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DATA Nugget

Urbanization and estuary eutrophication

Featured scientists: Charles Hopkinson from University of Georgia and
Hap Garritt from the Marine Biological Laboratory Ecosystems Center

Research Background:

An estuary is a habitat formed where a freshwater river or stream meets a saltwater ocean. Many estuaries can be found along the Atlantic coast of North America. Reeds and grasses are the dominant type of plant in estuaries because they are able to tolerate and grow in the salty water. Where these reeds and grasses grow they form a special habitat called a **salt marsh**. Salt marshes are important because they filter polluted water and buffer the land from storms. Salt marshes are the habitat for many different kinds of plants, fish, shellfish, and birds.

Scientists are worried because some salt marshes are in trouble! Runoff from rain washes nutrients, usually from lawn fertilizers and agriculture, from land and carries them to estuaries. When excess nutrients**,** such as **nitrogen** or **phosphorus**, enter an ecosystem the natural balance is disrupted. The ecosystem becomes more productive, called **eutrophication**. Eutrophication can cause major problems for estuaries and other habitats.

With more nutrients in the ecosystem, the growth of plants and algae explodes. During the day, algae photosynthesize and release O_2 as a byproduct. However, excess nutrients cause these same algae grow densely near the surface of the water, decreasing the light available to plants growing below the water on the soil surface. Without light, the plants die and are broken down by decomposers. Decomposers, such as bacteria, use a lot of O_2 because they respire as they break down plant material. Because there is so much dead plant material for decomposers, they use up most of the O_2 dissolved in the water. Eventually there is not enough O_2 for aquatic animals, such as fish and shellfish, and they begin to die-off as well.

Two features can be used to identify whether eutrophication is occurring. The first feature is *low levels of dissolved O_2 in the water*. The second feature is when there are *large changes in the amount of dissolved O_2 from dawn to dusk*. Remember, during the day when it's sunny, photosynthesis converts CO_2, water, and light into glucose and O_2. Decomposition reverses the process, using glucose and O_2 and producing CO_2 and water. This means that when the sun is down at night, O_2 is not being added to the

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water from photosynthesis. However, O_2 is still being used for decomposition and respiration by animals and plants at night.

Scientists Charles and Hap have studied estuaries most of their careers. Over time they noticed a serious decline in estuary health worldwide. The health of their local estuary, Plum Island Estuary in Massachusetts, appeared to be declining over time as well. They noticed a loss of salt marsh habitats, and that the remaining salt marshes had fewer fish. They thought that urbanization nearby might be causing these losses. Charles and Hap set out to test if the loss of salt marshes in Plum Island Estuary was occurring because of eutrophication from large amounts of excess nutrients entering the estuary in runoff from the nearby urban areas.

The scientists focused on two locations in the Plum Island Estuary and measured **dissolved O_2 levels**, or the amount of O_2 in the water. They looked at how the levels of O_2 changed throughout the day and night. They predicted that the **upper** part of the estuary would show the two features of eutrophication because it is located near an urban area. They also predicted the **lower** part of the estuary would not be affected by eutrophication because it was farther from urban areas.

Hap Garritt removing an oxygen logger from Middle Road Bridge in winter.

Scientific Question: What are the effects of urbanization on salt marshes in the Plum Island Estuary?

What is the hypothesis? Find the hypothesis in the Research Background and underline it. A hypothesis is a proposed explanation for an observation, which can then be tested with experimentation or other types of studies.

Charles Hopkinson out taking dissolved O_2 measurements.

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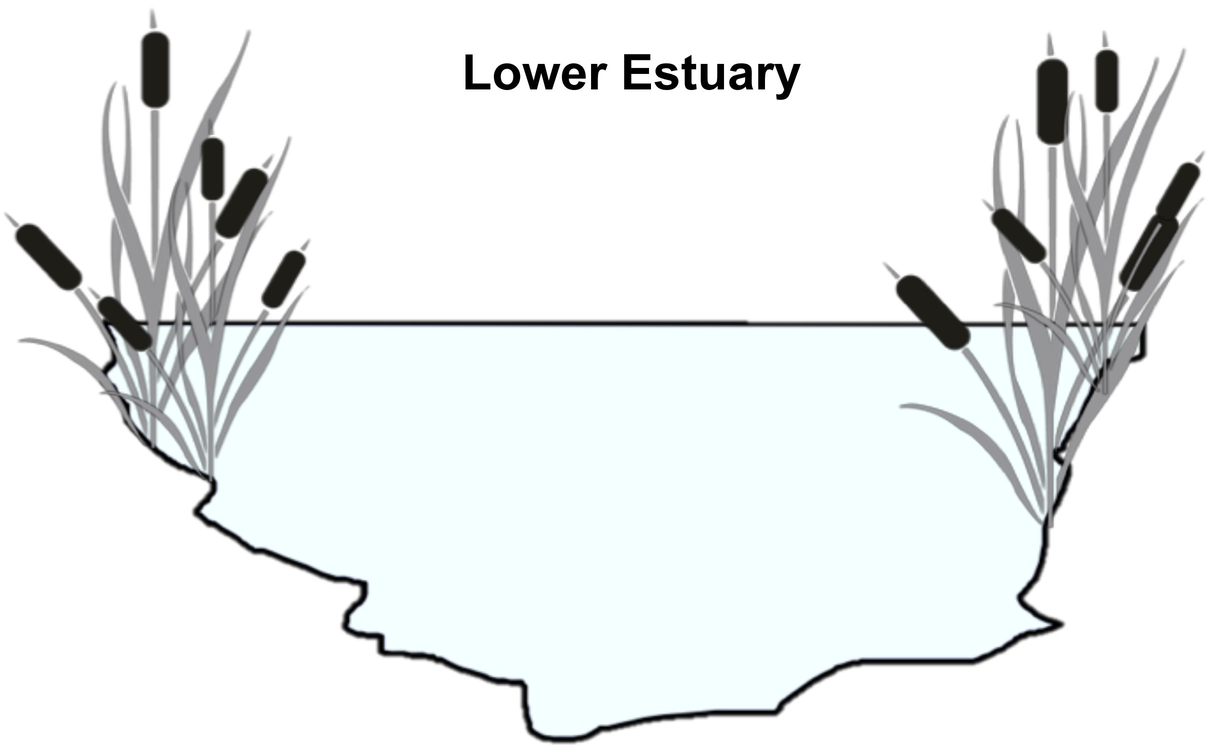
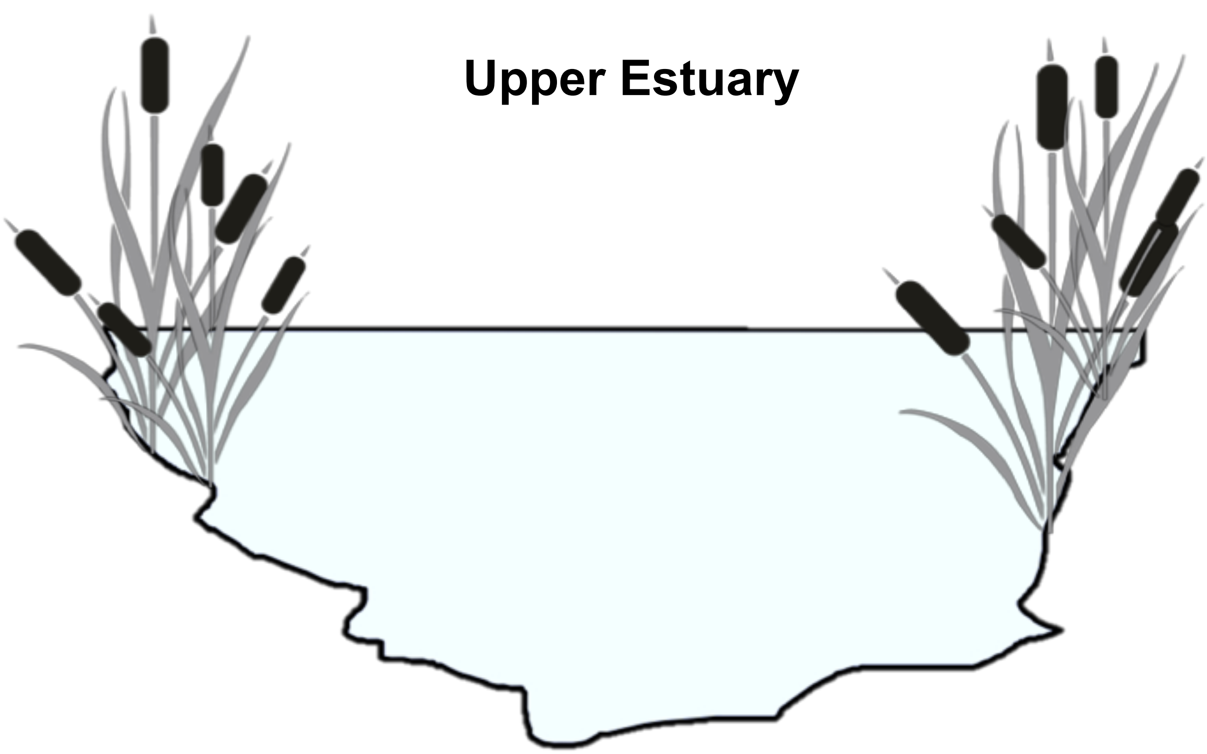
Draw your predictions: Below is a diagram of an estuary where you can draw your predictions. Fill in the diagram to show your predictions for the upper and lower parts of the Plum Island Estuary. Be sure to include the following organisms: 1) algae, 2) plants, 3) decomposers, and 4) fish. Also include your predictions for levels of 1) nitrogen (N), 2) phosphorus (P), and 3) dissolved oxygen (O_2) in each location. Label each part of your diagram or create a legend.





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Scientific Data:

Finish filling in the tables below. Use the data to answer the scientific question.

Part of Estuary	Sample number	Dawn O_2 (mg/l)	Dusk O_2 (mg/l)	Fluctuation in Dissolved O2 (dusk - dawn)
Upper Estuary	1	10	11	
Upper Estuary	2	7	12	
Upper Estuary	3	7.5	10	
Lower Estuary	1	11.2	12.8	
Lower Estuary	2	8.5	9.5	
Lower Estuary	3	9	10	

Dissolved O2				
Part of Estuary	Dawn Mean	Dawn SE	Dusk Mean	Dusk SE
Upper Estuary		0.9		0.6
Lower Estuary		0.8		1.0

Fluctuation in Dissolved O2		
Part of Estuary	Mean	SE
Upper Estuary		1.2
Lower Estuary		0.2

** Standard error (SE) tells us how confident we are in our estimate of the mean and depends on the number of replicates in an experiment and the amount of variation in the data. A large SE means we are not very confident, while a small SE means we are more confident.*

What data will you graph to answer the question?

Independent variable(s): ____

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Dependent variable(s): ____

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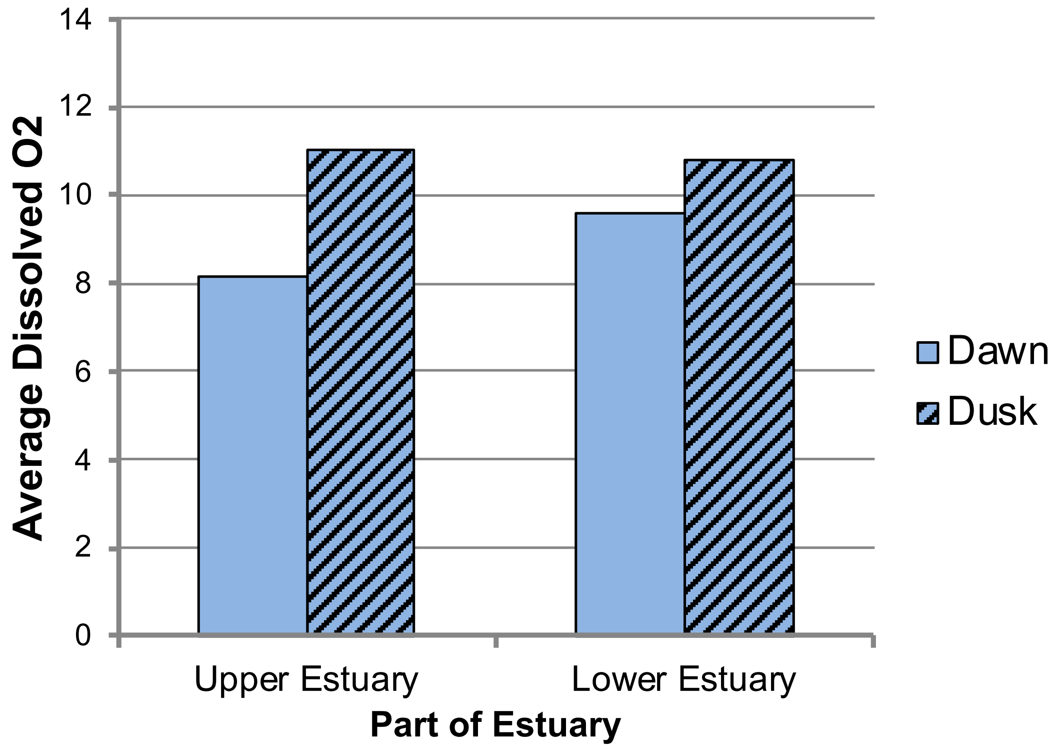
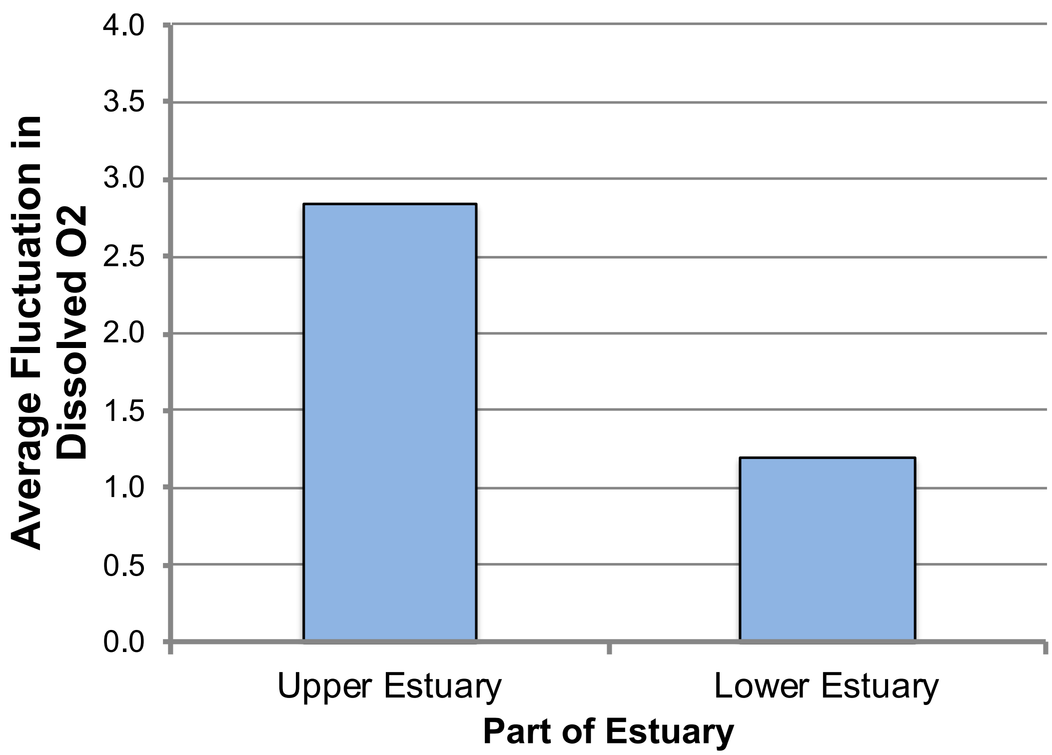
Below are graphs of the data: Identify any changes, trends, or differences you see in your graphs. Draw arrows pointing out what you see, and write one sentence describing what you see next to each arrow.





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Interpret the data:

Make a claim that answers the scientific question.

What evidence was used to write your claim? Reference specific parts of the tables or graphs.

Explain your reasoning and why the evidence supports your claim. Connect the data back to the two features used to identify whether eutrophication is occurring.

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Did the data support Charles and Hap's hypothesis? Use evidence to explain why or why not. If you feel the data were inconclusive, explain why.

Your next steps as a scientist: Science is an ongoing process. What new question(s) should be investigated to build on Charles and Hap's research? What future data should be collected to answer your question(s)?