

QUESTION OF THE WEEK:

Why are local beaches sometimes closed to shellfish harvesting and swimming?

INTRODUCTION:

In a one-inch rainstorm, every acre of land receives 27,000 gallons of water. Where does it all go? Into streams, rivers, lakes, ponds, and the ground, eventually making its way into marine waters. Along its path, this water picks up pollutants from the air and ground, carrying those pollutants into our local waterways. A 2000 survey by the US Environmental Protection Agency found that 40% of rivers and 45% of lakes in the United States are considered too polluted for shellfish harvesting, fishing, swimming, or aquatic life.

Commercial shellfish harvest is banned along many beaches on the east side of Puget Sound from Everett to Tacoma. Growing numbers of beaches along relatively pristine Hood Canal are also being closed to commercial and recreational shellfish harvest. Swimming, diving, water skiing and other recreational uses of lakes and the Sound are also restricted at times in specific locations. For example, it is not uncommon for Matthews Beach, the popular swimming beach along Lake Washington, to close for several weeks each summer. Such restrictions result when state regulatory agencies deem the water quality unsafe for human activity or consumption. The Washington State Department of Health and the Department of Ecology monitors the water quality of our local beaches.

How is water quality determined? Measuring chemical variables and bacterial abundance has been the traditional approach to water quality assessment. Regulatory agencies assess water quality by measuring a set of parameters. Common parameters include bacterial abundance (fecal coliforms), pH, alkalinity, nutrients, dissolved oxygen, turbidity (suspended sediment), and toxic substances.

What are dangerous effects of fecal contamination? Enteric viruses (those present in fecal matter) have extremely high infection potential in humans. Enteric viruses have been shown to survive up to 130 days in seawater and up to 90 days in oysters. Non-selective filter feeding by shellfish concentrates pathogens (and anything else suspended in the water). Generally, these bacteria do not harm the shellfish. However, when people eat raw or undercooked shellfish, they are exposed to the pathogens concentrated in the shellfish meat, and may develop illnesses or disease. Hundreds of cases of shellfish transmitted hepatitis are reported every year.

What are coliform bacteria? Coliform bacteria are a collection of mostly harmless bacteria that live in large numbers in the intestines of humans, as well as other warm- and cold-blooded animals. They are essential to good health and digestion. Fecal coliform bacteria are a subgroup of coliform bacteria, and their most common member is *Escherichia coli* (*E. coli*). Fecal coliform bacteria are distinguished among the total coliform group by their ability to grow at higher temperatures, and they are associated only with the fecal material of warm-blooded animals. High coliform concentrations indicate contamination with fecal matter, and correlate with disease carrying viruses dangerous to humans such as those that cause hepatitis, polio, typhoid, salmonella, cholera, and yellow fever. Such viruses are called pathogens and are derived from human gastrointestinal tracts and released to the environment with sewage waste. Because so many pathogens exist, and can be difficult to detect, scientists do not monitor all of them directly. Instead, the total concentration of fecal coliform bacteria is measured as an indicator. The presence of fecal coliform bacteria in aquatic environments indicates that the

water has been contaminated with fecal material from man or other animals, and poses a potential health risk.

Although pathogens do not behave exactly the same as fecal coliforms, federal and state regulatory agencies measure them because they are easy to isolate and cheaper to quantify. The regulatory agencies make the assumption that dangerous pathogens are transported, accumulated and released by shellfish to the same extent as the fecal coliform bacteria. Scientists know that pathogens and fecal coliforms do not behave exactly the same in the aquatic environment, but still make this assumption because we lack a better approach.

What are sources of fecal contamination? Fecal coliform bacteria may occur in water as a result of overflow of domestic sewage, or nonpoint sources¹ of human and animal waste. The amount of sewage derived pathogens in water and shellfish changes seasonally as a result of rain (and resulting runoff) patterns. Large wastewater treatment plant discharges are merely the most obvious possible source of sewage contamination to intertidal zones. Wastewater treatment plants disinfect our wastewater unless rain is heavy enough to cause overflow.

Fecal coliform also enters Puget Sound from numerous smaller, more diffuse and harder-to-regulate sources. Improperly sited or failing septic tank systems on numerous waterfront properties are major sources of sewage to beaches in WA state, and are difficult to regulate. Heavy rainfall often leads to high amounts of fecal waste entering local waterways from dairies and small farms. High bacterial counts have also been measured during areas with heavy pleasure boat traffic, due to improper discharges of untreated human wastes.

Where do regulators draw the line? Areas used for commercial harvest of shellfish are closed if fecal coliform bacteria are detected in excess of 230 bacteria colonies per 100 grams of shellfish tissue, or 14 bacterial colonies per 100 ml of water.

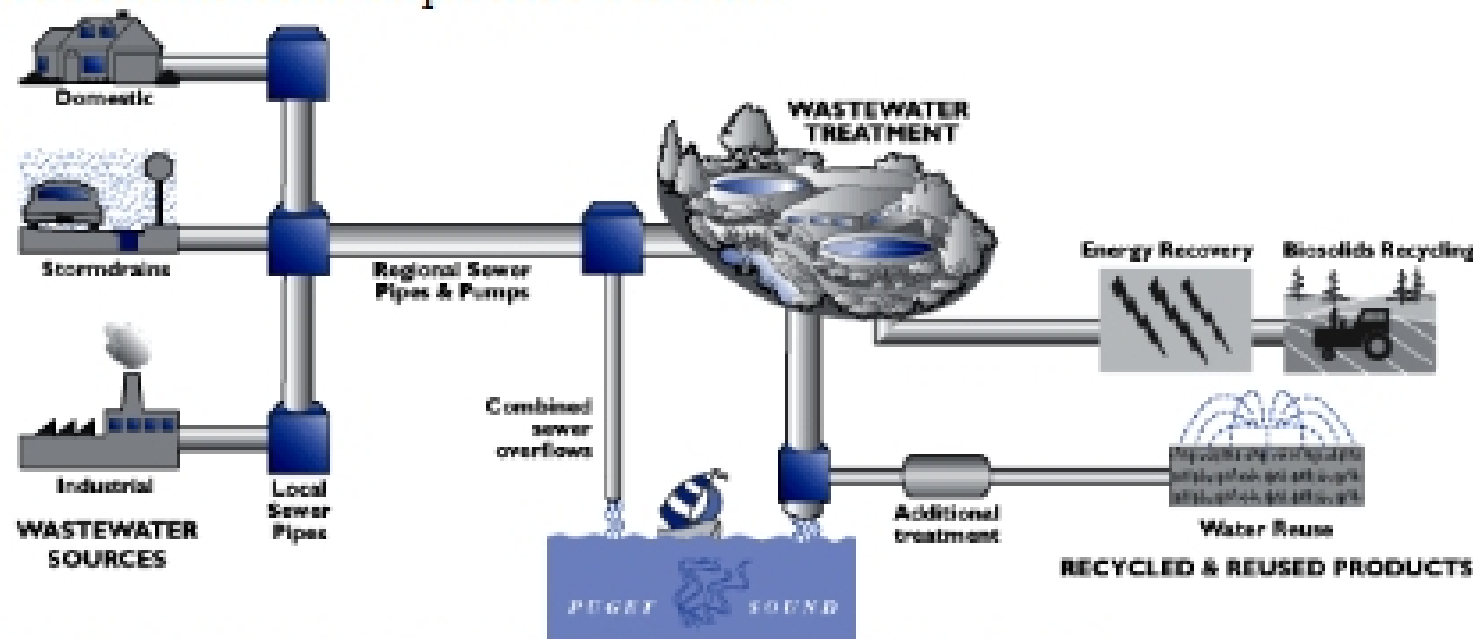


IMAGE: <http://www.kingcounty.gov/environment/wtd/About/System/TreatmentProcess.aspx>

READING QUESTION: (1 pt.) Answer this question **before** the beginning of your lab section. Would you expect fecal coliform concentrations to be higher in waters off the West Point Wastewater Treatment Plant (near Discovery Park in Magnolia) before or after a big rainstorm? Explain your answer.

¹ nonpoint source: a source of something to the environment, which comes from many different locations. A point source comes from one specific location. One example of a nonpoint source of coliform bacteria would be dog poop, which can be found all over the place.

PURPOSE:

In lab this week, you will measure water quality parameters and fecal coliform concentrations in water samples from several local areas, and compare results with concentrations deemed by regulatory agencies to be safe for shellfish harvest and water contact recreational activities.

Samples to be analyzed: Water samples will be collected in sterilized plastic containers, the morning of the analysis day, and kept refrigerated to slow bacterial growth. Water will be collected from sites expected to have differing levels of water quality and wide ranges of coliform counts:

- just outside the Ocean Teaching Building and sites adjacent to the large storm water overflow drain into Portage Bay
- in front of the UW Waterfront Activities Center on Lake Washington
- Carkeek Park located in northwest Seattle, this popular park offers extraordinary views of Puget Sound and the Olympic Mountains (salt water)
- Edmonds Underwater Park located north of Seattle on Puget Sound, is a popular Scuba diving spot
- Shilshole Marina in Ballard (salt water)
- Puget Sound beach at West Point (adjacent to Seattle's largest sewage treatment plant, salt water)
- seaward side of the Ballard Locks (salt water)
- the popular Golden Gardens along the eastern side of Puget Sound north of Shilshole Marina (salt water)
- Fresh pond (Drumheller Fountain)

PROCEDURE – WATER QUALITY MEASUREMENTS

You will use simple test strips to determine the water's pH, alkalinity, hardness, nitrite and nitrate concentrations. These test strips can be used in both freshwater and saltwater.

pH is a term used to describe the degree of acidity or basicity of a solution. It is measured on a 14 point scale where pH=1 is strongly acid, pH=7 is neutral and pH=14 is strongly basic. The majority of aquatic species are found in fresh water with a pH level between 6.0 and 8.0 and in saltwater between 8.0 and 8.4. *Total alkalinity* (sometimes referred to as buffering capacity) indicates the total amount of buffers (pH stabilizing compounds) that are present in the water. Adequate buffering capacity protects the environment from sudden changes in pH by absorbing excess acids or bases. *Water hardness* is a measure of the quantity of metallic ions present in the water, mainly calcium and magnesium. Water hardness affects an aquatic organism's ability to maintain the balance between its internal body fluids and the external environment. The test strips cannot be used to measure hardness for salt water. In aquatic systems close to land, *nitrate* and *nitrite* can reach high levels that can potentially cause the death of organisms. Nitrite levels above 0.75 parts per million (ppm) can cause stress and greater than 5 ppm can be toxic. While nitrate is much less toxic than nitrite, levels of nitrate over 200 ppm in freshwater and 20 ppm in saltwater can inhibit growth, impair the immune system and cause stress in some aquatic species.

- 1) TAs will divide the class into groups based on the number of water collection sites.
- 2) Each group will be provided with test strips and a graduated cylinder or small beaker.
- 3) Each group will be assigned to test the pH, alkalinity, hardness, nitrite and nitrate concentrations of a water sample using the test strips. *You will use this same water sample to culture fecal coliforms.*
- 4) Fill a small graduated cylinder or beaker with enough water that the pads on the test strip will be completely submerged when the test strip is dipped into your water sample.