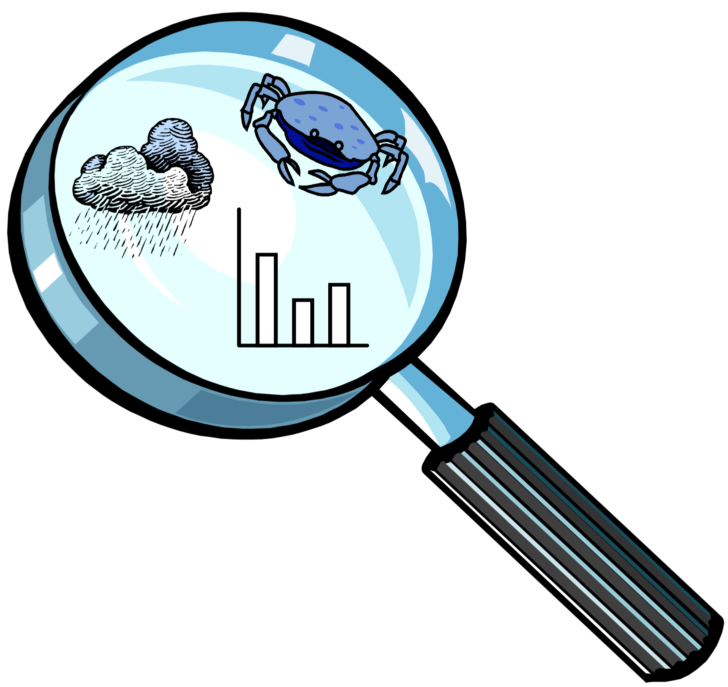
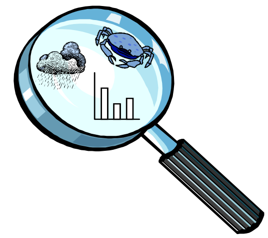
Eyes on Salinity



Eyes on Salinity



Goal

- For students to understand how salinity levels across the Chesapeake Bay vary and change with weather events.
- For students to use the Eyes on the Bay website to analyze the effects of salinity variations on aquatic species.

Student Learning Objectives

1. Students will learn about the properties of salinity and how salinity relates to the survival of aquatic organisms in the Chesapeake Bay and tidal tributaries;
2. Students will learn to build a hydrometer, and practice skills in measuring salinity;
3. Students will learn factors that influence salinity levels in the Chesapeake Bay and tributaries;
4. Students will learn and practice the difference between quantitative and qualitative measures;
5. Students will use a salinity map to determine salinity tolerance levels of different Bay species and relate what they have learned about salinity to the Chesapeake Bay ecosystem.

Voluntary State Curriculum

Grades 6-8

Social Studies

2.0 Geography: A.1.a. Using geographic tools, describe distribution of natural resources & modifications to the environment; 4.a. How humans modify their natural environment (water use; economics of modified environment); and, b. (consequences of modifying the environment).

Science

1.0 Skills & Processes (all)

2.0 Earth Science: E. Interactions of Hydrosphere & Atmosphere – a. (water cycle; properties of salt & fresh water).

3.0 Life Science: F. Ecology: a-c (conditions of environment; limiting factors; competition amongst organisms).

6.0 Environmental Science: B. Environmental Issues (impact on ecosystems; impact of environmental changes on the local & regional level; acceleration or magnification of naturally occurring changes).

Grades 9-12

Goal 1 Skills & Processes

Goal 2 Earth Science 2.1.1 Current technology to study the atmosphere, land and oceans; 2.5 connect prior understanding & new experiences to evaluate natural cycles (all); 2.8.1 (investigate an earth science issue) & 2.8.5 (real problems have more than one solution).

Goal 3 Biology 3.1.1 (chemistry's effect on living systems; density of water); 3.5 (interdependence); 3.6 (investigate a biological issue).

Time

- 3 or 4 50-minute periods

Materials

Per Group

- Computer with Internet access
- Unsharpened pencil
- Sharpened pencil
- 250 mL graduated cylinder
- 3 thumb tacks
- Freshwater sample
- Saltwater sample
- Thermometer
- Hydrometer
- Annual mean salinity map
- Map of the Chesapeake Bay

Per Student

- Student Sheets: Investigating Salinity, Investigation #1, Investigation #2, Investigation #3, Investigation #4

Overview

In these four investigations, students will learn about salinity by making a hydrometer and then comparing it to a purchased one. They will also examine some data connecting salinity to the organisms that live in aquatic environments. Lastly, students will look at how salinity levels are an important part of the Chesapeake Bay.

Science Understanding For Teachers

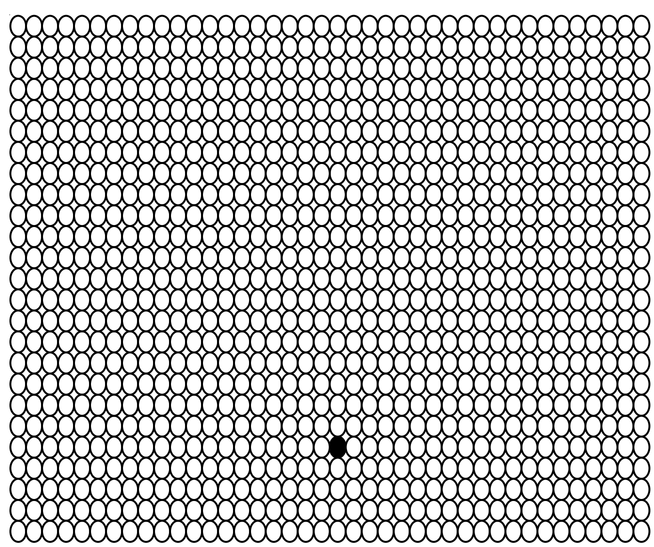
Over 70% of the earth's surface is water. Most of that water is saltwater. Plants and animals have special adaptations to live in saltwater. The Chesapeake Bay is an environment where fresh water from rivers and streams combines with the salty Atlantic ocean water. This mixture of salt and fresh water creates a solution known as "brackish water." The salinity levels in the Bay fluctuate depending on the time of year and local weather patterns.

Most of the salt in the oceans comes from rain falling on the land and dissolving the salts in eroding rocks. These salts are carried down the rivers and out to sea. The salts accumulate in the ocean as water evaporates to form clouds. The oceans are getting saltier every day, but the rate of increase is so slow that it is virtually immeasurable. The salt content of ocean water is currently about 3.5 percent.

When we measure the salinity of water, we are really measuring its density. Saline water is denser than fresh water. The **density** of something has to do with its mass (in grams) relative to the amount of space it takes up (**volume**). For example, a quart of oil has a larger mass than a quart of water. Therefore, the oil is denser than the water. Similarly, as water becomes saltier, its mass increases relative to its volume, making it denser.

Salinity is measured in parts per thousand (ppt). What does that mean? If you have a total of 1000 gumballs, and 999 of them are white, and one of them is black, the black gumball could be expressed as 1 part per 1000. Let's say you use the hydrometer and gives you a measurement of 20 ppt. That means for every 1000 molecules, 20 of them are salt molecules and 980 of them are water molecules.

Of these 1000 gumballs, one of them is a different color. If each white circle represented a water molecule, and the black circle represented a salt molecule, we would say the salinity is 1 part per thousand.



When the hydrometer is placed in the water, the indicator will float to a certain level, depending on how dense the water is. The extra salts in the saltwater make the water more dense, which means it can support more weight than water lacking those salts. This makes the indicator on the hydrometer float higher as the water gets saltier.

Engage

Part I: Introduction to Salinity

Students will be conducting four different investigations, plus making the hydrometer. They should complete all four investigations in the time you specify. Students may work in pairs. Each pair should make their own hydrometer.

Ask students if they know what are the basic needs for life (food, water, shelter, space). How much of the earth is covered with water? *(Over 70%).* What is the difference between water in a river and water in the sea? Make sure they understand the difference between salt water and fresh water. Tell them that different organisms are found in each of these environments. The Chesapeake Bay is an environment where fresh water from rivers and streams combines with the salty Atlantic Ocean water. This mixture of salt and fresh water creates a solution known as "brackish water." We measure the salt content, or *salinity* of the water with a hydrometer.

Reading for Understanding
Either individually or in pairs, have students read background information on salinity:

- Visit http://www.eyesonthebay.net
- Go to "What's it mean?" and read the section on salinity.
- As students read, they should answer the following questions:
    1. Describe how salinity varies in the Chesapeake Bay? *Salinity is low during flow and high during droughts.*
    2. Why are extreme changes in salinity a problem for some organisms? *Because some organisms are not adapted to certain salinity levels. Extreme changes can cause stress.*
    3. How are clams, oysters, and yellow perch affected by salinity changes? *Low salinity can cause clams to die. High salinity, in addition to drought, can cause oyster mortality by increasing the distribution and virulence of parasites. High salinity can cause yellow perch to move toward the headwaters or upriver, and can reduce habitat areas, perhaps making them more vulnerable to environmental stresses.*
    4. Why are bay grasses particularly vulnerable to salinity changes? *Because they are sessile (cannot move) and cannot escape from the changes.*

Before you Begin...

- *Visit the Eyes on the Bay website to see if there are any specific salinity stories you want your students to read.*
- *Review the following concepts: density, molecules, brackish.*
- *To prepare your students, try these activities:*
    - *A Drop in the Bucket (Project WET)*
    - *Adventures in Density (Project WET)*

Engage

Pairs -- Make your own hydrometer

Students will need the following materials:

- Unsharpened pencil
- Sharpened pencil
- Student worksheet "Introduction to Salinity"
- 3 thumbtacks
- 250 mL graduated cylinder
- Ruler

1. Starting 1 cm from the unsharpened end of the pencil, use the sharpened pencil to make marks every 0.5 cm along the side of the pencil.

2. Label each mark, starting at the unsharpened end of the pencil, with the label 0.5.

3. Insert 3 thumbtacks as weights into the eraser.

4. Fill the graduated cylinder with water at room temperature. Place the pencil in the water, eraser down.

5. Add or remove thumbtacks and adjust their placement in the eraser until the pencil floats upright, with about 2 cm sticking up above the surface of the water.

6. Record the number next to the mark where the pencil hydrometer projects from the water. As the density of the water increases, the hydrometer will float higher.

Vocabulary

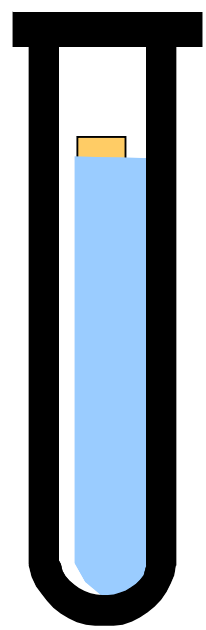
Brackish -- somewhat salty

Density -- mass of a substance per unit volume. Density = mass/volume

Hydrometer -- an instrument for determining the specific gravity of a liquid.

Molecule -- the smallest particle of a substance that retains all the properties of that substance and is composed of one or more atoms.

Volume -- the space occupied by an object as measured in cubic units.



Explore

Part II

Investigation #1 -- Hydrometers[1]

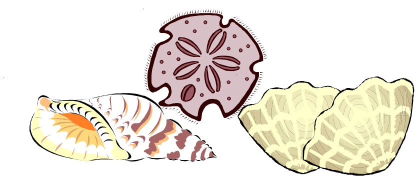
In this activity, students will use two different hydrometers to test the salinity of different samples of water. They will complete the activity in POE format. Students will need the following materials:

- 1 cup of fresh water
- 1 cup of salty water
- Paper towels
- Investigation #1 Student Sheet
- Pencil hydrometer
- Store-bought hydrometer
- Thin-line marker

[1] Adapted from MSDE 5th grade public release task, "Salinity".

Try It!

- *Fill two beakers or jars with tap water.*
- *Add 3 teaspoons of salt to one beaker. Stir to dissolve.*
- *Place a whole, uncooked egg in each jar. Observe.*
- *What happens to the two eggs?*



Did You Know...

If you boiled a kilogram of seawater in a pot until the water was all gone, there would be approximately 35 grams of salts left in the bottom of the pot.

Pairs or Group Work

Explain to students that they will be comparing the results of their pencil hydrometer to the store-bought one.

1. In pairs, student should **predict** what would happen if they placed the pencil in the fresh water sample and released it. What would happen if they placed the store-bought hydrometer in the fresh water sample and released it? Have students record their predictions.
2. Next, have them submerse each hydrometer in the fresh water sample. They should **observe** what occurs and draw, label, and record their observations for both hydrometers.
3. Next, have students predict what will happen if they place the hydrometers in the salt water sample and release them. Have them record their prediction.
4. Have students submerse each hydrometer in the salt water sample. They should observe what occurs and draw, label, and record their observations for both hydrometers.

Explain

5. Have students discuss, based on their existing knowledge, why they observed what they did. They should record an **explanation**.
6. Lastly, students should describe any differences between the two water samples and their salinities.
7. Engage the students in a group discussion to explain their findings.

Part II - Investigation #2: Measuring Salinity

There are many different instruments and methods for measuring salinity, most involving expensive probes or meters. Today, students will use a less expensive, but fairly accurate hydrometer. This hydrometer works in the same way that the homemade one did. Both are influenced by density.

The density of something has to do with its mass relative to the amount of space it takes up (volume). For example, a quart of oil is more dense than the water. Therefore, the oil is more dense than the water. Similarly, as water becomessaltier, its mass increases relative to its volume, making it denser.

When the hydrometer is placed in the water, the indicator will float to a certain level, depending on how dense the water is. The extra minerals, or salts, in saltwater make the water more dense, which means it can support more weight than water lacking those salts. This makes the hydrometer float higher the saltier the water.

Materials

For Engagement

- 1 Jar
- ½ cup water
- ½ cup vegetable oil
- Stir stick

For Student Investigation #2

- Student worksheet Investigation #2: *"Measuring Salinity"*
- Fresh water sample
- Saltwater sample
- Graduated cylinder
- Thermometer
- Hydrometer

Engage (re-engagement)

1. Explain to students that they will be investigating the salinity of water, and that hydrometers are influenced by the **density** of the water measured. Define density as a measure of **mass** relative to the amount of space it takes up (**volume**). Describe the oil example above, then conduct the following demonstration:

2. Ask students "How do we know that oil has a different density than water?"

3. Mix them together to see what happens:
    - Take ½ cup of water (you can add food coloring to make it easier to see).
    - Add ½ cup of vegetable oil.
    - What happens? What happens when you stir the mixture? Which is more dense, water or oil?

Explore

Have students work in pairs or small groups

1. Hand out “Investigating Salinity” reading material and have students read the background information on density and salinity.

2. Have students measure the fresh water sample and the saltwater sample. Record the salinity in parts per thousand (ppt).

3. Which sample had the higher salinity?

Explain

Investigation #3: Qualitative vs Quantitative

The hydrometer the students made provided them with a *qualitative* measurement of salinity. A qualitative measurement uses comparisons or descriptions to measure a characteristic. For example, if you were sitting under a tree at the same time for two days in a row, you may notice that it was hotter on the first day. That is a *qualitative* measurement. However, if you used a thermometer on both days and recorded the temperature, then you would have *quantitative* data. The hydrometer you used to measure

Pairs or Small Groups

Explain to students that in this investigation, students will think about the difference between qualitative and quantitative data and how scientists use both to gain valuable information.

Have students read the opening paragraph on their worksheet and then work in pairs to answer the following 3 questions:

1. If you were a scientist, describe a situation where qualitative measurements may be appropriate. *Community members saying the air quality has gotten worse; anglers reporting that there seems to be fewer fish found a particular fishing spot; noticing that more people visit the park after planting a butterfly garden.*
2. If you were a scientist, describe a different situation where quantitative measurements would be more useful. *Conducting an experiment on temperature range tolerances of brook trout; measuring the amount of carbon monoxide*

Characteristics of Qualitative Data

- *Qualitative research involves analysis of data such as words (e.g., from interviews), pictures (e.g., video), or objects (e.g., an artifact).*
- *Researcher may only know roughly in advance what he/she is looking for.*
- *Researcher is the data gathering instrument.*
- *Data is in the form of words, pictures or objects.*
- *Qualitative data is more ‘rich’, time consuming, and less able to be generalized.*

Characteristics of Quantitative Data

- *Quantitative research involves analysis of numerical data.*
- *Researcher knows clearly in advance what he/she is looking for.*
- *Researcher uses tools, such as questionnaires or equipment to collect numerical data.*
- *Data is in the form of numbers and statistics.*
- *Quantitative data is more efficient, able to test hypotheses, but may miss contextual detail.*

emitted from SUVs versus compact cars; estimating the population of terrapin turtles in Maryland.

3. If you had a choice, which hydrometer would you use to monitor the salinity of a saltwater fish tank? Explain your answer.

Pairs or Small Groups

Work in pairs to answer the following 3 questions:

1 If you were a scientist, describe a situation where qualitative measurements may be appropriate. *Community members saying the air quality has gotten worse; anglers reporting that there seems to be fewer fish found a particular fishing spot; noticing that more people visit the park after planting a butterfly garden.*

2 If you were a scientist, describe a different situation where quantitative measurements would be more useful. *Conducting an experiment on temperature range tolerances of brook trout; measuring the amount of carbon monoxide emitted from SUVs versus compact cars; estimating the population of terrapin turtles in Maryland.*

3 If you had a choice, which hydrometer would you use to monitor the salinity of a saltwater fish tank? Explain your answer.

Engage

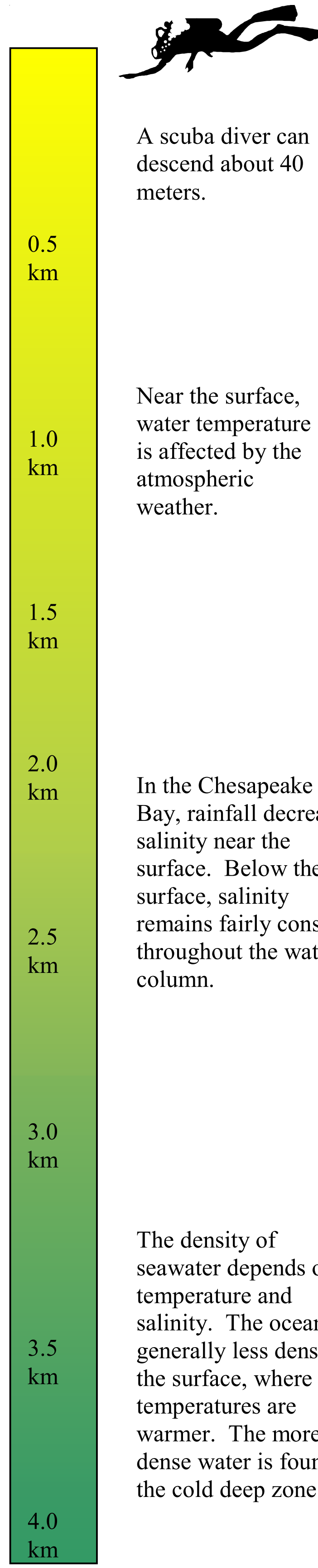
Ask students if they have ever gone crabbing? Where did they go to catch crabs? *(brackish waters, not fresh non-tidal waters)* Do you think you'd be able to catch crabs off the Jefferson Memorial in Washington, D.C.? *(no, this water is not salty enough for crabs)* Why are crabs found closer to the Chesapeake Bay? *(because these waters contain the right levels of salinity for crabs – crabs are adapted to brackish water, not fresh water).*

Explain to students that they will be viewing a salinity map of the Chesapeake Bay, and the will be identifying different plants and animals that live in different regions of the Bay and tributaries, based on their salinity requirements.

Explore

Investigation #4: Saltwater Organisms

Students will use the "Average Annual Salinity" map to determine answers to questions about animals and plants that live in the Chesapeake Bay. Salinity levels will change throughout the year in different parts of the Bay. The salinity map provided



A scuba diver can descend about 40 meters.

Near the surface, water temperature is affected by the atmospheric weather.

In the Chesapeake Bay, rainfall decreases salinity near the surface. Below the surface, salinity remains fairly constant throughout the water column.

The density of seawater depends on temperature and salinity. The ocean is generally less dense at the surface, where temperatures are warmer. The more dense water is found in the cold deep zone.

shows the mean salinity levels of the Chesapeake Bay and its tributaries over a 3-year period.

You will need the following materials:

- Annual Mean Salinity Map
- Map of the Chesapeake Bay
- Investigation #4 Student Sheet

Small Groups

1. Have students use the Chesapeake Bay and salinity maps to answer the questions that are on the student sheet.

Did you know...

Water near the Eastern Shore of the Bay is saltier than water near the Western Shore. This is for two reasons: 1) The greatest volume of freshwater enters the Bay from northern and western tributaries, and 2) the Coriolis Forse deflect flowering water to the right in Northern Hemisphere so that saltier water moving up the Bay is deflected toward the Eastern Shore.

Explain

2. After students have completed the table on organisms and salinity tolerances, facilitate a discussion that encourages them to think critically about what they have learned. Ask the following questions:

- What special adaptations to saline environments does each animal or plant have? How do you think weather changes salinity levels throughout the year?
- How do you think weather changes salinity levels throughout the year?
- How do you think human activities can influence the salinity levels along the shorelines? Use the Eyes on the Bay website to check salinity levels near the cities they listed in the chart. How do the salinity levels change during snowstorms?

Extend

We suggest using the following activities to extend this lesson:
Water Quality Windows (Healthy Water, Healthy People)

Part III: Salinity and the Bay

This last investigation serves to relate what students have learned thus far with what's happening in the Chesapeake Bay *right now* – in real time! Students will explore real-time data using the Eyes on the Bay website.

Introduce the students to http://www.eyesonthebay.net. Go to the "Monitoring News & Reports" and then "New Monitoring Technologies" link and read the sections on Continuous Monitoring, Spatially Intensive Monitoring, and Eyes on the Bay.

Investigating the Bay

1. From the Eyes on the Bay homepage, go to "Monitoring News & Reports." Have students read "Historical Trends Used to Assess 2002 Drought." They should be able to answer the following questions:
   - How did the drought effect salinity levels in 2002?
   - How did the lack of rain effect the sedimentation into the Bay?

2. Then, have students read "Water Quality Mapping Reveals Salinity Reversal in Severn and Magothy Rivers." They should be able to answer the following questions:
   - How do dams affect salinity levels?
   - What are the consequences for yellow perch?

3. Have students read "Continuous Monitors Capture Hurricane Floyd Impacts" and "Hurricane Isabel Water Quality Impacts." They should be able to answer the following questions:
   - Based on the graphs, how did the hurricane affect salinity levels in the Pocomoke River? Compare this to the impacts of Tropical Storm Isabel.

Explain

1. Working in pairs, students should choose a site (either continuous or monthly monitoring) from the map.
2. Have students look at the salinity data for one year. When are salinity concentrations the lowest? When are they the highest? Why?
3. Find out the extended weather forecast. Make a prediction about what you think the salinity levels will be next week and why. What other factors might influence the salinity levels?
4. Engage students in a discussion about their findings regarding the website information. Discuss the articles they read and the questions they answered. Ask students the following questions, take notes on the blackboard so that students can follow the train of thought:
   - "If you were a fisheries biologist monitoring yellow perch populations and your data indicated a mysterious fall in the perch population, what factors would you look at to determine what might be happening with the perch?" (*dam releases; storms; and drought*).

Resources

Project WET and Healthy Water, Healthy People
Cindy Etgen, Maryland State Coordinator, Maryland DNR
410-260-8715
cindy.etgen@maryland.gov
http://www.dnr.maryland.gov/education/are

Or,

- "If you were going to go perch fishing, what information would help you determine where to find the perch?" (*dam releases; storms; and drought*).
- "Based on the 3 excerpts you read, how does continuous monitoring data help scientists make decisions for managing natural resources in the Chesapeake Bay?"

Evaluation

After completing this module, students should be able to:

- Put the following in order of lowest salinity to highest salinity:

- Lake Superior *(lowest)*
- The Dead Sea (or Great Salt Lake) *(highest)*
- Chesapeake Bay *(middle)*

- Describe how hydrometers work? *When the hydrometer is placed in the water, it will float to a certain level, depending on how dense the water is. The saltwater is more dense, which means it can support more mass than water lacking those salts. This makes the hydrometer arm float higher as the water gets saltier.*

- Describe what "parts per thousand" mean? Suggesting they give an example, or draw a picture may help. *Parts per thousand (ppt) is a way of measuring a quantity of a substance that is contained in another sub-stance. For example, in saltwater, if there are 35 parts per thousand, it means that there are 35 molecules of salt for every 1000 molecules.*

- Describe how salinity in the Chesapeake Bay affect aquatic vegetation? *Certain submerged aquatic vegetation cannot tolerate high salinity levels and visa versa. Dramatic changes in salinity can cause SAV die-offs.*

- Describe factors that influence salinity levels and how salinity affects aquatic species (e.g., yellow perch).

Extensions

Calculating Density
Have students practice calculating density using the following formula:

$$D = m/v$$

- 1 liter of ocean water has a mass of 1.03 kg. What is its density? *D = 1.03kg/1L = 1.03kg/L*
- 5 liters of crude oil has a mass of 4.10 kg. What is its density? *D =4.10kg/5L = 0.82kg/L*
- If this oil spilled on the ocean's surface, would it sink or float? Explain your answer in terms of density. *If the oil is spilled on the ocean's surface, it would float because it is less dense than the ocean water.*

Resources

Project WET and Healthy Water, Healthy People
Cindy Etgen, Maryland State Coordinator, Maryland DNR 410-260-8715
cetgen@dnr.state.md.us http://www.dnr.state.md.us/education/ are

Name______________________

Part I: Introduction to Salinity

You will be conducting four different investigations, plus making a hydrometer – an instrument that measures salinity. During this activity, you will be reading to understand how salinity affects different living organisms in the Chesapeake Bay.

Reading for Understanding

- Visit http://www.eyesonthebay.net
- Go to "What does it all mean?" and read the section on salinity. As you read, try to answer the following questions:

1. Describe how salinity varies in the Chesapeake Bay.

2. Why are extreme changes in salinity a problem for some organisms?

3. How are clams, oysters, and yellow perch affected by salinity changes?

4. Why are SAV particularly vulnerable to salinity changes?

Name__________________

Investigating Salinity

During this series of activities, you will work with a partner to learn about salinity and how to use hydrometers. First, you will build your own hydrometer, then you will do four investigations that will teach you about salinity and how to use hydrometers.

Make Your Own Hydrometer

Background

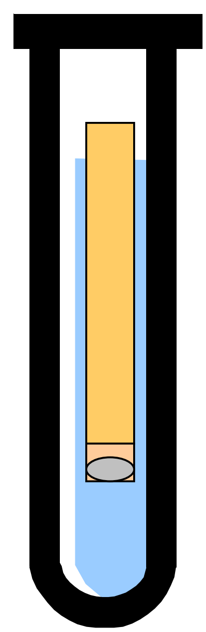
Over 70% of the earth's surface is water. Most of that water is salt water. Plants and animals have special adaptations to live in salt water. The Chesapeake Bay is an environment where fresh water from rivers and streams combines with the salty Atlantic Ocean water. This mixture of salt and fresh water creates a solution known "brackish water." We measure the salt content, or *salinity*, of the water with a *hydrometer*.

Materials

- 1 unsharpened pencil
- 1 sharpened pencil or waterproof marker
- 3 thumbtacks
- 250 mL graduated cylinder
- ruler

Procedure

1. Starting 1 cm from the unsharpened end of the pencil, use the sharpened pencil or waterproof marker to make marks every 0.5 cm along the side of the pencil.
2. Label each mark, starting at the unsharpened end of the pencil, with the label 0.5.
3. Insert 3 thumbtacks as weights into the eraser end of the pencil. **Use caution not to cut yourself!**
4. Fill the 250 mL graduated cylinder with water at room temperature. Place the pencil in the water, eraser down.
5. Add or remove thumbtacks and adjust their placement in the eraser until the pencil floats upright, with about 2 cm sticking up above the surface of the water.
6. Record the number next to the mark that is closest to the point where the pencil hydrometer projects from the water. As the density of the water increases, the hydrometer will float higher.



Part II: Investigation #1: Hydrometers

Directions

Using the materials provided, predict what would happen in each scenario. Then, perform the scenario and record your observations. Based on what you already know, provide an explanation of what you saw.

Materials

- 1 graduated cylinder of fresh water
- 1 graduated cylinder of salty water
- Pencil hydrometer
- Paper towels

Procedure

1. **Predict** what would happen if you placed the hydrometer in the *fresh water* sample and released it.

____

____

____

2. Now, try it! **Observe** what happens. Record the level of the hydrometer. Draw a picture of what you see. Label your diagram.

3. **Explain** your observations. Why did the hydrometer do what it did?

____

____

____

4. **Predict** what would happen if you placed the hydrometer in the *salt water* sample and released it.

____
____
____

5. Now try it! **Observe** what happens. Submerge each hydrometer in the salt water sample. Observe what happens. Draw a picture of what you see. Label your diagram.

6. **Explain** your observations. Why did the hydrometer do what it did?

____
____
____

7. Describe the differences between the two water samples and their salinities.

____
____
____

Investigation #2: Measuring Salinity

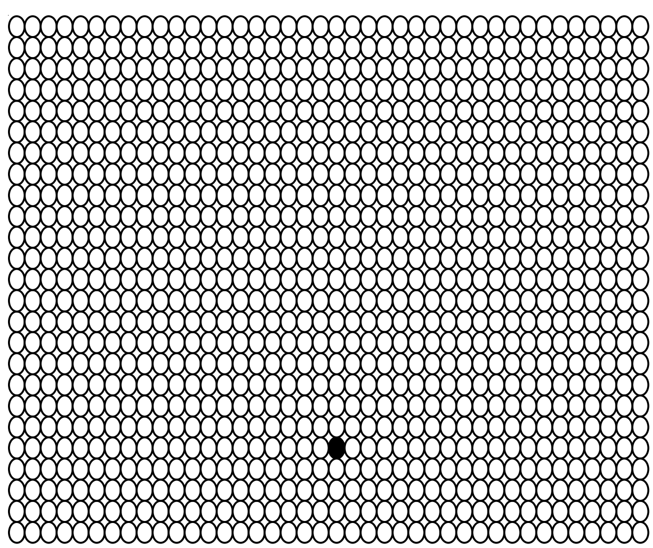
Background

Most of the salt in the oceans comes from rain falling on the land and dissolving the salts in eroding rocks. These salts are carried down the rivers and out to sea. The salts accumulate in the ocean as water evaporates to form clouds. The oceans are getting saltier every day, but the rate of increase is so slow that it is virtually immeasurable. Ocean water is currently about 3.5 percent salt.

There are many different instruments and methods for measuring salinity. Today, you will use a less expensive, but fairly accurate hydrometer. This hydrometer works in the same way that the homemade one did. Both are influenced by ***density***.

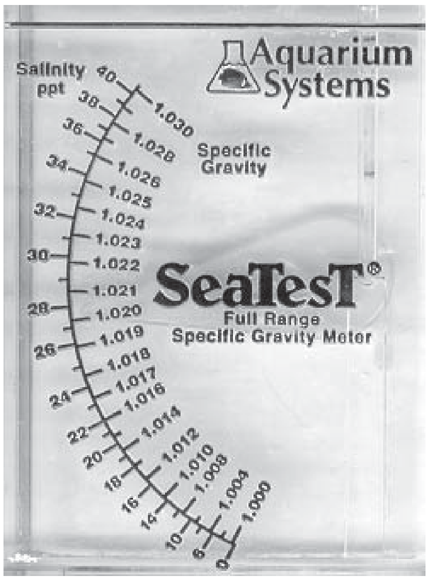
The density of something has to do with its mass (usually expressed in grams) relative to the amount of space it takes up (***volume***). At a temperature of 3 degrees Celsius, a glass of fresh water has a density of 1 gram per cubic centimeter ($1g/cm^3$). For example, a quart of one particular type of oil has a larger mass than a quart of water. Therefore, the oil is denser than the water. Similarly, as water becomes saltier, its mass increases relative to its volume, making it more dense.

Salinity is measured in parts per thousand (ppt). What does that mean? If you have a total of 1000 gumballs, and 999 of them are white, and one of them is black, the black gumball could be expressed as 1 part per 1000. Let's say you use the hydrometer and it gives you a measurement of 20 ppt. That means for every 1000 molecules, 20 of them are salt molecules and 980 of them are water molecules.



Of these 1000 gumballs, one of them is a different color. If each white circle represented a water molecule, and the black circle represented a salt molecule, we would say the salinity is 1 part per thousand.

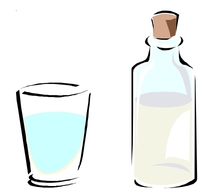
When the hydrometer is placed in the water, it will float to a certain level, depending on how dense the water is. The extra minerals, or salts, in saltwater make the water more dense, which means it can support more weight than water lacking those salts. This makes the hydrometer arm float higher as the water gets saltier. The hydrometer in the picture below registers approximately 28 parts per thousand.



This hydrometer measures salinity in parts per thousand (ppt).

Try It!

How do you know that oil has a different density than water? Mix them together and see what happens:



Take 1/2 cup of water (you can add some food coloring to make it easier to see). Add 1/2 cup of vegetable oil. What happens? What happens when you stir the mixture?

Materials

- Fresh water sample
- Hydrometer
- Salt water sample

Directions

Gather the materials and use the background reading to answer the following questions.

1. Place the hydrometer in the fresh water sample. Record the reading in parts per thousand.

_______________ppt

2. Place the hydrometer in the salt water sample. Record the reading in parts per thousand. Important! Thoroughly rinse the hydrometer when you are finished taking this measurement.

________________ppt

3. Which sample has the higher salinity? Based on the reading, how do you know?

____

____

____

Investigation #3: Qualitative v.s. Quantitative

Background

The hydrometer you made in class provided you with a *qualitative* measurement of salinity. A qualitative measurement uses comparisons or descriptions to measure a characteristic. For example, if you were sitting under a tree at the same time for 2 days in a row, you may notice that it was hotter one day. That is a qualitative measurement. However, if you used a thermometer on both days and recorded the temperature, then you would have *quantitative* data. The hydrometer you used that measured salinity in parts per thousand provided a quantitative measurement of the amount of salt in the water. A quantitative measurement assigns numeric information to data.

1. If you were a scientist, describe a situation where qualitative measurements may be appropriate.

____

____

____

2. If you were a scientist, describe a different situation where quantitative measurements would be more useful.

____

____

____

3. If you had a choice, which hydrometer would you use to monitor the salinity of your saltwater fish tank? Explain your answer.

____

____

____

Investigation #4: Using a Salinity Map

Directions

Use the salinity map and a map of the Chesapeake Bay to answer the following questions.

Materials

- Map of Chesapeake Bay
- Salinity map

1. Most horseshoe crabs survive best in water that has a salinity level between 20-25 ppt. Which zone on the "Annual Mean Salinity" map would be best suited for horseshoe crabs?

____

2. Using the map of the Chesapeake Bay, record as many towns and cities as you can that border that zone. How might human activities affect salinity levels? Use the Eyes on the Bay website to check salinity levels near these cities. Do they change during snowstorms?

3. The table below lists several organisms that live in salt and fresh water. Use the "Annual Mean Salinity" map to locate the zone where these organisms would be best suited. Record this information in the table.

Organism	Salinity Range	Cities where the organism can be found
Blue crab	0-30 ppt	
Black sea bass	15-30 ppt	
Sea nettle	7-30 ppt	
White crappie	0 ppt	
Striped bass	0-30 ppt	
Common sea star	18-30 ppt	
Marsh periwinkle	0-15 ppt	
Waterweed	0-9 ppt	
Yellow pond lily	0 ppt	

Salinity and the Bay

1. From the Eyes on the Bay homepage, go to Monitoring News and Reports. Read "Historical Trends Used to Assess 2002 Drought". Answer the following questions:
   a. How did the drought effect salinity levels in 2002?
   b. How did the lack of rain affect the sedimentation into the Bay?
2. Read "Water Quality mapping Reveals Salinity Reversal in Severn and Magothy Rivers". Answer the following questions:
   a. How do dams affect salinity levels?
   b. What are the consequences for yellow perch?

3. Read "Impacts of Hurricane Isabel on Maryland's Aquatic Resources". Answer the following questions:

    a. Based on Figure 3, how did the hurricane affect salinity levels at the stations?

    b. How did salinity change in the Magothy River (figure 4)?

    c. What happened to salinity levels on the Chester River (Figure 5)? Why?

    d. According to Figure 6, where was the greatest change in salinity levels?

4. Working with a partner, choose a site (either continuous or monthly monitoring) from the map on the homepage.

5. Look at the salinity data for one year. When are salinity concentrations the lowest? When are they the highest? Why?

6. Find out the extended weather forecast. Make a prediction about what you think the salinity levels will be next week and why. What other factors might influence the salinity levels?

7. Choose several other sites and look at their salinity levels. Based on the different geographic locations, why might they be different?

Wrap up: Answer one of the questions below (hint: the answers are the same for both questions).

1. Imagine that you are a fisheries biologist monitoring yellow perch populations. During routine sampling, you discover a mysterious fall in the perch population. What factors would you look at to determine what might be happening to the perch?

2. If you were going to go perch fishing, what information would help you determine where to find the perch?