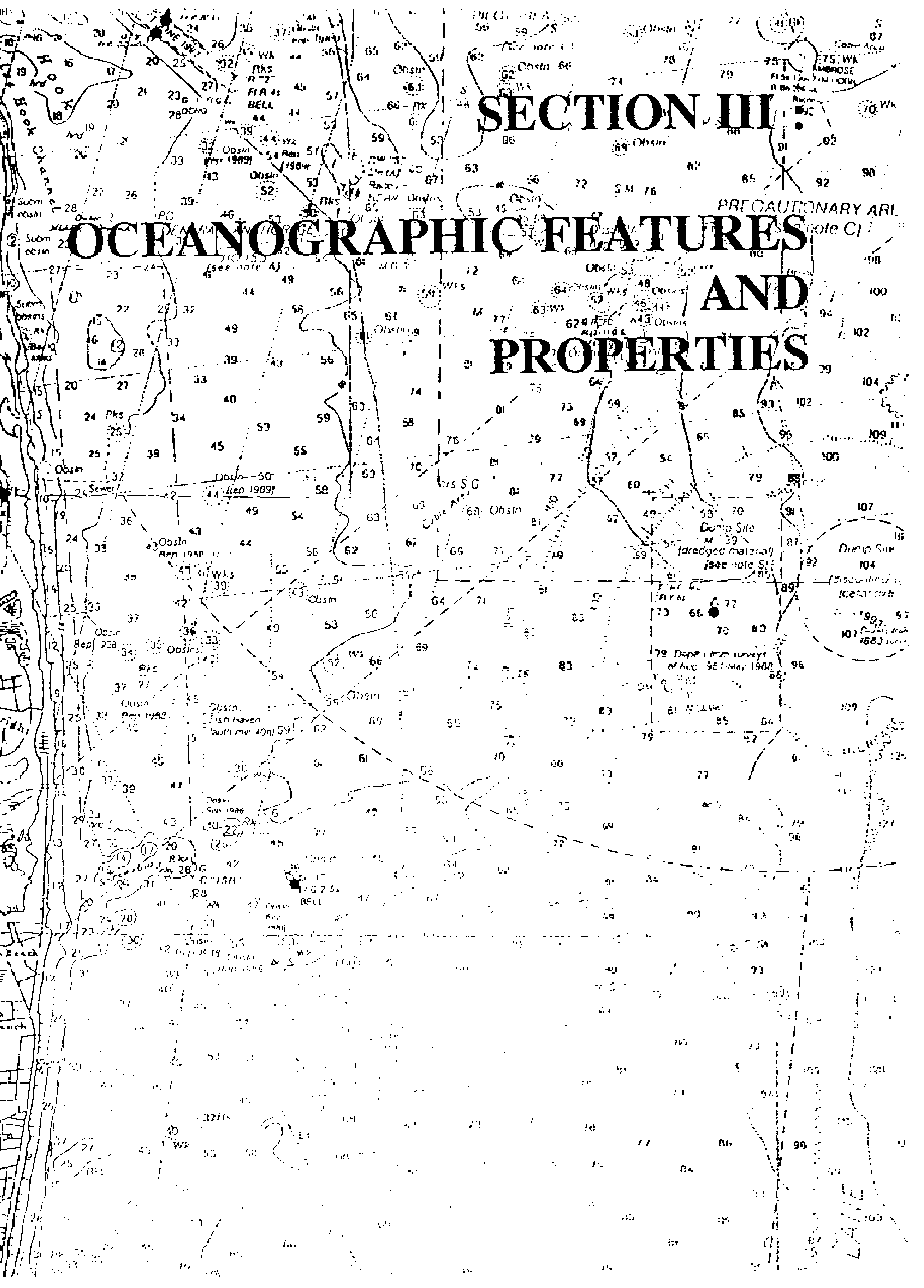
SECTION III: OCEANOGRAPHIC FEATURES AND PROPERTIES



OCEANOGRAPHIC FEATURES AND PROPERTIES

OCEANOGRAPHIC FEATURES

The Hudson-Raritan Estuary connects with the ocean at the Sandy Hook-Rockaway Point transect and Hell's Gate. Water elevation varies at these ocean boundaries and within the Estuary itself. Factors influencing these variations include both predictable astronomical tides and wind driven meteorological tides.

The major freshwater input to the system originates in the Hudson River Basin, which discharges through Upper New York Bay, at the Verazzano Narrows into Lower Bay and continues onto the New Jersey coast and the Atlantic Gcean A portion of the discharge through the Narrows moves southwesterly along Staten Island into the easterly area of Raritan Bay. Exact conditions at any time and location are dependent on the key factors of freshwater inflow and the tidal motion, which affect the degree of mixing.

There is a net outflow of lower salinity surface waters and an inflow of higher salinity waters along the bottom of the Estuary due to tides. Both tidal dispersion and circulation contribute to the differences of salinity in any given area of the Estuary. This two-layer circulation pattern provides the Estuary with a far greater flushing rate than would be the case if circulation were in a seaward direction due to freshwater discharges only.

Salinity differences in the Hudson-Raritan Estuary are typical of a partially mixed estuary. Throughout most of the year, the Hudson-Raritan can be classified as a partially mixed, moderately stratified estuary.

Circulation in the Hudson-Raritan Estuary can be understood by separating it into two parts; tidal circulation driven by the astronomical tides at the ocean boundaries and a residual or net circulation which is the average circulation over one or more complete tidal cycles. The reversing tidal currents serve to move water over distances of about 5 to 10 kilometers on either a flood or ebb portion of a tidal cycle. The net displacement over a complete tidal cycle is the major factor that determines exchange and renewal of the Estuary. This average or residual circulation is as variable as are tides, winds, and freshwater discharges. The key point is that the residual currents by themselves fail, in general, to predict the transport pattern through the Estuary.

Residual tidal circulation, combined with the residual or net circulation driven by other mechanisms, affects the transport of contaminants through the Estuary, and exchanges the estuarine waters with adjacent coastal ocean waters. These forces also flush and renew the waters of the Estuary. The net or residual circulation is of primary concern, from the viewpoint of water quality. If the Lower Hudson River, Raritan Bay, Upper Bay, and Lower Bay were dependent only on freshwater inflow for their renewal, then residence time for these waters would be about three to six months during low flow conditions in the Hudson. The actual residence time is more nearly one to two weeks, which is testimony to the vigor of the residual circulation arising from the interplay of the tidal, wind, and freshwater discharge processes of the Estuary.

Circulation which arises from regional wind blowing over the adjacent continental shelf water is called meteorological tides. Meteorological tides can cause substantial exchange of estuarine and ocean waters, especially when storm surges occur. These surges can inundate low-lying land. Variable local winds over the Estuary also produce changes in circulation patterns within the Estuary. This is most evident in Raritan Bay, which is broad and relatively shallow.

The last major force in estuarine circulation is freshwater discharge. The difference in density between the freshwater entering at the upstream limits of the Estuary and seawater at its downstream limit drives vertical and horizontal residual circulations which increase net transport and exchange of water through the Estuary.

PROPERTIES OF LOCAL WATERS

Currents and tidal action move water within the Estuary, causing water quality conditions in one area to influence conditions in other areas. Tributary and adjacent water bodies also affect conditions in the Estuary. These include the Middle Hudson, Hackensack, Raritan, Passaic, Rahway, and South Rivers, Western Long Island Sound and adjacent ocean waters of the New York Bight.

With each rainfall, pollutants such as fertilizers, pesticides, pet wastes, oil, and grease are washed from lawns and streets into storm drains that flow into streams, rivers, the Estuary and eventually the ocean. Known as nonpoint source pollution, this process degrades coastal water quality and can result in negative impacts to aquatic life and habitat quality within the system.

When materials such as sand, dirt and other fine particles become suspended in water, clarity is reduced making the water turbid. The clarity or transparency of marine and estuarine waters is of prime importance. Since photosynthesis is confined to the sun-lit upper layers of marine ecosystems, light penetration is of great importance for primary productivity. In the marine environment, absorption and scattering of light causes rapid loss. This loss of light is further accelerated by turbidity or particles suspended in water.

Materials contributing to turbidity are varied. In the summer, turbidity may be due to plankton. Plankton grows and multiplies rapidly in warm, sunlit, nutrient rich water, giving the water a cloudy appearance. During periods of heavy runoff, silt-laden surface water flows into the Bay. Wind-generated waves, boat wakes and waves breaking on shore also stir up sediments contributing to turbidity.

In addition to turbidity, other measurable properties of water include temperature, salinity, dissolved oxygen, and pH. These four basic properties influence the biological, physical and chemical processes that occur in the Estuary.

Water temperature exerts a strong control over the distribution and activities of marine organisms. For example, some species of phytoplankton will grow more rapidly under certain temperature conditions.

PH is a measure of how acidic or basic (alkaline) a solution is. Pure water has a neutral pH of 7.0. When pH is less than 7.0, water is said to be acidic. When the pH is greater than 7.0, water is basic or alkaline. A pH of 6.5 to 9.0 is generally accepted as the range necessary to support survival of marine organisms. The pH of sea-water normally ranges from 7.5 to 8.4. Fluctuations in pH can occur in association with photosynthesis and bacterial activity. In bright light, photosynthesis can raise the oxygen content appreciably and the resulting withdrawal of carbon dioxide from the water raises pH Diminished oxygen, increased carbon dioxide, and reduced pH may result from the rapid bacterial decomposition of detritus. Events in a watershed that may affect pH include increased leaching of soils or mineral outcrops during heavy precipitation, human activities including accidental spills and agricultural runoff of pesticides, fertilizers, soil leachate and sewer overflow. Seawater is resistant to fluctuations in pH due to the carbonate dissolved in the water, which acts as an acid buffer in marine systems.

Dissolved oxygen at the proper level is one of the most critical factors for maintaining aquatic life. It is essential for all plants and animals inhabiting the water of the Estuary. When oxygen levels in the water fall below 3-5 parts per million (ppm), fish and many marine organisms cannot survive. Oxygen levels are influenced by chemicals present in the water and biological activity. The amount of dissolved oxygen available in a water body is also directly related to temperature. Dissolved oxygen depends on the balance between the respiration demands of organisms present in the water, bacterial decomposition, and the addition of oxygen from the atmosphere and the photosynthetic activity of plants. Oxygen depletion is a significant event that can occur as a result of nutrient pollution and excessive phytoplankton production (i.e., algal blooms) and may result in mass killings of fish and shellfish in coastal waters if the reduced level of dissolved oxygen is prolonged.

Salinity is a key factor affecting the physical make-up of coastal waters. It refers to the concentration of dissolved salts in the water, usually expressed in parts of salts per one- thousand parts of water or parts per thousand (ppt or o/oo). Freshwater contains few salts (drinking water usually has a salinity of less than 0.5 ppt), while seawater averages 35 ppt. In estuaries, salinity changes with the tides and freshwater input. Since seawater enters bays through the inlets, salinity is highest at that point and decreases as one moves away from the inlet. Salinity decreases in the spring when rainfall and groundwater cause increases in freshwater inflows. In the fall, when freshwater inflows are reduced, salinities increase as more salt water penetrates further into the Estuary.

Salinity generally increases with depth since the presence of salts increases water density and lighter, less saline water tends to remain at the surface. The relationship between depth and salinity is not constant. If a bay is shallow, winds and tidal action can cause mixing and salinity would become the same throughout that water column. Perhaps the most important aspect of a bay’s salinity regime is its effect on the distribution of the various biological populations living in the bay. Different species have different salinity tolerance ranges. Those that are euryhaline can tolerate a wide range of salinities and may be found throughout the Estuary. Species that are stenohaline can only live in a very narrow salinity range and are confined to a relatively small area of the Estuary.

Sediments of the Hudson-Raritan Estuary

Words to Know:
Siltation
Coring
Hypothesis

Materials:
For this activity you will need 4 glass cylinders, 4 large jars with lids, stop watch, prepared sediments, an aluminum roasting pan, over flow basin, and clear plastic tubing.

Activity One:
The students collect a wide range of sediments ranging in size from fine sand to pebbles. After collecting, they make predictions as to which type of particle will sink fastest when dropped in water. Using a stop watch, they record the time it takes for particles to fall and settle to the bottom. Using the large jars for the second part of the activity, the students create a mixture of particles in each jar. Once filled with water, the jars are inverted and observations are made as to what happens.

Activity Two:
Students learn about the sampling technique, coring, by actually forcing a tube through sedimentary layers. Making predictions beforehand the students learn if the hypothesis they made was right.

Reading A Tide Chart

Words to Know:
Navigation
Semi-diurnal tides
Neap tide
Spring tide

Materials:
In this activity you will need a tide chart (supplied), flashlight, index cards labeled: full moon, quarter moon, new moon, spring tide, neap tide; two students to represent the earth and the sun; one student per labeled index cards.

Activity:
Using the tide chart, the students answer questions about the tides in the first part of this activity. For the second part, using the labeled index cards, the students demonstrate the phases of the moon that give us the different tides.

Ocean Currents

Words to Know:
Upwelling
Downwelling

Materials:
For this activity you will need a 2-liter soda bottle (cut off at the shoulder to make a wide-mouth container), one large ice cube colored dark blue, hot water colored red, tap water, plastic-foam cup, blue and red colored pencils, and unlined paper.

Activity:
The students fill a 2-liter bottle half full with tap water. A blue ice cube is floated in it and using unlined paper the students sketch their observations. Using a plastic foam cup containing hot water with red food coloring in it, the cup is poured slowly down the side of the 2-liter bottle. The changes are added to the drawing. For an extension, this experiment is repeated using very salty water and observations are made and differences noted.

Turbidity

Words to Know:
Benthic
Runoff

Materials:
For this activity youwill need a water sampling kit, Secchi disk, three or four hydrometer jars (optional), water (optional), soil, sand, clay, rocks (all optional), clock with second hand (optional).

Activity:
In this activity students will measure the turbidity of the water using a secchi disk. This is done by lowering the disk with a calibrated line, into the water until it disappears, reading the measurement, and recording the depth. This leads to a discussion on why turbidity is important.

Salinity

Words to Know:
Hydrometer
Meniscus
Refractometer
Specific gravity

Materials:
For this activity you will need water, salt, hydrometer, hydrometer jar, salinity conversion table, two pans, two eggs, thermometer, eye dropper (optional) and refractometer (optional).

Activity:
In this activity students place two pans on a table, one with fresh water and one filled with very salty water, putting an egg in each pan they observe what happens. Using the hydrometer jar filled with salty water the students obtain a temperature and a hydrometer reading. This process is repeated using fresh water. A comparison is made. After that a variety of objects are experimented with to see what sinks and floats.

pH

Words to Know:
SAV
buffer
reagent

Materials:
For this activity you will need a water sample freshly drawn, LaMotte pH colorimetric test kit, chemical waste receptacle, and hand-held pH meter (optional).

Activity:
In this activity students take a freshly drawn water sample to measure pH. This leads to a discussion on acid rain and how it can cause problems for the Estuary and surrounding region. The method and test kit used in this activity are the same ones that are used by field scientists.

Oxygen in the Water

Words to Know:
Colorimetric
Diffusion
Phytoplankton
Photosynthesis

Materials:
For this activity you will need a LaMotte Winkler-Titration test kit, LaMotte Oxygen in the Water test kit, bucket, thermometer, water sample, and a chemical waste receptacle.

Activity:
Students in this activity measure dissolved oxygen in the water by two methods using two different test kits. It is important to obtain fresh samples. These tests can be done in the field, making sure the students are familiar with all test equipment beforehand.

Sediments of the Hudson-Raritan Estuary

Objectives: 1) You will be able to investigate and analyze the natural patterns of sedimentation in the Hudson-Raritan Estuary.
2) You will learn about coring, a sampling method that is used to study sediment.
3) You will observe how heavier particles sink faster than finer particles in an estuary.

Background: Sediments collect as particles, settling slowly to the bottom, varying in composition depending on location. The sediments of the Hudson-Raritan Estuary are the product of materials, principally minerals and rocks derived from various upland sources, delivered by rivers and streams. Particles of sediment are also carried into the Estuary from the ocean's tidal currents. The sediments found in the Hudson-Raritan Estuary can be made up of very fine particles consisting of silt and clay. Since fine particles remain suspended in the water column longer than larger, denser particles, the particles are carried up into the tidal creeks, collecting as marsh mud or finely grained shorelines. Other factors that influence where sediments are deposited are waves, tides, weather conditions, wind and artificial structures such as jetties, groins and bulkheads.

Words to Know:
Siltation
Coring
Hypothesis

Materials:
Clear Cylinders
Large Jars with lids
Stop Watch
Prepared Sediments
Aluminum Roasting Pan
Over Flow Basin
Clear Plastic Tube
Watering can

Activity One:
1) Collect a variety of sediments ranging in size from pebbles to fine sand. Arrange the particles in separate piles and predict which particles will sink the fastest when dropped in water. Using a stop watch and a clear container of water, record the time it takes for each different type of particle to fall to the bottom of the container.
2) Based on your findings predict what will occur when a mixture of particles are placed in a container of clear water. Using large jars with lids, create a "sediment mix" in each jar. Fill jar slowly with water. When the sediments have settled invert the jars and observe the action.

Discussion:
1. Discuss the relationship of **siltation** rates from your activity and what effects it might have on the Hudson-Raritan Estuary.
2. How do sedimentation rates affect the composition of various locations within the estuary?
3. What factors (human and natural) influence the layering of sediments?

Activity Two:
In order to study and analyze bottom sediments scientists utilize a process known as coring. By forcing a pipe through sedimentary layers, a sample core can be extracted, representing sediments in the order in which they were deposited.
1) Using a large aluminum roasting pan set up on an angle, build an estuarine sediment deposit by placing at least three different types of sedimentary materials in separate piles at the top of the pan. Using a source of water that you can regulate, slowly water each pile, one at a time, moving them down to the bottom of the pan. Be sure the pan is placed in a larger basin to allow for waste water overflow. Continue moving sediment until the sample is complete.
2) Predict how you think the layers have settled.
3) To test your **hypothesis**, take samples using this simple coring method. Using a clear plastic

tube, carefully insert the tube into the drained sediment. This method should yield a core. Observe the layers within the tube. Did you make a correct prediction?

Reading a Tide Chart

Objectives: 1) You will learn how to read and interpret tide charts.
2) You will use information contained in tide charts to plan and predict marine-related events.

Background: Tide charts are used to determine at what time of day the two high or low tides will occur in a specific location on a daily basis. A tide chart posts the projected time for daily high and low tides, based on the effects of the phases of the moon, the position of the sun and observed local changes. Tidal predictions assume average weather conditions, so actual tides may deviate during extreme weather situations. Tides are an important phenomenon. They affect **navigation,** replenish sea life, and assist in keeping coastal areas like the Hudson-Raritan Estuary clean. The ability to read tide charts becomes important if you plan to work or recreate in coastal areas. To find a tide chart look in the local newspaper or check with a local marina.

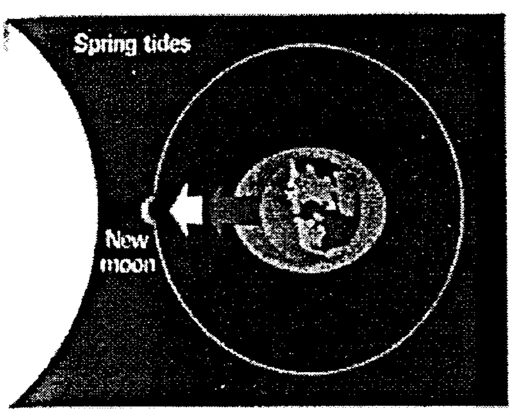
Words to Know:
Navigation
Semi-diurnal tides
Neap tide
Spring tide

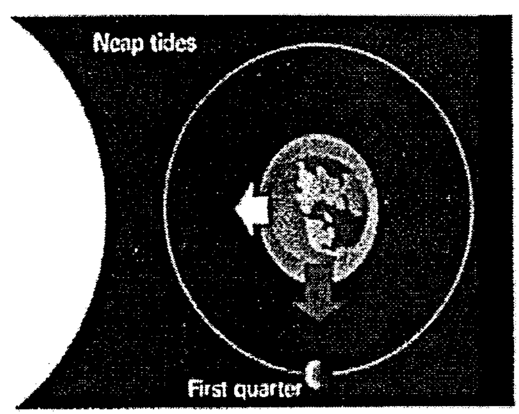
Materials:
Tide Chart
Flash Light
Index cards labeled: full moon, quarter moon, new moon, **spring tide, neap tide.**
Two students: l-Earth, l-Sun
One student: l-moon chosen by the labeled cards.

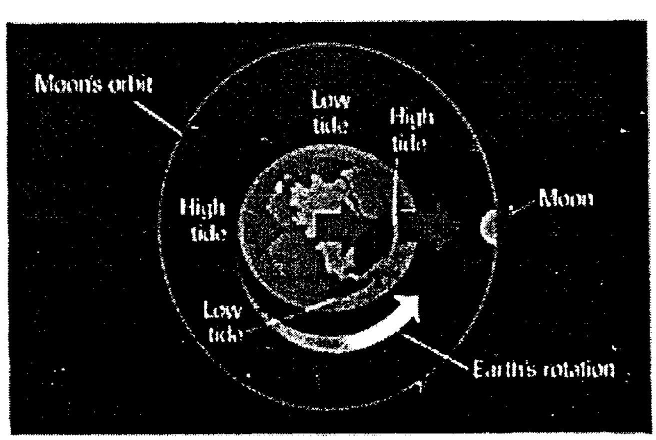
Activity One:
1) Using the given tide chart, look at one month of your choice, use the information to answer the following questions.
a) What is the relationship in time between the two daily high tides?
b) What is the relationship in time between the two daily low tides?
c) Compute the average time lapse between high and low tide?
2) There are two high tides and two low tides each day in the Hudson-Raritan Estuary. These are known as semi-diurnal tides. The rule of thumb for high tides is that they occur 12 hours and 25 minutes apart. This is because the moon passes the same spot on the Earth every 24 hours and 50 minutes. If the morning high tide arrives at 8 a.m. it will occur at 8:50 a.m. tomorrow morning. The same is true of low tides.
Using a tide table look at the morning tides and answer the following questions.
a) What date will the morning high tide appear just after sunrise?
b) When is the next high tide?
c) Calculate the difference between the high tides.
d) What is the time difference between the morning high tide and the next low tide on the date you chose.

Activity Two:
The moon's gravity pulls on Earth's near side more than it pulls on Earth's far side, because gravity depends on distance. These forces tend to create two bulges in Earth's oceans. One bulge is on the near side of the Earth, the other is on the far side. As Earth rotates, a coastline approaching a bulge has a high tide. Between the bulges, coastlines have low tides. The sun's gravity also contributes to the tides. Twice each month, at new moon and full moon, the sun and moon combine their gravity to produce very high tides and very low tides. At the first quarter and the third quarter phases, the sun and moon are not working together, and there is a smaller difference from low to high tide. These smaller-than-average changes are called neap tides. Neap tides occur at the first quarter and third

quarter phases. Spring tides occur at new moon and full moon. We can only see that part of the moon which is facing the sun. If the sun is shining on the half moon that we see, we call it a full moon. If the moon is between the earth and the sun making it difficult to see, we call it a new moon. The following activity will demonstrate the phases of the moon. Acting as the earth, one student will be assigned a position in the center of the classroom. Holding a light source, another student will be positioned to act as the sun. The balance of the class will then, one by one, draw prepared cards. The cards will say full moon, quarter moon, new moon, neap or spring tide. Acting as the moon, each student will see if he or she can assume the proper position as assigned by the card, for example, if the student has drawn the full moon card, the student would position themselves facing the earth on the side opposite the sun.







Ocean Currents

Objectives: 1) You will investigate how temperature differences in waterbodies causes currents.
2) You will have a better understanding of density as it relates to water.
3) You will better understand the impact of human actions on the marine environment.

Background: Currents are like giant rivers of water flowing through a given waterbody. Some flow on the surface, while others move huge amounts of water deep in the ocean. Currents are fueled by winds, heat, water density and the gravitational pull of the sun and the moon. Winds are caused by the accumulation of energy generated by the sun. As winds push across water, friction creates waves. Winds that push up against waves are the driving force behind surface currents. Currents formed by temperature start in the ocean's colder regions, (i.e. earth's polar areas) and move slowly across the sea floor towards land. When they run into a land mass or converge with another current they rise to the surface. When the cold water is forced to the surface it sinks down since it is heavier. The water or current then moves sluggishly towards warmer water at the equator. Gradually, these once chilly waters work their way back to the surface, replacing new, cold surface water that sinks. This **upwelling** and **downwelling** carries all sorts of interesting life with it including plankton and other marine creatures. Like cold water, salt water is denser than fresh, so it sinks when it encounters fresh waters causing currents. This is the case in the bays of the Hudson-Raritan Estuary. Fresh water from rivers converge with salty, colder ocean water. The ocean water sinks, causing vertical currents that continuously mix the water. Currents keep the Estuary's waters mixed constantly, carrying and supporting a myriad of marine organisms.

Words to Know:
Upwelling
Downwelling

Materials:
2-liter soda bottle (cut off at the shoulder to make a wide-mouth container)
One large ice cube colored dark blue
Hot Water (colored red)
Tap Water
Plastic-foam Cup
Blue- and Red pencils
Unlined Paper

Activity:
1) Fill a 2-liter bottle about half full with tap water. Float a blue ice cube in it. Use unlined paper to sketch your observations.
2) Obtain a plastic foam cup containing hot water with red food coloring in it. Be careful not to spill the hot water. Slowly pour the hot water down the side of the 2-liter bottle.
3) Allow the 2-liter bottle to sit as you continue to observe. Add any changes you observed to your drawing.

Discussion:
1. Keeping in mind the poles and the equator, how does this experiment explain the flow of some ocean currents?
2. Write a simple explanation of how the temperature of water is one cause of ocean currents.

Extension:
1. Repeat this experiment with a blue ice cube made with very salty water. Drop into a 2-liter bottle half full of fresh tap water. Sketch your observations.
2. Add moderately salty water to this mixture. You may want to tint this water red before slowly pouring it down the side of the 2-liter bottle. Once again, observe and sketch your observations.

Turbidity

Objectives: 1) You will be able to measure the turbidity of the water.
2) You will be able to identify possible environmental complications caused by excess turbidity.

Background: Turbidity or cloudiness in the water is caused by suspended solid matter which scatters light passing through the water. There are many possible sources of turbidity. Most people think primarily of sediment from disturbed or eroded soil and **runoff as** sources of turbidity. Microscopic plankton also contribute to high turbidity when their numbers are increased due to excess nutrients. Apparent water color, microscopic examination and streamwalk observations can help determine the sources of turbidity. In addition to blocking out the light needed by submerged aquatic vegetation (SAV) and burying eggs and **benthic** creatures, suspended sediment can carry nutrients and pesticides throughout the water system. Suspended particles near the water surface also absorb additional heat from sunlight, raising surface water temperature.

Words to Know:
Benthic
Runoff

Materials:
Water sampling kit
Secchi disk
3 or 4 hydrometer jars (optional)
Water (optional)
Soil, Sand, Clay, Rocks (optional)
Clock with second hand (optional)

Activity:
1) Attach a secchi disk to a calibrated line. Lower the disk into the water until it just disappears. Record the depth of water from the surface to the disk. If the secchi disk reaches the bottom before disappearing, the secchi depth is greater than the water depth and cannot be accurately measured. When this occurs, a notation must be added to the secchi depth reading in your data.
2) Slowly raise the disk until it reappears. Record this depth.

Discussion:
1. Very clear water, typically found in the open ocean, supports only sparse plant and animal life. With that in mind, what might low levels of turbidity indicate?
2. What environmental complications might be indicated by a high turbidity environment?

Extension:
1) Fill 3 or 4 hydrometer jars with water. To each jar, add a different type of sediment, for example, sand, rocks, clay or soil.
2) Mix the jars well and time how long it takes for the sediment to settle down below a predetermined point in the hydrometer jar.
3) Discuss the effects different types of sediment might have in the estuarine waters.

Salinity

Objectives: 1) You will be able to determine the salinity of a water sample by using a hydrometer.
2) You will understand how salinity affects when an object will or will not float in water.

Background: Salinity is the total of all salts dissolved in water. Salt water is more dense (heavier per unit of volume) than fresh water. Salinity is usually expressed in "parts per thousand" (ppt). In an estuary, the flow of fresh water from streams and rivers mix with salty ocean water, producing salinity ranging from 0 to 35 ppt. The salt content of water can cause currents and affect the distribution of animal and plant species according to the amount of salinity they can tolerate. Salinity may be calculated by measuring the specific gravity of a sample of water using a **hydrometer**, correcting for the effect of temperature and converting the readings to salinity by means of a salinity conversion table.

Words to Know:
Hydrometer
Meniscus
Refractometer
Specific gravity

Materials:
Water
Salt
Hydrometer jar
Hydrometer
Salinity conversion table
2 pans
2 eggs
Thermometer
Eye dropper (optional)
Refractometer (optional)

Activity:
1) Place two pans on a table, one filled with fresh water and the other filled with very salty water. Place an egg in each pan. Note what happens.
2) Fill the hydrometer jar with salt water and obtain a temperature reading. Remove the thermometer and place the hydrometer in the hydrometer jar.
3) Wait until the hydrometer stops bobbing. Be sure that your eye is even with the water level in hydrometer jar, not the **meniscus,** because viewing down or up at an angle can give an inaccurate reading. Read and record the specific gravity. Use the conversion tables that came with your hydrometer to determine the salinity of your sample.
4) Repeat this procedure with fresh water.

Discussion:
1. Why did the eggs behave the way they did when placed in the pans of water?
2. How might the different seasons effect the salinity of the oceans and the estuaries?

Extension:
1) After obtaining a salinity measurement from the hydrometer, use a refractometer to create a comparison between the two readings. Discuss how the readings may be similar or different.
2) Attempt to float or sink a variety of objects in salt water after making predictions of what will sink or float.

pH

Objectives: 1) You will be able to test the pH level of a water sample.
2) You will understand the dramatic effect the pH level can have on a waterbody.

Background: The pH test is one of the most common analysis in water testing. An indication of the sample's acidity, pH is actually a measurement of the activity of hydrogen ions in the sample. pH measurements run on a scale from 0 to 14, with 7.0 considered neutral. Solutions with a pH below 7.0 are considered acids. Solutions with a pH of 7.0 to 14.0 are considered basic. In a lake or pond, the water's pH is effected by its age and the chemicals discharged by communities and industries. Most lakes are basic when they are first formed and become more acidic with time due to the build-up of organic materials. As the organic substances decay, carbon dioxide forms and combines with water to produce a weak acid called carbonic acid. Large amounts of carbonic acid lower the water's pH A range of pH of 6.5 to 8.2 is optimal for most organisms. Most fish can tolerate pH values of 5.0 to 9.0. Rapidly growing algae or **SAV** remove carbon dioxide from the water during photosynthesis. This can result in a significant increase in pH levels. The pH of salt water is not as vulnerable as the pH of fresh water to acid wastes. This is because the different salts in sea water tend to **buffer** the water. Normal pH values in sea water are about 8.1 at the surface and decrease to about 7.7 in deep water. Shellfish and algae are generally more sensitive than fish to large changes in pH, so they need the sea's relatively stable pH environment to survive.

Words to Know:
SAV
Buffer
Reagent

Materials:
Water sample (freshly drawn)
LaMotte pH Colorimetric test
Chemical waste receptacle
Hand-held pH meter (optional)

Activity:
1) The pH measurement must be made in the field or from a freshly drawn sample. The pH of a bottled sample will quickly change due to biological and chemical activity in the sample container.
2) Using the LaMotte pH colorimetric test, rinse and fill two sample tubes with water to the mark. Cap one tube and use it as the blank.
3) To the second tube, add ten drops of the **reagent.** Cap the tube and invert gently several times to mix the solution.
4) Insert both tubes into the color comparator. Facing a source of natural light, match the sample color to a color standard.
5) The color corresponds with a number and that number will be the pH value of the sample.

Discussion:
1. Using a hand-held pH meter, compare the results with the wide range colorimetric pH test.
2. Use the topic of pH to discuss acid rain and the problems it causes in the Estuary and the surrounding region.

Oxygen in the Water

Objectives: 1) You will be able to use a test kit to measure dissolved oxygen in a water sample.
2) You will be able to determine if the dissolved oxygen level is reflective of a healthy system.
3) You will understand that it is possible to describe a process that you cannot see by taking measurements of dissolved oxygen in a water sample.
4) You will develop an understanding of how oxygen enters and exits the water.

Background: A large percentage of all the oxygen we breathe is manufactured by green plants. A total of three-fourths of the earth's oxygen supply is produced by **phytoplankton.** Oxygen is a necessary component of life to virtually every living creature on this planet. Commonly, we think of oxygen as being the air that surrounds us, but then how would aquatic creatures get the oxygen they need to survive? Oxygen gets into the water by **diffusion** from the surrounding air, by tumbling over falls and rapids, and as a bi-product of **photosynthesis.** The oxygen in water is dissolved oxygen. The two test kit procedures described below will yield results of varying degrees of accuracy. The LaMotte Oxygen in the Water Test Kit is a **colorimetric** test kit which allows for only a broad generalization of the level of dissolved oxygen in a water sample. The LaMotte Winkler-Titration Test Kit offers much more accurate results, in the range of 0.2 ppm (parts per million).

Words to Know:
Colorimetric
Diffusion
Phytoplankton
Photosynthesis

Materials:
LaMotte Winkler-Titration Test Kit
LaMotte Oxygen in the Water Test Kit
Bucket
Thermometer
Water sample
Chemical waste receptacle

Activity:
1) Obtain a water sample, ideally one that has just been pulled from the source under investigation. Follow the procedures as outlined below for the dissolved oxygen test kit selected:

LaMotte Wiikler-Titration Test
1. Rinse sample bottle 3 times
2. Obtain an air-tight sample by submerging the sample bottle fully under the water and slowly allowing the water to fill the bottle. Cap the bottle underwater.
3. When you are ready to do the test, uncap the sample bottle, making sure that the plastic cone from the cap stays in the cap (this displaces the proper amount of water to allow room for the chemicals that are about to be added to the sample. Please keep the plastic cone in the cap at all times).
4. Add **8 drops** of **Manganous Sulfate Solution** (pinkish solution) and **8 drops of Alkaline Potassium Iodide Azide Solution** (same size bottle, clear solution).
5. Cap the sample bottle and mix by inverting several times. A precipitate will form.
6. Place bottle in an undisturbed area and allow precipitate to settle below the shoulder of the bottle (approximately 5 minutes).
7. Add **8 drops of sulfuric acid** (clear solution with red cap).
8. Cap and gently shake until precipitate is completely dissolved.
9. Fill titration tube (glass bottle with the cap with the hole in top) to the 20 ml mark.
10. Fill the direct reading titrator (syringe) with **Sodium Thiosulfate.** When filling the direct reading titrator, the upper part of the black rubber stopper should be even with the zero mark. Make sure that there are no air bubbles in the column.

11. Insert the direct reading titrator into the center hole of the titration tube cap.

12. Add 1 drop of Sodium Thiosulfate and gently swirl the tube. Continue one drop at a time until the yellow-brown color is reduced to a very faint yellow. The term “very faint” is subjective. It is helpful to bring a piece of white paper with you to hold the sample up against to determine the “faintness” of the color.

13. Remove the titration tube cap, being careful not to disturb the plunger.

14. Add **8 drops** of **Starch Indicator Solution** and gently swirl.

15. Replace the titration tube cap.

16. Continue adding **1 drop** of **Sodium Thiosulfate** and swirling until the blue solution turns clear.

17. Read the test result where the plunger tip meets the scale. Record dissolved oxygen in parts per million (ppm) .

LaMotte Oxygen in the Water Test Kit

1. Collect the water sample as described above.
2. Fill the vial to overflowing with the water sample and cap underwater.
3. Add ***two*** **Dissolved Oxygen Tablets** and cap. The water will overflow the vial. Make sure that there aren’t any air bubbles in the sample.
4. Gently invert until the tablets have dissolved.
5. Wait 5 minutes for full color development.
6. Facing a source of natural light, hold the vial flat against the white section of the ColoRuler. Match the sample color to a color standard.
7. Record the oxygen level as zero, low or high.

Discussion:

1. How could overfertilization of water plants deplete the dissolved oxygen levels?
2. Overall, how would an algal bloom effect the environment? What would happen to the other life in the water?

Extension:

1) Obtain a dissolved oxygen meter, or readings from a meter and use the test kits to measure for accuracy.