counts for bubbles from the other groups and record them as well. Calculate the average rate of change for each replicate.

Finally, calculate the average rate of change.

Eelgrass Dark Incubations

|  |  |  |  |
| --- | --- | --- | --- |
| Replicate | Starting Oxygen Bubbles | Ending Oxygen Bubbles | Rate of Change |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  | Average: |

Eelgrass Light Incubations

|  |  |  |  |
| --- | --- | --- | --- |
| Replicate | Starting Oxygen Bubbles | Ending Oxygen Bubbles | Rate of Change |
|  | 0 |  |  |
|  | 0 |  |  |
|  | 0 |  |  |
|  | 0 |  |  |
|  | 0 |  |  |
|  |  |  | Average: |

# Analysis:

1. Which type of incubation is measuring respiration? NPP?

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1. What units should you use for respiration and net primary productivity?

*(Hint: look at the measurement of DO and how long you are running the incubation for)*

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1. Which (respiration or NPP) has a higher rate of change? Does this support your hypothesis? Does this make sense? Justify your answer using the data you collected.

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# Part 2: Comparing Productivity of Different Species

Not all seagrass species have the same rates of NPP and R. In the Chesapeake Bay, we have two seagrass species: Eelgrass (*Zostera marina*) and Widgeon Grass (*Ruppia maritima*). These species differ in shape and size with Eelgrass having bigger and taller leaves while Widgeon Grass is typically shorter with thinner, round leaves.

# Pre-Lab:

Why might species have different rates of NPP and R? Provide at least two reasons.

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# Form a hypothesis:

Which species (Eelgrass or Widgeon Grass) do you think will have the higher rate of NPP? Why? *Remember to write your hypothesis as an if-then statement and include both your independent and dependent variables.*

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# Record the rates of Respiration and NPP of your second species in the data tables.

Look at the Widgeon Grass incubations (light and dark) for your group and write down the replicate number in the same way as with Eelgrass! Calculate the rate of change as you did with Eelgrass.

Widgeon Grass Dark Incubations

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| --- | --- | --- | --- |
| Replicate | Starting Oxygen Bubbles | Ending Oxygen Bubbles | Rate of Change |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  | Average: |

Widgeon Grass Light Incubations

|  |  |  |  |
| --- | --- | --- | --- |
| Replicate | Starting Oxygen Bubbles | Ending Oxygen Bubbles | Rate of Change |
|  | 0 |  |  |
|  | 0 |  |  |
|  | 0 |  |  |
|  | 0 |  |  |
|  | 0 |  |  |
|  |  |  | Average: |

# Analysis:

1. Which species had a larger rate of respiration? NPP? Use data to support your answer.

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1. Why might these species differ?

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# Calculate the Gross Primary Production (GPP) using the average rates of NPP & respiration.

GPP is a measure of energy or biomass produced, but we are using oxygen to indirectly measure this. Calculate the GPP of the seagrass meadow using the data from the last page and show your work.

*Remember we calculate GPP by subtracting the Light - Dark Incubations:*

*(Oxygen rate from Photosynthesis) - (Oxygen rate from Respiration).*

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| Species | Average Rate of NPP | Average Rate of Respiration | Rate of GPP |
| Eelgrass |  |  |  |
| Widgeon Grass |  |  |  |

# Graph the rates of respiration, NPP, and GPP for each species as a bar graph.

*Don’t forget to add all parts of a graph!*

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1. Are your rates of GPP positive or negative? Are they bigger or smaller than the average rate of NPP? Why does this make sense? Use specific data points to justify your answer.

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1. Does this mean seagrasses net add oxygen or remove oxygen from the water in the Chesapeake Bay?

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# Part 3: Scaling Up in Time

The incubations marine scientists run only show a snapshot in time. In the incubations, you only measured the change in dissolved oxygen for 1 hour in the morning. Scientists often need to scale up their measurements both in time (for example: calculating GPP for a day, month, or year) and by space (for example GPP of all the seagrasses in the Chesapeake Bay).

# Answer the following questions:

1. Why would scientists want to know the rate of GPP for longer periods of time? Think about what that data means for the ecosystem.

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1. Why don’t scientists measure the grass for long periods of time?

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# Calculate the GPP for a day for each of the species.

To calculate the GPP for different time periods, we must multiply our rate by the amount of time we want to estimate. Be sure to show your work and include units.

*How many hours are our incubations for? How many hours in a day?*

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| Species | Rate of GPP per hour | Rate of GPP per day |
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# Discussion Questions:

1. Are seagrass meadows net autotrophic or heterotrophic? What does this mean in the context of the bay ecosystem?

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1. Which species had the larger rate of GPP per day? What does this mean for a meadow of Eelgrass vs a meadow of Widgeon Grass? Support your response with data.

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1. What would happen if a meadow that had Eelgrass switched to one with Widgeon Grass? How would the animals living in seagrass meadows be affected?

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1. Connect what you learned about productivity to your knowledge of the carbon cycle. Why is seagrass productivity important for the bay ecosystem?

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# Part 4: 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 this data to see how rates of GPP change over time depending on coverage and species identity.

# 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 benthic chambers measured 1 square foot. There are 0.9 square meters in one square foot.



Calculate the GPP of each species, then for all Seagrasses in the Chesapeake Bay for one day in 2020 using the coverage in square meters of each species and their rates of GPP per day. Use data from Part 3 to complete your calculation. Be sure to show your work & include units.

GPP in 2020

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| --- | --- | --- | --- | --- |
| Species | Rate of GPP per day per Square Foot | Rate of GPP per day per Square Meter | Area of Species is 2020 | Rate of GPP for one day in the Chesapeake Bay |
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|  |  |  |  | Total GPP for seagrasses in the Chesapeake Bay for one day: |

# 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. Calculate the GPP of each species and for all Seagrasses in the Chesapeake Bay for one day in 1990. Show your work & include units. *(Hint: Which rate should you use from the first part to get GPP for one day?)*

GPP in 1990

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| --- | --- | --- | --- |
| Species | Rate of GPP per day per Square Meter | Area of Species is 1990 | Rate of GPP for one day in the Chesapeake Bay per square meter |
|  |  |  |  |
|  |  |  |  |
|  |  |  | Total GPP for seagrasses in the Chesapeake Bay in one day: |

# Graph the changes in total GPP from 1990-2020 as a line graph.

*Don’t forget to add all parts of a graph!*

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# Discussion:

1. Was the rate of gross primary production higher in 2020 or in 1990? What is causing this? Use data to support your answer.

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1. Do you think your graph accurately represents the change in gross primary productivity over 30 years? Why or why not?

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1. Why would doing these calculations every year be helpful to scientists?

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1. What do you think the differences between 2020 and 1990 mean for the ecosystems in the Chesapeake Bay? What does this mean for the carbon cycle?

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1. What would cause changes in the amount of seagrass year to year?

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*Originally designed by Allyson Hall, VIMS-2023*

*Edited by Jennifer Dunn-2023*