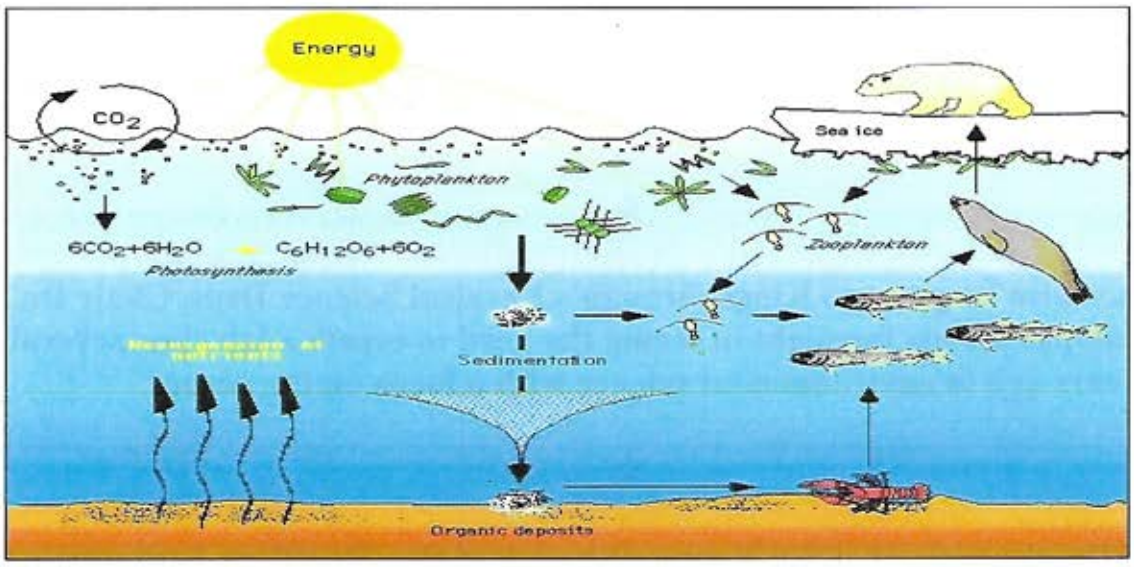
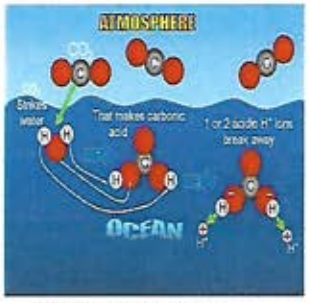
KINGSBOROUGH COMMUNITY COLLEGE
★ DREAMS BEGIN HERE ★

Marine Environmental Science Lab Manual



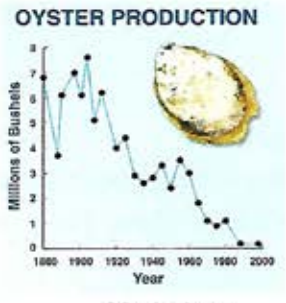
Ecological Relationships



Water Chemistry

Water Pollution

Water Quality



Mariculture

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(Science 5100)
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May 1, 2022

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❖

Credit must also be given to Kingsborough's Physical Science Dept. Chair Dr. John Mikalopas for his foresight in seeing the need to create a lab class several years ago in environmental science with a focus on the ocean.

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A special thanks to Capt. John Nappo, Director of the Maritime Technology Dept., for making Kingsborough's marina available to the Physical Science Dept.'s Environmental Science Class(Sci 5100)

❖

We much appreciate, and are most grateful to KCC Lab Tech's, Donovan Withers and Paul Risi for their advice and support while we conduct marine environmental science activities

To The Student

More than ever before, environmental science is in the news. Global warming, climate change, pollution, endangered species and alternative energy, to name a few, are the hot topics that appear in the headlines on a daily basis. All these issues involve the **environment**, the physical setting of living things. The science that deals with the interaction between the living and non-living parts of the environment is called **environmental science.**

How salty is the sea? Is there acid rain in Brooklyn? Why was Kingsborough's beach closed briefly last summer? The investigations in this lab manual relate to the marine environment – our coastal ocean. After all, more than 70% of Earth's surface is covered by the oceans. In fact, metropolitan New York is really an island City. Just look at a map. Which island do you live on?

This body of knowledge called **science,** which includes the living and non-living worlds, has been largely acquired by scientists working actively in the laboratory and in the field. They conduct experiments following an organized approach called the **scientific method**. This investigative process consists of first **making observations** and then **identifying a problem** to solve. This is followed by testing a **hypothesis** by conducting an **experiment**. This investgation generates numerical data called **results.** The results are analyzed and interpreted to form **conclusions.**

In the following investigations, you will become a citizen scientist by using the scientific method to gain a greater understanding and appreciation of the physical world and its relationship to the living environment. You will be required to bring this manual with you to lab each week. The completed lab reports, which will be submitted to the instructor, will be graded and returned to you the following week.

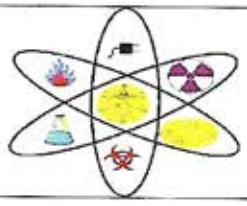
All the best in your endeavors to learn about marine environmental science by engaging in exciting and challenging real-world problems to solve.

Thomas Greene
Adjunct Lecturer
May, 2022

Safety in the Science Laboratory

In the science laboratory, health and safety come first. You will be carrying out a number of laboratory activities that if not followed correctly, could be hazardous to your health and well-being. The rules listed below will help ensure your safety and comfort. Please read and follow these 10 rules.

Safety Rules

	**1.** Food and Drinks are **not** permitted in the Lab.	
2. Conduct yourself in a responsible manner whenever you are in the science lab. When you enter the lab, do not touch any equipment or chemicals until you are instructed to do so	**5.** Keep your hands away from your eyes, mouth and face when using chemicals. Wash your hands with soap and water before leaving the laboratory.	**8.** Never point the open end of a test tube that is being heated at yourself or anyone else. Set aside hot glassware on a cooling pad
3. Wear a lab coat or apron and gloves in all wet labs. Wear goggles when instructed to do so. Follow instructions for inserting glass tubing into stoppers. Do not use glassware that is cracked or chipped	 **Lab Safety**	**9.** Long hair, hanging jewelry and baggy clothing are hazardous in the lab. Long hair must be tied back. Hanging jewelry and loose clothing must be secured
4. Know where the safety equipment including the eyewash station, safety shower, fire extinguisher and fire blanket are located.	**6.** Report any accident including a chemical spill or breaking of equipment to your instructor. Be careful when using a gas burner. Keep hair, clothing and your hands safely away from an open flame	**10.** Do not taste, touch, or smell any chemicals unless told to do so. Don't return unused chemicals to their stock containers.
	**7.** Dispose of all chemicals by following your instructor's directions.	

Marine Environmental[bc1][TG2][bc3] Science Labs

Lab # Measuring the Temperature of the Atmosphere and Hydrosphere

Introduction

We hear a lot these days about **global warming**, an increase in the temperature of the atmosphere (air) and the hydrosphere (oceans). Is our Earth really warming up?

To understand temperature we need to first learn how to measure it. **Temperature** is a measure of the average kinetic energy of a substance as measured in degrees Celsius (^{0}C). The instrument used to measure temperature is the **thermometer.** In the following activity you will use different kinds of thermometers to measure air and water in order to gain a better understanding about the relationship between the atmosphere and hydrosphere.

Materials

Alcohol thermometer, digital thermometer, ocean water, beakers, buckets of surface and bottom ocean water, water sample bottles

Procedure

1. Carefully remove a thermometer from its container. Examine it with care by holding it horizontally. (Don't hold the thermometer at the bulb).Some thermometers have two scales, Fahrenheit (^{0}F) and Celsius (^{0}C). Look at the thermometer shown in the figure below. Notice a thin line of colored liquid which expands or contracts depending on the temperature. The thermometer is marked off in lines representing degrees that form a scale. The thermometer has two scales, the Celsius (C) and the Fahrenheit (F) Scientists use the Celsius scale, which, like other metric measurements, is based on units of ten, making it easier to read.
2. Observe the indoor air temperature after holding the thermometer for about one minute. Record the indoor air temperature in your data table. Repeat using the digital and steel probe thermometers.
3. Take the three different thermometers outdoors and measure the air temperature. Record the temperatures in the data table.
4. Go outside and record the ocean water temperature in the buckets labeled "surface" and "bottom". Record the temperatures in the Data Table using the two different thermometers
5. To convert from one temperature scale into the other temperature scale use one of the following formulas :

   $^0C = {}^0F - 32 \times 5/9$ $\quad$ $^0F = {}^0C \times 1.8 + 32$ $\quad$ $^0C = F - 32/1.8$

   Do the calculations in the data table

Student Lab Report

Last Name……First……Class…….. Date……..

Lab # Measuring the Temperature of the Atmosphere and Hydrosphere

Results

Data Table

Sample Site	Alcohol Thermometer		Digital Thermometer			Calculations
	^0C	^0F	^0C	^0F		
Air (indoor)						
Air (outdoor)						
Ocean (surface)						
Ocean (bottom)						

Concluding Questions

1. Why do scientists use Celsius instead of Fahrenheit?

2. One student found that the water on the surface was warmer than on the bottom. How can you explain this difference?

3. Convert a room temperature of 70^0F into degrees Celsius. Show work.

4. Based on your temperature data compare similarities and differences when using the two different thermometers.

Lab # Temperature Variation in the Water Column

Introduction

Did you ever tread water? You might have noticed a difference in temperature between your upper body and your feet. The vertical section of water from top to bottom is called the **water column.** In the following activity you will analyze the temperature at different depths in the ocean to find out if there is a true difference. Water samples at different depths are obtained using a special instrument called a **Nansen Bottle (Figure1)** The metal bottle is attached to a cable that is lowered from the deck of an oceanographic vessel. At a desired depth, a metal weight, released from the surface slides down the cable and hits the bottle causing it to invert. The bottle fills with water and is brought back to the surface. This instrument will help us gain a better understanding of the relationship between ocean depth and water temperature.

Figure 1 Nansen Bottle

Materials Pencil and ruler

Procedure

1. Examine the Data Table below which shows water temperature in degrees Celsius at different depths.

2. Use the information in the data table to construct a line graph on the graph provided.

3. Mark an appropriate scale for the horizontal and vertical axes based on the data table. Plot the data on the graph (you should have seven points). Surround each point with a small circle and draw lines connecting the points.

4. Examine the line graph and locate the two adjacent points on the graph that show the greatest temperature change. Using your ruler draw a horizontal dotted line through each temperature. This layer of ocean water that shows a rapid change in temperature is called the **thermocline.**

Student Lab Report

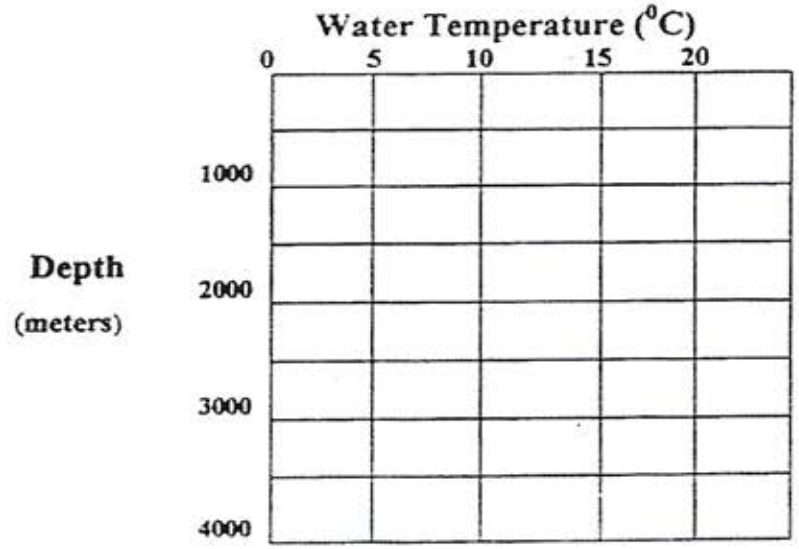
Last Name.....First.....Class..... Date.....

Lab # Temperature Variation in the Water Column

Results

Data Table

Depth (meters)	0	500	1000	1500	2000	3000	4000
Water Temperature (^{0}C)	18	15	4	3	2	2	2



Concluding Questions

1. Describe the relationship between ocean depth and temperature.

2. What is a thermocline? Where is it located in the water column?

3. How can you explain why temperature should vary with depth?

Lab # Understanding El Niño

Introduction

Flooding in North, Central and South America, droughts in Australia and other unusual climate disturbances in the Eastern and Western Pacific Ocean have been attributed to an unpredictable warm ocean current originating in the Western Pacific Ocean called **El Niño.** El Nino originates in the mid-latitudes around the equator and moves west to east across the Pacific ocean. The name "El Niño" is Spanish for "the (Christ) child" since this ocean current flows near South and Central America during Christmastime. El Nino is part of a cycle called the *El Nino-Southern Oscillation (ENSO)* event which usually lasts from 1 to 2 years and occurs every 4-6 years.

In the following activity you will analyze maps of surface ocean temperatures in order to determine in which year an El Nino event took place.

Materials

Colored pencils (red, orange, yellow, blue, green, & violet) and a pencil.

Procedure

1. Examine map A and map B. Notice the lines called **isotherms** on both maps. These are lines that connect points of equal ocean surface water temperature. Each isotherm has a different temperature.

2. First color in the temperature key with the appropriate colors and then use the colored pencils to trace and highlight the isotherms with the correct color using the color key below as a guide.

3. Fill in any areas with color (example 24^0 to 26^0C) where needed.

4. Visually compare the two completed maps.

Temperature Color Key

28 ^{0}C or >	26-28 ^{0}C	24-26 ^{0}C	22-24 ^{0}C	20-22 ^{0}C	20 ^{0}C 04 <
Red	**Orange**	**Yellow**	**Blue**	**Green**	**Violet**

KINGSBOROUGH

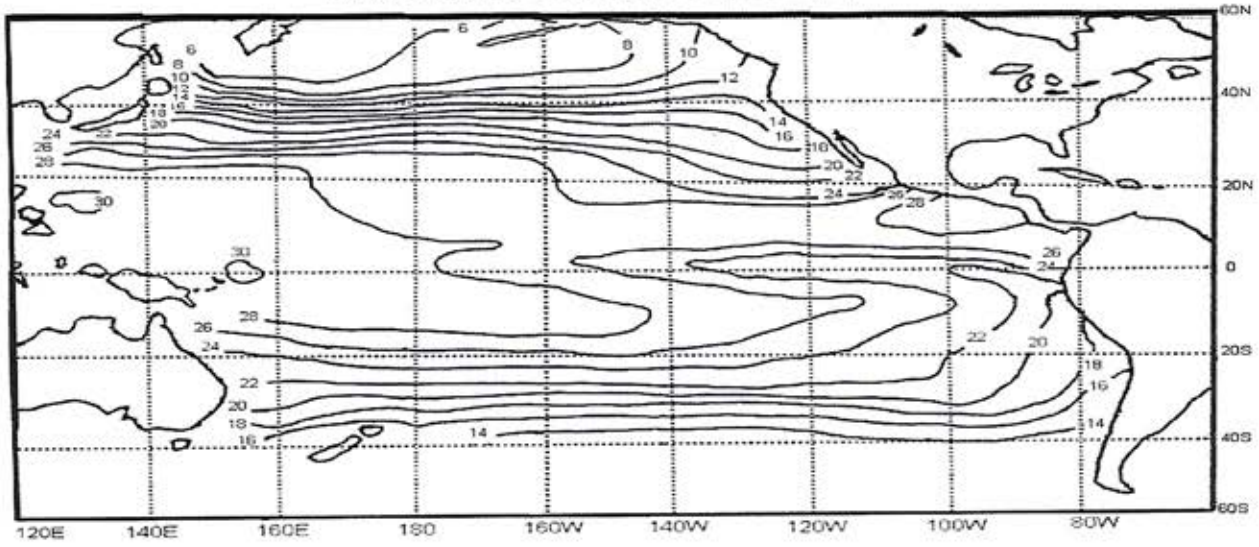
Physical Science Department
Physical Science and the Environment (Sci 5100)

Student Lab Report

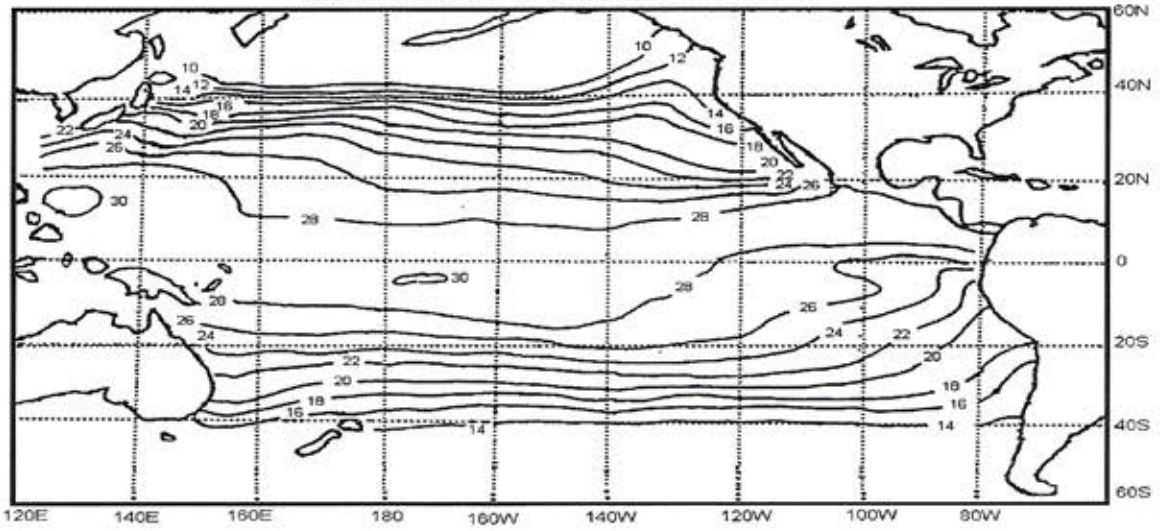
Last Name……First……Class…….. Date……..

Lab # Understanding El Niño

Map A - June 1987 - Sea Surface Temperature (C°)



Map B: June 1988 - Sea Surface Temperature °C



Physical Science Department
Physical Science and the Environment (Sci 5100)

Student Lab Report

Last Name……First……Class…….. Date……..

Lab # Understanding El Niño (continued)

Questions

1. Describe the characteristics of El Niño

2. Based on temperature differences between map A and map B, which one shows an El Niño event. Write El Nino on the map for A or B. Explain your answer here..

3. At what latitude is the warmest water and coldest bodies of water found? Based on your general knowledge of global climate can you explain why there is a difference?

4. At what latitudes does the sea water temperature show the least change? Explain

Marine Environmental Science Lab # Measuring the Salinity of Ocean Water

Introduction

Ocean water is salty to the taste. The salty taste is due to the presence of compounds of salt, called **sea salts** that are dissolved in the water. The sea salt consists of several different compounds. The most common, about 30%, is sodium chloride(NaCl), or table salt. Other compounds in sea salts include potassium chloride (KCl), magnesium chloride $MgCl_2$, and calcium chloride ($CaCl_2$). The amount of salt dissolved in ocean water is called its **salinity,** which can vary anywhere from 17‰ (parts per thousand or ppt) to about 37ppt. The average salinity of ocean water is about 35 ppt.

Knowing the salinity of a body of water is important in understanding the habitat for a wide variety of marine organisms. Some marine creatures like the oyster, require a narrow salinity range, while others like the salmon can tolerate a wider salinity range. Salinity can be affected by changes in temperature of the air and water, precipitation, and fresh water run-off from the land.

Salinity can be determined by first measuring density. **Density** is defined as mass per unit volume. The density of the ocean is due almost entirely to the presence of **salt.** In the following activity you will determine the density and salinity of ocean water by using two different kinds of instruments the **hydrometer** and **refractometer.**

Materials

100 ml graduated cylinder, refractometer, hydrometer, ocean water, tap or distilled water.

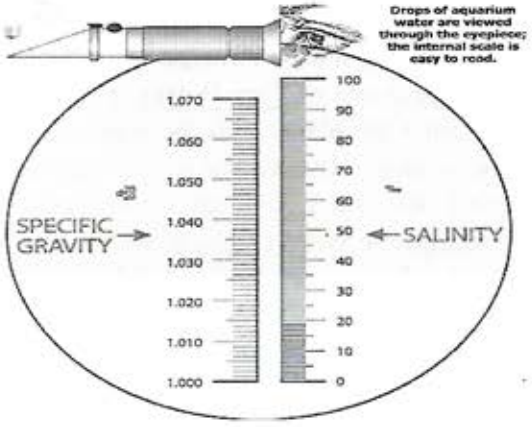


Figure 1.0 Refractometer.

Hydrometer

Procedure

1. Carefully remove a hydrometer from its box and place it the space on your lab sheet. Using a pen or pencil draw or trace the shape of the hydrometer into the space on the sheet and mark off the scale on the narrow stem. Notice the two interior scales on the hydrometer. Water temperature is read from the lower scale in both ^0C and ^0F. The numbers on the upper scale represent the **Specific Gravity** or density values

of a liquid. Since fresh water has a density of 1 gram per cubic centimeter, (gm/cm^3) its **Specific Gravity** is equal to 1.0 (no units needed)

2. Pour tap water into a graduated cylinder up to the 100 ml mark. This will represent the "**Tap Water A**" sample. Carefully place a hydrometer in graduated cylinder **A**, until it floats by itself. **Caution: Do not drop the hydrometer into the cylinder or it will break**. The ***hydrometer must float*** in order to obtain an accurate reading. After it comes to rest, observe the specific gravity reading on the hydrometer at the point where it floats. Record the specific gravity reading in **Table 1** in the **Results** section. Examine the Density/Salinity Conversion chart below to obtain the salinity. Record the salinity in **Table 1**.

Figure 1 Density-Salinity Conversion Chart
(Parts Per Thousand (ppt) at 20°C)

Density	Salinity (ppt)	Density	Salinity (ppt)	Density	Salinity (ppt)
.998	0	1.009	14	1.020	29
.999	1	1.010	15	1.021	30
1.000	2	1.011	17	1.022	31
1.001	4	1.012	18	1.023	33
1.002	5	1.013	19	1.024	34
1.003	6	1.014	21	1.025	35
1.004	8	1.015	22	1.026	37
1.005	9	1.016	23	1.027	38
1.006	10	1.017	24	1.028	39
1.007	11	1.018	26	1.029	41
1.008	13	1.019	27	1.030	42

To complete this part measure the temperature of the Tap Water by observing the middle scale in the hydrometer. Record temperature in **Table 1.**

3. Obtain a **refractometer** from your instructor. Notice it looks like a telescope and has an eyepiece or ocular on one end and a wedge-shaped lens on the other. This lens is covered by a plastic cap. Carefully open the cap over the lens and place **two** or **three** drops of **Tap Water A** on the glass plate. Lower the cover so that it presses the drop flat against the plate. Aim the refractometer at a window or other light source as you look through the ocular. Observe the scales: the scale on the left measures specific gravity as a number between 1.000 and 1.070, while the scale on the right measures salinity in % from 0 to 100. Notice the margin between the light and blue regions (see long thin arrows on **Figure 1.0**). Record density and salinity readings in **Table 1**

4. Wipe the **refractometer** clean and dry with a paper towel. Empty your graduated cylinder of Tap Water. Complete this activity by repeating the above procedure for **Ocean Water B** and **Brackish Water C**. Make up brackish water containing 50% fresh water and 50% ocean water. Record data in **Table 1** When you have finished, clean up and return equipment to the instructor.

Student Lab Report

Last Name.....First.....Class..... Date.....

Marine Environmental Science Lab # Measuring the Salinity of Ocean Water

Results

Drawing of a Hydrometer

Table 1.0 Temperature, Hydrometer and Refractometer Readings

Water Sample	Hydrometer Density Reading (1.000 - 1.070)	Hydrometer Salinity (ppt)	Refractometer Density (1.000-1.070)	Refractometer Salinity (ppt)	Water Temperature $^0C/^0F$
Tap Water (A)					
Ocean Water (B)					
Brackish Water (C)					

Questions

1. Referring to the chart in Figure 1, describe the relationship between density and salinity.

2. Describe two methods of measuring ocean salinity.

3. How is the density of 50 ml of ocean water affected by adding 50 ml of tap water?

4. Why is it important for marine scientists to know the salinity of ocean water?

Marine Environmental Science Lab # Analyzing the Temperature, Density and Salinity of Ocean Water

Introduction

The density, salinity and temperature of ocean water are interrelated. Take temperature for example. Cold water is denser than warm water because the water molecules are packed closer together and are not vibrating as much. Warm water is less dense because the higher temperature causes the water molecules to vibrate more quickly and move farther apart. Therefore temperature affects the density of ocean water. Temperature also affects salinity in a similar fashion.

In the following lab, you will analyze the relationships between temperature, density and salinity in ocean water.

Materials

Ruler and a pencil.

Procedure

1. Examine the Temperature-Salinity diagram in **Figure 1.0**. Along the vertical axis is the salinity ranging from 33‰ to 36.5‰, while the horizontal axis is the temperature ranging from -2° to 25°C. The many curved lines represent different sea water densities on this diagram densities range from 1.0225 to1.0290. Notice that a range of temperatures and salinities exist for a particular value of sea water density. For example, a sea water sample with a density of 1.0260 can range in salinity from 33‰ to 36.5‰, while its temperature can only range from 5° to 20°C.

2. Two sea water samples were previously collected (**A** & **B**). Their temperatures and salinity values were measured. The results were plotted on **Figure 1.0** as points **A** and **B** on the Temperature-Salinity Diagram. Find the temperature, density, and salinity for points **A** & **B** and record the data in **Table 1.0**.

3. When two different ocean currents of the same density flow into one another, they generally mix together. The temperature and salinity of the resulting mixture exists somewhere between the original values of the starting masses of water. Calculate the water temperature and salinity of mixed water sample **C** that would result if equal mixtures of waters **A** and **B** were mixed together; record your results in **Table 1.0**. Use the equation: $\mathbf{T_C = (T_A + T_B)/2}$, where **T** = temperature in ° C and **A** and **B** represent the initial water samples, and water

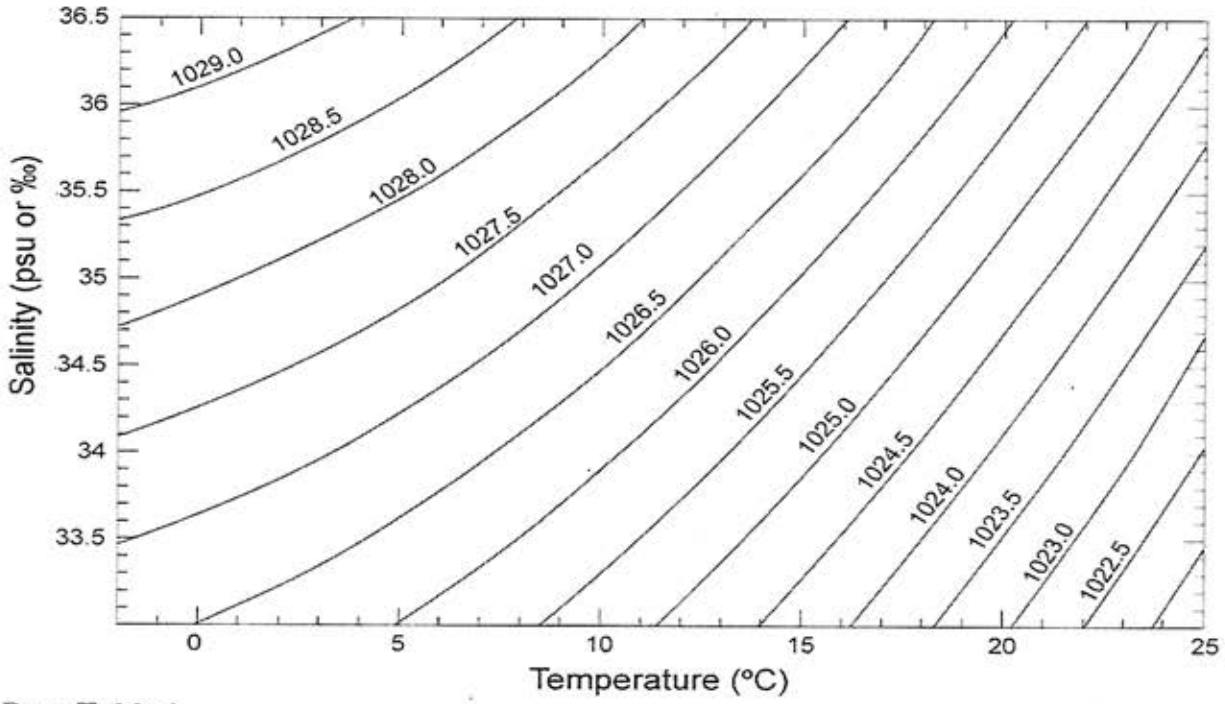
4. Sample **C** is the resultant mixture. To calculate the salinity use: $\mathbf{S_C = (S_A + S_B)/2}$, where **S** = salinity and **A, B,** and **C** also represent the water samples.

5. Plot the temperature and salinity results of the new water sample **C** on **Figure 1.0** on the Temperature-Salinity Diagram. Now using the new temperature and salinity data for sample **C**, determine its density, record in **Table 1.0** and plot this value on the diagram in **Figure 1.0**.

6. On **Figure 1.0**, draw a straight line between points **A** and **B**. Any possible mixture of these sea water samples would be represented by a point falling somewhere on this straight line.

Results

Figure 1.0 Temperature-Salinity Diagram for Surface Water



Data Table 1

Sample	Temperature (°C)	Salinity (ppt)	Density(g/cm^3)
A			
B			
C			

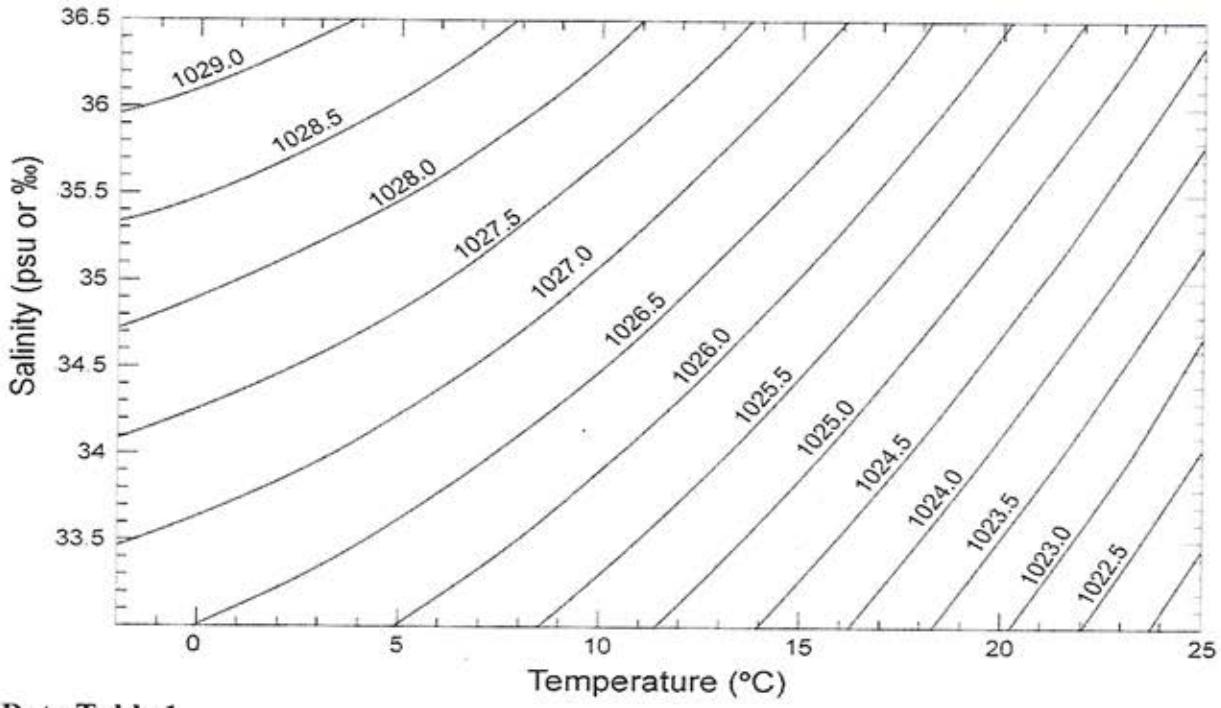
Student Lab Report

Last Name.....First.....Class..... Date.....

Lab # The Effect of Temperature and Salinity on the Density of Sea Water

Results

Figure 1.0 Temperature-Salinity Diagram for Surface Water



Data Table 1

Sample	Temperature(°C)	Salinity (ppt)	Density(g/cm^3)
A			
B			
C			

Student Lab Report #5 (continued)

Questions

1. Does Sample **C** on **Figure 1.0** have a density that is equal to, less than, or greater than the density of Samples **A** and **B** prior to mixing? Explain your answer.

2. What would be the range of temperatures and salinities for a water sample with a density of 1.0285?

3. What would be the temperature of a water sample be, if the salinity was 36.3‰ and the density was 1.0270 g/cm^3?

4. If the temperature of the water was 19°C and the salinity was 36‰, what would be its approximate density?

5. At 5°C and a salinity value of 36‰, what would be the water density?

6. How does an increase or decrease in temperature affect the density of sea water?

7. How does an increase or decrease in salinity affect the density of sea water?

Marine Environmental Science Lab # 7 Measuring Water Transparency

Introduction

The clarity or **transparency** of a body of water is important for algae and other chlorophyll bearing organisms which require sunlight to carry on photosynthesis. If the water is too cloudy or **turbid,** not enough light will enter the cells of the green plant to make food and oxygen.

Natural conditions such as wave action and tidal change can stir up the bottom and also make the water cloudy. Naturally occurring seasonal fluctuations in plankton concentrations will also affect water clarity. On the other hand, unnatural conditions caused by humans such as sewage, and chemical waste run-off from the land into the sea and into lakes have polluted these waters resulting in poor visibility. Since cloudy water can be due to natural conditions the EPA does not specify a specific standard for water transparency.

The need to measure water transparency was first recognized by an Italian astrophysisist Father Pietro Secchi (1818-1878). He constructed a simple device, the **Secchi disk,** named in his honor, to measure the clarity of water in the Mediterranean Sea.(**Figure 1**)

Another method of measuring turbidity is to use an instrument called a **turbidimeter** (**Figure 2**) This instrument measures the amount of light that is deflected or scattered from suspended particles in a water sample .The light is measured in **nephelometric turbidity units** or (**NTU).** The greater the density of suspended particles the higher is the NTU value**.** Tubidimeters can measure the cloudiness in shallow bodies of water, from drinking water sources, beverages and the effluent from sewage treatment plants. In the following lab you will use both instruments to measure turbidity.

Materials

Secchi disk with a line marked off at intervals of one meter, meter stick, turbidimeter

Procedure

1. Examine the Secchi disk to see that it is securely attached to the line. The line or rope should be measured or **calibrated** at one meter intervals. Use a string or tie a knot at each one meter interval if the rope is not calibrated.

Figure 1 Secchi Disk

2. Check to see that the Secchi disk has a secure weight attached to its underside to prevent it from drifting away when it is lowered into the water. Slowly lower the Secchi disk into the water from a floating dock, pier or boat. Observe the disk as you continue to lower the disk. Stop lowering the disk at the point when you no longer can see the disk. The distance from the water surface to the disk will give you the water clarity. Enter distance in Data table

3. Pull up the disk and measure the length of the rope that was under water. Record this distance in meters in your data table. Do several trials.

4. To measure water depth lower the Secchi disk to the bottom .Measure the length of the line that is wet. Record the depth in your data table.

Figure 2 Turbidimeter

5. To measure the turbidity in a shallow bay or stream where the Secchi disk is not suitable, the turbidimeter is employed. Five scales with different ranges of NTU units are indicated on the screen depending on the type of the water being tested. Follow instructions on turbidimeter for testing of the three different samples shown in Figure 2. Record data in table.

Student Lab Report

Last name..... First..... Class..... Date.....

Results

Figure 1 Secchi Disk						Figure 2 Turbidity (NTU's)		
Trials	**Water Clarity (Meters)**	**Depth (Meters)**	**Weather (sunny, cloudy, rain)**	**Tide (high, low, mid)**	**Wind Speed (high, low, moderate)**	**Ocean Water**	**Tap Water**	**Aquarium Water**

Concluding Questions

1. Describe how water clarity is measured.

2. Why is it necessary to do several trials?

3. Describe a natural and unnatural condition that can diminish water clarity.

Marine Environmental Science Lab # Finding the pH of Ocean Water

Introduction

Organisms and their aquatic environments need to maintain a proper pH to remain healthy. The term pH (**p**ower of the **h**ydrogen ion concentration) is a measure of the acidity or alkalinity of a liquid. Substances that have a high concentration of hydrogen ions (H^+) are **acids.** The presence of a high number of hydroxyl ions (OH^-) in a substance means that it is **alkaline** or **basic.** An equal number of hydrogen and hydroxyl ions in a liquid means that it is **neutral**. Liquid substances are classified according to whether they are acid, basic or neutral. pH is measured on a scale of 0 to 14, called the **pH scale** as follows:

<--- ----------Acid----------→ <----------alkaline (basic)----------→

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

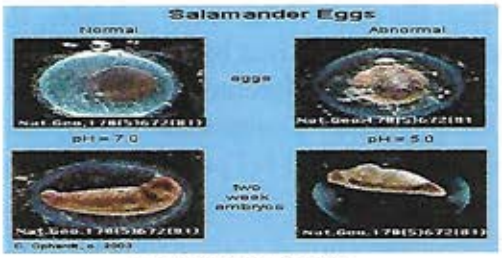
very acid slightly acid neutral slightly basic very basic

Low pH values (< 5) have been discovered in lakes and ponds, a result of **acid rain**. Acid rain occurs when smoke emisions containing sulfur dioxide (SO_2) and nitrogen dioxide (NO_2) react with water in the atmosphere to create dilute forms of sulfuric acid(H_2SO_4) and nitric acid (HNO_3). When it rains the dilute acids enter fresh water lakes, ponds and streams negatively affecting the health of fresh water animals and plants.(**Figure 1**) In the ocean, a condition called, **ocean acidification** occurs when excessive CO_2 from the atmosphere enters the ocean and reacts with water producing carbonic acid(H_2CO_3), which is responsible for the **bleaching** and the eventual death of corals.(**Figure 2**) During recent decades the pH of ocean water has declined from approximately 8.1 to 8.0. This may not appear to be a significant decline but a 0.1 unit fall in pH is a 30% increase in acidity.

The purpose of the following lab is to measure the pH of different bodies of water to see if they are in compliance with EPA standards.

Figure 1 Effect of Acid Rain

Monument Erosion



Embryonic Death

Defoliation of Forest

Figure 2 Ocean Acidification

Coral Bleaching

Thin Shelled Mussels

Jellyfish Bloom

Materials Litmus paper, pH paper, pH kits, pH probes, trays, medicine droppers, tap water, ocean water, rain water

Litmus Paper

pH Paper

pH Test Kit

Procedure

1. Chemical substances called **indicators** are used to reveal the chemical nature of an unknown substance. Litmus paper is used to determine whether ocean water is acid, basic or neutral. pH paper and test kits contain indicators that reveal the specific pH value of a substance. pH probes give digital read-outs of pH values.

2. Place on a piece of loose-leaf paper one piece of red litmus paper and one piece of blue litmus paper side by side in sets of four. Label each set with the water samples being tested: ocean water, rain water, tap water and pond water.

3. Using the medicine dropper, place one drop from each water sample on the red litmus paper and one drop on the blue litmus paper. Do one water sample at a time. Observe the color change, if any.

4. Record the color in your data table. Repeat for each of the water samples. Red litmus paper stays red in acid or in a neutral solution but turns blue in a base. Blue litmus paper stays blue. in a base or in a neutral solution but turns red in acid. Record your results in the data table. Litmus paper is only useful for determining whether a substance is acid, basic or neutral. To determine the numerical value of the pH you will need pH paper with a color comparator with numerical values.

5 Place four strips of pH paper on a sheet of loose leaf paper. Put a drop of water from one of the samples on one of the strips. Compare the color on the strip with the color scale. Record the pH value in your data table. Repeat for the other water samples.

6. Use the pH test kits to test for each sample. Follow the instructions in the kits. Record the pH value in your data table for each of the samples tested.

7. Read the instructions in how to use the pH probe. Consult your instructor before using the probe. Record the pH values in your data table for each of the samples tested.

Student Lab Report

Last Name.....First.....Class..... Date.....

Marine Environmental Science Lab # Finding the pH of Ocean Water

Data Table

Samples	Red Litmus	Blue Litmus	pH paper	pH Test kit	pH probe
Rain Water					
Ocean Water					
Tap Water					
Pond Water					

Concluding Questions

1. How does the pH of tap water differ from ocean water??

2. What is the advantage of using pH paper over litmus paper?

3. Why is it important to know the pH of liquid solutions?

4. Compare and contrast acid rain and ocean acidification

Marine Environmental Science Lab # Measuring Oxygen in the Ocean

Introduction

Living things need air to survive. Air contains a mixture of gases, one of which is molecular oxygen (O_2). Oxygen is produced during photosynthesis and is released by green plants into the air and into water. The oxygen that dissolves in ocean water is called **dissolved oxygen** or **DO** for short.

Oxygen (O_2), being a gas, is not very soluble in water because it is lighter than water. It tends to rise to the surface. The quantity of DO in water is fairly small, so scientists measure the DO in parts per million (ppm) or in its equivalent unit of milligrams per liter (mg/l). Ocean water can hold from 1 to 20 ppm of dissolved oxygen, depending on the water's temperature and salinity. In comparison, air holds about 200 ppm.

The amount of oxygen dissolved in ocean water is probably the single most important measure of habitat quality, for without O_2 many living organisms will perish. When DO concentrations drop below **4 mg/l**, the more sensitive creatures such as amphibian and fish eggs fail to develop normally, especially if exposed to these conditions for prolonged periods. When the DO is below **3 mg/l,** the water is called ***hypoxic***. This low DO cannot support healthy communities of plant and animal life. Less than **2 mg/l** for more than a few hours will result in a **fish kill**, the sudden death of large numbers of fish and other creatures. Below **0.5 mg/l**, the water is called ***anoxic***, no DO. No marine plants and animals that require oxygen can survive in anoxic conditions. The EPA Standard for DO in a water sample is that it should not be less than 4 mg/l.

In the following lab you will measure dissolved oxygen in ocean water to see if it is in compliance with EPA standards.

Figure 2 DO Test Kit

Materials

Dissolved oxygen (DO) kit, water sample collection bottles, Nansen bottle or similar water collection device, ruler, and pencil

Procedure

1. You will collect three seawater samples: one near the top, one at mid-depth, and one close to the bottom of Sheepshead Bay. Using the DO kit provided, determine the amount of dissolved oxygen in each sample. Also an electronic version of dissolved oxygen measurement will be used. Make sure you record the temperature of the water as well. Record your data in **Table 1**

2. Begin by opening the DO Test Kit. Fill the round DO bottle with the glass stopper with your water sample by allowing the sample to overflow the bottle above a basin or sink. **Avoid turbulence and bubbles in the sample while filling.**

3. Incline the bottle slightly and insert the glass stopper, **avoid trapping air bubbles.** Pour off any excess water sample over the sink.

4. Remove the glass stopper. Take **one** thin silver foil packet labeled **Dissolved Oxygen Reagent #1** from the plastic bag. Add the entire contents of white powder to the DO bottle by squeezing the packet after opening. Try not to get any powder on the neck of the DO bottle. Now open **one** silver packet from the **Dissolved Oxygen Reagent #2** within the other plastic bag and add this powder to the DO bottle. Stopper the bottle and dispose the foil packets

5. Cover the stoppered bottle with a paper towel and shake vigorously to mix. A brownish-orange flocculent (floc) or precipitate will form, which indicates that oxygen is present; wait a few minutes for it to completely form.

6. Wait a few more minutes for the floc to settle about half the bottle volume. The floc will not settle if high concentrations of chloride ions (Cl^-) are present. In this case, wait 4 to 5 minutes before proceeding.

7. Shake the covered bottle vigorously again. Wait a few minutes for the floc to settle halfway.

8. Remove the stopper, cut open with the nail clippers and add the entire contents of **one Dissolved Oxygen #3 Reagent** plastic powder pillow from the round white container with the orange label. Stopper the bottle to avoid air bubbles and shake the paper towel covered bottle vigorously to mix. The floc will slowly dissolve and the water sample will turn **amber-yellow** if oxygen is present. Wait until the floc is gone before proceeding to the next step.

9. Fill the thin glass test tube **to the rim** with the amber-yellow sample over a basin or sink.

10. Next invert the square glass bottle over the test tube. Then invert the entire set up such that the liquid from the test tube goes directly into the square bottle. Tap the test tube slightly to empty its contents.

11. Now open the white plastic dropper bottle of **Sodium Thiosulfate** solution. Add **one drop** (with no bubbles!) and swirl the square bottle gently to mix. Continue to add drops **as you count them** and carefully swirl the contents without splashing the liquid out of the bottle. Keep adding drops until the solution turns crystal clear. Place the DO bottle upon a white piece of paper to determine clarity. Replace the cap and close the Thiosulfate bottle.

12. The **number of drops** used determines the milligrams per liter (mg/l) of dissolved oxygen present. One drop equals one mg/l. Record your data at different depths along with temperature in the **Data Table 1** in the **Results** section.

13. Complete the Data Table by indicating whether water sample is in compliance with EPA Standards.

Student Lab Report

Last Name.....First.....Class..... Date.....

Marine Environmental Science Lab # Measuring Oxygen in the Ocean

Results

Data Table 1

Depth	Temperature (°C)	DO (mg/l)	EPA Compliant? (Yes or No)
Surface			
Mid Depth			
Bottom			

Concluding

1. Compare and contrast oxygen in water with oxygen in the air.

2. Distinguish between hypoxia and anoxia.

3. Describe one poor technique that could produce an inaccurate result.

4. Based on your data could a fish kill occur in this body of water? Explain.

Marine Environmental Science Lab # Factors Affecting DO Levels in the Ocean

Introduction

The quantity of oxygen dissolved in ocean water is affected by a variety of factors, two of which are temperature and water depth. To gain a greater understanding of the chemical, physical and biological features of ocean water samples must be taken at different depths in the **water column** from top to bottom. This **vertical transect** is carried out using a variety of water sample bottles.(**Figure 1**)

Figure 1 Water Sample Bottles

Materials

Ruler and pencil

Procedure

Part A - Depth

1. Examine the information in the **Data Table 1** collected by oceanographers in a vertical transect of the ocean. The amount of oxygen was measured at different depths. Using this information construct a line graph on **Graph 1** in the **Results** section. Plot the depth on the vertical axis and amount of dissolved oxygen on the horizontal axis. Surround each point with a small circle. Using your ruler draw straight lines connecting the points.

Part B - Temperature

1. Examine data in **Table 2** below. Plot the temperature on the Y-axis and the DO value on the X-axis in **Graph 2** provided in the **Results** section. Connect the point with a best-fit straight line.

Student Lab Report

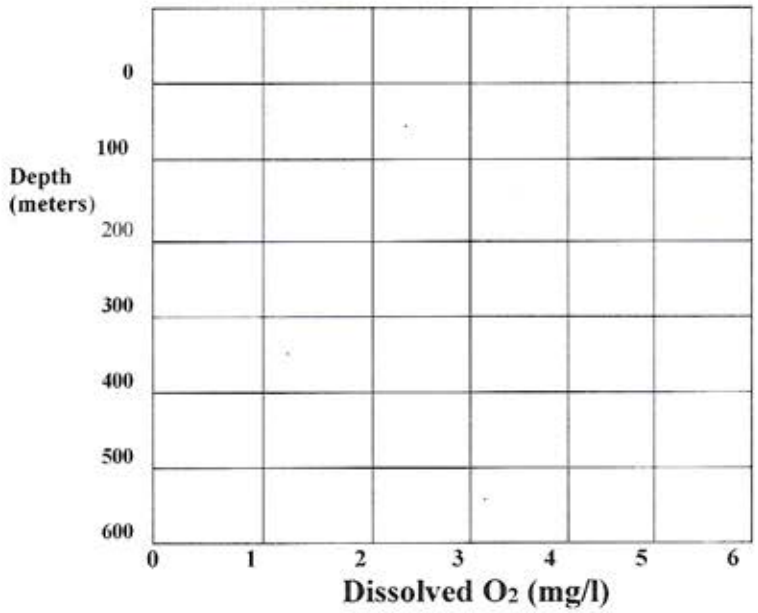
Last Name.....First.....Class..... Date.....

Marine Environmental Science Lab # Factors Affecting DO Levels in the Ocean

Data Table 1 DO and Depth

Depth (meters)	DO (mg/liter)	Depth (meters)	DO (mg/liter)	Depth (meters)	DO (mg/liter)
0	7.0	20	6.0	39	1.6
3	7.0	23	6.2	43	1.5
7	6.8	26	6.0	46	1.5
10	6.4	30	5.9	49	1.4
13	6.4	33	5.1	52	1.4
16	6.4	36	2.0	56	1.4

Graph 1 Temperature vs Depth



Student Lab Report

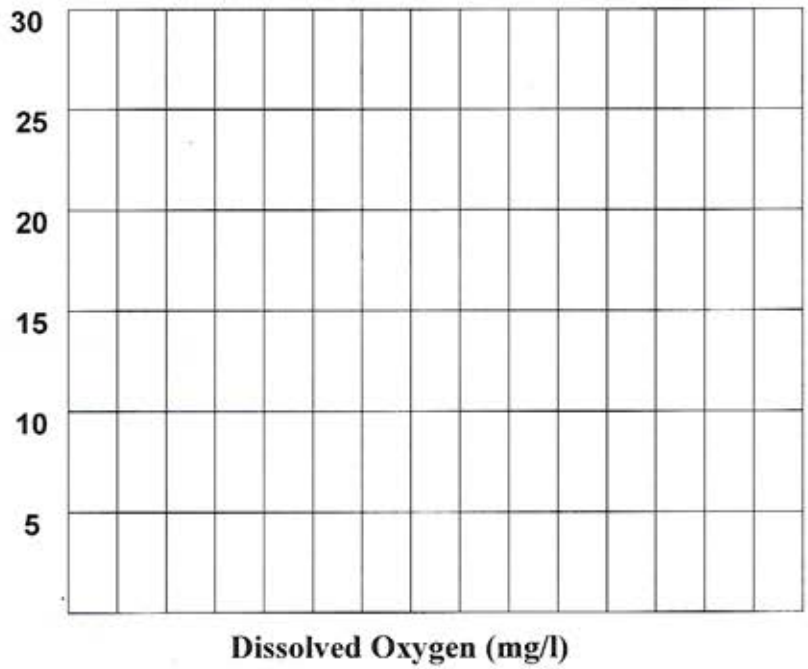
Last Name.....First.....Class..... Date.....

Marine Environmental Science Lab # Factors Affecting DO Levels in the Ocean (continued)

Data Table 2 DO Concentration at Different Temperatures

Temperature (^{0}C)	DO (mg/l)
30	6.4
25	7.0
20	7.6
15	8.4
10	9.3
5	10.0

Graph 2 Temperature vs DO



Questions

1. Describe the relationship between DO and depth.

2. How does dissolved oxygen vary with temperature?

3. What conclusion can you draw from the Data in Table 2?

Marine Environmental Science Lab # Measuring Nitrogenous Wastes in the Water

Introduction

Nature recycles its waste products into useful substances. In one type of cycle, the **nitrogen cycle (Figure 1)** the remains of dead animals and plants decomposes into compounds that contain the element nitrogen. This process of decay, which occurs on land and in bodies of water produces compounds including **ammonia** (NH_3/NH_4^+), **nitrites** (NO_2^-)and **nitrates** (NO_3^-). Nitrites and ammonia can be toxic, but nitrates are useful to green plants. When absorbed by photosynthetic plants nitrates are used to make proteins, the building blocks of life. All proteins contain the element nitrogen (N).

On the other hand, high concentration of nitrates can precipitate algae blooms, which lead to poor water quality, a condition called **eutrophication**. **(Figure 2)**

The purpose of the following investigation is to assess the quality of ocean water by measuring the level of toxic and non-toxic nitrogen compounds present in the water .

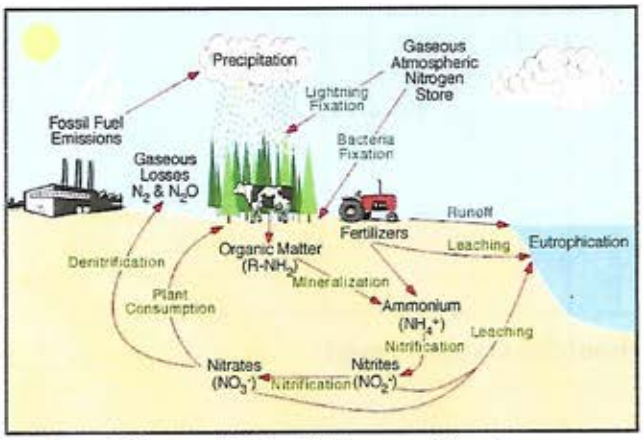


Figure 1 The Nitrogen Cycle

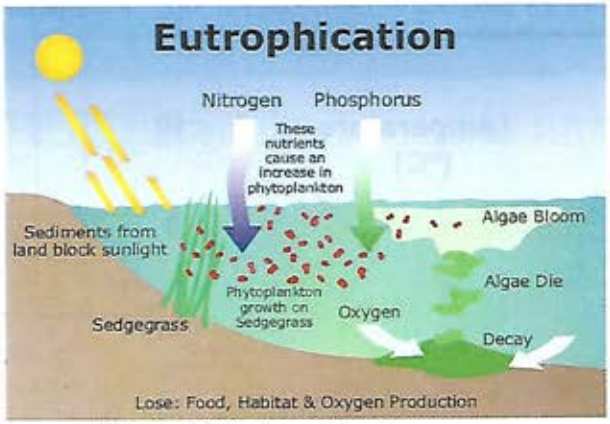


Figure 2 Eutrophication

Materials

Test kits, test probes, ocean water

Procedure

1. Read instructions on each of the test kits for ammonia, nitrate and nitrite. Perform the tests. Record your results in the data table.

2. Read instructions for the use of the sensors. Perform the tests. Record your results in the data table.

Student Lab Report

Marine Environmental Science Lab # Measuring Nitrogenous Wastes

Last Name.....First.....Class..... Date.....

Data Table **Nitrogenous Wastes in Ocean Water**

Test	Quantity(mg/l)	Sensors	Evaluation Criteria
ammonia			Standard for ammonia-< 0.25 mg/l
nitrite			Standard for nitrite - < 0.25 mg/l
nitrate			Standard for nitrate - < 40 mg/l

Concluding Questions

1. Why is the standard for nitrate different from the standards for nitrite and ammonia?

2. Describe a poor technique that would result in an inaccurate result.

3. What would you conclude about water quality if ammonia and nitrite levels did not exceed 0.25 mg/l?

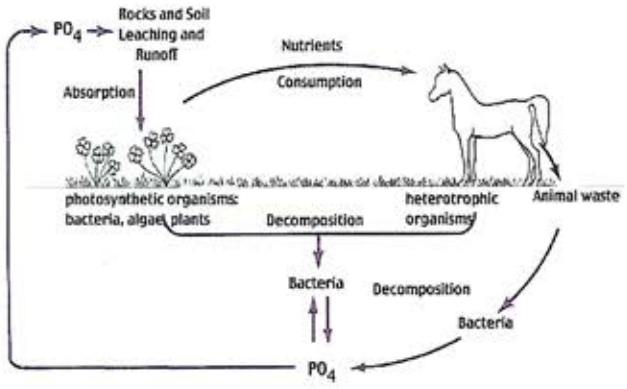
4. How would high nitrate levels affect water quality?

Marine Environmental Science Lab # Role of Phosphates in Water Quality

Introduction

One very important chemical element found in all living things is **phosphorus (P).** Our genetic blueprint DNA contains phosphorus. Chemical energy in the form of adenosine triphosphate or ATP, produced during cellular respiration, is also high in phosphorus. This vital element, found in all foods, provides for the energy needs of all living things. When animals and plants die, the phosphorus found in dead matter is recycled, through the **phosphorus cycle (Figure 1),** back into the environment in the form of **phosphate (PO_4^{-3})**. In the ocean, phosphates are absorbed by chlorophyll bearing organisms including algae and corals for their growth and energy needs. Animals, in turn, will consume the plants thus completing the cycle. Similarly on land, phosphate, an important nutrient in fertilizer is used to grow crops.

Figure 1 The Phosphorus Cycle



However, if too much dead matter or crop fertilizer accumulates in bodies of water, phosphates levels increase, which stimulates the growth of too much algae, resulting in an **algae bloom.** The overcrowding reduces light penetration causing the death of many algae, an increase in bacterial growth and a reduction in dissolved oxygen. The EPA sets a standard for the phosphate levels in water. In the following lab you will measure the phosphates levels in a body of water to see if it is in compliance with EPA standards.

Materials

Phosphate Test Kits

Procedure

1. Read the instruction sheet in the test kit. Carefully follow the directions in how to perform the tests. Record your results in the data table.

Student Lab Report

Last Name.....First.....Class..... Date.....

Marine Environmental Science Lab # The Role of Phosphates in Water Quality (continued)

Data Table

Water Sample	Test Kit Phosphate Level (mg/l)	Sensor (mg/l)	EPA Evaluation Criteria Standard for phosphate < 0.25 mg/l
Ocean			
Tap			
Aquarium			

Concluding Questions

1. Are the results in the data table in compliance with the EPA Standard? Explain

2. How do phosphates benefit living things?

3. Explain how the phosphorus recycles phosphates?

4. What is the role of phosphates in algae blooms?

5. Why are algae blooms harmful to the environment?

Marine Environmental Science Lab Measuring Sewage Pollution in a Body of Water

Introduction

Sewage contaminated waters can be identified by locating a group of bacteria called **fecal coliforms** in the water to be tested. Fecal coliforms originate in the large intestine or **colon** in mammals, including humans. Fecal coliform bacteria do not cause disease but may be associated with disease causing species or **pathogens** that can lead to illness or even life-threatening diseases. The discharge of raw or partially treated sewage into our waterways is considered a serious form of water pollution since it can adversely affect the health of the human population.

Since bacteria are microscopic in size it is necessary to grow or culture them in the laboratory to see and count them more easily. When grown under suitable conditions of warmth, food and moisture they produce enough cells to form masses called **colonies.** Water that is contaminated with lots of sewage will have a high coliform colony count. Cleaner water will have fewer or no coliform colonies.

The purpose of this investigation is to test water samples for fecal coliform bacteria, the indicator organism for sewage pollution. The results of your investigation, in the form of colony counts will be compared with Environmental Protection Agency Standards for different bodies of water as indicated below.

Type of Water	EPA Fecal Coliform Colony Standard
Drinking Water	zero colonies of coliform
Shellfish Waters	should not exceed 14 coliform colonies/100ml
Swimming Water	should not exceed 200 coliform colonies/100ml
Harbor Water	should not exceed 2000 coliform colonies/100ml

Materials: Millipore membrane filters, filter holder and funnel, absorbent pads, nutrient ampoules, Petri dish, forceps, syringe and tube, water samples

Procedure.

1. Label sterilized Petri dish with your name, date and sample site.

2. Open an ampoule of sterilized nutrient media and pour all the contents on to the absorbent pad in a Petri dish. Put on cover and set aside.

3. With forceps remove the sterilized membrane filter from package and place on the filter holder grid surface up. Discard blue cover paper. Screw on filter funnel.

4. Measure out 10 ml of the water sample to be tested **plus** 10 ml of distilled water into a graduated cylinder to give a total of 20 ml. Distilled water is added to dilute a potentially high number of coliform colonies.

5. Pour the contents into the funnel. Swirl the contents in the funnel to mix thoroughly

6. Attach one end of the syringe with rubber tubing to the two -way valve. Attach the valve to the plastic syringe. Insert the other end of the tubing into the side arm of the plastic receiving flask. Close the other side arm with a rubber cap. Using the plunger apply suction gently until all the water drain.

7. Unscrew the funnel and take the top off the Petri dish. With forceps, transfer the membrane filter to the nutrient filled absorbent pad. Be sure that the grid surface is facing up. Put on Petri cover. Place in the incubator at 44.5^{0}C upside down for 24 hours

8. After 24 hours remove Petri dish from incubator. **Caution**: **DO NOT OPEN PETRI DISH**. Seal with tape around the edges. Count the number of colonies through the cover of the Petri dish. The cover will fog up if you wait too long. Invert Petri dish to de-fog. Record the number in the data table. Calculate the number of colonies per 100ml. Record in data table.

9. If the membrane filter contains too many colonies to count accurately you can obtain a very close estimate by carrying out the following calculations: Select 5 squares equally spaced apart. Count the number of colonies in each square. Divide this number by 5 to get an average per square. Multiply this average by the total number of squares which is 154. This will give you the total number of colonies on the membrane filter from a 10 ml water sample. Multiple by 10 to get the number of colonies in a 100ml sample.

Student Lab Report

Last Name.....First.....Class..... Date.....

Data Table

Water Sample	# of colonies in 10ml	# of colonies in 100ml	Evaluation Is it safe for shellfishing, drinking, and/or swimming ?
Ocean (Top)			
Ocean (Bottom)			
Tap Water			
Aquarium			

Concluding Questions

1. How can the number of bacteria be counted if they are so difficult to see?

2. Explain a higher colony count could occur can on the bottom than on the ocean surface.

3. Why was distilled water added to the water sample?

4. Why was the Petri dish, membrane filter and nutrient media sterilized?

5. Count the number of colonies in the Petri dish, to the right, of a 10ml water sample taken from a public beach. Calculate the number per the 100ml standard. Is the water safe for swimming? Explain.

Marine Environmental Science Lab # Observing Oceanic Plankton

Introduction

Plankton ('wanderers') are tiny organisms that float and drift on, or near the surface of the ocean. They can be conveniently divided into three groups, the chlorophyll bearing photosynthetic "plant" plankton called **phytoplankton,** which are referred to as the "grasses of the sea", the mobile **animal plankton or zooplankton**, which feed on the phytoplankton, and the **dinoflagellates**, which have both animal and plant-like characteristics. Collectively, the plankton serve directly or indirectly as the basic food supply for all living things in the ocean.

Of all the plankton, the **zooplankton** are the easiest to observe because they move about. Many are microscopic. But some like the jellies **(Figure 2)** are **macroscopic** and can be seen with the naked eye. The zooplankton are conveniently sub-divided into **temporary zooplankton** and **permanent zooplankton.** The temporary zooplankton are the larval forms of crabs, clams, sponges, worms and other invertebrates that eventually mature into their adult forms. The permanent zooplankton, such as the copepods and arrow worms, to mention a few, are the species that remain in the plankton population throughout their life cycle.**(Figure 2)**

A robust species diversity is considered a good indicator of the health and vitality in both terrestrial and aquatic environments. In the following lab you will focus on the animal plankton by observing, identifying, recording and sketching the different species found in local waters..

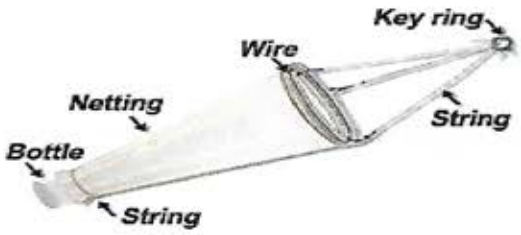
Materials

Plankton net, compound and dissecting microscopes, hand lenses, fresh plankton, plankton net, prepared slide of medicine droppers, slides, cover slips, lens paper, methyl cellulose

Procedure

1. Since plankton are largely microscopic and dispersed widely in the ocean, you will need to use a plankton net to strain them from the water **(Figure1)** . The plankton net is pulled along the surface of the water for a few minutes from a pier or from behind a moving boat. The plankton get stuck in the tiny mesh openings in the nylon net and are collected in a clear plastic or glass jar attached to the other end.

Figure 1 Plankton Net



2. Pour the contents from the plankton jar into a Petri dish. Place the dish on the stage of the **dissecting microscope**. You can also use a hand lens to view the plankton in the Petri dish. Move the dish around on the microscope stage while viewing through the scope. Look for moving creatures. These are the zooplankton. One of the most common is the **copepod**, a tiny shrimp-like organism. Sketch several on your lab sheet. Identify each one using the attached guide.

3. You will need to use the **compound microscope**, with its higher magnification, to observe animal structures in more detail. Under the microscope movements are also magnified, so you need to use the chemical **methyl cellulose**, to slow them down. With a medicine dropper, obtain a sample of plankton. Put two drops on a glass slide. Add a drop of methyl cellulose. Apply a cover slip and view under low power. Move the slide around on the microscope stage until you see a zooplankton moving slow enough to be observed and sketched.

4. Make a drawing for each species observed. Use the attached guide to identify the species of zooplankton in the results section. Write your observations on how the species moves (speed, direction, type of locomotion). Observe the reaction to different light intensities by manipulating the substage condenser. Touch the slide to see if there is a reaction to a mechanical stimulus. Add a drop of cold and warm water. Record your observations to these different stimuli in the results section.

Figure 2 Some Common Zooplankton


Jellyfish


Comb Jelly


copepod


crab larva


sea star larva


Barnacle


worm larva


clam larvae


Arrow worm


snail larva


sponge larva


fish larva


sea anemone larva


jellyfish larva


mussel larvae


oyster larvae


Rotifer


Radiolarian


Sea squirt


scallop larva


horseshoe crab larva

Student Lab Report

Last Name.....First.....Class.....Date.....

Marine Environmental Science Lab # Observing Oceanic Plankton

Results

Drawings of Zooplankton

Draw and Identify Species	Draw and Identify Species	Draw and Identify Species	Draw and Identify Species
Written Observations	**Written Observations**	**Written Observations**	**Written Observations**

Concluding Questions

1. How are zooplankton conveniently classified?

2. How would you distinguish between a phytoplankton and a zooplankton?

3. Explain why a drop of water taken from the ocean's surface and viewed under the microscope would not reveal any plankton?

4. What is the evidence that a plankton sample shows diversity?

Student Lab Report

Last Name.....First.....Class.....Date.....

Marine Environmental Science Lab # Observing the "Grasses of the Sea"

Introduction

One of the most important creatures on Earth are the one- celled microscopic green "plants", the **phytoplankton**. They float and drift on the surface of the ocean and are part of the plankton ("wanderer") population. Collectively, the phytoplankton produce most of the oxygen in the atmosphere and are the foundation for every food chain in the ocean. The cells of the phytoplankton contain the same green chlorophyll pigments found in land plants. One of the most common types of phytoplankton are the **diatoms** .These "grasses of the sea", like their terrestrial counterparts, carry out the vital process of photosynthesis. They come in a variety of geometrical shapes. (**Figure 1**). In the following lab you will observe the many different species of phytoplankton.

Figure 1 Diatoms Carrying out Photosynthesis

Word Equation for Photosynthesis

six molecules of carbon dioxide plus twelve molecules of water, in the presence of light and chlorophyll, yields one molecule of glucose plus six molecules of oxygen plus six molecules of water

Formula Equation for Photosynthesis

$$6CO_2 + 12H_2O \xrightarrow[\text{chlorophyll}]{\text{Light}} C_6H_{12}O_6 + 6O_2 + 6H_20$$

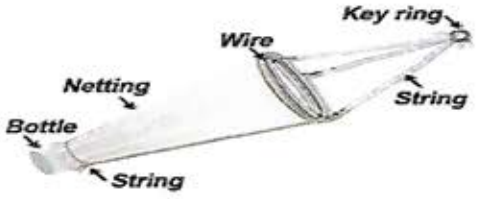
Materials

Plankton net, compound and dissecting microscopes, hand lenses, fresh plankton, plankton net, prepared slide of plankton, medicine droppers, slides, cover slips, lens paper

Procedure

1. Since plankton are largely microscopic and dispersed widely in the ocean, you will need to use a plankton net to strain them from the water (**Figure1**) . The plankton net is pulled along the surface of the water for a few minutes from a pier or from behind a moving boat. The plankton get stuck in the tiny mesh openings in the nylon net and are collected in a clear plastic or glass jar attached to the other end

Figure 1 Plankton Net



2. Pour the contents from the plankton jar into a Petri dish. Place the dish on the stage of the **dissecting microscope**. Move the dish around on the microscope stage while viewing through the scope. Look for cells with color. These are the **diatoms**, the most common of the phytoplankton. The diatoms contain different colored pigments and come in a variety of geometric shapes.. Some diatoms are round or centric in shape with **radial symmetry**, while others are pen-shaped or pinnate diatoms with **bilateral symmetry**. Still other diatoms form chains of cells that look like box cars**(Figure 2).**

3. To observe the diatoms under higher magnification you will need to use the **compound microscope.** Using a medicine dropper, obtain a sample of plankton. Put two drops on a glass slide. Apply a cover slip and view under low power.(40x) Move the slide around on the microscope stage until you see colored cells. Switch to high power(100x) for a closer view. Notice the colored pigments inside the cells; the green chlorophyll used in photosynthesis and the accessory pigments, xanthophyll (yellow) and carotene(orange and red) that aid in photosynthesis.. The pigments are visible because the cell walls are made of a glassy substance containing **silica** which makes them transparent to light. Note the different shapes of the cells which increase buoyancy, another adaptation for photosynthesis.

4. Make a drawing in the results section for each species observed. Describe cell shape and structure. Use the attached guide to identify the species.

Some Common Phytoplankton (Diatoms) Species

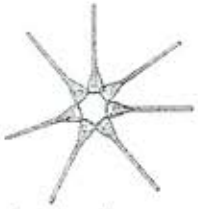
Cosinodiscus

Navicula sp

Nitzschia sp

Pseudo-nitchia sp

Ditylum



Asterionella sp

Chaetoceros sp

Melisoria sp

Limophora

Fragilaria

Thallisionema

Thalassiosira

Skeletonema

Pleurosigma

Rhizosolenia

Student Lab Report

Last Name.....First.....Class.....Date.....

Marine Environmental Science Lab # Observing the "Grasses of the Sea "

Results

Drawings of Phytoplankton

Draw and Identify Species	**Draw and Identify Species**	**Draw and Identify Species**	**Draw and Identify Species**
Descriptions of Cell Shape and Structure	**Descriptions of Cell Shape and Structure**	**Descriptions of Cell Shape and Structure**	**Descriptions of Cell Shape and Structure**

Questions

1. Why are phytoplankton called the "grasses of the sea?"

2. How are the diatoms adapted for photosynthesis?

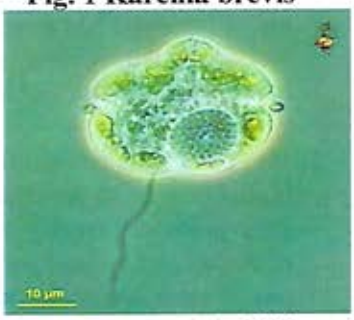
3. Write the word and formula equations for photosynthesis.

Marine Environmental Science Lab # Toxic Algae

Introduction

Have you ever seen this critter before? If so, you will need to notify the National Oceanographic and Atmospheric Administration (NOAA), the government agency that monitors our coastal waters for toxic species of plankton. This one happens to be Karenia brevis, a microscopic **toxic** alga that is part of the plankton population.

Fig. 1 Karenia brevis



A toxic species is any organism that produces harmful effects on living things. This particular species contains a **neurotoxin,** a chemical that harms the nervous system in animals including humans. Karenia brevis also contains a red pigment inside its cell. When these cells reproduce in large numbers, which occurs during an **algal bloom** the water takes on a reddish color, the so-called **red tide** (Fig. 2) The red tide is responsible for outbreaks of respiratory ailments among humans and shellfish poisoning bivalve mollusks.

Toxic algae are found among two groups of plankton, the phytoplankton and the **dinoflagellates**. The phytoplankton are the chlorophyll bearing cells that exhibit **autotrophic nutrition**, the ability to make food. The **dinoflagellates** also possess chlorophyll and are also autotrophic. But in addition, the dinoflagellates also possess two microscopic hairs, called **flagella**, which enables them to search for, and consume food, an example of **heterotrophic nutrition.** Thus the versatile dinoflagellates are both animal and plant-like. They can make food and consume food.

In the following lab you will look for toxic algae and count the total number of phytoplankton to see if there is evidence of a plankton bloom. Many plankton blooms contain toxic algae.

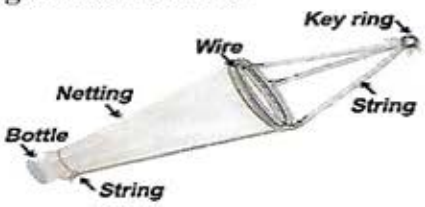
Materials

Compound and dissecting microscopes, plankton net (20um) mesh size, slides and cover slips ,medicines droppers, lens paper, cleaning fluid, gridded slides, grid guide sheet

Procedure

1. Since the toxic species of phytoplankton species are widely dispersed in the ocean, you will need to use a plankton net to strain them from the water (**Figure1**) . The plankton net is pulled along the surface of the water for a few minutes from a pier or from behind a moving boat. The plankton get stuck in the tiny mesh openings in the nylon net and are collected in a clear plastic or glass jar attached to the other end

FigurePlankton Net



Red Tide

2. Pour some of the water from the plankton jar into a Petri dish. Fill up a medicine dropper. Put two drops on the gridded slide Apply a cover slip. Place the slide on the stage of the microscope. Move the stage clips out of the way. View under low power (4X). Move the slide around. Notice the letters along the horizontal axis side of the grid and the numbers along the vertical axis (**Figure 1**)

Figure 1 - Plankton Grid

	A	B	C	D	E	F	G
1	A1						G1
2							
3							
4				D4			
5							
6							
7							
8	A8						A8

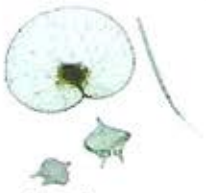
3. Move the slide to the A1 square. Using low power and then switching to higher power(40 X) count the number of phytoplankton seen in the A1 square. Record the number in the data table in the results section. Many of these cells are diatoms. Some of them may be dinoflagellates. Select one of each and draw them in the results section. Refer to the phytoplankton images as your guide.

4. Next, move the slide down to the A7 square. Follow the same procedure as described above. Repeat for square D4, G1, and G7.

5. Is the number of phytoplankton species you observed evidence of an algae bloom? The National Oceanographic and Atmospheric Administration(NOAA) defines an algae bloom as >9000 per grid. To calculate the number per grid first add up the number in the 5 squares, divide by 5 to get and average, and then multiply by the total number of squares in the grid, which is 56 to get the number of phytoplankton per grid.

Some Common Dinoflagellate


Protoperidinium sp


Noctiluca


Karina brevis


Alexandrium sp


Dinophysis


Ceratium arcticum


Dinogymniu sp


Gonyalux sp


Prorocentrum


Gymnodiium

Phytoplankton (Diatoms) Species (toxic)


Nitzschia sp


Pseudo-nitchia sp


Chaetocero sp


Aureococcu

Student Lab Report

Last Name.....First.....Class.....Date.....

Marine Environmental Science Lab #	Toxic Algae

Results

Labelled Drawings

Drawing of Dinoflagellate	Drawing of Diatom

Data Table

Grid Number	Number of Species	Calculations
A1		
A7		
D4		
G1		
G7		
Total		
Av.		

Questions

1. Does the data in the table show evidence of an algae bloom? Explain.

2. Distinguish between diatoms and dinoflagellates

3. Why are algae blooms harmful to living things?

Marine Environmental Science Lab # Oyster Gardening

Introduction

In the 1800's New York was known as the "oyster capital of the world". Oysters were harvested from natural oyster reefs along the shore in the many bays and inlets in the City of New York(**Figure 1**). By the late 1880's fifty thousand oysters were sold from the Fulton Fish Market every day. Mountains of empty shells accumulated along the shore after New Yorkers consumed raw oysters. Unfortunately, overharvesting, water pollution and habitat loss due to coastal development put an end to the oyster industry by the early 1900's.

Today not a single oyster is harvested in NY City water commercially for human consumption. But that may change. Water quality has dramatically improved. Coastal marshes like Jamaica Bay in Queens were oyst once thrived are protected by law from development. The New Jersey/New York Baykeeper, an environmental organization, encourages interested civic and educational groups to start their own oyster gardens to see if the oyster industry can be revived. Kingsborough Community College participates with its own oyster garden on campus in Sheepshead Bay.

Oysters are bivalve mollusks that grow best in **estuaries**, coastal areas that contain a mixture of salt and fresh water, referred to as **brackish** water(**Figure 1**). Some species grow in the intertidal zone while others are subtidal. Oysters are filter feeders. Specialized cells inside the oyster contain cilia that beat back and forth caus currents of water containing food, and other suspended matter to enter, and waste products to leave. It is estima that a single oyster can filter eight liters (~2 gallons) of ocean water per hour. Oysters, therefore serve the dual purpose in the marine ecosystem of being a source of food and filtering harmful substances from the water. In addition, oysters form reefs that provide a habitat for other living creatures and protect the shore from erosion b diminishing the effect of storm surge. For these reasons the oyster is considered a **keystone species**, a living creature that plays a vital role in the health and vitality of the environment.

Figure 1- The Oyster

A Bivalve Mollusk

A Source of Food

Oyster Life Cycle

In the following lab activity you will learn how to monitor the health and viability of oysters grown in the oyster garden on Kingsborough's campus. In the late Spring the viable mature oysters will then be transported reef pads located in the Hudson River estuary to create larger reefs and a more healthy ecosystem.

Marine Environmental Science Lab # Oyster Gardening (continued)

Materials

Eastern Oyster (*Crassostrea virginia*). wire mesh oyster cage, rope, mm ruler, caliper, paper towels, plastic tie bucket

Procedure

1. NY/NJ Baykeeper provides authorized groups of oyster gardeners 300 oysters to be kept in an oyster w mesh cage submerged in the subtidal zone and attached by a sturdy rope to a floating dock. The cage should be off the bottom to avoid sediments covering the oysters and 2-3 feet below the surface to prev the oysters from freezing in the winter **(Figure 2)**

Submerged Oysters

Oyster Cage

Oyster Garden

Measuring Oysters

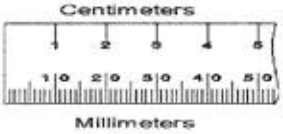
2. Each month remove the cage from the water by pulling it up with the attached rope, and placing it on a secure platform. Cut the plastic ties and open the top of the cage. Carefully remove fifty oysters in the smaller compartment and place them in a bucket of ocean water. Close the cage. Secure the lid with tw plastic ties and re-submerge the cage**(Figure 2)**

3. Bring the bucket of oysters back to the lab. Organize the class into groups to monitor the health of oys with 2-3 students per oyster. First, determine if the oyster is alive. Examine the oyster and notice that o the two shells one is more curved and the other is flat. If the shells are opened the oyster is dead. Indica on the data sheet with an X any dead oysters.

4. One measure of the health of an organism is its growth rate. Using a millimeter (mm) ruler or a caliper measure the length of the oyster in mm **(Figure 3)**. Record the length in your data table. Don't measure t dead oysters. Copy your data into the group tally chart on the board. Copy the measurements from the board into your data table. After measuring, put all the oysters, both alive and dead, back in the bucket sea water.

Figure 3

Caliper



5. Complete this activity by calculating the average length of the oysters. Indicate the range from smallest to biggest in size. Determine the mortality in %. Return all the oysters to the small compartment in the submerged cage. Measure the oysters again the next month by following the same procedure. The other 250 oysters will be released back into the ocean along with the measured ones in the Spring to reproduce creating the next generation of oysters.

Student Lab Report

Last Name.....First.....Class.....Date.....

Marine Environmental Science Lab # Oyster Gardening

Results

Oyster Length Measurements(mm's)

1		11		21		31		41	
2		12		22		32		42	
3		13		23		33		43	
4		14		24		34		44	
5		15		25		35		45	
6		16		26		36		46	
7		17		27		37		47	
8		18		28		38		48	
9		19		29		39		49	
10		20		30		40		50	

Overage Average = _____

Range : Lowest_____ Highest _____

Mortality in % _____

Questions

1. Why is the oyster considered to be a keystone species?

2. How can the health of an oyster be determined?

3. What is the evidence that there is variability in the oyster population?

4. Why aren't oysters harvested commercially in New York?

Marine Environmental Science Lab # Analyzing Fishery Data

Introduction

The economy of New England and other coastal regions is linked, in large part, to the success of the fishing industry. Bottom food fish such as cod, haddock, pollock and flounder are the backbone of commercial fishing economy in the Gulf of Maine **(Figure 1).** These groundfish are caught using a bottom trawl as shown in the **Figure 2.**

Figure 1 Gulf of Maine

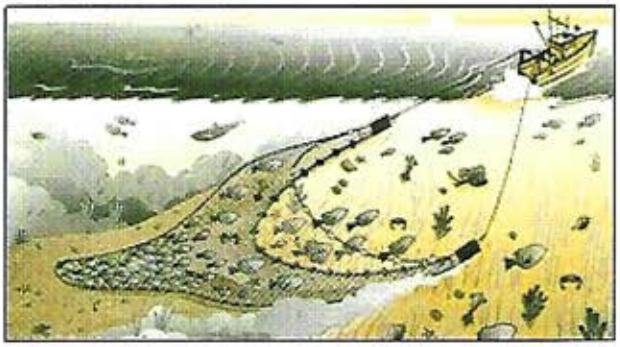


Figure 2 Bottom Trawl

In recent years **overharvesting** of these food fish have reduced their numbers to the point that **sustainabilit** of certain species is being threatened **(Figure 3)** Sustainability is maintaining a stable and healthy population c natural resource, such as fish, while not adversely affecting its environment. The creation, by the United Natior of an Exclusive Economic Zone (EEZ) that extends to 200 miles offshore in coastal nations is a conservation measure to protect fisheries from being overexploited.

Figure 3 Overharvesting Affects Sustainability

In the following lab you will analyze East Coast fishery data in order to determine how well New England and Long Island fisheries are faring

Materials pencil and a ruler

Procedure

1. Examine the data in **Table 1.0** below which shows the average cod fish catch per trawl in kilograms (kgs) in the Gulf of Maine for the years from 1970 to 2011.

Table 1.0 Gulf of Maine Cod Fish Catch Per Trawl

Year of Trawl	Catch per Trawl (kgs)
1970	32
1972	27
1974	21
1977	46
1978	42
1980	47
1982	49
1984	37
1986	33
1988	26
1990	33
1992	35

Year of Trawl	Catch per Trawl (kgs)
1994	30
1996	27
1998	26
2000	18
2002	14
2004	13
2006	12
2008	10
2010	08
2011	06

2. Using the information in **Table 1** construct a line graph(**Graph 1)** in the results section by plotting the data on the graph and drawing lines connecting the points.

3. Examine the data in **Table 2** which shows the weight and value of the fish caught from the Hampton and Shinnicock Bay on Long Island, NY.

Table 2 Weigh and Value of Fish Catch from Hampton and Sninnicock Bays on Long Island NY

Year	Millions of Pounds	Millions of Dollars	Year	Millions of Pounds	Millions of Dollars	Year	Millions of Pounds	Millions of Dollars
1984	8.2	4.6	1993	16.4	9.3	2002	11.1	8.3
1985	9.1	5.5	1994	17.5	10.6	2003	6.5	6.5
1986	8.5	5.5	1995	17.8	10.3	2004	6.5	6.6
1987	11.1	7.9	1996	15.7	9.0	2005	5.5	8.1
1988	10.0	7.4	1997	13.6	9.8	2006	6.1	8.0
1989	8.3	5.7	1998	14.7	9.7	2007	5.8	6.4
1990	6.1	3.8	1999	11.7	8.4	2008	5.0	5.7
1991	11.0	6.9	2000	13.7	9.5	2009	5.0	5.3
1992	11.5	7.8	2001	10.2	9.2	2010	4.4	5.1
						2011	3.9	4.5

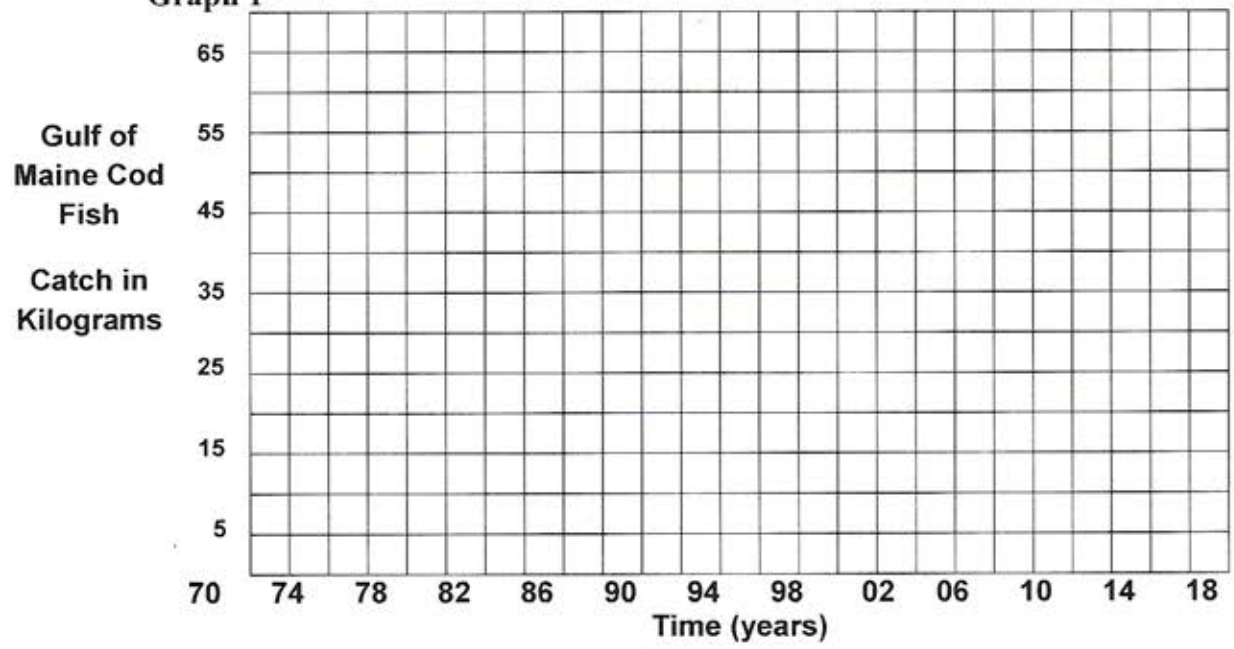
4. Plot the data from Table 2 on to Graph 2 in the Results section. Use different colored lines for each s data point

Student Lab Report # – Analyzing Fishery Data

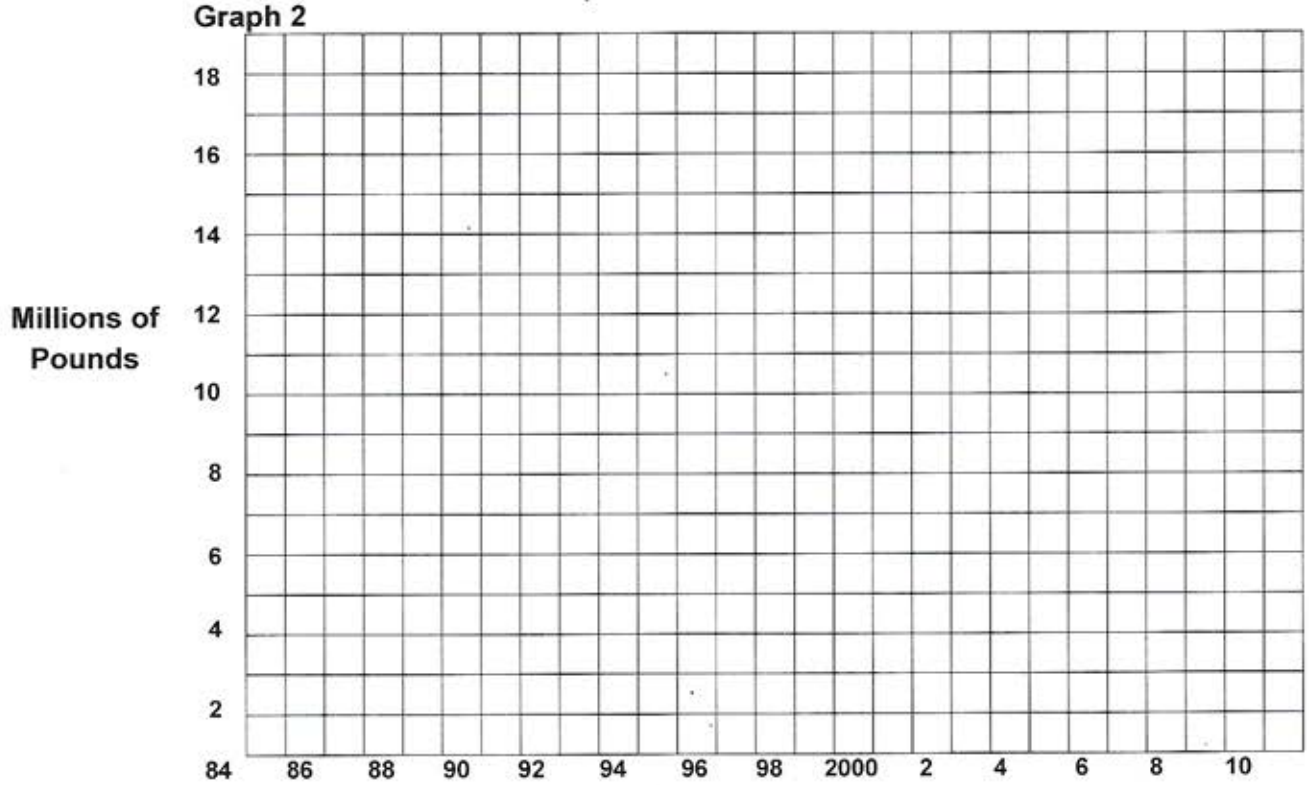
Last Name……First……Class……Date……..

Results

Graph 1



Graph 2



Time (years) Hampton Bay-Shinnicock, New York

Student Lab Report # – Analyzing Fishery Data (continued)

Questions

1. On the first graph for the Gulf of Maine, how has the cod fishing industry generally fared between 1990and 2011?

2. On the second graph for Hampton Bay-Shinnicock, New York, how has the fishing industry general fared between 1984 and 2011?

3. The Magnuson Act was created by Congress in 1976 and enforced in 1977 to forbid foreign fishing boats to fish in our coastal waters within 200-miles of the Exclusive Economic Zone (EEZ), **Figure 1.0**. Based on the data in the Gulf of Maine cod fish graph, how effective was this conservation measure after 1977?

4. In 1992, the US fishing fleet grew rapidly due to the addition of larger and more modernized fishing boats. How did this affect the catch the following year on both graphs?

5. Noting the general trend of the Gulf of Maine graph, project what the cod fish catch might be for the next 5 or so years. Mark your projected plots after 2012 to 2018 with a dashed line. Now what does this graph suggest about future cod fish catches for the Gulf of Maine?

6. Examine the Hampton Bay graph, has the value of the fish catch changed much. Explain your answer.

Marine Environmental Science Lab # Locating Marine Sanctuaries

Introduction

Marine sanctuaries are designated areas along the coast of the United States and in the Pacific Ocea that are protected by the Federal Government from being exploited in order to provide a safe and secure marir habitat for animals and plants that are threatened or endangered. The Marine Sanctuaries program, established i 1972, consists of 13 areas totaling over 150,000 square miles. Some sanctuaries also contain historic sunke wrecks and battlegrounds of cultural importance.

In the following investigation you will locate 12 of these designated marine sanctuaries by using th coordinates of latitude and longitude.

Materials

colored pencil, global charts

Procedure

1. Specific locations on Earth are identified by using a set of coordinate lines called **lines of latitude** ar **lines of longitude**. Lines of latitude run east/west and parallel to the equator. The equator is designat as zero degrees latitude, and North Pole is at 90^0 North Latitude, and the South Pole is at 90^0 Sou Latitude. (**Figure** 1)
2. The lines of longitude run north/south from zero degrees at the Prime Meridian that runs through Englar to 180 degrees west (180^0W) on one side of the meridian to (180^0E) on the other side.
3. The intersection of the two lines represents a particular geographical location. For example, using t coordinates of latitude and longitude Kingsborough Community College would be located approximately 40^0N Latitude and 73^0W Longitude. Using a red colored pencil mark the approximate sp on world map in Figure 1.
4. Twelve marine sanctuaries with their coordinate points of latitude and longitude are shown in **Table 1** to the right. Using the world map in the Results section locate the sanctuary where the points of latitude and longitude intersect. Place the number of the sanctuary for that location on the world map in the Results section.

No.	Marine Sanctuary	Latitude	Longitude
1	Channel Islands	34° N	119° W
2	Cordell Bank	38° N	123° W
3	Thunder Bay	45° N	87° W
4	Florida Keys	24° N	81° W
5	Flower Garden Banks	27° N	93° W
6	Gray's Reef	31° N	80° W
7	Gulf of the Farallones	37° N	123° W
8	Hawaiian Islands	21° N	157° W
9	Monitor	35° N	75° W
10	Monterey Bay	36° N	122° W
11	Olympic Coast	48° N	124° W
12	Stellwagen Bank	42° N	70° W

Table 1

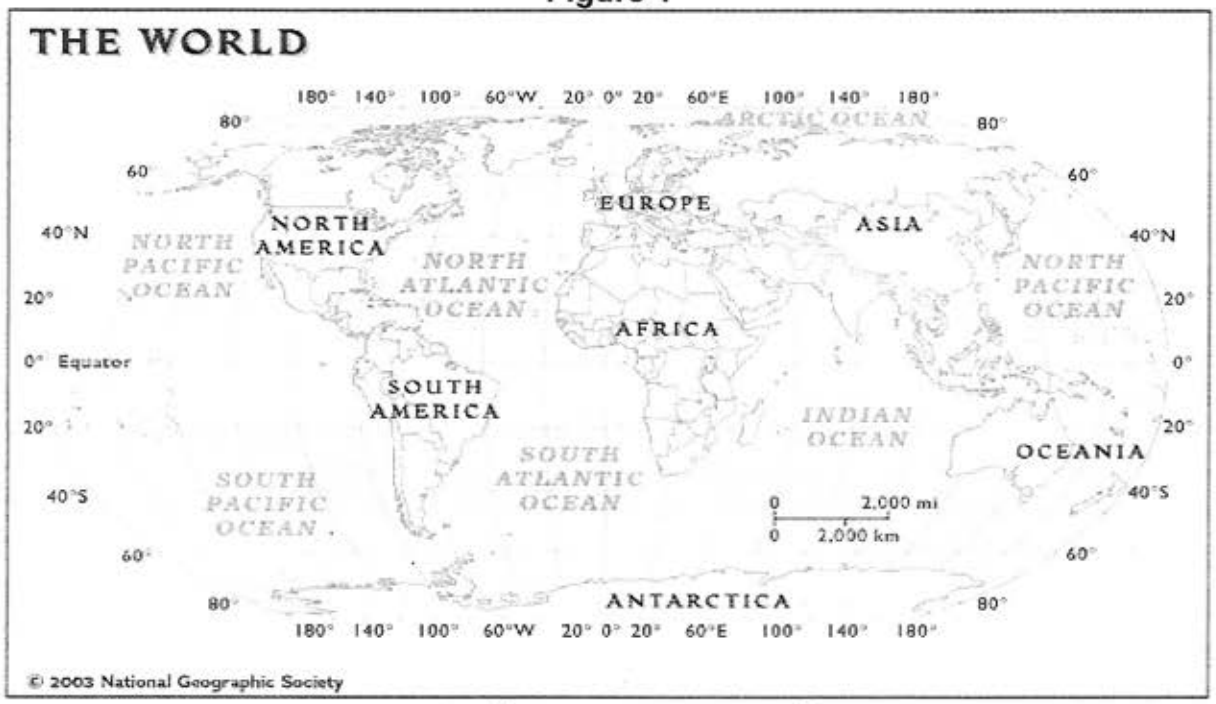
Student Lab Report

Last Name.....First.....Class.....Date.....

Lab Locating Marine Sanctuaries

Results

Figure 1



NATIONAL GEOGRAPHIC marcopolo
XPEDITIONS
www.nationalgeographic.com/xpeditions

Questions

1. Why were marine sanctuaries created?

2. How are marine sanctuaries located

3. Geographically speaking, what do all the marine sanctuaries have in common?

Marine Environmental Science Lab # Analyzing Global Warming

Introduction

A hot topic being discussed today is **global warming**, the gradual increase in Earth's temperature ov time(**Figure 1).** Global atmospheric temperatures are measured using satellite technology and from worldwid weather stations. The hottest year on record was 2014 with an atmospheric temperature of 13.9 ^{O} C (57.0^{O} F).

The global oceans also showed a slight rise in temperature since it is in contact with the atmosphere.(**Figure 2**)

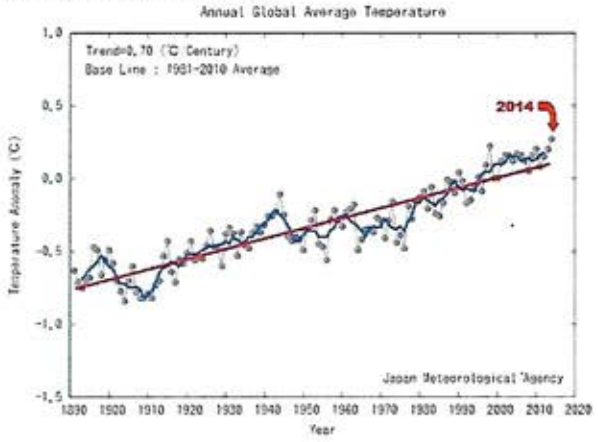


Figure 1 Global Atmospheric Temperature Change

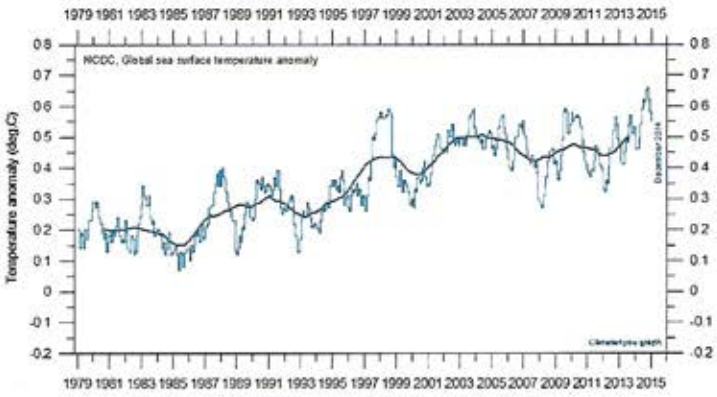


Figure 2 Sea Surface Temperatures

One cause for the increase in the temperature of the atmosphere (air) and the hydrosphere (oceans) is the increase in the amount of carbon dioxide (CO_2) discovered in the atmosphere(**Figure 3).** Carbon dioxide is normally found in small concentrations, about 0.04% when compared with other gases like oxygen(21%) and nitrogen(78%). Scientists like to use the unit "parts per million" or ppm to represent concentrations of gases in the atmosphere. Current CO_2 levels are around 399 ppm. This means that for every million molecules in the atmosphere, 399 of them are CO_2.

According to Figure 3 CO_2 has increased dramatically since 1960. Scientists are worried because CO_2 normally is a heat trapping **greenhouse gas** because, like a warm greenhouse, it helps to keep Earth warm. But if CO_2 increases inthe atmosphere global warming will result.

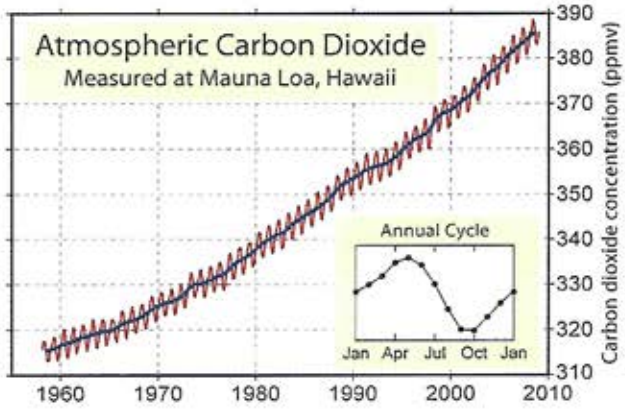


Figure 3 CO_2 in the Atmosphere

KINGSBOROUGH

Physical Science Department
Sci 5100

Student Lab Report

Last Name.....First.....Class.....Date.....

Marine Environmental Science Lab # Analyzing Global Warming

Questions

1. Examine the chart in **Figure 1**.What was the change in temperature between 1860 and 2000 in degrees C? Do you consider this value as evidence for global warming? Explain.

2. Examine Figure2. What was the temperature anomaly between 2002 and 2010? What conclusions ca you draw when comparing Figure 1 and Figure 2?

3. The average global temperature in 2012 was 55.3 degrees F. Using any of the following formulas convert this temperature into degrees C. Show all work.

$^0C = {}^0F - 32 \times 5/9$ $^0F = {}^oC \times 1.8 + 32$ $^0C = F-32/1.8$

4. Examine the chart in Figure 3 and notice that every year there is a increase and decrease in the CO_2 concentrations. What explanation can you give for this annual rise and fall?

5. In Figure 3 the CO_2 concentrations were measured on a mountain top in Hawaii and not in a big city. Why?

Marine Environmental Science Lab # Effects of Global Warming

Introduction

Global warming has resulted in the gradual melting of the polar ice caps (**Figure 1**). Satellite images sho a dramatic change in ice cover between 1980 and 2012.The shrinkage and thinning of the ice caps has affectec the polar bear population (**Figure 2**). Since polar bears feed almost exclusively on seals which they can only capture on ice, habitat loss has caused a dramatic decline in the number of polar bears in the Arctic.

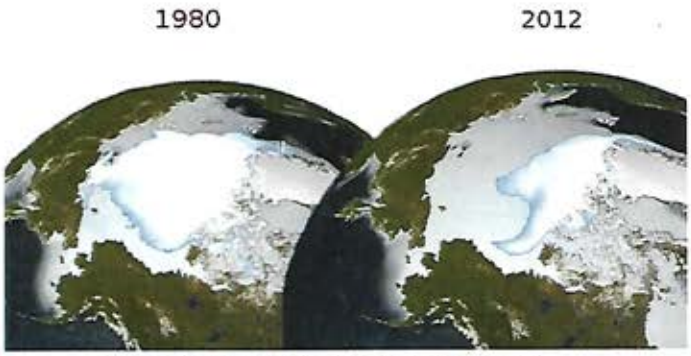


Figure 1 Melting of Polar Ice Caps

Figure2 Habitat Loss for the Polar Bear

It only takes a one degree change in temperature for ice to melt into water When the polar ice melts over the continents in the Arctic and Antarctic the melt water flows into the ocean causing it to rise. A rising sea level also caused by **thermal expansion**, an increase in the volume of water due to an increase in its temperature. A increase in the volume of ocean water causes an elevation in sea level. When **glaciers,** which are rivers of moving ice melt, the water runs off into the ocean. Melting icebergs also contribute to a rising sea level.

How do scientists measure the change in sea level caused by the addition of water from melting ice? The sea level has been measured very accurately by orbiting satellites using an instrument called a **radar altimeter. (Figure 3).** The radar altimeter inside the orbiting satellite emits very short radar pulses which are beamed down and bounce off the sea surface back to the satellite. By timing the interval between the transmission and reception of the signals the precise height above the water and the topography (surface features) can be determined.

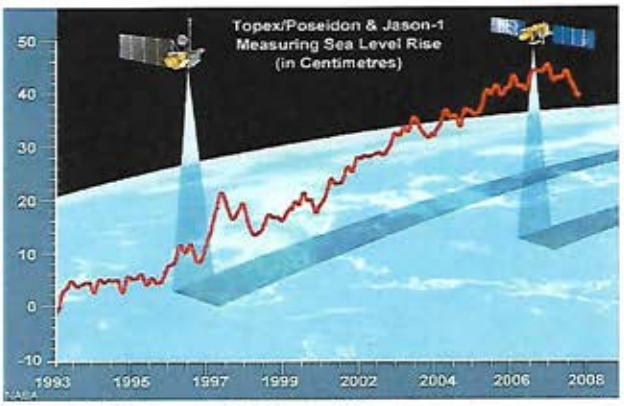


Figure 3 Radar Altimetry

Physical Science Department
Physical Science and the Environment (Sci 5100)

Student Lab Report

Last Name.....First.....Class.....Date.....

Marine Environmental Science Lab # Effects of Global Warming

Questions

1.Examine the chart in **Figure 4.** What was the change in sea level between 1880 and 2010?

2. Does the chart show evidence of global warming? Explain.

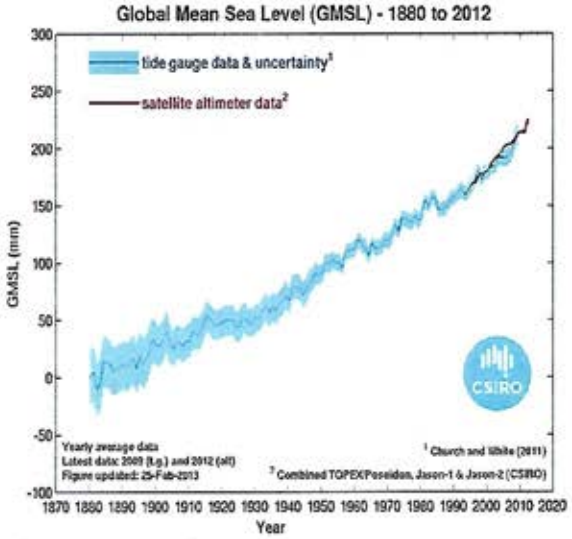


Figure 4 Sea Level Rise

3. How do scientists measure sea level?

4. Identify three causes that would account for the rise in sea level.

Lab # Water Quality Log

Physical Science Department
Chemistry and the Environment Class (Sci 051)

KINGSBOROUGH COMMUNITY COLLEGE

Water Quality Data Report
Kingsborough Marina

EPA Water Quality Standards

DO ->4mg/ ph - approximately 8
Water Clarity(Turbidity) - more than 3 meters desireable
Fecal Coliform Bacteria -Swimming<200colonies/100ml
shellfishing <14colonies/100ml,Harbor Water<2000colonies

EPA Water Quality Standards

Ammonia - < 0.25mg/l Nitrites - < 0.25mg/l
Nitrates - < 40mg/l phosphates(PO_4^{---})
phytoplankton(per grid) 1-600=present;601-4000=common; 4001-9000=abundant; >9000=bloom

Date	Air Temp (^{0}C)	Water Temp (^{0}C)	Dissolved Oxygen (DO) (mg/l)	pH (0-14)	Salinity (ppt)	Turbidity (meters)	Ammonia (NH_4^+, NH_3) (mg/l)	Nitrites (NO_2^-) (mg/l)	Nitrates (NO_3^-) (mg/l)	Phos-phates (PO_4^{---}) (mg/l)	Fecal Coliform Bacteria (per/100ml)	Phyto-plankton Count (per grid)	Oyster Growth (mm/ month)	Tide (low, mid, high)	Weather (rain cloudy, sunny)	Depth (meters)

Periodic Table of the Elements

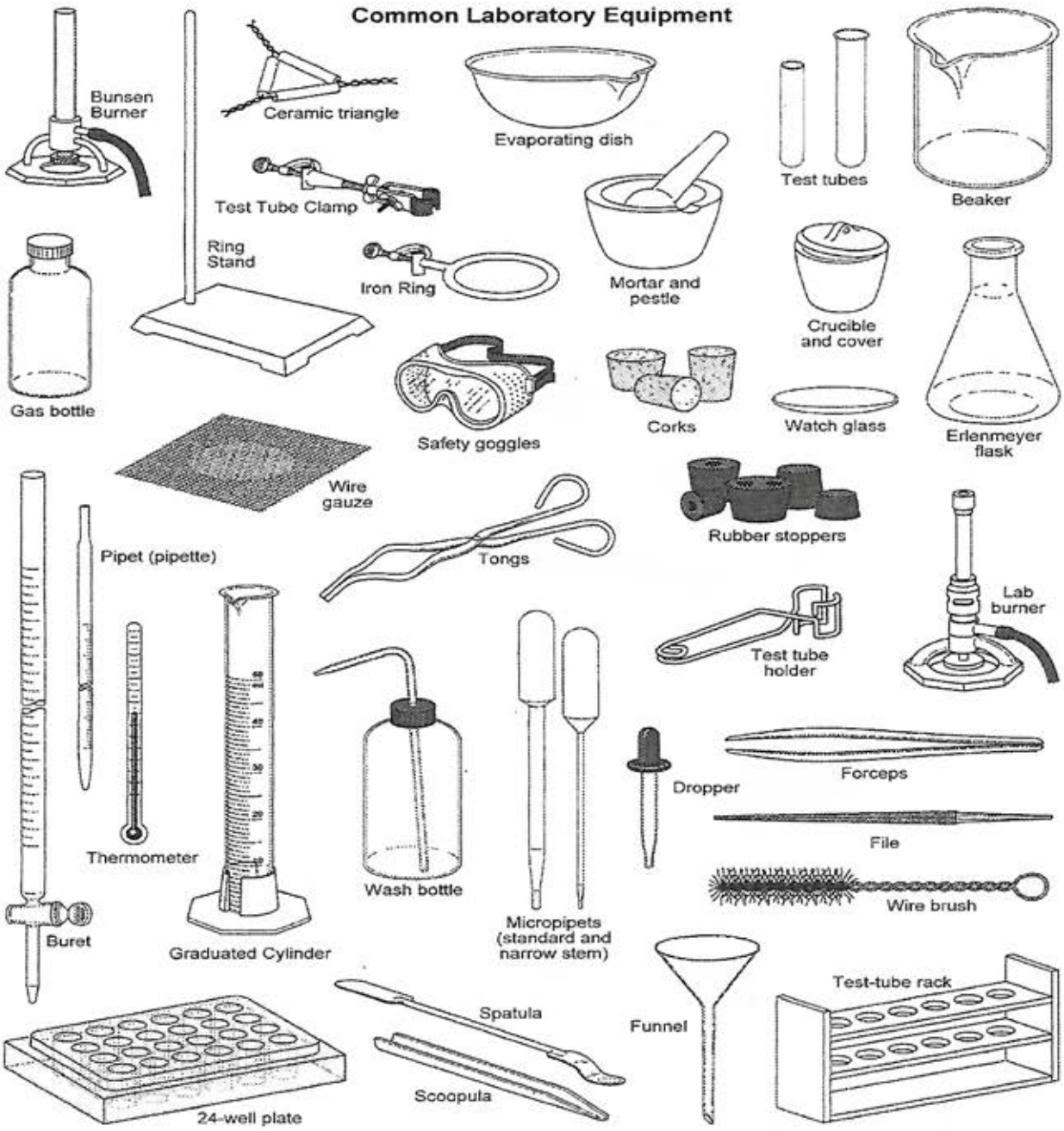
I IA																	13 VIIIA
H 1 Hydrogen 1.00794 $1s^1$	2 IIA																He 2 Helium 4.00260 $1s^2$
Li 3 Lithium 6.941 $2s^1$	Be 4 Beryllium 9.012182 $2s^2$																
Na 11 Sodium 22.989768 $3s^1$	Mg 12 Magnesium 24.3050 $3s^2$	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8 VIIIB	9 VIIIB	10 VIIIB	11 IB	12 IIB						
K 19 Potassium 39.0983 $4s^1$	Ca 20 Calcium 40.078 $4s^2$	Sc 21 Scandium 44.955910 $3d^14s^2$	Ti 22 Titanium 47.88 $3d^24s^2$	V 23 Vanadium 50.9415 $3d^34s^2$	Cr 24 Chromium 51.9961 $3d^54s^1$	Mn 25 Manganese 54.93805 $3d^54s^2$	Fe 26 Iron 55.847 $3d^64s^2$	Co 27 Cobalt 58.93320 $3d^74s^2$	Ni 28 Nickel 58.69 $3d^84s^2$	Cu 29 Copper 63.546 $3d^{10}4s^1$	Zn 30 Zinc 65.39 $3d^{10}4s^2$	Ga 31 Gallium 69.723 $4p^1$	Ge 32 Germanium 72.61 $4p^2$	As 33 Arsenic 74.92159 $4p^3$	Se 34 Selenium 78.96 $4p^4$	Br 35 Bromine 79.904 $4p^5$	Kr 36 Krypton 83.80 $4p^6$
Rb 37 Rubidium 85.4678 $5s^1$	Sr 38 Strontium 87.62 $5s^2$	Y 39 Yttrium 88.90585 $4d^15s^2$	Zr 40 Zirconium 91.224 $4d^25s^2$	Nb 41 Niobium 92.90638 $4d^45s^1$	Mo 42 Molybdenum 95.94 $4d^55s^1$	Tc 43 Technetium (98) $4d^55s^2$	Ru 44 Ruthenium 101.07 $4d^75s^1$	Rh 45 Rhodium 102.90550 $4d^85s^1$	Pd 46 Palladium 106.42 $4d^{10}5s^0$	Ag 47 Silver 107.8682 $4d^{10}5s^1$	Cd 48 Cadmium 112.411 $4d^{10}5s^2$	In 49 Indium 114.82 $5p^1$	Sn 50 Tin 118.710 $5p^2$	Sb 51 Antimony 121.75 $5p^3$	Te 52 Tellurium 127.60 $5p^4$	I 53 Iodine 126.905 $5p^5$	Xe 54 Xenon 131.30 $5p^6$
Cs 55 Cesium 132.90543 $6s^1$	Ba 56 Barium 137.327 $6s^2$	*57 - 71 Lanthanide series*	Hf 72 Hafnium 178.49 $5d^26s^2$	Ta 73 Tantalum 180.9479 $5d^36s^2$	W 74 Tungsten 183.85 $5d^46s^2$	Re 75 Rhenium 186.207 $5d^56s^2$	Os 76 Osmium 190.2 $5d^66s^2$	Ir 77 Iridium 192.22 $5d^76s^2$	Pt 78 Platinum 195.08 $5d^96s^1$	Au 79 Gold 196.96654 $5d^{10}6s^1$	Hg 80 Mercury 200.59 $5d^{10}6s^2$	Tl 81 Thallium 204.3833 $6p^1$	Pb 82 Lead 207.2 $6p^2$	Bi 83 Bismuth 208.98037 $6p^3$	Po 84 Polonium (209) $6p^4$	At 85 Astatine (210) $6p^5$	Rn 86 Radon (222) $6p^6$
Fr 87 Francium (223) $7s^1$	Ra 88 Radium (226) $7s^2$	*89 - 103 Actinide series*	Unq 104 Unnilquadium (261) $6d^27s^2$	Unp 105 Unnilpentium (262) $6d^37s^2$	Unh 106 Unnilhexium (263) $6d^47s^2$	Uns 107 Unnilseptium (262)	108	109									

Group new → I 1A ← Group old
Symbol → K 19 ← Atomic number
Name → Potassium
Atomic mass → 39.0983
Electron configuration → $4s^1$

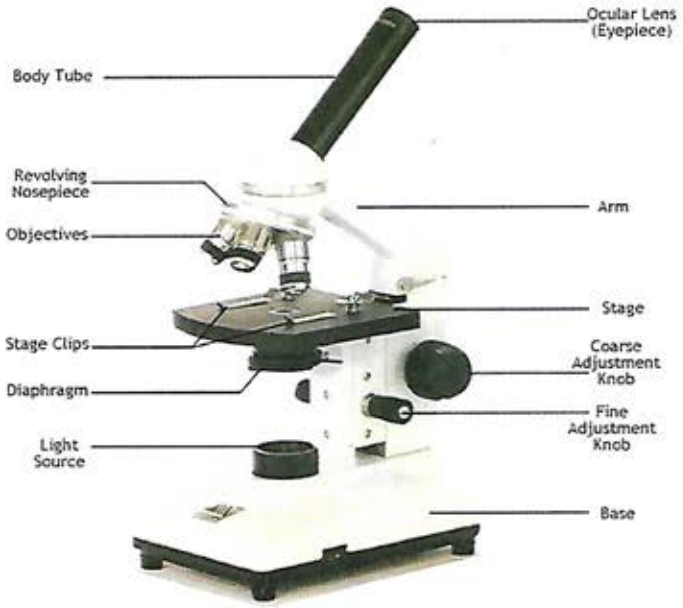
Metalloids: 13 IIIA, 14 IVA, 15 VA
Nonmetals: 16 VIA, 17 VIIA

Lanthanide series	La 57 Lanthanum 138.9055 $5d^16s^2$	Ce 58 Cerium 140.115 $4f^15d^16s^2$	Pr 59 Praseodymium 140.90765 $4f^36s^2$	Nd 60 Neodymium 144.24 $4f^46s^2$	Pm 61 Promethium (145) $4f^56s^2$	Sm 62 Samarium 150.36 $4f^66s^2$	Eu 63 Europium 151.965 $4f^76s^2$	Gd 64 Gadolinium 157.25 $4f^75d^16s^2$	Tb 65 Terbium 158.92534 $4f^96s^2$	Dy 66 Dysprosium 162.50 $4f^{10}6s^2$	Ho 67 Holmium 164.93032 $4f^{11}6s^2$	Er 68 Erbium 167.26 $4f^{12}6s^2$	Tm 69 Thulium 168.93421 $4f^{13}6s^2$	Yb 70 Ytterbium 173.04 $4f^{14}6s^2$	Lu 71 Lutetium 174.967 $4f^{14}5d^16s^2$
Actinide series	Ac 89 Actinium (227) $6d^17s^2$	Th 90 Thorium 232.0381 $6d^27s^2$	Pa 91 Protactinium 231.03588 $5f^26d^17s^2$	U 92 Uranium 238.0289 $5f^36d^17s^2$	Np 93 Neptunium (237) $5f^46d^17s^2$	Pu 94 Plutonium (244) $5f^66d^07s^2$	Am 95 Americium (243) $5f^76d^07s^2$	Cm 96 Curium (247) $5f^76d^17s^2$	Bk 97 Berkelium (247) $5f^96d^07s^2$	Cf 98 Californium (251) $5f^{10}6d^07s^2$	Es 99 Einsteinium (252) $5f^{11}6d^07s^2$	Fm 100 Fermium (257) $5f^{12}6d^07s^2$	Md 101 Mendelevium (258) $5f^{13}6d^07s^2$	No 102 Nobelium (259) $6d^07s^2$	Lr 103 Lawrencium (260) $6d^17s^2$

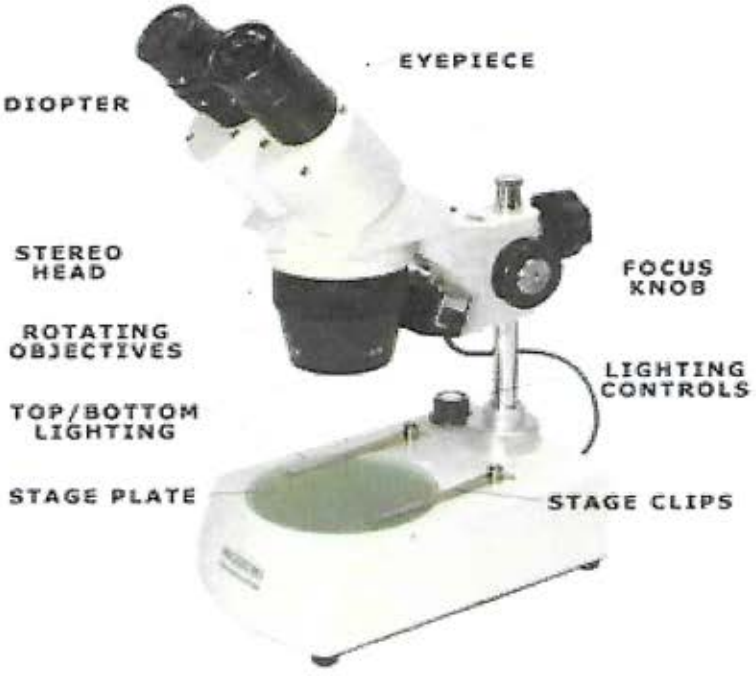
Appendix 2


Common Laboratory Equipment
Bunsen Burner
Ceramic triangle
Evaporating dish
Test tubes
Beaker
Test Tube Clamp
Ring Stand
Iron Ring
Mortar and pestle
Crucible and cover
Gas bottle
Safety goggles
Corks
Watch glass
Erlenmeyer flask
Wire gauze
Rubber stoppers
Pipet (pipette)
Tongs
Lab burner
Test tube holder
Thermometer
Wash bottle
Dropper
Forceps
File
Wire brush
Buret
Graduated Cylinder
Micropipets (standard and narrow stem)
Spatula
Funnel
Test-tube rack
Scoopula
24-well plate

Appendix 3 - Types of Microscopes



Compound Light Microscope



Dissecting Microscope