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Connecting to the Standards Through Marine Science

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NEW JERSEY MARINE SCIENCES CONSORTIUM

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"Connecting To The Standards Through Marine Science"

ABSTRACT

It is the assertion of the Education Program at the New Jersey Marine Sciences Consortium (NJMSC) that marine and related environmental science topics represent a rich source of meaningful material for New Jersey's teachers as they seek to develop standards-based instructional strategies. By adopting and integrating the marine and environmental science programs and curriculum materials developed by the Education Program at the NJMSC into their own classroom plans, teachers could effectively begin realize the goals of the science standards for their students.

This project correlated this curriculum of the NJMSC to the standards. Plans were compared and revamped as necessary to be of maximum value to educators as they seek to implement the goals of the standards. Copies of these revamped plans are included in this document. For quick reference, this document also contains a matrix indicating NJMSC lesson plan titles as they correlate to the Cumulative Progress Indicators of the New Jersey Core Curriculum Content Standards which they address.

BACKGROUND

On May 1, 1996, the NJ State Board of Education formally adopted a set of Core Content Curriculum Standards in seven subject areas, including science. Twelve science content standards have been approved and these serve to establish a Science Curriculum Framework for New Jersey's schoolchildren. A brief synopsis of these standards can be found on the following page. The first five standards (5.1- 5.5) address the nature and process of science and apply to all disciplines, including marine and environmental science. The remaining standards (5.6 - 5.12) address specific, fundamental understandings in life, earth, physical, marine and environmental sciences. It must be understood that these standards are a framework for curriculum design, not a statewide science curriculum or a "how-to" teacher's manual. New Jersey's teachers must develop their own personal ways to implement the standards with their students.

Over the years, The Education Program at the NJMSC has developed a series of lesson plans and learning activities related to teaching marine science and coastal environmental issues. These plans have been field and classroom tested with students, teachers and the general public during pre-college education programs at the NJMSC and various professional development initiative including Operation Pathfinder, The Biology of the Hudson-Raritan Estuary and The New Jersey Statewide Systemic Initiative. A broad variety of topics, ideas and issues from fish anatomy to coastal erosion. Copies of these lesson plans and accompanying classroom and field activities have been disseminated to formal and informal educators involved in NJMSC programs, although on a limited basis.

This document seeks to prove that many of the NJ Science Standards can be met through the discipline of marine and environmental science using NJMSC Education Program lesson and activity plans. The plans are multidisciplinary, incorporating mathematics, technology, language and fine arts concepts. The NJMSC Education Program encourages all teachers to make the connection between marine and environmental science for their own uses. The plans will promote understanding, appreciation of and stewardship for the coastal and marine environment.

This document contains information on the science standards including a synopsis of their content, a correlation matrix and copies of standards-based lesson and activity plans that have been developed over the past seven years for use by the Education Program at the New Jersey Marine Sciences Consortium.

SYNOPSIS: NJ CORE CONTENT CURRICULUM STANDARDS FOR SCIENCE

5.1 All students will learn to identify systems of interacting components and understand how their interactions combine to produce the overall behavior of the system.

5.2 All students will develop problem-solving, decision-making and inquiry skills, reflected by formulating usable questions and hypotheses, planning experiments, conducting systematic observations, interpreting and analyzing data, drawing conclusions, and communicating results.

5.3 All students will develop an understanding of how people of various cultures have contributed to the advancement of science and technology, and how major discoveries and events have advanced science and technology.

5.4 All students will develop an understanding of technology as an application of scientific principles.

5.5 All students will integrate mathematics as a tool for problem-solving in science, and as a means of expressing and/or modeling scientific theories.

5.6 All students will gain an understanding of the structure, characteristics, and basic needs of organisms.

5.7 All students will investigate the diversity of life.

5.8 All students will gain an understanding of the structure and behavior of matter.

5.9 All students will gain an understanding of natural laws as they apply to motion, forces, and energy transformations.

5.10 All students will gain an understanding of the structure, dynamics, and geophysical systems of the earth.

5.11 All students will gain an understanding of the origin, evolution, and structure of the universe.

5.12 All students will develop an understanding of the environment as a system of interdependent components affected by human activity and natural phenomena.

New Jersey Science Standards												
NJMSC Lessons	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	5.10	5.11	5.12
Beach Profiling	✓	✓		✓	✓		✓	✓	✓			✓
Beach Zonation	✓	✓		✓	✓		✓		✓	✓		✓
Classification & Identification	✓	✓			✓	✓	✓		✓			✓
Fish Morphology	✓	✓			✓	✓	✓		✓			✓
Food Web	✓	✓			✓	✓	✓		✓			✓
Mapping the Ocean Floor	✓	✓		✓	✓		✓	✓	✓			✓
Nearshore Community Sampling	✓	✓			✓	✓	✓		✓			✓
Ocean Currents	✓	✓		✓	✓	✓	✓		✓	✓	✓	✓
Oxygen in the Water	✓	✓		✓	✓		✓		✓	✓		✓
Plankton	✓	✓			✓	✓	✓		✓			✓
pH	✓	✓		✓	✓	✓	✓		✓	✓	✓	✓
Salinity	✓	✓	✓	✓	✓	✓	✓			✓		✓
Seashells are Houses for Mollusks	✓	✓			✓	✓	✓					✓
Turbidity	✓	✓		✓	✓	✓	✓		✓			✓
Water Quality Monitoring	✓	✓		✓	✓		✓		✓	✓		✓

List of Lesson Plans

1) Beach Profiling
2) Beach Zonation
3) Classification and Identification
4) Fish Morphology
5) Food Web
6) Mapping The Ocean Floor
7) Nearshore Community Sampling
8) Ocean Currents
9) Oxygen In The Water
10) Plankton
11) pH
12) Salinity
13) Seashells Are Houses For Mollusks
14) Turbidity
15) Water Quality Monitoring

THE EDUCATION PROGRAM AT THE NEW JERSEY MARINE SCIENCES CONSORTIUM

BUILDING #22, FORT HANCOCK, NEW JERSEY 07732 (732)872-1300

Topic: BEACH PROFILING

Grade Level: K-12th

New Jersey Science Standards: 5.1, 5.2, 5.4, 5.5, 5.7, 5.8, 5.9, 5.12

Skills: Measuring, Observing, Configuring, Graphing, Referencing, Drawing Conclusions

Scope: Science, Math, Technology

Science Framework: The investigation of beach profiling can lead to the discovery of changes that occur on the beach due to natural phenomenon and human interaction.

Mathematics Framework: Mathematics is used as a cycle of investigation that is intended to lead to the development of valid ideas.

Technology Framework: Technology extends our abilites to cut, shape, or put together materials; to move things from one place to another; to reach farther with our hands, voices and senses.

Sequence: Spend at least 30 minutes at the beach measuring changes in the elevation of the beach from point to point (2 meters apart) on the beach.

Objectives: Students will be able to 1) Understand that waves, winds, currents shape the beach and redistribute thousands of tons of sand each day. 2) Identify storm and tide levels as well as how a beach is changing over time 3) Make and record observations 4) Graph the beach profile.

Materials: 2 inexpensive 2"x 1" x 2 meter (39.37" or about 40") wooden poles with measurement lines on them at intervals of ten centimeters from a zero point at eye level (four feet from the bottom is adequate). Data sheet, pencil, graph paper.

Activity: Students using a horizontal reference line on the 2 meter pole, take vertical measurements based on the horizon (where the ocean meets the sky). Standing 2 meters apart and starting at the base of the dunes, students move forward toward the ocean after each measurement of rate of change is sighted. Students then graph data to provide a visual representation of the beach profile.

Issue Statement: Waves, wind and currents shape the beach and redistribute thousands of tons of sand each day. Beach profiling can give an indication of how a beach is changing and provides a way of comparing these changes over time.

Background: Sand along New Jersey's shore comes from the mountains of the Northeastern

States. Rock is broken into pieces by the actions of water and wind. It is then carried by rivers and streams to the ocean to create sand deposits. These sand deposits are then carried up the coast by the longshore current to form the beaches that you see.

Key Vocabulary:

Littoral Drift - The movement of sediment by the longshore current. The littoral drift moves more than 370,000 cubic yards of sand per year along New Jersey beaches.

Longshore Current - A current located in the surf zone and running parallel to the shore in a northerly direction as a result of waves breaking at an angle on the shore.

Sand Dune - A hill or ridge of sand piled up by the wind. At Sandy Hook, seeds from birds planted vegetation which stabilized the shifting sands. As more plants grew, sand grains were blown across the beach and trapped. Repeated burials enhanced the formation of a primary sand dune barrier, thus reducing erosion by the ocean waves.

Barrier Flat - The area lying between the salt marsh and dunes of a barrier island, it is usually covered with grasses and forest.

Beach - Sediment seaward of the coastline through the surf zone that is in trasnport along the shore and within the surf zone.

Berm - In the summer the berm is low and wide. It is the beach on which beach-goers sunbathe and frolic. The winter berm is higher and narrower, as most of the sand moves underwater to create the bars. The reason for the shift is the change in wave action with the season.

Backshore - The part of the beach located above the mean spring high tide line and covered by water only during storms with extreme high tides. Also called the spray zone.

Foreshore - The part of the beach between the normal high and low tidal marks. Also called the intertidal zone.

Possible Extensions: While on the beach use collection bags to pick up trash found on the beach. Discuss how the trash got there and what can be done to improve the trash problem.

Make a collection of shells found on the beach and identify each one. In the classroom, use trays filled with sand to make models of the profiles found on the beach.

References:

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Topic: BEACH ZONATION

Grade Level: K-12th

New Jersey Science Standards: 5.1, 5.2, 5.4, 5.5, 5.7, 5.9, 5.10, 5.12

Skills: Applying, Classifying, Social Interacting, Identifying, Drawing Conclusions

Scope: Science, Math, Social Science, Technology

Science Framework: Working in small teams instead of individually, students ask and answer questions about their surroundings and share their findings with classsmates.

Mathematics Framework: Making observations, collecting and sorting using information gathered and problem solving skills. Math supports/informs solutions to problems/questions.

Social Science Framework: The gaining of knowledge through understanding human and environmental interactions.

Technology Framework: Humans have the ability to gather data, interpret findings and in turn develop ways of communicating ideas to others.

Sequence: Spend about 30 minutes at the beach. Identify the different zones of beach. Use small collection bottles to collect one sample of the sand at each zone: the base of the dunes, the berm, berm crest, and the foreshore area of beach.

Objectives: Students will be able to: 1) Distinguish the different zones of the beach by observation of characteristics. 2) Identify the areas where samples were taken. 3)Understand that zones of the beach respond to movements of the ocean. 4) Draw conclusions after making observations about the size of sand grain found in the different zones of beach.

Materials: a trip to the beach, 4 containers for collecting sand.

Activity: Students collect one sample from each of the different areas of beach: 1) Base of the dunes, 2) Berm, 3) Berm Crest, 4) Foreshore. Conclusions are drawn about the different size of sand grains found in each area.

Issue Statement: The beach is one of the earth's most dynamic environments. The beach, or zone of active sand movement, is ever changing and migrating, and we now know that it does so in accordance with the earth's natural laws. It is important to keep in mind that the beach extends from the toe of the dune to an offshore depth of 40 to 50 feet. Man interferes with the natural beach processes in all the zones by building structures such as homes, snow fences, jetties, groins, sea walls and by replacement of sand to the foreshore.

Background: The part of the beach on which we walk is only the upper beach. The natural laws of the beach control a logical environment that builds up when the weather is good, and strategically but only temporarily retreats when confronted by big storm waves. This system depends on four factors: wave energy, water level, the amount of beach sand, and shape of the beach. The relationship among these factors is a natural balance referred to as a dynamic equilibrium. When one factor changes, the others adjust accordingly to maintain a balance. When we alter the system, as we often do, the dynamic equilibrium continues to function in a predictable way, but in a way that often has repercussions for our use of the system. It is to our benefit, therefore, to understand how the natural shoreline system functions.

Key Vocabulary:
Dune - Winds blow sand inland during dry periods forming natural hills or mounds which are stabilized by dune grasses. Dunes are protection against excessive flooding during storm-driven high tides.
Berm - The portion of the beach from the base of the dunes to the berm crest. The place where people place their beach chairs and umbrellas.
Berm Crest - The highest part of the berm found just before the drop off to the ocean.
Foreshore - The portion of the beach exposed at low tide and submerged at high tide.
Backshore - The portion of the beach which extends from the normal high tide to the coastline.
Nearshore - The zone between the low tide shoreline and breakers.

Possible Extensions: While at the beach make observations of shore birds and document the species found. At the library do research on their nesting habits, path of migration, what they like to eat, etc. Make observations of the type of waves hitting the shore that day. Draw conclusions as to the type that cause the most erosion.

References:
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BUILDING #22, FORT HANCOCK, NEW JERSEY 07732 (732)872-1300

Topic: CLASSIFICATION AND IDENTIFICATION

Grade Level: K-12th

New Jersey Science Standards: 5.1, 5.2, 5.5, 5.6, 5.7, 5.9, 5.12

Skills: Classifying, Identifying, Organizing, Enumerating/Measuring, Observing, Developing concepts, Reading, Interpreting.

Scope: Science, Math, Art

Science Framework: Continuing to gain knowledge about how science operates is based on the classification of the entities or components of scientific systems into organized groups or units. These groups or units can then be referenced easily for further scientific investigation.

Math Framework: Sizes, numbers and proportions are important tools for classification and drawing inferrences about similarities and differences between variables.

Art: Through visual representation, relationships between real life entities and classification of real life entities can be documented.

Sequence: Spend at least thirty minutes on each activity. Discuss the importance of classifying organisms.

Objectives: Students will be able to 1) classify objects and organisms based on physical attributes; 2) identify objects and organisms; 3) create a Diagrammatic key; 4) use a taxonomic key.

Materials: A bag for each student containing ordinary household items (eg. straw, rubber band, screw, washer, eraser); an additional household item for each student that is not placed in the bag (eg. button); a bag of shells for each student (these can be collected from the beach by the students or supplied by the teacher); drawing paper; poster board; glue; colored pencils and/or magic markers; four or five different kinds of local marine or estuarine fish (these may be obtained by the students through a seining activity or from a local fish market; fish may be frozen and reused for this activity or for fish printing); a taxonomic key for the fish of the area.

Activity: Give each student a bag with ordinary household items. Instruct the students to divide their objects into two groups using any one observable characteristic and the other group not having the characteristic (eg. hard objects and objects that are not hard). Have the students repeat this procedure until each object has its own group. Have the students draw diagrams of how they classified their objects and draw a key (eg. Figure 1). Discuss the different ways the students grouped the objects. Ask the students to vote on which key is "correct", and discuss the concept that different ways of grouping are acceptable. Supply the students with an additional household item unlike any in the original set and ask them to classify it using their keys. Using the above items, the button would be classified as a washer if using the key in Figure 1. Have the students incorporate the button into their keys (eg. Figure 2), and discuss the possible need for modifying and expanding keys to include different objects. Have the students repeat the activity using seashells, and when their keys are complete, have them glue the seashells to poster board in the form of a dichotomous Diagrammatic key. Explain to the students that most keys are not pictorial like theirs, and supply them with a key to the local fish as well as some actual whole fish obtained from the fish market. Have the students start with the first key character and use the key to identify the fish by their Latin names (provide them with the common names, as well). Have the students write down the number of each step that they followed to identify their fish so that they can back-track if they make a mistake. Discuss the importance of using Latin names instead of common names (see Background).

Issue Statement: To understand and depict how organisms are related and how they differ from each other, methods of classification have been developed which group like organisms with like organisms. Humans classify organisms for future identification. If an organism can be identified and it has been studied, it is possible to associate the organism with the role that it plays in the environment. Also, if organisms can be identified, the number of different organisms in a habitat can be determined. Generally, a greater number of different kinds of organisms indicates a healthier environment.

Background: Systematics is used to classify plants and animals into organized groups. This is usually done using physical characteristics, presuming that organisms that look similar are similar. Once organisms are classified, and each organism is in a group by itself, organisms can be named, and a taxonomic key can be created. Usually keys are dichotomous, dividing organisms into groups of two at each step of the key. When organisms are named, they are given Latin names which usually describe their form or function and are used universally. This is because people speak many languages, and even people that speak the same language will call the same animal different things (eg. *Mya arenaria* is also called soft-shell clam, steamer, and squirt clam among other names). Using Latin names creates a universally understanding of which organism is being referred to. Each plant and animal has two names - a genus name and species name - just like we have a first name and a last name. The genus name is capitalized and comes first, the species name is lower case and comes second, and each name is either italicized or underlined (eg. *Genus species* or Genus species). There is only one organism for each species, but there can be many species for each genus (eg. *Etropus crossotus*, *Etropus microstomus*, and *Etropus rimosus* are three different kinds of flounder from the same genus). There are different levels of classification, and at each taxonomic level, organism groups are described on more specific and less general details until the species level is reached. This creates an hierarchical system of nomenclature and grouping organisms. Kingdom is the broadest category, and species is the narrowest category (Figure 3).

Key Vocabulary:

Systematics - The classification and study of organisms with regard to their presumed natural relationships.

Classification - The arrangement of anything into groups or categories.

Taxonomy - The system of nomenclature (naming) for plants and animals based on their orderly classification into groups.

Taxon - The name applied to a taxonomic group in a formal system of nomenclature.

Nomenclature - A system of naming. An international system of standardized New Latin names used in biology for kinds and groups of kinds of animals and plants.

Binomial nomenclature - The system of naming plants and animals by two names - a genus name and a species name.

Key - An aid to identification. An arrangement of the descriptive characters which define a group of objects, taxa, plants or animals and facilitates identification.

Dichotomous - Anything divided into two parts.

Possible extensions: See "Activity 1" and "Activity 2". Have students write a dichotomous key for each diagramatic key they have created. Have students use keys to identify plants, birds and invertebrates as well as fish. Once students determine the genus and species names of organisms, have them determine the Latin names of the larger groups that the organisms fall into (eg. The sea star *Asterias vulgaris* belongs to the family Asteriidae, which contains asteriid sea stars, the class Stelleroidea, which contains all sea stars and brittle stars, the phylum Echinodermata, which contains all animals that have radial symetry and surface spines, and the kingdom Animalia which contains all animals).

Suggested references:

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HIERARCHICAL SYSTEM OF CLASSIFICATION

KINGDOM

PHYLUM

CLASS

ORDER

FAMILY

GENUS

SPECIES

Other taxonomic levels include subphylum, subclass, superorder, suborder, superfamily, subfamily, and strain (within a species), but these are not used for most organisms. In plant taxonomy, the term *division* is uses in place of phylum.

HOW TO USE A TAXONOMIC KEY:

1) Many keys will provide pictures and diagrams to illustrate descriptions and indicate external features that one must recognize to be able to use the key. Study diagrams of anatomy first to become familiar with the terminology, and refer back to the diagram as necessary.

2) Start with the first couplet of the key and decide which set of characters describes the organism being identified (a or b).

3) Move to the next couplet as indicated at the end of the set of characters chosen, and repeat these steps until the organism has been identified.

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BUILDING #22, FORT HANCOCK, NEW JERSEY 07732 (732)872-1300

Topic: FISH MORPHOLOGY AND ANATOMY

Grade Level: K-12th

New Jersey Science Standards: 5.1, 5.2, 5.5, 5.6, 5.7, 5.9, 5.12

Skills: Reading, Classifying, Identifying, Defining, Observing, Inferring, Social Participation, Developing Concepts, and Drawing Conclusions.

Scope: Science, Math, Art

Science Framework: Scientific investigation requires the collection of relevant evidence. Logical reasoning and imagination are applied to devise hypotheses and explanations to make sense of the collected evidence.

Math Framework: The progression of experiences takes students from recognizing shapes as mere objects to recognizing the explicit properties of shapes. An understanding is developed of the relationship between form and function.

Art: Students gain perspecitives such as size, shape and design. They also visualize and conceptualize about images that can be identified.

Sequence: Approximately 30 minutes is spent doing Gyotaku (ghio-ta-koo) - the Japanese art of fish printing. Additional time is spent discussing fish morphology and anatomy at the teacher's discretion.

Objectives: Students will be able to 1) describe basic fish morphology; 2) identify the various parts of a fish; 3) relate structure to function; 4) draw inferrences about where and how fish might live based on its morphology.

Materials: Several different kinds of whole fish that demonstrate different shapes - we suggest a fluke, flounder, skate or ray, an eel, a sea bass, a spot, and a tuna, mackerel or bonito (these can be obtained from your local fish market, and are usually free as an educational tool; they can also be frozen and reused for this activity or for the marine animal identification activity); tempera paint; paint brushes (1 1/2 - 2 1/2" brushes seem to work best); colored markers; newsprint paper, construction paper or other kind of craft paper; newspaper.

Activity: Fish are washed and blotted dry, taking care not to remove scales. If frozen, fish will need to thaw before printing. Lay fish flat on top of newspaper. Brush a thin layer of paint on the exposed side of the fish. The best prints result from the least amount of paint while still attaining full coverage. Place a piece of newprint paper on top of the painted fish, and gently press paper down onto all parts of the fish. Lift the paper to reveal the print and place aside to dry. Do not wash the fish between prints. Often a fresh coat of paint is not necessary before the next print. Have students describe the shape of the fish used for their print, indicate the different parts of the fish that are visible on their print, and compare their print to prints which were made from other kinds of fish.

Issue Statement: Fish shape and anatomy determine how a fish moves, how fast it moves, and where and how the fish lives. Humans have learned from morphology how to better design things like submarines, torpedos, airplanes, automobiles and other things.

Background: Several features of an organism can indicate how it lives. For example, we know by the shape, color and eyes of a flounder that it lives on the sea bed and swims like a flying bird. Because its top is brown, it blends in with the ocean floor. Since it lives on and near the bottom, both eyes are on the same side of its head. Fish that are flat or depressiform like a skate or flounder flap their fins up and down to swim through the water in the same way a bird flaps its wings. Meanwhile, fish that are long and skinny or filiform like an eel slither through the water like a snake. Fish that have an oval or fusiform cross-section like a tuna are fast swimmers and usually live in open water. An oblong or compressiform shape like that of menhaden means the fish is built for quick bursts of speed over short distances. The shape of a fish's tail indicates how the fish moves as well. A rounded tail or a truncate tail like that of a killifish or minnow is good for maneuverability and short bursts of speed. This kind of tail is commonly found on fish in coastal embayments. A forked tail like that of a sardine is good for maneuverability and speed over longer distances. Lunate tails like those found on a swordfish are not good for maneuvering but allow for speed over long distances and are usually seen on fish in open ocean.

Key Vocabulary:
Anatomy - The separation of the parts of an organism in order to ascertain their position, relations, structure and function.
Morphology - The study of structure or form.
Operculum - The protective gill cover of a fish.
Lateral line - The row of sensory tubules along the side of a fish which allows it to sense pressure changes in the surrounding water. This can alert the fish to approaching predators or to changes in direction if the fish is traveling with a school.
Pelvic fin - The forward bottom fin of a fish which helps it to swim backwards, stay in one spot, or move up and down in the water.
Pectoral fin - The fin on the side of a fish which helps the fish swim backwards, stay in one place, or move up and down in the water. Also called the chest fin.
Anal fin - The rear bottom fin of a fish which helps the fish keep on a steady course and prevents roll over (gives balance).

Caudal fin - The tail fin of a fish which gives the fish thrust for moving forward and helps the fish steer left and right.
Dorsal fin - The fin on the back of a fish which helps keep the fish on a steady course and prevents roll over (gives balance).

Possible extensions: See "Activity 1" and "Activity 2." Have students use the diagram of the fish parts to lable the parts of the fish they printed. Have students use the fish morphology charts to label the shape of their fish and the fish's tail on their prints. Have students write a paragraph about their fish's habitats based on its shape and anatomy. There are actually eight different body morphologies. Those selected here provide the best instruction for the relationship between shape and function. For additional information on body shapes, consult Bond (1979).

Suggested references:
Bond, C.E. 1979. Biology of Fishes. Saunders College Publishing, Philadelphia. pp. 11-32.
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BUILDING #22, FORT HANCOCK, NEW JERSEY 07732 (732)872-1300

Topic: FOOD WEB

Grade Level: K-12th

New Jersey Science Standards: 5.1, 5.2, 5.5, 5.6, 5.7, 5.9, 5.12

Skills: Applying, Classifying, Constructing, Observing group interaction, Social participation, and Draw conclusions.

Scope: Science, Math, Social Science, Art

Science Framework: The importance of gaining knowledge of salt marsh life and how humans affect an environment.

Mathematics Framework: Animals and organisms can be classified by what they eat and what eats them, making generalizations. The amount of energy at any tropic level depends on how much energy is being passed on from lower trophic levels to higher tropic levels and the amount of habitat available to the organisms.

History-Social Science Framework: Understanding human and environmental interactions.

Art Framework: The use of abstract thought and generalization in projecting certain food chains collapsing because of land development and pollution.

Sequence: Spend at least 15 minutes, can be an indoor or outdoor setting, on a large table or grouped in a circle.

Objectives: Students will be able to: 1) Understand that marine animals are all inter-related by food, 2) Identify what happens if there is a break down in the food web due to anthropogenic effects (eg. pollution, overfishing, habitat destruction, etc.) 3) Demonstrate how they can play a role in reducing marine debris, 4) Identify the effects of humans to the salt marsh.

Materials: 100 feet of rope, 1 set of salt marsh species cards (attached.)

Activity: Students choose cards of salt marsh species and classify who eats whom by holding the rope that is passed to them. They draw conclusions of what would happen if some food chains are broken.

Issue Statement: The salt marsh is a fragile environment. The incoming tide carries organisms and nutrients that bring life to the salt marsh. Marshes filter pollution and other materials by deposition. Currents are slowed in the salt marsh. The area of the salt marsh is a tremendous food source for all living creatures. Humans affect the salt marsh through development of land and pollution.

Background: Salt marshes are a tremendous food source for all sorts of living creatures. Commerical fish and shellfish caught in the Eastern United States come from species that live at least part of their lives in the salt marsh.The larva of most marine organisms and small fish spend some time in the salt marsh. Salt marshes act like sponges absorbing storm water and help protect inland areas from flooding. The salt marsh is a rich food source for clams, oysters, crabs, birds, and small animals. Salt marshes act as rest stops for migrating birds. Within the salt marsh can be found varied food chains. Marine debris, land development, pollution comes from people.

Key Vocabulary:

Food Chain - The transfer of energy in the form of food from one organism to another.
Scavenger -An animal that feeds on dead animals it finds.
Filter Feeder - An animal that feeds by filtering water through its body.
Detritus - Tiny particles of decaying remains of dead plants and animals. It is an important food source for many marsh creatures.
Generalist - An organism that is adapted to using many different kinds of resouces in a fairly efficient way.
Specialist - An organism that is physically or behaviorally restricted to a specific habitat or food source.
Predator - An animal that lives by hunting and capturing other animals for food.
Prey - An animal that is pursued and eaten by a predator.
Producer - An organism that makes its own food. Usually the base of the food chain.
Consumer - An organism that feeds on plants and other animals.
Decomposer - an organism that breaks down the remains of dead organisms into simpler sůbstances. (Bacteria and Fungi)
Benthic -Living in or on the sea bed. Starfish, clams, worms, snails, and crabs are benthic organisms.
Pelagic - Living in the water column. Pelagic organisms can be either of the following:

Plankton - Microscopic plants and animals that are free floating and their movement is controlled entirely by ocean currents; an important food source in the tidal marshes.

Nekton - Larger free swimming marine organisms. Nektonic organisms include squid, fisdes, turtles, seals, and whales.

Possible Extensions: Sequence the cards from lowest level species on food chain up to highest. Make a diagram or pyramid of the findings to see at a glance who eats whom. Play a game with the children to see if they remember, for example, "If humans eat flounder, what do flounder eat?" etc. As the children get familar with the food web, have them use the cards pronouncing the species name by it's scientific name. After the food web activity have the children write what they can do to help lower marine debris and pollution.

References:

Synder, Mann, Brecht, Ludwig, Stasik. 1991. The Challenge of Discovery. Life Science. Teacher's Edition. D.C. Heath and Company Lexington, Massachusetts.

Schraer, Stoltze. 1993 The Study of Life. Biology. Teacher's Edition. Prentice Hall, Inc.

THE EDUCATION PROGRAM AT THE NEW JERSEY MARINE SCIENCES CONSORTIUM

BUILDING #22, FORT HANCOCK, NEW JERSEY 07732 (732)872-1300

Topic: MAPPING THE OCEAN FLOOR

Grade Level: 4th-12th

New Jersey Science Standards: 5.1, 5.2, 5.4, 5.5, 5.7, 5.8, 5.9, 5.12

Skills: Measuring, Observing, Configuring, Graphing, Drawing Conclusions

Scope: Science, Math, Technology

Science Framework: Mapping a simulated ocean floor can lead students to an understanding of how sailors and scientists used to make nautical charts, and how it is possible to measure and map something they cannot see.

Mathematics Framework: Mathematics is used to measure, calculate, and graph data gathered during the application of acquired information.

Technology Framework: Technology extends our abilities to cut, shape, or put together materials; to move things from one place to another; to reach farther with our hands, voices and senses.

Sequence: Spend 25 to 35 minutes taking measurements off the cooler bottom, 15 to 20 minutes graphing data, and 10 minutes to remove water and observe cooler bottom.

Objectives: Students will be able to 1) develop the understanding that scientists can map the bottom structure of underwater habitats, 2) understand that it is possible to describe something they cannot see through the collection and correlation of accurate data and 3) simulate how water body contours are mapped.

Materials: A large watertight Styrofoam cooler, a dark plastic bag, waterproof marker, water to fill the cooler, dark food coloring - blue or green, bricks, rocks, sand or gravel, two strings marked at 1 cm intervals with a waterproof marker, 2 metal nuts or washers, two meter sticks, data sheets for each pair of students, bucket or pan to bail out cooler.

NOTE: Preparing coolers.
1. Before class, write north, south, east, and west on the sides of the coolers so the students' maps will all have the same orientation.
2. Using the magic marker, draw lines one centimeter apart around the top of the cooler. Label with a, b, c's going north and south and 1, 2, 3's east to west across the cooler.

3. Modify and copy the attached data sheet to correspond to the size of the students' coolers.
4. Line the cooler with a dark plastic garbage bag and place a variety of objects (rocks, bricks, sand or gravel) inside the cooler to simulate a varied underwater terrain.
5. Once prepared, place the cooler on a table and fill with water and add food coloring.

Activity: This activity demonstrates the old fashioned method of measuring depth. Using a length of string weighted with a washer at one end, students take depth readings at predetermined coordinates by lowering the weighted string into the cooler until it touches the bottom surface. Coordinates are determined by laying the meter sticks across the marked cooler, perpendicular to one another. After the string hits bottom, it is then measured and the resulting figure is placed at the corresponding coordinate on the work sheet. Have students make at least fifteen measurements, entering data on the work sheet as it is gathered. When the students are done with the activity, select volunteers to record their data on a large map in front of the class. Draw lines that connect the points of common depth to make a contour map of the bottom for the entire class.

Issue Statement: Despite the fact that it is under water, the ocean floor can be mapped by scientists. Until recently, the depth of coastal waters, rivers, and lakes was measured by a weighted, marked line. Now depth sounders and sonar accomplish the same task more quickly and efficiently.

Background: Introduce the topic of underwater mapping by asking students how they might go about accomplishing this task. In the past, people lowered weighted, marked ropes into rivers, lakes and coastal waters to test depths. Inquire if the students regard this method as reasonable. How might early readings have been inaccurate? Today, sonar is used to determine bottom measurements. Sonar sends impulses of sound downward and measurements of depth are determined by the length of time it takes the sound impulse to travel to the water body bottom and bounce back again.

Possible Extensions: Ask students to make predictions about their cooler bottom topography based on the fifteen readings. Have the students connect the points of common depth, creating their own contour maps. When predictions have been completed, drain the cooler and allow the students to look in the cooler. Compare the cooler bottom to their prediction/contour map. Ask the students how they might have made a more accurate prediction/contour maps (gather more data).

Show students a nautical chart, as produced by the National Oceanic and Atmospheric Administration (NOAA). Discuss how the chart was produced and how it is used. For information on how to get nautical charts, please contact: NOAA Distribution Branch, N/C G33, National Ocean Service, Riverdale, MD 20737-1199, Telephone: (310) 436-6990.

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BUILDING #22, FORT HANCOCK, NEW JERSEY 07732 (732)872-1300

Topic: NEARSHORE COMMUNITY SAMPLING

Grade Level: K-12th

New Jersey Science Standards: 5.1, 5.2, 5.5, 5.6, 5.7, 5.9, 5.12

Skills: Classifying, Identifying, Defining, Enumerating/Measuring, Observing, Group Interaction, Social Participation, Communication, Developing Concepts, Investigating, Hypothesizing and Identifying Variables, and Drawing Conclusions.

Scope: Science, Math, Social Science

Science Framework: Scientific investigation requires the collection of relevant evidence. Observations and identifications are used to classify the evidence collected, draw inferrences about ecological relationships, and analyze the evidence collected for variations induced by environmental variation and human impacts.

Math Framework: Numbers and proportions are used to classify scientific data collected.

Social Science Framework: Students gain insight to human behavior and culture as well as how technology changes and influences the natural world.

Sequence: Spend at least one hour (may be longer depending on the number of students participating and the amount of data collected) at a shallow embayment. The amount of additional time spent on classroom activities is left to the teacher's discretion.

Objectives: Students will be able to 1) use a seine net; 2) identify organisms (plants and animals) in the nearshore community; 3) classify the organisms collected based on their morphology/physiology, where they live within the habitat, and their role in the community; 4) describe the community based on the number of each species and type of organism present; 5) compare the data collected with data collected from other years, other seasons, other locations, other habitats, at different stages of the tidal cycle, with different sampling gear, over a different size area; 6) hypothesize what would happen to the community sampled as a result of changes in environmental variables or the habitat due to natural causes or human impacts.

Equipment: One or more seine nets; two pairs of chest waders per seine net (opt.); one five- or six-gallon plastic bucket per seine net; field guides for identifying fish, invertebrates and algae.

Activity: Two students wearing chest waders walk through the water with the net stretched between them. When the students return to the beach, the sample is scooped up in the pocket formed by the net and placed on the beach. Organisms collected are identified, classified, and enumerated as they are placed in a bucket of water, and all observations are recorded on a data sheet.

Issue Statement: Many organisms utilize shallow water habitats, and the numbers and types of organisms that can be collected is dependent on many variables. One of these variables is the degree of human impact on the area. If shallow water habitats are disturbed either chemically or physically, there may be a decrease in the number of different organisms found and the abundances of each organism found. There may also be a change in the kinds of organisms found, and more stress tolerant species may replace the species normally found in the undisturbed community.

Background: Nearshore shallow water areas provide important habitat for many marine organisms. Salt marshes, seagrass beds and reefs, which are some of our most productive habitats, are found in shallow water. They provide shelter, food and niches for many different organisms, and harbor very diverse communities. In shallow nearshore areas, there is generally higher light and nutrient availability. Therefore, primary production is generally greater, which means there is more energy/food to be passed on to higher trophic levels (primary consumers, secondary consumers, etc.), There is also more biomass and/or are greater abundances of organisms at each higher trophic level. Because nearshore environments are used more by humans for recreation and development than any other aquatic environments, they are also most impacted.

Key Vocabulary:

Ecology - The study of plants and animals and how they interact with each other and their physical environment.

Pelagic - Living in the water column. Bluefish, tuna, dolphins and jellyfish are pelagic. Pelagic organisms can be either of the following:

Plankton - Microscopic plants and animals that live in the water column. They are free floating and their direction of movement is controlled by ocean currents.

Nekton - Larger free swimming organisms that live in the water column.

Benthic - Living in or on the sea bed or on submerged stationary structures.

Trophic level - One of the hierarchical strata of a food web characterized by organisms which are the same number of steps removed from the primary producers.

Feeding guild - A group of organisms that feed in the same manner or utilize similar resources. Types of feeding guilds include the following:

- **Producer** (autotroph) - An organism that obtains energy by making its own food.
- **Consumer** (heterotroph) - An organism that obtains energy by eating other organisms. The following are types of consumers:
  - **Scavenger** - An organism that feeds on dead animals.
  - **Herbivore** - An animal that eats plants.
  - **Detritivore** - An animal that eats detritus. Detritus is small pieces of decaying plant material.
  - **Omnivore** - An animal that eats plants and other animals.

Carnivore - An animal that eats other animals.
Predator - An organism that hunts and kills other animals for food.
Filter feeder - An organism that eats by filtering microscopic food items from the water.
Deposit feeder - An organism that feeds by ingesting sediment. The organic component may be digested, and the remainder just passes through the gut.

Biomass - The amount in weight of living matter.
Invertebrate - An animal without a backbone.
Vertebrate - An animal with a backbone.
Community - A group of plants or animals that live in the same area and interact with each other.
Dominant - Prevailing over the community in terms of biomass or numbers (could be a dominant species, a dominant feeding guild, or other type of classification).
Abundance - The numbers of organisms collected.
Diversity - The number of different things in a collection.
Species richness - The number of species in a community (sometimes called species diversity).
Species diversity - The number of species in a community and the relative proportions of their abundances.
Evenness - The relative proportions of the abundances of species in a community.
Habitat - A place where an organism lives. To sustain life, each habitat must have food, water, oxygen, shelter and space available to the organisms.
Niche - The role of an organism in a community.
A habitat is where an organism lives, and a niche is how it lives. For example, your workplace is your habitat and your job is your niche.

Possible extensions: See "Activity 1" and "Activity 2." Bring some organisms back to the classroom to maintain in a salt-water aquarium.

Suggested references:

Gosner, K.L. 1978. The Peterson Field Guide Series - A Filed Guide to the Atlantic Seashore from the Bay of Fundy to Cape Hatteras. Houghton Mifflin Company, Boston. 329 pp.
The Hook Book - A Guide to Common Marine Organisms of Sandy Hook. The New Jersey Marine Sciences Consortium, Sandy Hook, New Jersey. 174 pp.
Nybacken. Marine Biology: An Ecological Approach.
Robins, C.R., G.C. Ray and J. Douglass. 1986. The Peterson Field Guide Series - A Field Guide to Atlantic Coast Fishes of North America. Houghton Mifflin Company, Boston. 354 pp.

THE EDUCATION PROGRAM AT THE NEW JERSEY MARINE SCIENCES CONSORTIUM

BUILDING #22, FORT HANCOCK, NEW JERSEY 07732 (732)872-1300

Topic: OCEAN CURRENTS

Grade Level: 4-12th

New Jersey Science Standards: 5.1, 5.2, 5.4, 5.5, 5.6, 5.7, 5.9, 5.10, 5.11, 5.12

Skills: Measuring, Observing, Applying, Drawing Conclusions, Documenting

Scope: Marine Science, Earth Science, Social Science

Science Framework: Through observation of a model, students will observe the formation of currents which will lead to an understanding of density as it relates to water.

Social Science Framework: By understanding this aspect of physical oceanography, students will better understand the impact of human actions on the marine environment.

Background:
Currents are like giant rivers of sea water flowing through the ocean. Some flow on the surface, others move huge amounts of water deep in the ocean. An ocean current is capable of moving much more water than the widest river on land. Currents are fueled by winds moving over the ocean's surface, the earth's rotation, the sun's heat, and the gravitational pull of the sun and the moon. Winds are caused by the accumulation of energy generated by the sun onto the ocean. This energy causes warming, evaporation, and precipitation. The sun's heat is also distributed by horizontal surface currents and deep vertical currents. As an indirect result, the sun's heat causes an accumulation of energy which creates winds that, in turn, distribute heat over the ocean's and the earth's surface.

WIND DRIVEN CURRENTS

As winds push across the ocean, friction with the water creates waves. Winds that push up against waves are the driving force behind surface currents. Wind driven currents are mainly in response to prevailing winds, which are a product of planetary forces, rather than local forces. The prevailing winds blow according to paterns and are usualy from a constant direction.

TEMPERATURE DRIVEN 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 cold water is forced to the surface, it soon sinks down since it is heavier. Once sunk, the water or current 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 up and downwelling carries all sorts of interesting life with it including plankton and other marine creatures.

DENSITY DRIVEN CURRENTS

Like cold water, salty water is denser than fresh, so it sinks when it encounters fresh water. This is the case in Sandy Hook Bay which is an estuarine system. Fresh water from several rivers converge with salty, colder ocean water. The ocean water sinks, causing vertical currents that continuously mix the Bay's water. The currents keep Sandy Hook Bay constantly moving, carrying and supporting a myriad of marine organisms.

ACTIVITY: OCEAN CURRENTS

Purpose

To investigate how temperature differences in the ocean can cause currents.

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-colored pencils
Unlined paper

Activity

Background: You have just signed a contact with the publisher of children's books. You are to write an explanation of how the temperature of water causes currents in the oceans.
The publisher will use your explanation in an upcoming book about water on the earth to be used by first and second graders.
You decide to try an experiment that will help you visualize what happens when water with different temperatures interact.

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 very 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 observe to your drawing.
4. Think about how this experiment explains the flow of ocean currents. Think about the equator and the poles.

Conclusions

Now write a simple explanation of how the temperature of water is one cause for ocean currents. Since the book is intended for use by first and second grade students, try not to use big words. You may include a diagram of the earth if you think it will help.

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BUILDING #22, FORT HANCOCK, NEW JERSEY 07732 (732)872-1300

Topic: OXYGEN IN THE WATER

Grade Level: 4th -12th

New Jersey Science Standards: 5.1, 5.2, 5.4, 5.5, 5.7, 5.9, 5.10, 5.12

Skills: Observing, Measuring, Analyizing

Scope: Science, Math, Social Science, Technology

Science Framework: The investigation of dissolved oxygen will lead to an understanding of the importance to the ecosystem of maintaining a heathy dissolved oxygen level in a waterbody.

Mathematics Framework: Making observations, collecting samples and using information gathered and problem solving skills. Math supports/informs solutions to problems/questions.

Social Science Framework: The gaining of knowledge through understanding of human and environmental interactions.

Technology Framework: Humans have the ability to gather data, interpret findings and in turn develop ways of problem solving and imparting knowledge about the importance of healthy environments to the world.

Sequence: Approximately 20 to determine the dissolved oxygen content of a water sample using a test kit.

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

Materials: LaMotte Winkler-Titration Method Dissolved Oxygen test kit, LaMotte Oxygen in the Water test kit, bucket, thermometer, water sample, chemical waste receptacle.

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

LaMotte Winkler-Titration Test Kit

1) **Rinse** sample bottle 3 times.
2) Obtain an air-tight sample by submerging the sample the sample bottle fully under the water and slowly allow the water to fill the bottle and cap the bottle underwater.
3) Uncap sample bottle, making sure that the plastic cone from the cap stays in the cap. (this plastic cone displaces that 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 and cap with 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 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 **one 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 the **Starch Indicator Solution** and gently swirl.
15) Replace the titration tube cap.
16) Continue adding one **drop** of **Sodium Thiosulfate** and swirling until the blue solution turns clear.
17) Read the test results where the plunger tip meets the scale. Record as **ppm** (parts per million) dissolved oxygen.

LaMotte Oxygen in 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, just make sure that there are no 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.

Issue Statement: 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 what about aquatic organisms, how do they get oxygen?

Background: Dissolved oxygen is oxygen that is dissolved in the water. Oxygen gets into the water by diffusion from the surrounding air: aeration of water that has tumbled over falls and rapids, and as a bi-product of photosynthesis.

Introduce the topic of dissolved oxygen by telling the students that virtually 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 in the oceans.

Photosynthesis

In the presence of light and chlorophyll

Carbon dioxide	+	Water	--->	Oxygen	+	Sugar
(CO_2)		(H_2O)		(O_2)		($C_6H_{12}O_6$)

Dissolved oxygen levels can be depleted by organism respiration, increase of water temperature, excess of bacteria or aquatic animals in an area, or over fertilization of water plants fed by run-off.

It is impossible to determine exactly how much dissolved oxygen an organism needs to survive. What scientists do know is that if dissolved oxygen levels dip lower than 3 parts per million, even the hardiest of aquatic organisms die.

The two tests kit procedures described above 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 Dissolved Oxygen test kit offers a much more accurate result, in the range of 0.2 ppm.

Key Vocabulary:

Photosynthesis - The process by which green plants convert solar energy (sunlight) into needed chemical energy.

Run-off - The portion of water from rain or melted snow that flows over the land that ultimately reaches streams.

Possible Extensions: Obtain a dissolved oxygen meter, or readings from a meter and use the test kits to measure for accuracy.

References:

Cliff Jacobson. 1991. Water, Water, Everywhere - Water Quality Factors Reference Unit. Hach Chemical Company.

Gayla Campbell and Steve Wildberger. 1992 The Monitor's Handbook. LaMotte Chemical Company.

Methods for Water Quality Monitoring

Four Categories
water quality
sediment quality
biological resources
human health risks

WaterQuality
1. water column physical characteristics
2. water column chemistry

Sediment Quality
3. sediment grain size
4. sediment chemistry

Biological Resources
5. Plankton
6. Aquatic Vegetation
7. Bentic Infauna Community Structure
8. Fish Community Structure
9. Fish and Shellfish Pathobiology

Human Health Risks
10. Bioaccumulation
11. Bacterial and Vital Pathogens

We cannot look at part of our environment without regard for the whole. The bay relates to oceans as to land, air and space. Understanding the interconnectedness of the salt marsh to all things brings about the knowledge of how we play a part in contributing to the rivers, estuaries, bays, oceans, land, air, and space. The make up of the Hudson-Raritan estuary is only part of a bigger story. It is good to know about life in the estuary because it describes the physical, chemical, and dynamic characteristics of the water and its boundaries which mold and influence all life in them. To study this area is to know the rich biodiversity found here and to protect it for the future.

LaMotte Test for Dissolved Oxygen

I. Collecting the Sample

1) Take the dissolved oxygen sample bottle and rinse it out a few times with the water you'll be sampling.
2) Fill the bottle until it is overflowing. Tap out any air bubbles. Cap the bottle tightly underwater.
3) Open the cap and add 8 drops of Manganous Sulfate Solution, followed by 8 drops of Alkaline Potassium Iodide Azide. Cap and mix gently. A precipitate will form. Allow it to settle for two or three minutes.
4) Depending on the particular test kit used, you will either add a 1 gram spoonful of Sulfamic Acid Powder or 8 drops of a 1 M Sulfuric Acid Solution. The result is the same: The precipitate will dissolve and the sample will be fixed.

Note: At this point you can stop--The sample will no longer react to oxygen in the atmosphere. This allows you to take and fix many samples that can later be tested in the laboratory.

II. Testing the Sample

1) Fill the titration tube (glass container with a line on it and cap with a hole in it) to the 20 ml line with the fixed sample. If it is already a faint yellow, skip to step three.
2) Fill the direct reading titrator (it resembles a syringe) with Sodium Thiosulfate. Insert the titration tube cap. Add the solution one drop at a time until the yellow color becomes very faint.
3) When the yellow is very faint, remove the cap from the titration tube, being careful not to touch the plunger of the titrator. Add 8 drops of Starch Indicator Solution. The sample will turn blue.
4) Replace the cap with the titrator and continue adding the solution one drop at a time until the blue disappears. Read the scale on the titrator in parts per million (ppm) at the tip of the plunger, with each minor division equal to .2 ppm. If you run out of Sodium Thiosulfate, you can fill up the titrator again-- just remember to record the initial 10 ppm.

Catalog Numbers: (Most Kits)

Manganous Sulfate Solution 416-G	Alkaline Potassium Iodide Azide 7166-G
Sulfamic Acid Powder 6286-H	Sodium Thiosulfate 4169-H
Starch Indicator Solution 4170-G	Direct Reading Titrator 0377
Titration Tube 0299	Water Sampling Bottle 0688-DO

These numbers are on the materials if you cannot figure out what is what.

NEW JERSEY STATEWIDE SYSTEMIC INITIATIVE
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BUILDING #22, FORT HANCOCK, NEW JERSEY 07732 (732)872-1300

Topic: PLANKTON

Grade Level: K-12th

Skills: Collecting, Classifying, Identifying, Defining, Observing, Inferring, Developing Concepts, and Drawing Conclusions.

Scope: Science, Math, Art

Science Framework: Scientific investigation requires the collection of relevant evidence. Observations and identifications are used to classify the evidence collected and infer about ecological relationships.

Math Framework: Math provides a language for describing objects and events, to characterize relationships between variables and to argue logically.

Art: Students gain perspectives such as shape and structure. They also visualize and conceptualize about images that can be identified.

Sequence: Approximately ten minutes is spent in an embayment or area where there is no wave activity collecting a plankton sample (more time can be alotted as desired). Approximately one hour is spent in the laboratory observing the plankton sample through the microscope, and identifying and sketching organisms observed. Additional time is spent discussing plankton at the teacher's discretion.

Objectives: Students will be able to 1) collect plankton; 2) classify the various components of the plankton; 3) identify organisms in the plankton; 4) draw inferences about productivity and trophic transfer based on their sample.

Materials: A plankton net (this can be purchased or constructed); a collection jar with a lid; wash bottles; microscopes; plankton identification books; specimen drawing pages (sample page provided); colored pencils.

Activity: A plankton net with a jar at the end is tied to a structure such as a bridge or piling so that the current passes through the net. The net may also be towed through shallow water by hand, or deeper water by boat. A sample is collected for five minutes or longer if desired. Material that collects on the net is washed into the collection jar using sea water in a wash bottle. The sample is capped and brought back to the lab. In the lab, a few drops of well shaken sample are placed on a microscope slide under the microscope.

Students try to identify the organisms they see and draw labeled sketches of what they observe.

Issue Statement: Plankton are at the base of many marine and estuarine food chains. Detritus and phytoplankton provide energy in the form of food to many different primary consumers, and zooplankton provide energy for many secondary consumers. The amount of energy available to higher trophic levels depends on the amount of detritus and number of organisms in the plankton. The species composition of the plankton also can provide an indication of environmental health. The classic example is algal blooms associated with eutrophication, especially what are called "red tides". Other organisms may disappear as water quality deteriorates, and the number of species and total number of organisms found in the plankton may decline.

Background: Aquatic environments are essentially divided into domains, the benthic domain and the pelagic domain. Within the pelagic domain, there is nekton and plankton. Most plankton is microscopic plants and animals and larval forms of larger animals, but it also includes jellyfish and algae. The plankton has three components: detritus, phytoplankton and zooplankton. The amount of detritus in the plankton depends on how much dead decaying plant material is going into the water. The amount of phytoplankton in the water depends on light availability, the amount of nutrients available, and the relative proportions of nutrients available (nitrogen and phosphorous are usually the limiting nutrients). The amount of zooplankton in the water depends generally on the amount of phytoplankton and detritus available. Generally, all three components of the plankton are more abundant in coastal waters than the open ocean, and they are most abundant in estuaries and embayments which serve as nutrient traps. Nearshore environments also harbor more terrestrial and marsh plant material which supplies the detritus.

Key Vocabulary:

Marine - Of or pertaining to the sea.

Estuarine - Of or pertaining to estuaries. An estuary is a place where salt water and fresh water meet and mix.

Aquatic - Of or pertaining to water. The following are aquatic environments:

- **Benthic** - Of or pertaining to the bottom of a body of water.
- **Pelagic** - Of or pertaining to the water column. Within the pelagic environment there are:
  - **Nekton** - Animals such as adult squid, fish, and mammals that are active swimmers that can determine their position in the ocean.
  - **Plankton** - Organisms such as jellyfish, seaweeds, and microscopic plants and animals that passively drift or are weak swimmers and are not independent of the currents. The plankton has the following components:
    - **Detritus** - Dead and decaying organic material.
    - **Phytoplankton** - Plant plankton. The most important community of primary producers in the ocean.
    - **Zooplankton** - Animal plankton.
    - **Holoplankton** - Organisms that spend their entire life as plankton.

Meroplankton - Planktonic larval forms of organisms that spend their adult lives as nekton or benthos.

Food chain - The passage of energy materials from producers through a sequence of consumers.

Producer - An organism that makes it own food. Also called an autotroph.

Consumer - An organism that gets food from eating other organisms. Also called a heterotroph.

Productivity - The amount of organic matter synthesized by an organism within a given volume of habitat or in a unit of time.

Trophic transfer - The transfer of energy materials from one trophic level to the next.

Trophic level - A nourishment level in a food chain. Producers constitute the lowest energy level followed by organisms that eat the producers called primary consumers, then secondary consumers and so forth.

Eutrophication - The process by which a body of water becomes rich in nutrients either naturally or through pollution, and biological productivity is stimulated.

Red Tide - A reddish brown discoloration of surface water, usually in coastal areas, caused by high concentrations of microscopic organisms, usually dinoflagellates. It probably results from increased availability of certain nutrients for various reasons. Toxins produced by the dinoflagellates may kill fish directly; or large populations of animal forms that spring up to feed on the plants and detritus may use up the oxygen in the surface water to cause asphyxiation of many animals.

Possible extensions: See "Activity 1". Have students create a plankton book of their own by compiling their drawings. Discuss how longer spines, antennae, and cilia which they see on the organisms of their sample help keep the organisms suspended in the water. This can keep phytoplankton closer to their light source and zooplankton closer to their food source. Collect samples from different locations, at different stages of the tide, at different times of day, and at different times of year. Discuss when more plankton and more different kinds of planktonic organisms are observed and why this may be.

Suggested references:

Thurman, H.V. 1990. Essentials of Oceanography (3rd ed.). Merrill Publishing Company, Columbus. pp. 248-251.

Thurman, H.V and H.H. Webber. 1984. Marine Biology. Charles E. Merrill Publishing Company, A Bell & Howell Company, Columbus, Ohio. pp. 101-121.

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BUILDING #22, FORT HANCOCK, NEW JERSEY 07732 (732)872-1300

<u>Topic:</u> pH

<u>Grade Level:</u> 5-12th

New Jersey Science Standards: 5.1, 5.2, 5.4, 5.5, 5.6, 5.7, 5.9, 5.10, 5.11, 5.12

<u>Skills:</u> Measuring, Observing, Analyzing, Documenting

<u>Scope:</u> Science, Mathematics

<u>Science Framework:</u> The investigation of pH can lead to an understanding of how changes in the water's pH can affect aquatic life indirectly by changing other aspects of the water chemistry.

<u>Mathematics Framework</u>: At the High School level this is an opportunity to introduce the concepts of logarithms. The pH scale is logarithmic, so every one-unit change in pH actually represents a ten-fold change in acidity.

<u>Sequence</u>: Spend approximately 10 minutes to determine the pH of a water sample using a test kit or a hand-held pH meter.

<u>Objectives</u>: Students will be able to: 1) test the pH level of a water sample, 2) understand the dramatic effect the pH level can have on a water body.

<u>Materials</u>: Water sample (freshly drawn), LaMotte pH Colorimetric test, chemical waste receptacle, (optional hand-held pH meter).

<u>Activity</u>: 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.
Using the LaMotte pH Colorimetric test, rinse and fill two sample tubes with water to the mark. Cap one tube and use as the blank. Add to the second tube, ten drops of the reagent. cap tube and invert gently several times to mix the solution. Insert both tubes into the color comparator. Facing a source of natural light, match the sample color to a color standard. The color corresponds with a number and that number will be the pH value of the sample.

Issue Statement: 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 runs on a scale from 0 to 14, with 7.0 considered neutral. Solutions with a pH below 7.0 are considered acids, those between 7.0 and 14.0 are considered bases.

Background: In a lake or a 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 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 6.5 to 8.2 is optimal for most organisms. Most fish can tolerate pH values of about 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 fresh water's pH 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. Many shellfish and algae are more sensitive than fish to large changes in pH, so they need the sea's relatively stable pH environment to survive.

Key Vocabulary:
Buffer - A substance capable in a solution of neutralizing both acids and bases and thereby maintaining the original acidity or basicity of the solution.
SAV - Submerged Aquatic Vegetation
Reagent - A substance used in preparing a product because of its chemical or biological activity.

Possible Extensions:
Use a hand-held pH meter to compare results with the wide-range colorimetric pH test.

Use the topic of pH to lead into the topic of acid rain and the problems that are occurring in the environment due to acid rain.

References:
Cliff Jacobson. 1991. Water, Water, Everywhere - Water Quality Factors Reference Unit. Hach Chemical Company.
Gayla Campbell and Steve Wildberger. 1992. The Monitor's Handbook. LaMotte Chemical Company.

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BUILDING #22, FORT HANCOCK, NEW JERSEY 07732 (732)872-1300

Topic: SALINITY

Grade Level: 2nd-12th

New Jersey Science Standards: 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.10, 5.12

Skills: Measuring, Observing, Developing Concepts, Drawing Conclusions

Scope: Science, Math

Science Framework: The investigation of salinity will lead to an understanding of density.

Mathematics Framework: The skills of measuring are basic but can lead to the understanding of quantity.

Sequence: Spend at least 10 minutes determining the salinity of a water sample.

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

Materials: Water, salt, hydrometer jar, hydrometer, salinity conversion table, 2 pans, 2 eggs, thermometer, optional: eye dropper, refractometer.

Activity: Place two pans on a table, one filled with fresh water and the other filled with salt water. Place an egg in each pan. The egg should sink in the fresh water and float in the salt water. Why?

Fill the hydrometer jar with salt water and obtain a temperature reading. Remove the thermometer and place the hydrometer in the hydrometer in the hydrometer jar. Wait until the hydrometer has stopped bobbing around. Be sure that your eye is even with the water level in the hydrometer jar, not the meniscus, because viewing down or up at an angle can give an inaccurate reading. Read and record the specific gravity.

Open the salinity conversion table to Table 1 (LaMotte hydrometer instructions). Follow along the top row of the column to the temperature (C) of the water sample. Then follow down the Observed Reading row to the reading obtained from the hydrometer. Where the column and the row meet, this is the salinity reading for the water sample in parts per thousand (ppt).

Issue Statement: Salinity is the concentration of dissolved salts in water, usually expressed in "parts per thousand" (ppt). Objects float higher in salt water than fresh water because salt water is more dense (heavier per unit of volume).

Background: Salinity is the total of all salts dissolved in water, usually expressed as parts per thousand (ppt). In an estuary, the flow of fresh water from streams and rivers mixes with salty ocean water, producing a range of salinity from 0 to 35ppt. The salt content of water affects 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.

Oceans supply 97% of the Earth's water. The next 2% is frozen and the remaining 1% is found in rivers, streams, lakes, and groundwater.

Key Vocabulary:

Hydrometer - a floating instrument for determining specific gravities of liquids.
Specific Gravity - the ratio of the density of a substance to the density of some substance (like pure water), taken as a standard when both densities are obtained by weighing in air.
Refractometer - an instrument for measuring indices of refraction caused by the level of salts dissolved in the water.
Meniscus - the curved upper surface of a liquid column that is concave when the containing walls are wetted by the liquid and convex when not.

Possible Extensions:

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.

Attempt to float or sink a variety of objects and have students make predictions of what will sink or float.

References:

Gayla Campbell and Steve Wildberger. 1992. The Monitor's Handbook. LaMotte Chemical Company.

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BUILDING #22, FORT HANCOCK, NEW JERSEY 07732 (732)872-1300

Topic: SEASHELLS ARE HOUSES FOR MOLLUSKS

Grade Level: Pre-K - 3rd Grade

New Jersey Science Standards: 5.1, 5.2, 5.5, 5.6, 5.7, 5.12

Skills: Classifying, Identifying, Developing Concepts, Interpreting.

Scope: Science, Math, Art, Literacy, Fine Motor Skills

Science Framework: Understand that seashells are made by animals from the family Mollusca (mollusks). Mollusks need the shells they produce for support and protection, as well as to live in. The shell is actually an external skeleton or exoskeleton which grows along with the mollusk, just as our bones grow as we grow. There are seven classes of mollusk. Some do not produce shells, including the squid and octopus, while most others do. For classification and identification purposes our local seashells are divided into bivalves and univalves (gastropods). There are many varieties of seashells in each of these classes.

Mathematics Framework: Patterns and proportion are important tools for classification and drawing inferences about the similarities and differences between variables.

Art: Through artistic creation of a seashell as a house, children will symbolically understand the function of mollusks' shells.

Sequence: Read shell book for 30 minutes, showing students pictures and asking questions about what they see in the pictures. Your lesson should take approximately 30 minutes, so if there is a need, you may take a short break now. Discuss where shells come from (the mollusk makes its own shell), and the purpose of this shell. Relate this information to the origin and purpose of our house. Allow 30 minutes to do drawing activity. If you'd like to have each student discuss their picture after completion, allow an additional 30 minutes.

Objectives: Students will be able to: 1) understand the origin and purpose of seashells; 2) identify clams, scallops, snails, and whelks; 3) classify these seashells into univalves and bivalves based on physical attributes.

Materials: One or more sets of Posterboard shells (foam core board works well) for children or teacher to trace (masters of clam, scallop, snail, and whelk included in back of lesson plan), paper, scissors (optional), crayons or markers, set of real seashells to familiarize the students with and to pass around. Have at least four types of local seashells, for example: clam, scallop, whelk, snail. (These may be included in your science center), a book to read to your students (choose one from the list at the end of this lesson plan. Eric Carle's *House for Hermit Crab* is excellent.)

Activity: Read the book of your choice taking time to discuss the pictures and any words which may be new to your students. If you choose the book *House for Hermit Crab*, ask students where they think the shells the hermit crabs use come from. Take out real shells and tell students that the animal who originally lived in the shell made it as an exoskeleton, or external skeleton. When telling them that the name of this animal is a mollusk, you may ask them to say the word. Explain to them that a hermit crab is not a mollusk. It is a crab. (That can be another lesson!) Ask them where our skeletons are (inside of us) and what they do for us (support, locomotion, protection). Discuss the similarities and differences between our skeletons and those of mollusks (similar functions but ours is inside of us and a mollusk's is external). Show the students the different shells and see if they can observe the similarities and differences (shapes may be spiral or curved, etc.). Explain the words bivalves and univalves, also introducing the word gastropod. Ask if they know the name of each type of shell, then ask if it is a bivalve or a univalve.
Show the students the Posterboard (or already traced) shells, one at a time. Ask them which variety of shell each represents (bivalve or univalve). Explain that they may choose one shell, trace it (if you have not done this for them), and draw details on to the picture to make it look like a home. You may have them use crayons or markers for this activity. If you are going to let the children cut out their shells, let them know before they start or they may want to draw the environment outside of the shell. You may have a sample shell if you desire, however this may stifle their creativity. Sometimes students draw windows and doors to make their shells look like homes, other ideas work also. After all children have completed their drawings you may want to ask them to talk about their shell's home, although this is optional.

Issue Statement: As young children mature, they can understand the differences and similarities between their bodies and environment, and that of other animals, specifically in this lesson, the mollusk. This understanding can represent itself in many different forms, and each kind of life requires its own kind of habitat. Individual habitats must be protected for the life within them to flourish.

Background: Mollusks are invertebrate animals which belong to the phylum Mollusca. Their bodies are soft, and consist of a visceral mass which contains the internal organs, a fleshy muscular foot which is used for locomotion (crawling, swimming, or burrowing), and (included in all mollusks except bivalves) a head. The mouth, located on the head, is possibly placed at the end of an elongated organ called a proboscis. Often the sensory tentacles and eyes are located on the head also. The pharynx, or chamber the mouth leads to, usually contains a radula. This flexible, membrane-like ribbon structure consists of numerous closely set rows of minute teeth which are used in obtaining food. The radula are used as a file to rasp against food or to drill holes through other shells.

The main part of the body, the visceral mass, contains organs of respiration, circulation (heart), reproduction (gonads), digestion (stomach, intestines), and excretion (kidneys). The body wall surrounding the visceral mass in all mollusks is prolonged into a fleshy or sheetlike mantle. This mantle usually contains glands that secrete the shell, although certain mollusks as the squid and octopus (class: Cephalopoda) do not create shells for themselves. The mantle distinguishes mollusks from other shellfish as crabs, starfish, and shrimp.
The phylum Mollusca contains 100,000 species. These are divided into seven classes, four living close to the shore. These are: Gastropoda (snails), Bivalvia (two-shelled mollusks), Polyplacophora (chitons), and Cephalopoda (squids and octopi). Most mollusks are aquatic, breathing via gills, and live primarily in marine environments. There are also freshwater species, while some species have developed lungs and live on land.

Key Vocabulary:

Bivalve - Mollusks with two shells joined together at one side by a hinge. Strong muscles hold the two valves together tightly, except when the mollusk feeds or breathes. Bivalves usually live in the sea. Clams, scallops, oysters, and mussels are examples of bivalves.
Exoskeleton - External skeleton.
Gastropod - Mollusks with their shells in one piece. Also called snails. The shell is usually coiled in a spiral. The body is coiled inside. The mollusk may push its head or foot outside the wide opening which the shell has at one end, but the body remains protected inside. Snails, whelks, slipper shells, and oyster drills are examples of gastropods.
House - Shelter (protection), place to live. All life requires five elements: 1)shelter, 2)air, 3)food, 4)water, and 5)space. In other words, we could not live without some type of house or shelter.
Mollusk - Invertebrate animals (Phylum Mollusca) that in most cases produce seashells to house and protect their soft bodies.
Univalve - Gastropod.

Possible Extensions:

Look at the mollusk food chain (Bivalves are filter feeders that filter water or deposit feeders which filter dirt instead of water; gastropods are predators or grazers which eat algae off rocks), and the specific predators and eating habits of our four varieties of sea shells:

Clams: filter feeders with two tubes (one eats, one excretes) called siphons which can be found sticking out the side of the shell when they are in water. They eat microscopic plants (phytoplankton) and animals (zooplankton). Clams burrow quickly for protection, but move slowly on the surface. They are eaten by gulls, skates and rays, flounders, seals, octopi, moon snails, oyster drills, walrus, crabs (predatory crabs as green, blue sometimes rock), and humans (hard shell only).

Scallops: Their diet and predators are the same as clams, except scallops are fast swimmers so they are not caught by the drillers (moon snails and oyster drills).

Moon snails: This predator eats anything with a shell including clams, scallops, oysters, other moon snails, mussels, and slipper shells. Moon snails are eaten by birds, walrus, skates, rays, and sometimes crabs. It is a lot of work for the crab to get into the hard shell. Snails can loop their mantle over their shell to push oyster drills off. Basket snails, mud snails, marsh snails, and oyster drills are eaten by hermit crabs who then steal and use their shell.

Whelk: predators which eat bivalves including oysters, clams, mussels, and moon snails. They are eaten by humans, moon snails, crabs, crabs, octopi, clams, scallops oysters, mussels, and slipper shells.

Other activities may include identifying additional local shells, listening to the sounds produced by a whelk shell, sand casting, students writing or dictating their own shell stories, making mollusk paper bag puppets and putting on a puppet show, reading and/or writing related poetry (including finger plays), singing along with or creating related songs ("Under the Sea" from *The Little Mermaid*), and going on a shell walk then creating a pictograph from the number of each variety of shell found on the walk.

Suggested References

Teacher References:

Gosner, K.L. 1978. The Peterson Field Guide Series - A Field Guide to the Atlantic Seashore from the Bay of Fundy to Cape Hatteras. Houghton Mifflin Company, Boston. 329 pp.

Rehder, H.A. 1990 (5th printing). National Audubon Society Field Guide to North American Seashells. Alfred A. Knopf, Inc., New York. 894 pp.

The Hook Book - A Guide to Common Marine Organisms of Sandy Hook. The New Jersey Marine Sciences Consortium, Sandy Hook, New Jersey. 174 pp.

Student References:

Pre-K through 3:

Carle, E. 1987. A House For Hermit Crab. Simon & Schuster Books for Young Readers, New York. 28 pp. *(A fun story about a hermit crab decorating, then outgrowing his home.)*

Grades 2 & 3:

Coldrey, J. 1993. Shells. DK Publishing, Inc., New York. 61 pp. *(This nonfiction book is written in children's terms, but some vocabulary may need to be explained.)*

Zoefeld, K.W. 1994. What Lives in a Shell? Harper Collins Publishers, New York. 31 pp. *(This storybook discusses shelled mollusks as well as crabs and turtles.)*

Related Student References:

de Leiris, L. 1983. Shells of the World Coloring Book. Dover Publications, Inc., Mineola, New York. 46 pp. *(The publisher gives limited permission to copy the nicely detailed pictures of a variety of shells, many including the mollusk living in the shell. May be used in Pre-K through grade 3.)*

Hurd, E.T. 1962. Starfish. Thomas Y. Crowell Company, New York. 35 pp. *(This nonfiction book may be used for Pre-K through 3rd grade. It is written very simply, with nice illustrations.)*

Shebar, J. & Shebar, S.S. 1981. Animal Dads Take Over. Julian Messner, a Simon & Schuster Division of Gulf & Western Corporation, New York. 64 pp. *(This is a particularly good father's day book which explains very nicely how the male sea horse bears its offspring. Appropriate for Pre-K through Grade 3.)*

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BUILDING #22, FORT HANCOCK, NEW JERSEY 07732 (732)872-1300

Topic: TURBIDITY

Grade Level: K-12th

New Jersey Science Standards: 5.1, 5.2, 5.4, 5.5, 5.6, 5.7, 5.9, 5.12

Skills: Measuring, Observing, Developing Concepts, Drawing Conclusions

Scope: Science, Math

Science Framework: The investigation of turbidity will lead to the understanding of how the amount of suspended solids in the water column can affect the health of a system.

Mathematics Framework: The ability to take and record measurements, make accurate observations and draw logical conclusions can be an essential tool used every day but especially by scientists.

Sequence: Spend 10 minutes at a sample site lowing a secchi disk and obtaining a turbidity measurement.

Objectives: Students will be able to: 1) identify possible environmental complications that can be attributed to turbidity, 2) measure the turbidity in a waterbody.

Materials: Water sampling site, secchi disk, (optional: 3 or 4 hydrometer jars, water to fill jars, soil, clay, sand, rocks, clock with second hand).

Activity: Attach a secchi disk to a calibrated line, and lower the disk into the water until it just disappears out of sight. The depth (distance from the disk to the surface of the water) is recorded and the disk is slowly raised until it reappears. The depth is recorded again and the average of the two readings is recorded as the "secchi depth".

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.

Issue Statement: Turbidity or cloudiness in water is caused by suspended solid matter which scatters light passing through the water.

Background: There are many possible sources of turbidity. Most people think primarily of sediment, from disturbed or eroded soil, clouding the water. But microscopic plankton also contribute to high turbidity when their numbers are increased due to excess nutrients and sunlight. Apparent water color, microscopic examination and stream walk 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 absorb additional heat from sunlight, raising surface water temperature.

Moderately low levels of turbidity may indicate a healthy, well-functioning ecosystem in which plankton flourish at a reasonable level to form the foundation of the food web. High turbidity is an indicator of either runoff from disturbed or eroded soil or blooms of microscopic organisms due to high nutrient inputs. Very clear water typical of the open ocean supports only sparse plant and animal life.

Key Vocabulary:

Benthic - Bottom dwelling

Runoff - The portion of water from rain or melted snow that flows over the land that ultimately reaches streams, rivers, or ocean.

Possible Extensions:

Fill 3 or 4 hydrometer jars with water. To each hydrometer jar, add a different type of sediments, for example, sand rocks, clay, or soil. Mix well and time how long it takes for the sediment to settle down below a pre-determined point in the hydrometer jar. Discuss the effects the different types of sediment might have in the environment.

References:

Cliff Jacobson. 1991. Water, Water Everywhere - Water Quality Factors reference unit. Hach Chemical Company.

Gayla Campbell and Steve Wildberger. 1992. The Monitor's Handbook. LaMotte Chemical Company.

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BUILDING #22, FORT HANCOCK, NEW JERSEY 07732 (732)872-1300

Topic: WATER QUALITY MONITORING

Grade Level: 6th -12th

New Jersey Science Standards: 5.1, 5.2, 5.4, 5.5, 5.7, 5.9, 5.10, 5.12

Skills: Applying, Classifying, Social Interacting, Identifying, Drawing Conclusions

Scope: Science, Math, Social Science, Technology

Science Framework: Working in small teams instead of individually, students learn how to test water quality and share their findings with classsmates.

Mathematics Framework: Making observations, collecting information, testing water quality and using information gathered and problem solving skills.

Social Science Framework: The gaining of knowledge through understanding human and environmental interactions.

Technology Framework: Humans have the resources and knowledge to insure a healthy water quality for all environments.

Sequence: Spend at least an hour out in the field at a local water source. This can be a local pond or creek, salt marsh or ocean. The students will do a series of 4 activities related to water quality testing for salinity, dissolved oxygen, turbidity and pH.

Objectives: Students will be able to: 1) understand why scientists and environmental managers monitor water quality and aquatic resources. 2) provide information about the physical and chemical properties of their local waterbody. 3) gather information that is valuable to local officials.

Materials: Hydrometer, D.O. test kit (LaMotte Winkler - Titration Method Dissolved Oxygen), bucket, water sample, chemical waste receptacle, thermometer, Ammonia test kit, secchi disk, Hach pH test kit.

Activity: Students determine the salinity of the water by using a hydrometer. Next using a test kit, dissolved oxygen content will be determined. Using a secchi disk, a turbidity test will be preformed. Using a Hach pH test kit the water will be tested for the pH range.

Issue Statement: We cannot look at part of our environment without regard for the whole. The bay relates to oceans as to land, air and space. Understanding the interconnectedness of waterbodies to all things brings about the knowledge of how we play a part in contributing to the rivers, estuaries, bays, oceans, land, air, and space. The make up of a waterbody is only part of a bigger story. It is good to know about the ingredients that effect water quality because it describes the physical, chemical, and dynamic characteristics of the water and its boundaries which mold and influence all life in them. To study water quality is key to gaining knowledge about achieving a cleaner future with a healthy environment for all living things.

Background: Salinity is the total of all salts dissolved in water, usually expressed as parts per thousand (ppt). In an estuary, the flow of fresh water from streams and rivers mixes with salty ocean water, producing a range of salinity from 0 to 35ppt. The salt content of water affects 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. A hydrometer is a floating instrument used to determine specific gravities of liquids. Place the hydrometer in the hydrometer jar with your water sample. Wait until the hydrometer has stopped bobbing around. Be sure your eye is even with the water level in the jar. Viewing up or down or at an angle can give an inaccurate reading. Read and record the specific gravity. Use the salinity conversion table to get the salinity reading in parts per thousand.

Using the D. O. test kit you can determine the dissolved oxygen in the water sample. Knowing the dissolved oxygen level helps you to determine if the waterbody where you took your sample is a healthy system. The method described at the end of the lesson plan is straight forward, easy to follow and reads like a recipe.

Turbidity blocks the sunlight that is so vital to aquatic life. Turbidity also chokes fish, oysters, and other creatures whose gills are clogged by sediment. The suspended particles absorb heat from sunlight which warms the water, decreasing dissolved oxygen. Light penetration is important to aquatic habitats. Submerged plants need light for growth: the plants give off oxygen which helps keep the water environment healthy. Many animals depend upon these plants for food. Follow turbidity test procedures attached at the end of lesson plan.

Changes in the pH value of water are important to many organisms. Most organisms have adapted to life in water of a specific pH and may die if the pH changes even slightly. At extremely high or low pH values (9.6 or 4.5) the water becomes unsuitable for most organisms. Some species are sensitive to changes in the pH value, and may die if the pH changes are too great. Immature stages of aquatic insects and immature fish are extremely sensitive to pH values. Like the sample collected for the dissolved oxygen test, the water sample for the pH test should be collected away from the riverbank and below the surface. The sample must be measured immediately because changes in temperature can affect the pH value. See instruction sheet at the end of lesson plan.

Key Vocabulary:

D.O. - Dissolved Oxygen.

Hydrometer - A floating instrument used to determine the specific gravities of liquids.

Possible Extensions: If time permits do water quality testing for comparison at another site. Contact your local health department and report your findings. Start a program of regular water quality testing done over the course of the year, during different seasons, and after rain or storm events.

References:

The American Association for the Advancement of Science. 1993. Benchmarks For Science Literacy. Project 2061. Oxford University Press.

Harold V. Thurman. 1993. Essentials of Oceanography. Fourth Edition. Macmillan Publishing Company.

Dissolved Oxygen Test Instructions

1) Rinse the sample bottle three times. Obtain an air-tight sample by submerging the sample bottle fully under the water and slowly allow the water to fill the bottle and cap the bottle under water.
2) Uncap sample bottle, making sure that the plastic cone from the cap stays in the cap. This plastic cone in the cap displaces the proper amount of water to allow room for the chemicals to be added to the sample. Keep the plastic cone in the cap at all times.
3) Add 8 drops of Manganous Sulfate solution (pinkish solution) and 8 drops of Alkaline Potassium Iodide Azide Solution (same size bottle, clear solution).
4) Cap the sample bottle and mix by inverting several times. A precipitate will form.
5) Place the bottle in an undisturbed area and allow precipitate to settle below the shoulder of the bottle. (About 5 minutes.)
6) Add 8 drops of Sulfuric Acid (clear solution with red cap). Cap and gently shake until precipitate is completely dissolved.
7) Fill titration tube (glass bottle and cap with hole in top) to the 20 ml mark.
8) 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.
9) Insert the direct reading titrator into the center hole of the titration tube cap.
10) Add one 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.
11) Remove the titration tube cap, being careful not to disturb the plunger. Add 8 drops of the Starch Indicator Solution and gently swirl.
12) Replace the titration cap. Continue adding one drop of Sodium Thiosulfate at a time and swirl until the blue solution turns clear.

13) Read the test result where the plunger tip meets the scale. Record as ppm (parts per million) of dissolved oxygen.

Turbidity Test Procedure

1) Lower the Secchi Disk into the water.
2) Stop when you can no longer see the dish.
3) Pull the dish out of the water and see how deep it went into the water by measuremnts on the rope before it was out of view. Repeat the procedure. Average the two readings.
4) How many "knots" deep did it go? Record your answer.

Discussion

1. What factors contribute to turbity?
2. What happens to loose soil from construction sites?
3. What happens to the large population of plankton in summer?
4. What happens to the sediment from bare lawns and unprotected shorelines?
5. What happens when excess nutrients from run off cause the growth of algae?
6. Why is there usually higher turbidity in the summer than the winter?
7. What happens if underwater plants do not get enough light?

pH Testing Procedure

1) Rinse each test tube with the water sample. Gloves should be worn if hands need to be in contact with the water.
2) Fill both viewing tubes with sample water to the first line (5 ml mark).
3) Add 6 drops of Wide Range 4 pH indicator solution into one tube and swirl to mix. This is your prepared sample.
4) Place the tube of the prepared sample into the right opening (the one nearest the center) of the comparator wheel.
5) Place the other tube into the left opening.
6) Hold the comparator up to the light source (or sun). Rotate the wheel until the color on the wheel matches the color of the prepared sample.
7) When the colors match, the pH value of the sample can be read through the window.
8) Record the pH value.
9) Wash your hands.

Discussion

1. What can happen if there is a sudden change in the pH value of the water?
2. Why is it important to know the pH of the water?
3. What living things are very vulnerable to a change in pH?