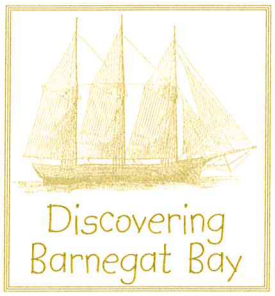
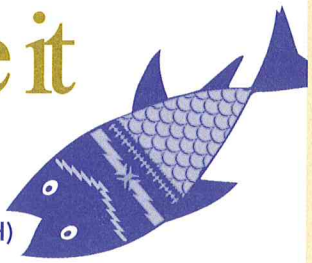


Some like it SALTY



(OSMOREGULATION OF FISH)

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Osmoregulation is the movement of water out of one area into another. The water moves in order to equalize the concentration of dissolved salts in the two areas. Water moves from the area with a lower concentration of salts to the area with a higher concentration of salts.

A river is a body of freshwater. The salinity, or amount of dissolved salt, in a freshwater habitat is usually near 0 parts per thousand (ppt). The body tissue of a freshwater fish is usually saltier than the fish's environment. Because of osmoregulation, water continually enters the fish's body through its skin and gills. Freshwater fish, therefore, have no need to drink water. In order to get rid of excess water, they produce large amounts of dilute urine.

The ocean has a salinity of approximately 35 ppt. A marine fish's body tissue is less salty than the ocean, so water continually leaks out of these fish. **To combat dehydration,** marine fish drink a lot of seawater, and produce small amounts of concentrated urine. In addition, their gills are adapted to secrete salt.

An estuary has a constantly fluctuating salinity, which is dependent upon the location within the estuary, the incoming and outgoing tides, and weather patterns. **Fish that live in any estuary must be able to adapt to fluctuations in salinity, and can move upstream (towards less salty water) or downstream (towards saltier water) if necessary.**

1 Objectives:

Students will be able to:

- **understand what salinity is and how and why the salinity of the Barnegat Bay Estuary is constantly changing;**
- **learn how certain fish are affected by changing salinities and their adaptation to tolerate this (osmoregulation).**

CORRELATION TO NJCCCS:

The correlations in this publication were done prior to 2002 utilizing the older standards from 1994.

SCIENCE:

5.2(1,2,4,5) 5.5.4, 5.5, 5.7, 5.8, 5.10, 5.12

Extension activities meet NJCCCS

for history and geography.

Subject Areas

Biology, Anatomy, Chemistry, Oceanography, and Geography

Duration

One hour for *Some Like it Salty...* extensions require additional time.

Setting

Activity is ideal for the classroom, but can also be done outdoors.

Skills

Problem solving, using scientific equipment, observation.

Vocabulary

marine, estuary, brackish, salinity, concentration, osmosis, diffusion, active transport, osmoregualtion, dilute, concentrated, semi-permeable, spring tide, neap tide, ebb, flood, dehydration, catadromous, andadromous.

2 Materials

- One small and one large Ziploc bag (or subsitute semi-permeable membrane for the small bag, if available),
- food coloring,
- a large pin,
- a bucket full of saltwater (can be made or taken from the ocean),
- a bucket full of freshwater (tap water is fine).
- Optional materials: a measuring cup.

3 Making Connections

This lesson is important for students to realize the chemical components of the Barnegat Bay and how it differs from seawater, and to appreciate and understand the adaptations of the fish that make the Barnegat Bay Estuary their home.

4 Procedure

WARM UP:

- Discuss the characteristics of the Barnegat Bay estuary, especially salinity.
- Discuss the types of animals found in the estuary and their adaptations for living there.
- Discuss osmosis in depth.

THE ACTIVITY

- Label the small bag "freshwater fish." You may also want to research the name of an actual freshwater fish that can be found in your area, such as a bluegill sunfish.
- Label the large bag "ocean."
- Color your freshwater with enough food coloring so it is very dark and distinguishable from the clear saltwater. The saltwater should remain clear.
- Fill the bag labeled "freshwater fish" with pre-colored freshwater and seal it.
- Into the bag labeled "ocean," pour uncolored salt water one-half way and seal it. You may also want to measure and record the amount of water you put into this bag for later comparison.
- Put your "freshwater fish" into the ocean. While it is floating in the water, use the pin to poke about thirty holes in the bag.

Note: If you used semi-permeable membrane instead of the plastic bag, you will not have to poke holes in it.

- Observe the movement of food coloring from one area to the other.

WRAP UP

Because there is more salt in the "ocean" than in the "freshwater fish," water should leave the fish and go into the ocean water. This will be easy to see because of the food coloring. If this had been an actual freshwater fish being placed in saltwater, the fish would lose so much water, it would shrivel up and die (much like putting salt on a slug). But fish that live in the estuary are able to adapt to salinity changes because these changes are gradual (not immediate like in our experiment) and the fish have the ability to move to a preferred salinity by swimming upstream or downstream.

ACTION

- Have students record their observations in a notebook and explain what happened. After they have seen the movement of the water, allow it to continue for a set amount of time (try 5 minutes). Then quickly remove the "freshwater fish." How much colored water did it lose? How quickly did it flow?
- Have students answer these questions in their notebooks.
- Have students draw diagrams explaining what they saw.
- Ask the students to hypothesize what would happen if a saltwater fish were suddenly placed into freshwater and draw a diagram of it in their notebooks.

5 Extensions

- Cattus Island County Park is a great location for field trips for Ocean County schools. There you can see some fish that live in the Barnegat Bay estuary and go seining to catch these fish with your class.
- A class could seine and measure salinity at different points in the estuary and record what types of fish are found in different salinities.
- Students can also practice using a

dichotomous key to identify fish that are common to the Barnegat Bay. Some fish they may want to begin with include: Atlantic silversides *(Menidia menidia)*, northern puffers *(Sphoeroides maculates)*, Mummichogs *(Fundulus heteroclitus)*, striped killifish *(Fundulus majalis)*, and sheepshead minnows *(Cyprinodan variegates)*.

- Students can also research (through typical media, local nature centers and museums, and commercial and hobby fisherman) the history of fishing on the Barnegat Bay and the species found here.

6 Resources Referenced

Barnegat Bay Estuary Plan (published report on the Barnegat Bay).

Biological Science: An Ecological Approach, Dubuque, Iowa: Kendall/Hunt Publishing Company, 1992.

Cunningham, William P. and Barbara Woodsworth Saigo, Environmental Science: A Global Concern, Dubuque, Iowa: Wm. C. Brown Publishers, 1995.

Project Wet: Curriculum and Activity Guide, Watercourse and Western Regional Environmental Education Council, 1995.

What kind of fish were they catching during the winter months in Toms River during the last century?

Photo Courtesy of: Ocean County Historic Society.

7 Additional Resources

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Ganeri, Anita. Why the Sea is Salty (and Other Questions About the Oceans). New York: Kingfisher, 1995.

Parker, Steve. Eyewitness Books:Fish. New York: Alfred A. Knopf, 1990.

Peterson Feild Guide to Freshwater Fishes. Page & Burr. New York: Houghton Mifflin Co., 1991.

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8 Stewardship Project Ideas

- As an extension of the above activity, each class of a school (or district) could seine the same area at even intervals (e.g. the last Friday of every month). These classes would record the types and amount of animals found and the salinities of those areas. By sharing the data from many classes over a period of time, students would see the status of the Barnegat Bay estuary's animals.
- Schools from different parts of the watershed could also seine the areas closest to them and create a map of the salinities and species they found. By sharing this information with other schools in the watershed, they could create a Barnegat Bay Habitat Map showing the salinity fluctuations and animal diversity throughout the Barnegat Bay Watershed.

The Osmotic Challenge

By Dr. Gale Jones

Estuaries are difficult places for plants to invade and grow due to the extreme variations in salinity. Because estuaries are areas where freshwater rivers and streams meet the sea, the mixture of salt and freshwater varies greatly with rainfall, water runoff, tides and currents.

Nearly all plants and animals require some moisture to carry out respiration, growth and reproduction. Controlling the amount of water that enters and leaves the living cell is a serious concern of all organisms. When materials enter or leave a cell without the use of any additional energy, this is known as diffusion. Diffusion is defined as the movement of molecules from an area of high concentration to an area of lower concentration. You may have experienced diffusion when you open a bottle of ammonia and begin to smell it across the room, or add tea to a glass of water.

When water diffuses, it is called osmosis. Osmosis of water occurs with the addition of energy – it happens because there is a higher concentration of water in one area than in another. If water is left standing in an open cup, it will evaporate, or diffuse out of the cup into the air. If celery is left standing in water, the water will move by osmosis into the celery. The water is moving from an area of higher concentration (the glass) to an area of lower concentration (the celery cells).

In living cells, it is also necessary to take into account the presence of salts in relation to the water. When you eat salty pizza, your body takes in extra salts. This causes you to feel thirsty, and you drink more fluid. The fluid moves by osmosis into your cells and dilutes your blood. This is accomplished not by actively moving water, but by actively moving salts. The salts are moved against the concentration gradient, requiring energy, and this is known as active transport. The water follows the salt movement by osmosis. For example, if you drank four liters of water, the water would diffuse into your body from your intestines. However, your body would not be able to use all this extra water and would have to expend energy, through active transport, to remove this water through the kidneys.

Estuaries are particularly hostile places for plants and animals to survive because of the osmotic challenges presented by the changing salinities due to the tides, currents and freshwater rivers. One hour the salinity may be high due to the high tides, and two hours later the salinity of the water may be greatly changed due to the outgoing tide and the incoming water from streams. Many plants and animals are unable to survive the wide range of salinities found in the estuary. However, some plants and animals have evolved remarkable adaptations to the changing conditions of the estuary. These organisms have been able to invade the estuary and use this special habitat to their advantage.