GETTING TO THE BOTTOM OF IT ALL

Background

Dredging is the process of removing sediments from the bottom of a water body in order to make it deeper. Additional depth in estuaries is usually needed to allow for commercial and or recreational water traffic such as oil tankers, other cargo ships, tour boats, ferries and larger power or sailboats.

The build up of sediments in an estuary is a natural process that is a result of weathering or erosion of the land due to rainfall. Rainfall carries small particles to streams and rivers, which delivers the sediments to estuaries such as Narragansett Bay. Stream flow allows the particles to be suspended in the fresh water. However when the particles reach the Bay the energy to keep them suspended is no longer present. Then gravity and density take over, and the sediments settle to the bottom where they collect. Over time they are eventually buried by the continuous delivery of new sediment from the watershed.

The pollution risk of dredging is generally not in the process of dredging the sediments, but with the disposal of the sediments. Sediments in bays located near populated areas often contain pollutants such as heavy metals from industrial processes in the watershed areas. Traditionally sediments dredged up are dumped somewhere else in the estuary such as bordering wetlands and deeper locations. Off shore locations have also been used. The process of dredging can allow the heavy metals to become free in the environment where they can affect living organisms.

Objective

In the following activity students will investigate how sediments build up in estuaries and why it might be necessary to dredge them. While it can be used as a demonstration, it could also be used as a group activity.

Materials

Water

Clear plastic trays
Short troughs (these could be rain gutters or PVC pipes cut in half lengthwise)
Buckets or jars
Sand, gravel, and soil
Small hand shovels or spoons

Procedure

Create an artificial watershed and estuary by placing a layer of gravel in the bottom of a clear plastic tray. Then cover the gravel with sand creating a slope up to one end of the tray. Finally cover the upper part of the slope with the soil. Add some water in it and a trough that will allow water to flow into the tray. Books or other objects can prop up the trough.

In a bucket, put water, sand or gravel, and a small amount of dirt so that after being shook or stirred much of the matter will be suspended in the water. (Too much dirt will cloud the water for an extended period of time and prevent quick observation.)

With the materials still moving in the water, pour some of the solution down the trough allowing it to flow into the tray.

After a few minutes, students will be able to make observations about the materials that were added to the water. Ask them to predict what will happen to these sediments when more particles enter the tray in a second pouring of water from the bucket.

Conduct a second pouring of the water from the bucket. Have the students record their observations now.

If the tray can be allowed to settle, then the students can use the shovels or spoons to “dredge” the material and place it a separate container representing the location the sediments might be moved to. What observations can be made during the dredging operation?

How does this activity relate to what happens in an estuary?

Follow up.

Using a map of any estuary, have students indicate where sediments are likely to become a problem. Discussion can follow and depending on the age of the students you can extend the lesson by considering the environmental and political impact of dredging.

EUTROPHICATION.

"UNDERWATER SUFFOCATION?"

Background.

Eutrophication is a process where a body of water like an estuary receives an influx in excess nutrients, especially nitrogen and phosphorus in forms that are easily taken up by plant life. Algae are small plant organisms found in most bodies of water (both salt and fresh). This influx of nutrients commonly results in an increase in algae. If the increase in algae is on a grand scale, it is usually referred to as an algal bloom.

The problems associated with algal bloom are multiple. Most importantly is how the amount of oxygen in the water is affected. Initially increased photosynthetic activity will result in an increase in oxygen. However as algae die and begin to sink in the water column, bacteria will start the process of decay on this organic material. As a result, large amounts of oxygen are removed from the water. All the organisms that require oxygen for respiration are then affected. During this time when oxygen levels decline, certain thresholds will be passed that will cause a die off of organisms sensitive to declining oxygen content.

Secondly, algal blooms also reduce clarity. A reduction in clarity can have a negative effect on macroscopic plant forms lower in the water column by reducing the amount of light reaching them. This would reduce their ability to photosynthesize.

Thirdly, some algae have been observed to release toxic compounds that impact organisms that consume them directly, or organisms up the food chain.

Objective.

The objective is to observe how the addition of nutrients to a body of water will affect oxygen content organisms. Following the activity students will be able to explain the affect of the addition of nitrogen and phosphorus to an estuary.

Materials.

Five jars (per group)
Grease pencils (or masking tape and pencils)
Marine sand and seaweed (or pond mud and plants)
Seawater (or pond water)
Nitrogen (in a soluble form)
Phosphorus (in a soluble form)
Dissolved oxygen kits (appropriate for student age level)

Procedure.
Start by labeling five jars A through E.

Add some seaweed and marine sand (or pond mud and plants) to the jars.

Pour the sea or pond water into the five jars.

Take a measure of the dissolved oxygen in the control samples of sea or pond water and record on a data table.

Following the quantities listed on the data table, add nitrogen and phosphorus to the jars. (Teachers may want to mass the quantities shown in the table ahead of time and change the instruction to mass units to reinforce lab skills.)

Place the jars in a sunny location or under grow lights.

Over the period of a couple of weeks, make and record observations.

Once each week, take a measurement of the dissolved oxygen in each jar and record.

Sample data table:

JAR	ADDITIVE	WEEK 1 Observations	WEEK 2 Observations	WEEK 3 Observations
A	Control			
B	_ tsp. nitrogen fertilizer			
C	_ tsp. nitrogen fertilizer			
D	_ tsp. phosphorus detergent			
E	_ tsp. phosphorus detergent			

Follow up.

Students should record quantitative and qualitative observations throughout the time of the activity. After several weeks the results can be discussed. What are sources of these nutrients in Narragansett Bay or estuaries in your own area? Should anything be done about controlling these sources? This activity can be concluded with a simple lab report or be incorporated into a larger project report about pollution.

This would be a good point to talk about sewage treatment plants and what they don't take out of the sewage (nitrogen and phosphorus).

WATER QUALITY.

"IS IT SAFE TO SWIM?"

Background.

Pollution is change in the estuary environment that has a negative impact on any of the living things in the estuary. The quality of an estuary can be measured by a variety of criteria. These might include the diversity of biota, or chemical properties such as the amount of dissolved oxygen, nitrogen, or phosphorus. It might also be judged by the presence of toxic substances. Another measure for quality is the amount of coliform bacteria present in a sample of the water. Although elevated coliform itself may not be a problem, it is indicative of the presence of other bacteria that do present health problems.

The source of pollution in an estuary can be difficult to pinpoint. Often there are multiple sources such as sewage treatment facilities, industrial waste, and the runoff of excess fertilizers or pesticides from agricultural areas in the watershed. This combination of potential sources makes it difficult for those groups charged with monitoring water quality to be fully effective.

The following activity is designed to be an Internet activity using the DOEE site along with links to other sites concerned with estuary quality and pollution. Some sites are being developed that will report real-time (or nearly real-time) data of factors that affect Narragansett Bay. This

activity does use some specific dates in the past on these web sites in order to facilitate the lesson. It is recommended that the links be checked before the students use them in order to determine if more recent data could be useful to the teacher's objectives.

This activity is designed for grades 7-10 but can easily be extended for older and more capable students, or modified for use with students with learning differences.

Objective.

The purpose of this activity is to allow students to research current data available about an estuary (Narragansett Bay). It is presumed that students have learned about the basic causes of pollution prior to starting this activity.

Upon completion, students should be able to distinguish which sections of Narragansett Bay are polluted and not to be used for swimming. Further, they will be able to justify their response.

Procedure.

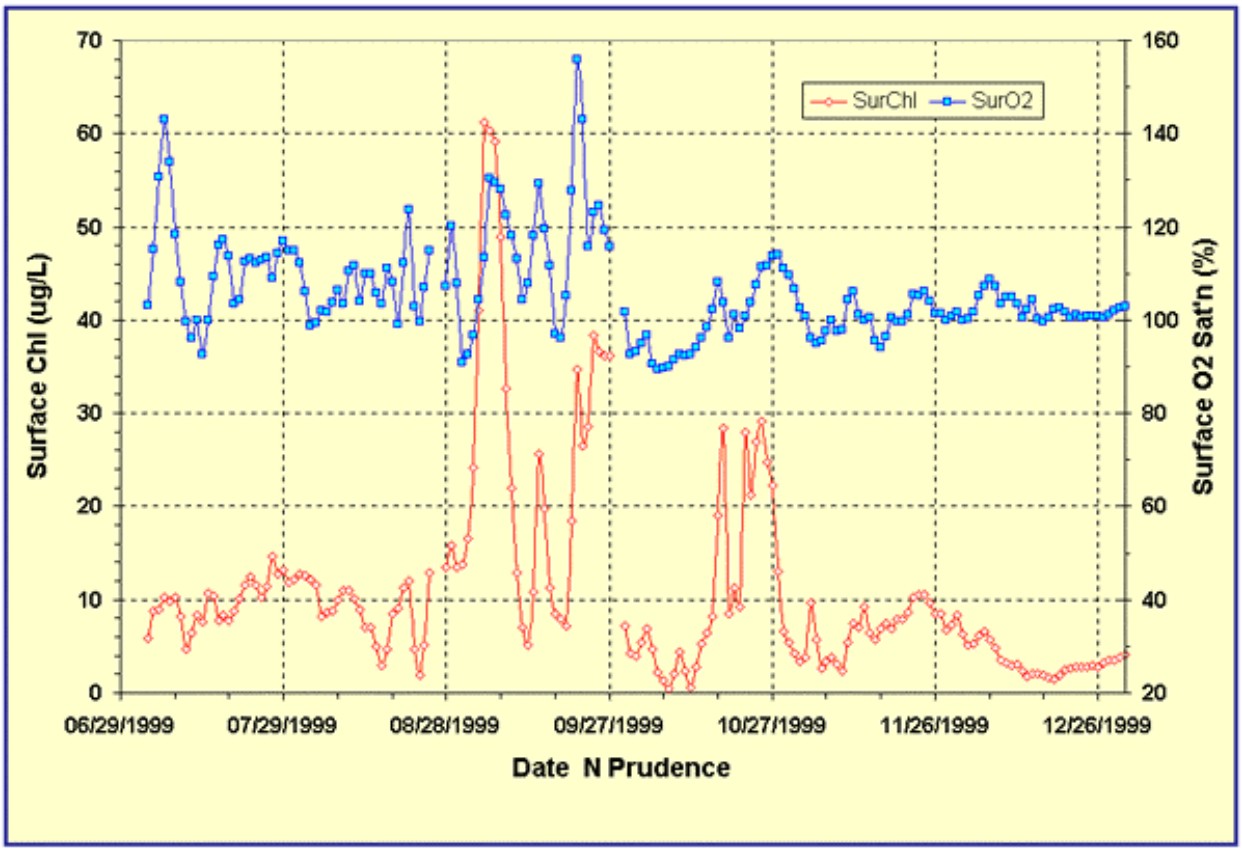
Go to the Department of Environmental Management web site and review what sections (if any) of the Bay are closed to shell fishing at this time. Many species of shellfish are known as filter feeders and as a consequence they often contain pollutants that are present in their habitat. Areas of an estuary that are closed for shell fishing are sure signs that the water there is a problem area.

Use the address: www.state.ri.us/dem/topics/index.htm
Select "water", then "shellfish". When the next screen appears, go to the right side and select "Narragansett Bay and Kickamuit River".

From the graphic, what observations can be made about the location of closures in the Bay?

Why would some areas be closed seasonally? When and why would they be closed?

It has been determined that at times when the quantity of chlorophyll and dissolved oxygen increase sharply, the likely cause for this is a bloom of algae in the surface waters. Look at the graph below which shows some results for surface chlorophyll and dissolved oxygen for part of 1999. This data is from research done by Dr. Dana Kester at the Graduate School of Oceanography at the University of Rhode Island.



Graph 1. Surface chlorophyll and dissolved oxygen for the South Prudence buoy.

At what times, if any, does it appear that blooms may have occurred? (If any, give approximate dates.)

Explain if there is a relationship between the line for surface chlorophyll and the line for surface oxygen.

When a bloom does occur in an estuary, what are the likely causes for the growth in chlorophyll and photosynthetic activity?

Let's see how other parties present similar information in a different format. Go to the Narragansett Bay Organization web site: http://www.narrbay.org/nushuttle/july12/july12.htm. This site shows a map of Narragansett Bay with various points labeled with abbreviations. Review the site names and note where in the Bay they are located. Choose the July 12, 2000 data and view the graphics shown. Select cross sectional profile of chlorophyll and oxygen.

At which points in the Bay are chlorophyll and oxygen levels high on this day?

How does this data for a day in 2000, compare with results that you saw in Dr. Kester's site for time periods in 1999?

Various agencies are responsible for monitoring water quality at beaches to determine if the water is clean enough to be used for swimming. The amount of fecal coliform present in samples is usually the deciding factor in a closure of a particular beach.

Visit the web site www.health.state.ri.us/beaches/index.html.
Select Rhode Island's licensed bathing facilities and water quality data.

Click on the letter "O" which will allow you to choose Oakland Beach.
Select "What do these samples mean?"

Briefly describe the sampling process.
What are the water samples tested for?
What is the maximum amount of CFU's considered acceptable for salt water in Rhode Island waters?

Return to the Oakland Beach table. Describe the results for Oakland Beach for the 2000 swimming season.

Specifically, when would you decide not to go swimming at this beach?

Return to the page with the alphabet, select “N” and look at Narragansett Pier Beach and also “S” for Scarborough North. Review both of these for their results from 1996-2001. Note where these are located in the Narragansett Bay area estuary. How do these beaches compare with Oakland Beach?

Follow up.

Have the students describe where on a map of Narragansett Bay they would choose to swim. Why would they choose these areas? Students could be assessed by giving them data in table or graph form along with other information about a real or fictional estuary. They could then justify their decision to swim there or close the area to swimming, and perhaps shellfishing.