Lesson Plan – How's the Water?

Summary
Part I of this lesson will explain the importance of nutrients in ocean water. Nutrients are essential components for growth of ocean plants and animals (just as they are essential for people). If beneficial nutrients are overloaded in ocean waters, they can cause problems for ocean health and productivity. This discussion about nutrients is a good lesson about how what happens upstream (streams and rivers) affects downstream (ocean).
Part II of this lesson builds off of part I and addresses the density of ocean water. Different densities of ocean water masses causes layering and stratification of ocean water.

Content Area
Oceanography, Ocean Chemistry

Grade Level
3-5

Key Concept(s)
- The amount of nutrients in ocean water is one factor of water quality. High nutrient levels in ocean water can lead to poor water quality by causing an excess of primary (plant) growth.

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Lesson Plan – How's the Water?

Key Concept(s)

- Of the three main pathways (runoff, atmospheric deposition, and upwelling) nutrients enter the ocean for use by plants, runoff from land is by far the greatest source of added nutrients to an ocean ecosystem.
- Water entering rivers and oceans from households and buildings is are routed to a wastewater treatment plant before being discharged into rivers and oceans.
- Runoff from farmland, towns, and cities drains into storm drains which lead to waterways or directly into streams, rivers, and oceans.
- Nitrogen and Phosphorous (from fertilizers and livestock waste) are the main nutrients leading to excess plant growth and poor water quality.
- A huge land area eventually drains into the Mississippi River and Gulf of Mexico. The excess nutrients lead to an area of hypoxia (depleted oxygen) known as the dead zone.

Objectives

Students will be able to:

- Understand that runoff from land (sewer and storm drains) is the greatest source of human caused addition of nutrients into the ocean.

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Lesson Plan – How's the Water?

Objectives

Students will be able to:

- Name and understand the two different pathways (treated water and stormwater) runoff containing nutrients ends up in the Gulf of Mexico.
- Explain what a watershed is and know that the Mississippi River watershed is the largest in the U.S.
- Explain where the Gulf of Mexico hypoxia or "dead" zone is and why it forms.
- Perform simple water tests on water samples and understand why it is important to monitor the parameters of ocean water.

Resources

GCOOS Hypoxia Interactive Map

Interactive map showing hypoxia observations from 2001-2106. Students can visualize where hypoxia occurs in relation to where they live and see the size and severity of hypoxia events from year to year.
http://gcoos.org/products/maps/hypoxia/

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Lesson Plan – How's the Water?

Resources

GCOOS River Discharge Data

Map with points showing river discharge data. Can click on various rivers to see amounts of water draining into the Gulf of Mexico from different river systems.
http://gcoos.org/products/index.php/waterquality/river-discharge-data/

GCOOS Data Portal

GCOOS data portal interactive map shows the stations from the Gulf of Mexico where timely oceanographic measurements are shown. These stations can be viewed and compared to measurements from student water tests or viewed as a stand alone activity showing real measurements of ocean parameters.
http://data.gcoos.org

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Lesson Plan – How's the Water?

National Science Education Standard or Ocean Literacy Essential Principle	Learning Goals
Unifying Concepts and Processes 2. Evidence, models, and explanation	Evidence consists of observations and data on which to base scientific explanations. Using evidence to understand interactions allows individuals to predict changes in natural and designed systems.
Unifying Concepts and Processes 3. Change, constancy, and measurement	Changes in systems can be quantified. Evidence for interactions and subsequent change and the formulation of scientific explanations are often clarified through quantitative distinctions—measurement. Mathematics is essential for accurately measuring change.
Science as Inquiry A.1. Abilities necessary to do scientific inquiry. Ask a question about objects, organisms, and events in the environment.	This aspect of the standard emphasizes students asking questions that they can answer with scientific knowledge, combined with their own observations. Students should answer their questions by seeking information from reliable sources of scientific information and from their own observations and investigations.

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Lesson Plan – How's the Water?

National Science Education Standard or Ocean Literacy Essential Principle	Learning Goals
Science as Inquiry A.1. Abilities necessary to do scientific inquiry. Employ simple equipment and tools to gather data and extend the senses.	In early years, students develop simple skills, such as how to observe, measure, cut, connect, switch, turn on and off, pour, hold, tie, and hook. Beginning with simple instruments, students can use rulers to measure the length, height, and depth of objects and materials; thermometers to measure temperature; watches to measure time; and microscopes to observe the finer details of plants, animals, rocks ,and other materials. Children also develop skills in the use of computers and calculators for conducting investigations.
Science as Inquiry A.1. Abilities necessary to do scientific inquiry. Use data to construct a reasonable explanation.	This aspect of the standard emphasizes the students' thinking as they use data to formulate explanations. Even at the earliest grade levels, students should learn what constitutes evidence and judge the merits or strength of the data and information that will be used to make explanations.

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Lesson Plan – How's the Water?

National Science Education Standard or Ocean Literacy Essential Principle	Learning Goals
Science as Inquiry A.1. Understandings about Scientific Inquiry	Simple instruments, such as magnifiers, thermometers, and rulers, provide more information than scientists obtain using only their senses. Scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge). Good explanations are based on evidence from investigations.
Physical Science B.1. Properties of objects and materials	Objects have many observable properties, including size, weight, shape, color, temperature, and the ability to react with other substances. Those properties can be measured using tools, such as rulers, balances, and thermometers.
Earth and Space Science D.1. Properties of earth materials	Earth materials are solid rocks and soils, water, and the gases of the atmosphere. The varied materials have different physical and chemical properties, which make them useful in different ways, for example, as building materials, as sources of fuel, or for growing the plants we use as food. Earth materials provide many of the resources that humans use.

Lesson Plan – How's the Water?

National Science Education Standard or Ocean Literacy Essential Principle	Learning Goals
Earth and Space Science D.3. Changes in earth and sky.	Weather changes from day to day and over the seasons. Weather can be described by measurable quantities, such as temperature, wind direction and speed, and precipitation.
Science and Technology E.2. Understanding about science and technology.	People have always had questions about their world. Science is one way of answering questions and explaining the natural world. Tools help scientists make better observations, measurements, and equipment for investigations. They help scientists see, measure, and do things that they could not otherwise see, measure, and do.
Science in Personal and Social Perspectives F.4. Changes in environments.	Changes in environments can be natural or influenced by humans. Some changes are good, some are bad, and some are neither good nor bad. Pollution is a change in the environment that can influence the health, survival, or activities of organisms, including humans.

Lesson Plan – How's the Water?

National Science Education Standard or Ocean Literacy Essential Principle	Learning Goals
Principle 1 (3-5, B.2.) The Earth has one big ocean with many features.	Water circulates from land to the ocean and back via watersheds and the water cycle.
Principle 6 (3-5, C., C.1., C.7., C.9.) The ocean and humans are inextricably interconnected. Human impact on the ocean	C. Humans impact the ocean in positive and negative ways. C.1. The trash and pollutants people put into the environment affects the ocean and the life in the ocean. C.7. Individuals can take action to protect the ocean. C.9. Public knowledge and opinion can greatly affect the choices that people make about the ocean.

How’s the Water? Part I

One factor that determines the quality of water is the amount of nutrients in it.

Food or other substances that provides energy or building material for the survival and growth of living organisms.

Too much of a good thing can be bad!

Any nutrient can be toxic in large amounts.

IN HUMANS

Examples of symptoms from too many vitamins

- Bladder and kidneys
- Eyes, ears, nose, mouth, and throat
- Heart and blood
- Muscles and joints
- Nervous system
- Skin and hair
- Stomach and intestines

IN THE ECOSYSTEM

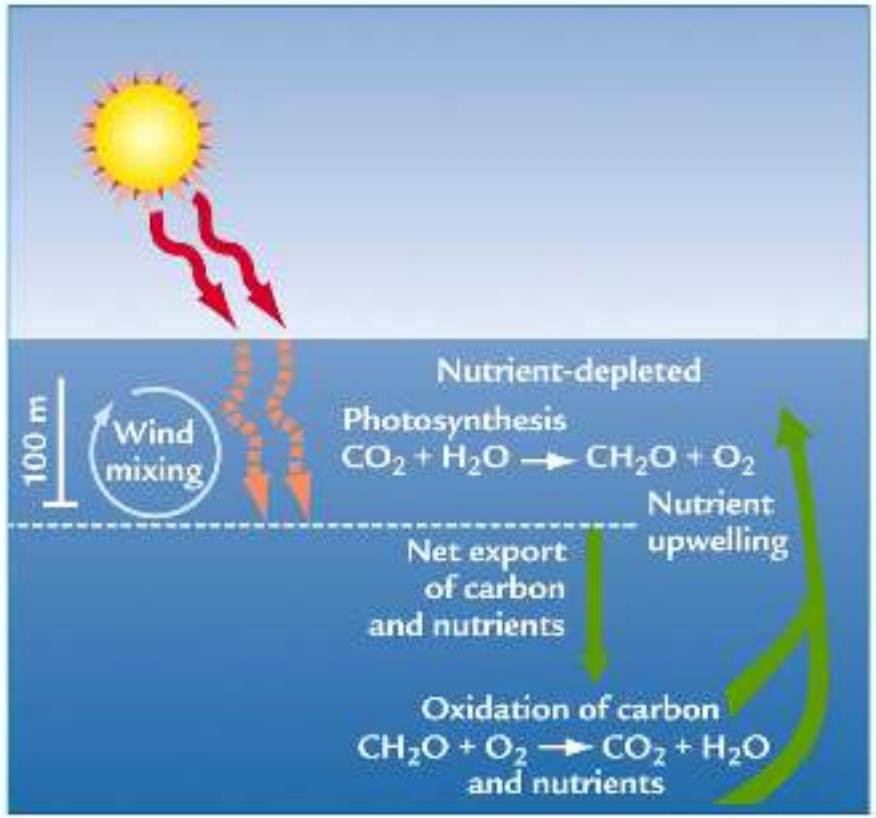
Examples of symptoms from too many nutrients

- Increased plant growth (primary productivity)
- Decrease in water clarity (increase in turbidity)
- Increase in the number of low oxygen events (hypoxia and anoxia)
- Changes in the numbers and types of species in a community (trophic structure)
- Changes in the way species interact with each other (trophic interactions)

There are three main pathways where ocean plants get nutrients.

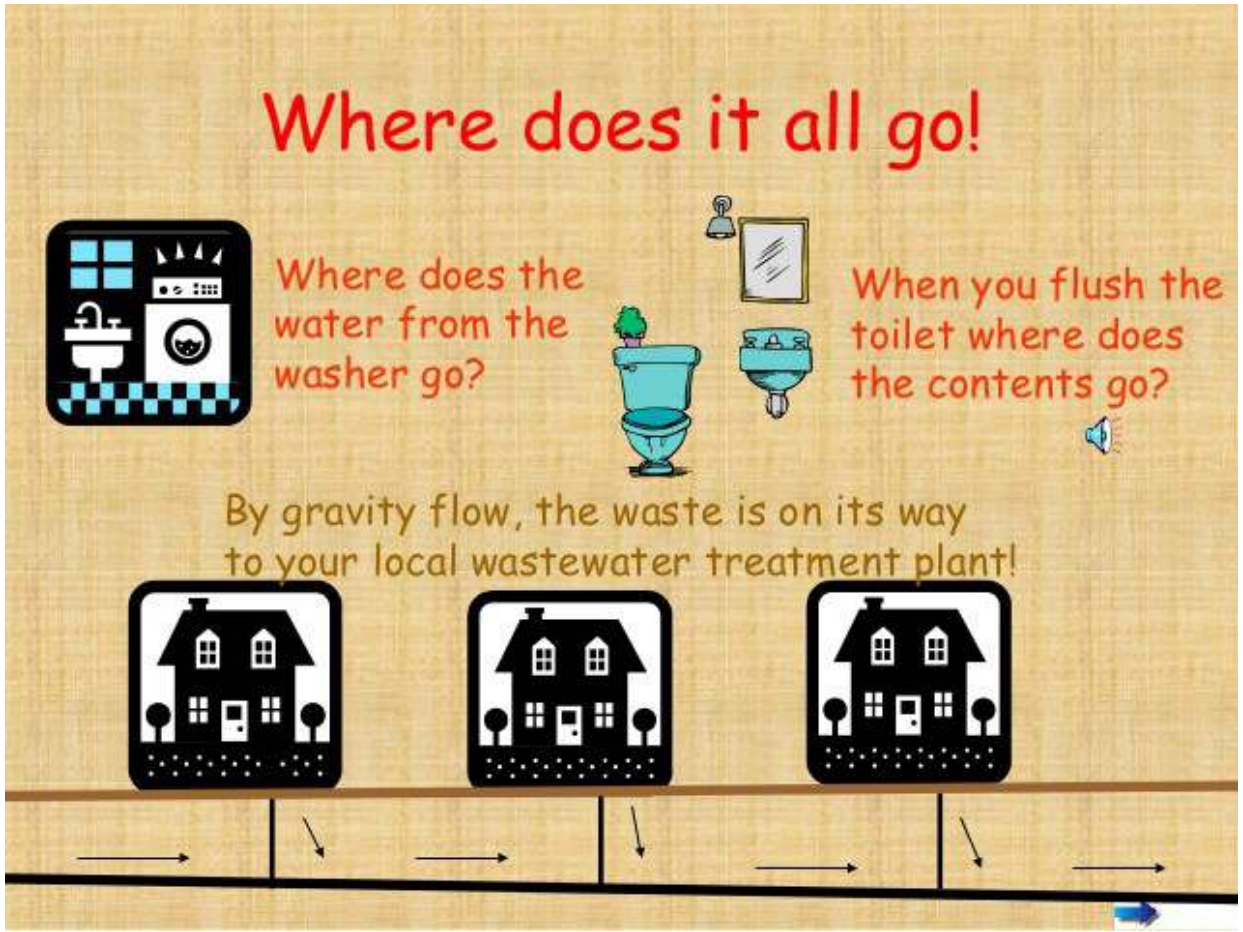
Runoff from land

Deposited at the ocean surface from the atmosphere (atmospheric deposition)



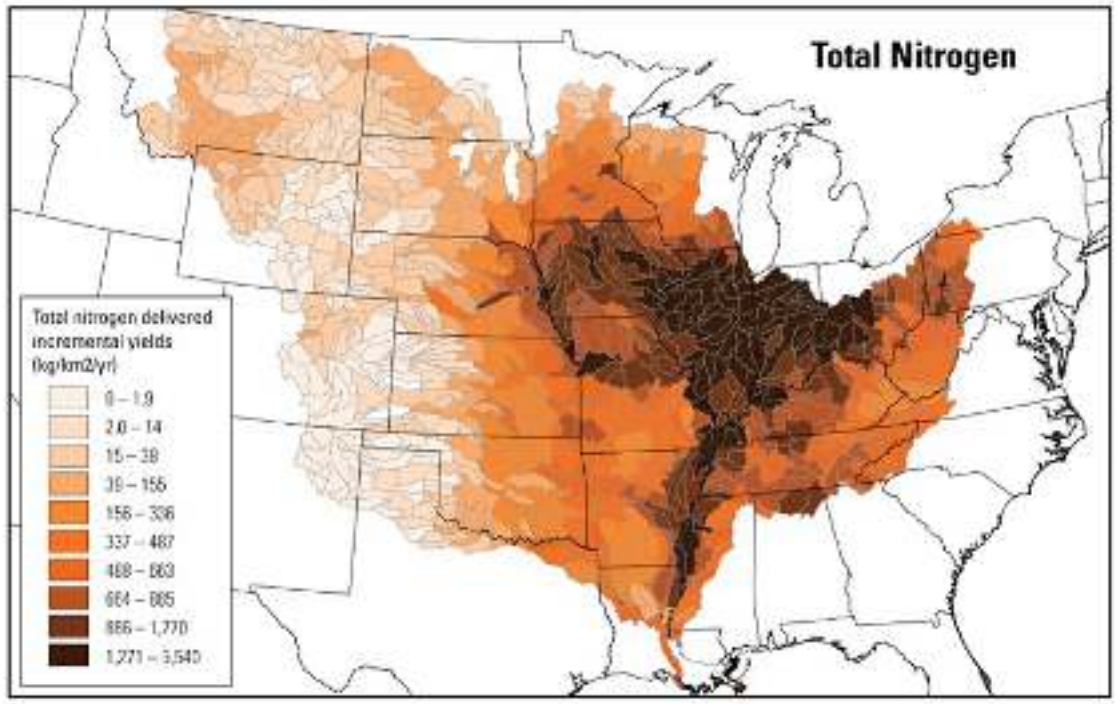
Recycled nutrients from deep in the ocean are returned to surface waters in a process called upwelling.

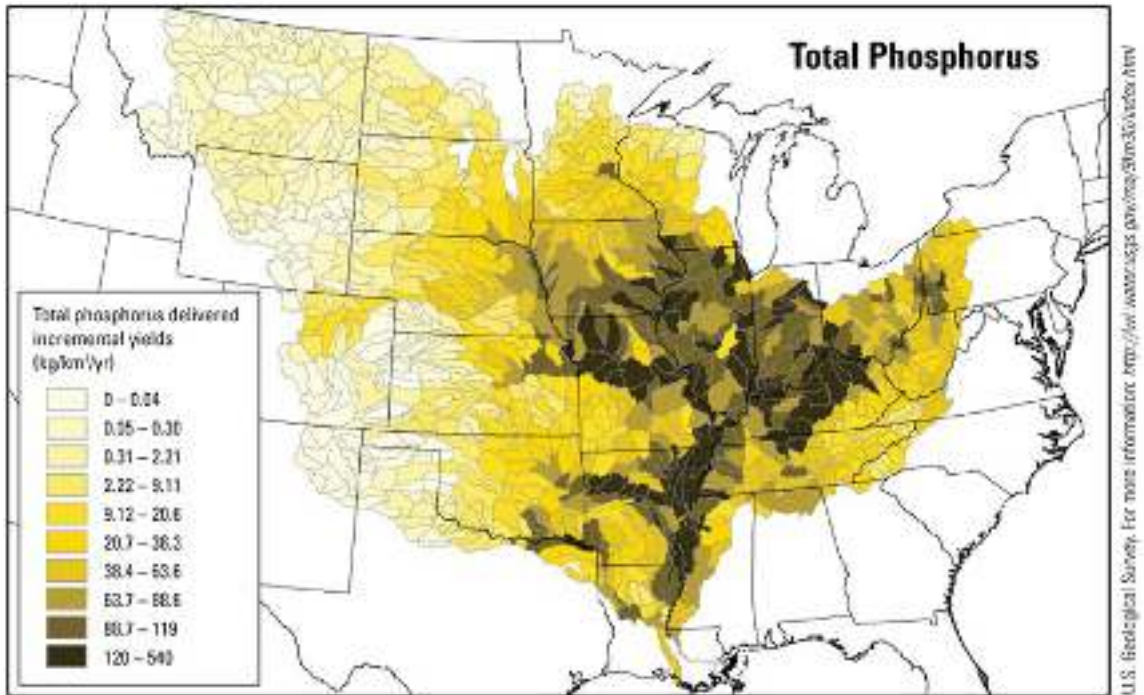
Sources of Runoff from Land




Stormwater Program
www.ocwatersheds.com
PREVENTION
HOUSEHOLD
WASTEWATE
"SINKS & TOILETS"
URBAN AND
STORMWATER
RUNOFF
CATCH BASIN
WASTEWATER
SEWER
PIPE
STORM
DRAIN
CHANNEL
WASTEWATER
TREATMENT
PLANT
STORM
DRAIN
CHANNEL
OCEAN OUTFALL

The Mississippi River watershed is a drainage basin for a huge area that ends up in the Gulf of Mexico. Other smaller river systems also bring runoff into the Gulf of Mexico. 60% of the continental U.S. drains into the Gulf of Mexico.





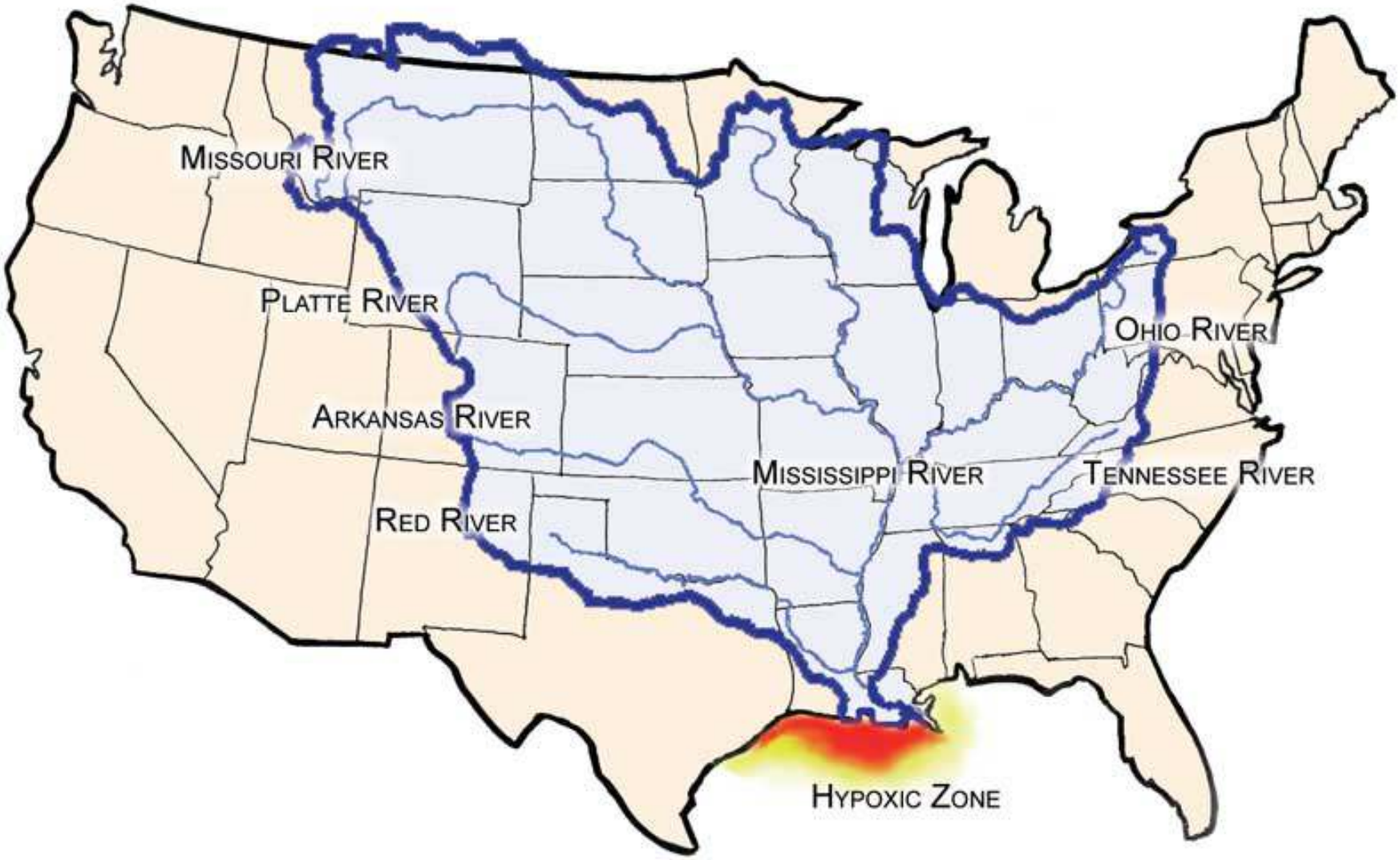
Upstream of the Gulf, there are a lot of people and farms.

All of the nutrients from things like fertilizing crops, waste from farm animals and taking care of lawns ends up in the water system.

The Gulf of Mexico is the 9th largest body of water in the world!

Even though it is a large body of water, nutrients from the 33 major *river* systems that empty into it *cause problems!*

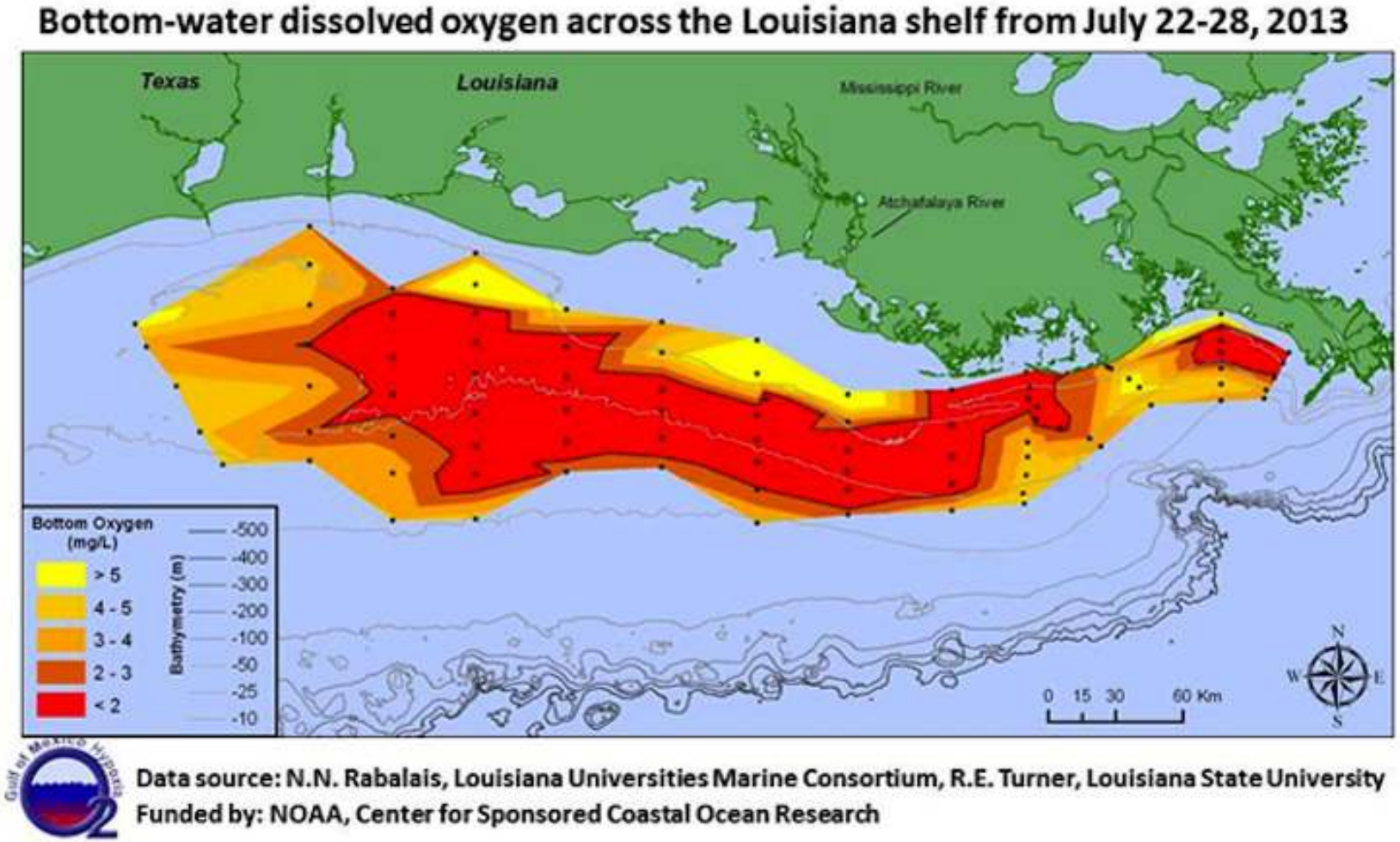
Gulf Hypoxia is a Serious Water Quality Issue



Hypoxia means that oxygen levels become so low as to be harmful to living organisms.

Seasonal Gulf hypoxia is also sometimes called the Gulf Dead Zone because so many plants and animals either die or leave the area.

Ocean conditions have to be right for a hypoxia event to develop. (Next week we will study the ocean conditions that are needed.)



About 550 Dead Zones occur annually worldwide. The Gulf of Mexico dead zone is the second largest human-caused hypoxic area in the world.

Only the Baltic Sea has a dead zone larger than the Gulf of Mexico.

Always take signs about water quality seriously!
NEVER swim in water where signs like these are posted.

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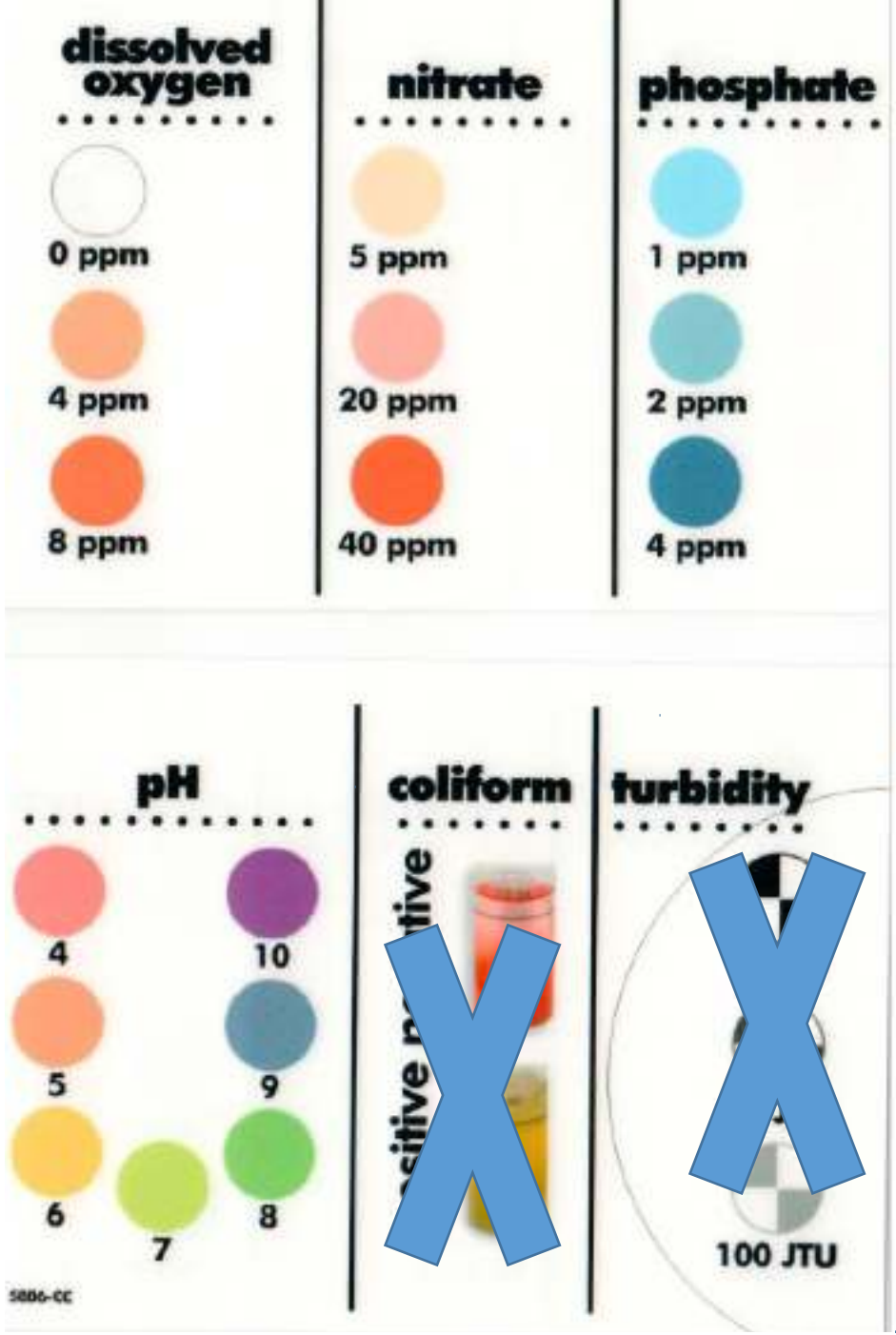
Lesson Plan – How's the Water?

Activity: Water Testing

Testing water samples is a great way to demonstrate the physical and chemical characteristics of water to students. Sources of water to test can include any natural or manmade waterways near your home or school. Beaches, lakes, ponds, rivers, even storm drains and ditches.

You can also check the GCOOS data portal and product links in the resources listed at the beginning of this lesson. These links contain real time and recent water quality data/maps that can accompany this activity and lesson.

Forestry Supploers http://www.forestry-suppliers.com is one vendor with a variety of environmental water quality test kits.



We are going to test the water in the BPE pond.

We are also going to test some mystery water samples.

Lesson Plan – How's the Water?
Part II: What does it mean when we say the water column is stratified

Summary
Part I of this lesson addressed the importance of nutrients in ocean water and some of the consequences that occur when an overload of nutrients make it into rivers, lakes, and oceans due to human activities (farming, livestock, waste water, sewage).
This lesson discusses how ocean water becomes "stratified" or layered in certain conditions. Physical attributes of water can make water more or less dense and cause masses of water with different densities to form layers instead of being uniformly mixed.

Content Area
Oceanography

Grade Level
3-5

Key Concept(s)
- When the nearshore waters of the Gulf of Mexico become stratified with denser layers toward the bottom of the Gulf of Mexico and less dense layers near the surface, conditions are more favorable for hypoxic (low oxygen) conditions in nearshore waters.

Lesson Plan – How's the Water?
Part II: What does it mean when we say the water column is stratified

Key Concept(s)

- Stratification is when water masses with different densities is layered on top of each other, not mixed.
- Density is the mass (how much stuff) in a given volume (space).
- Water with a higher salinity is more dense that fresh water and colder water is more dense than fresh water.

Objectives

- Students will be able to define volume, mass, and density.
- Students will understand that water can be more or less dense based on the physical characteristics (amount of dissolved salts, temperature).
- Students will be able to define stratified and be able to explain how ocean water can be stratified.

Resources

- See links to GCOOS data portal and products in Part I.

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Lesson Plan – How's the Water?

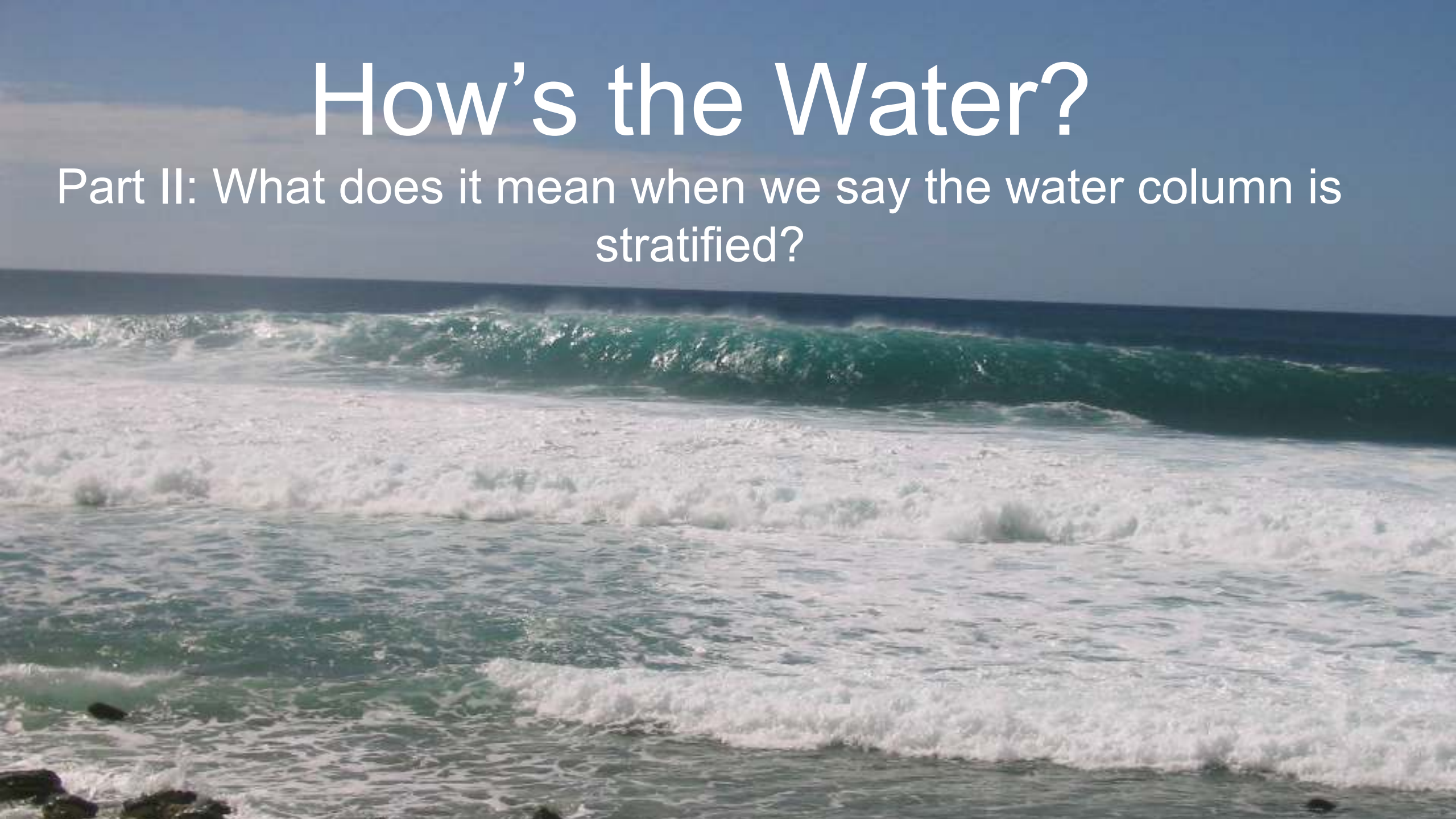
National Science Education Standard or Ocean Literacy Essential Principle	Learning Goals
Unifying Concepts and Processes 2. Evidence, models, and explanation	Models are tentative schemes or structures that correspond to real objects, events, or classes of events, and that have explanatory power. Models help scientists and engineers understand how things work.
Unifying Concepts and Processes 3. Change, constancy, and measurement	Changes might occur, for example, in properties of materials, position of objects, motion, and form and function of systems. Interactions within and among systems result in change. Changes vary in rate, scale, and pattern, including trends and cycles.
Physical Science B.1. Properties of objects and materials	Objects have many observable properties, including size, weight, shape, color, temperature, and the ability to react with other substances. Those properties can be measured using tools, such as rulers, balances, and thermometers.

Lesson Plan – How's the Water?

National Science Education Standard or Ocean Literacy Essential Principle	Learning Goals
Principle 1 (3-5, A.4.) The Earth has one big ocean with many features. Properties of Ocean Water	Salinity and temperature vary throughout the ocean.
Principle 1 (3-5, B.6.) The Earth has one big ocean with many features. Ocean Circulation	Water in the ocean is constantly moving and mixing vertically and horizontally.

How’s the Water?

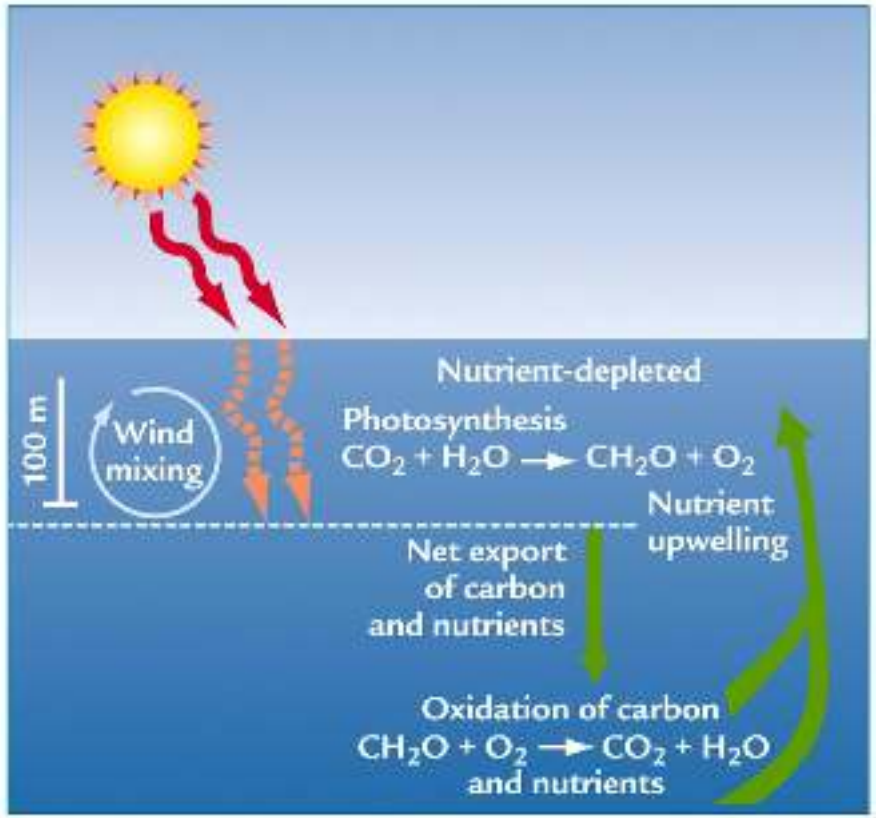
Part II: What does it mean when we say the water column is stratified?



Last time, we studied sources of nutrients to the ocean.

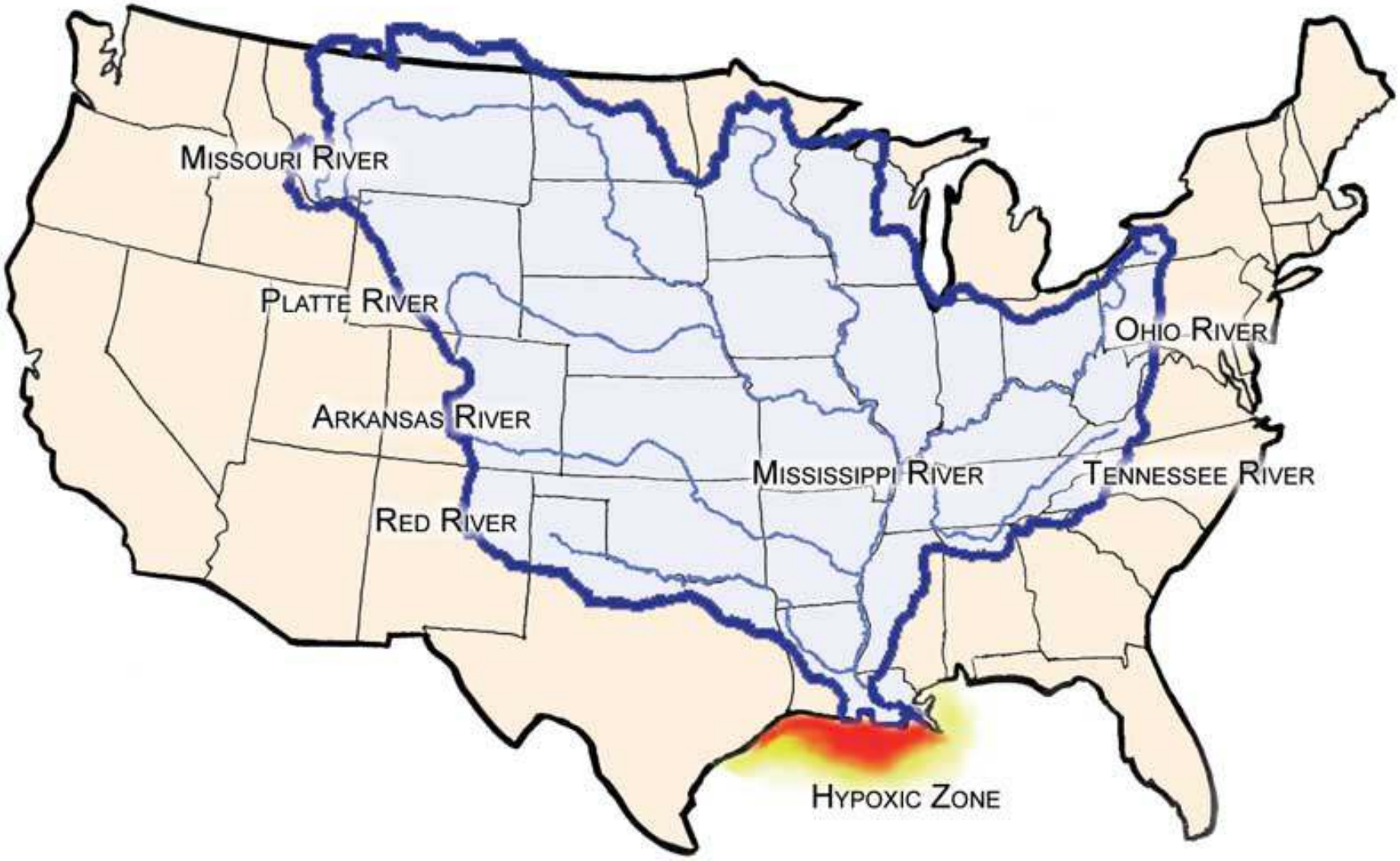
Runoff from land

Deposited at the ocean surface from the atmosphere (atmospheric deposition)



Recycled nutrients from deep in the ocean are returned to surface waters in a process called upwelling.

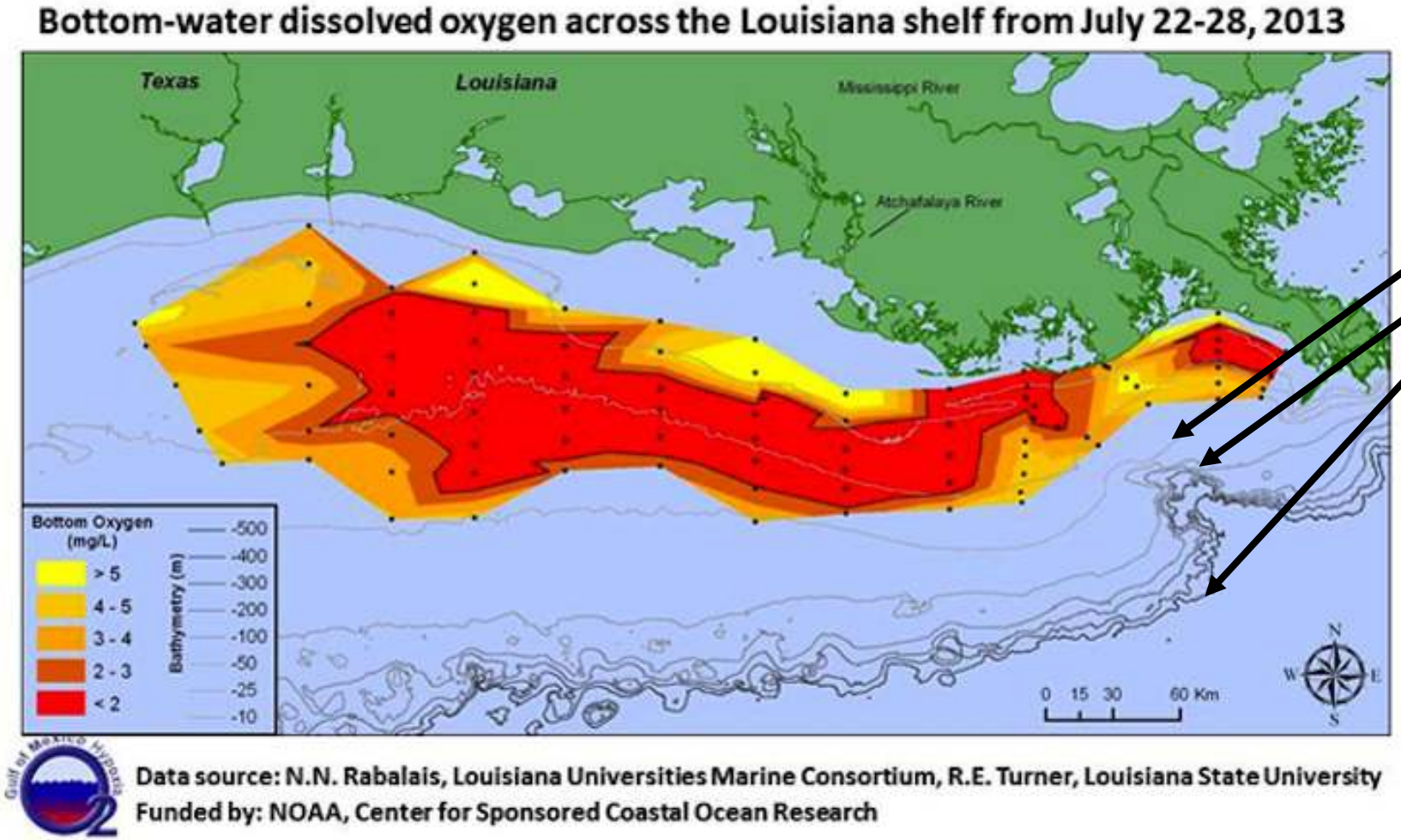
Nutrients are one factor that contributes to Gulf Hypoxia



Hypoxia means that oxygen levels become so low as to be harmful to living organisms.

Seasonal Gulf hypoxia is also sometimes called the Gulf Dead Zone because so many plants and animals either die or leave the area.

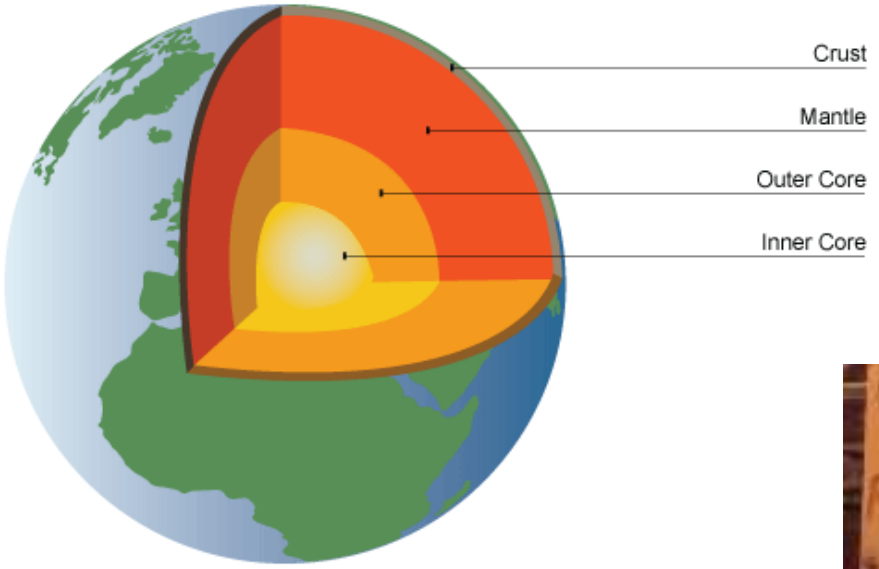
Ocean conditions have to be right for a hypoxia event to develop. Today we will study and experiment with those conditions.



Isobars on a nautical chart are lines that show places where the water depth is the same.

Usually, the further offshore you go, the deeper the water.

For hypoxic conditions to develop, the ocean must become stratified.

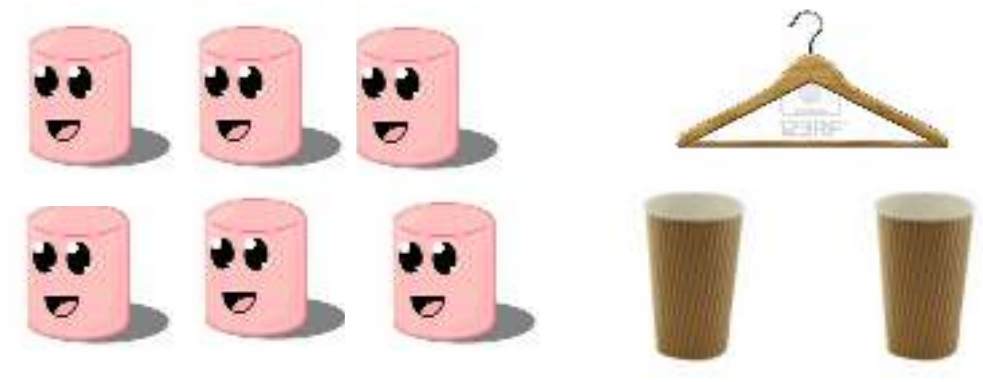


What does that mean?

Do you remember what mass is?

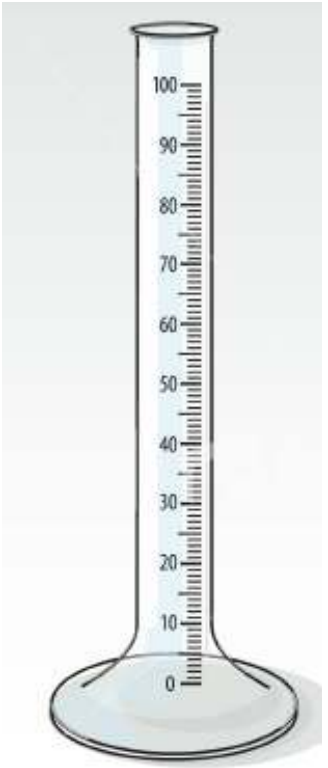
- Mass involves the measure of the amount of matter or stuff in an object.

- If I put 6 marshmallows in a cup, they would have the same MASS, even if I squished them and they took up less space in the cup!



Volume is a measure of the amount of 3-dimensional space of an enclosed container.

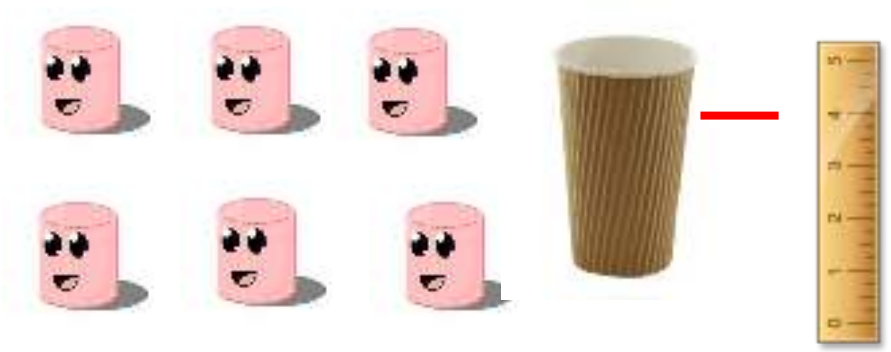
- The more a container can hold, the greater its volume.



Density

- The density of something is its mass in a given volume—how much can I squeeze into a space?

- If you put six marshmallows in a cup and draw a line where they reach the top, the line shows how much volume they occupy.



6 marshmallows per 4 cubic inches

- If you then squish the marshmallows to the bottom of the cup, their mass does not change, but they now occupy LESS volume because they do not reach as high up the side of the cup.

- The same amount of “stuff” packed into a smaller space means they have a greater density.

6 marshmallows per 2 cubic inches

Density

- Ocean water and fresh water have different densities.
- When compared at the same temperature and pressure, saltwater is more dense than freshwater.
- That means if you put them together, the saltwater will sink and the freshwater will float on top.
- Colder water is also more dense than warm water.
- This is the main way the Gulf gets stratified when there is little wind to mix the water.

Summary of Conditions that Influence the Gulf Dead Zone

- Level of nutrients entering the Gulf of Mexico.
- Rate of growth of marine plants, followed by their death and decay.
- Precipitation (heavy rains or drought?)
- Storms (is the water well mixed or not?)
- Long-term weather patterns (ocean currents respond to the speed and direction of the wind)

Making a Stratified Solution—Step by Step

Don’t let the liquids touch the sides as you add to the container!

We will start with the **most dense layer** and work our way up to the least dense layer.

Add 40 ml of the Sweet as Honey mix (honey and corn syrup) to your container.

Gently spoon 40 ml of the dish soap on top of the first layer. DO NOT MIX or let the spoon touch!

Gently add 40 ml water on top of the dish soap layer.

Gently add 40 ml of vegetable oil on top of the water layer.

The last layer, **isopropyl alcohol**, will be more visible if you add 1 drop of food coloring to 40 ml alcohol before gently adding on top of the oil layer.

Acknowledgements

Lesson developed by Dr. Chris Simoniello for Bay Point Elementary. Standards-cross-referencing and formatting by Grant Craig.

Questions, comments, edits? Contact Dr. Chris: chris.Simoniello@gcoos.org