Tracking Invisible Growth

Compare field measurements and satellite estimates of primary productivity.

MAQ.5.6 "Enrichment: Research, analyze, and communicate historical and current methodologies for measuring primary productivity. Use an engineering design process to design and develop improvements to measure primary productivity (e.g...."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline what each method measures, circle one limitation of each method, and number the team's design steps in order. Use your marks to compare the methods and explain how the team improves its estimate.

How Productive Is the Bay?

1 Scientists estimate how quickly phytoplankton make organic matter, called primary productivity. For decades, they have tested bay water in paired light and dark bottles. Oxygen change in the lit bottle reflects photosynthesis minus respiration. Oxygen loss in the dark bottle estimates respiration. Together, these changes estimate gross primary productivity, assuming respiration is similar in both bottles.

2 Today, satellites track ocean color across wide areas, often over many days. Scientists use color to estimate surface chlorophyll, then use models to estimate productivity. Satellites do not measure photosynthesis directly. Mud can distort color, and deep blooms may escape detection. Bottles give local oxygen measurements but cannot easily represent a whole coastline.

TWO WAYS TO ESTIMATE PRODUCTIVITY

Method	Coverage	Measured signal
Light and dark bottles	Sampled sites	Oxygen change
Satellite	Wide area	Ocean color

3 A team mapping a muddy bay combines both tools. They collect bottle samples at several locations and depths when the satellite passes overhead. They compare bottle-based estimates with satellite estimates, adjust the model for local conditions, and test it on new samples. If the estimates still differ near river mouths, they revise the model and test again.

2 ANSWER WITH EVIDENCE

Use the passage

1. Why does the bottle method need a dark bottle to estimate gross primary productivity?

2. A bloom grows deep below the surface. Why might the satellite estimate miss some of its productivity?

3. Which method better covers a whole coastline, and what limitation must scientists consider when using it?

4. How does the team's work near river mouths show an engineering design process rather than a single test?

3 YOUR TURN

Your own words

A lake's surface clears after a storm, but algae may be growing deeper. Design a plan using both methods to improve its productivity estimate. Say where and when you would sample, how you would check the estimate, and what you would change if it fails.

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PART 1 · READ AND MARK

Underline what each method measures, circle one limitation of each method, and number the team's design steps in order. Use your marks to compare the methods and explain how the team improves its estimate. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Why does the bottle method need a dark bottle to estimate gross primary productivity?	**Oxygen loss in the dark bottle estimates respiration, which must be accounted for when using oxygen change in the lit bottle to estimate total photosynthesis.**
2	A bloom grows deep below the surface. Why might the satellite estimate miss some of its productivity?	**The satellite uses ocean color to estimate surface chlorophyll, so a deep bloom may escape detection.**
3	Which method better covers a whole coastline, and what limitation must scientists consider when using it?	**Satellites cover wide areas, but their color-based estimates can be distorted by mud or miss deep blooms.**
4	How does the team's work near river mouths show an engineering design process rather than a single test?	**The team checks estimates against new samples, revises the model when estimates differ, and tests it again.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

On days when a satellite passes over the lake, I would collect light and dark bottle samples near the surface and in the deeper algal layer. I would compare the bottle estimates with the satellite estimate, then test any adjustment using samples from another day. If the satellite still underestimates productivity, I would add more deep sampling sites and revise the adjustment before testing it again.

Accept plans that use bottle measurements to check a satellite-based estimate and include a specific revision followed by another test. Students may choose different sampling depths or dates if they explain how those choices address the deep algae.