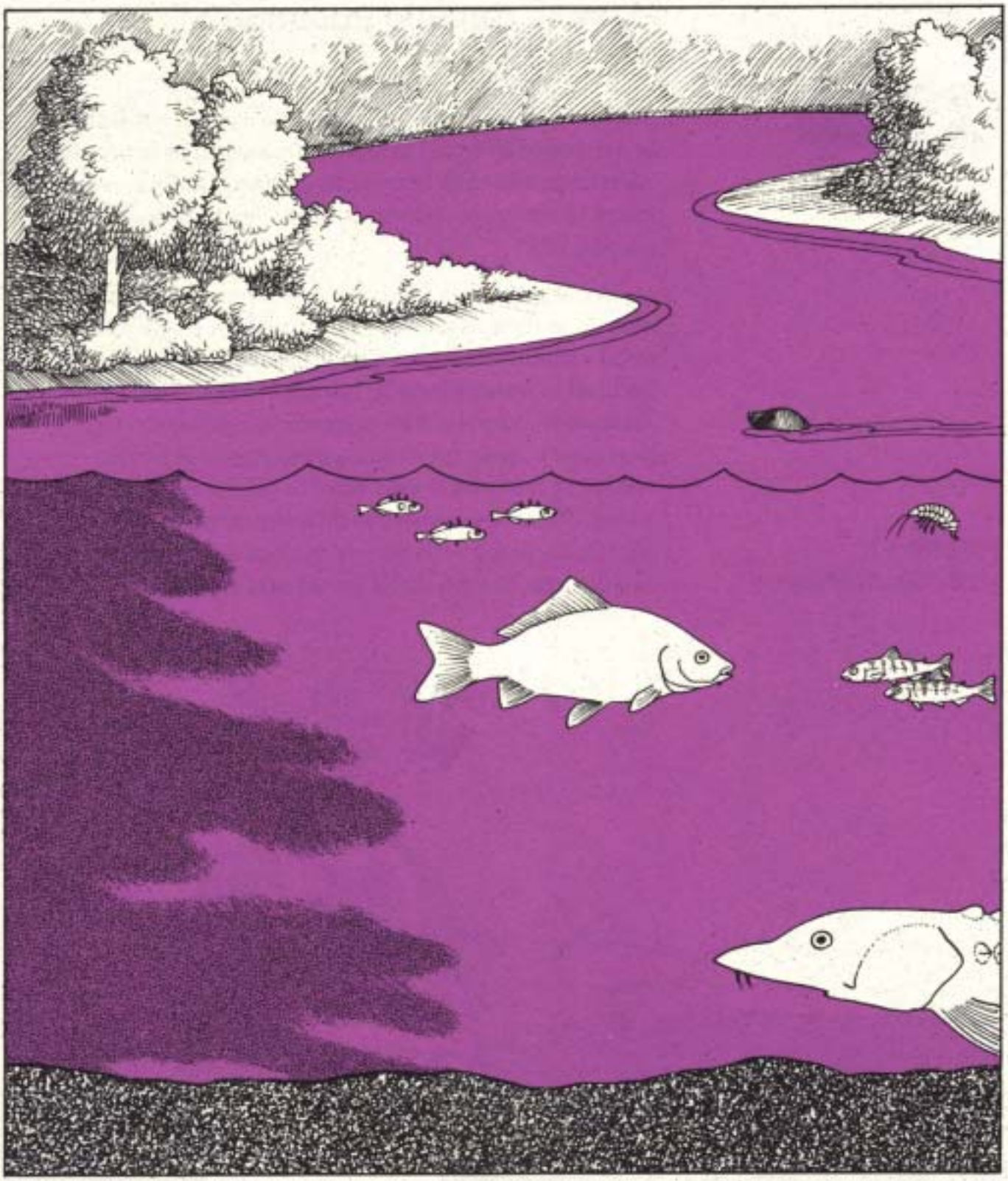


4. AQUATIC POLLUTION

Water is essential to aquatic habitats in estuaries because it provides many of the life-sustaining chemicals required by aquatic plants and animals. So we should be concerned about the potential effects of pollution on the estuary's aquatic habitat. This chapter describes some of the characteristics of pollutants.

What is Aquatic Pollution?

When we talk about a pollutant, we mean a substance that is not normally found in the environment, or is present in such large amounts that it can do harm. Pollution can be found in water, in sediments, and even in fish and other aquatic life.

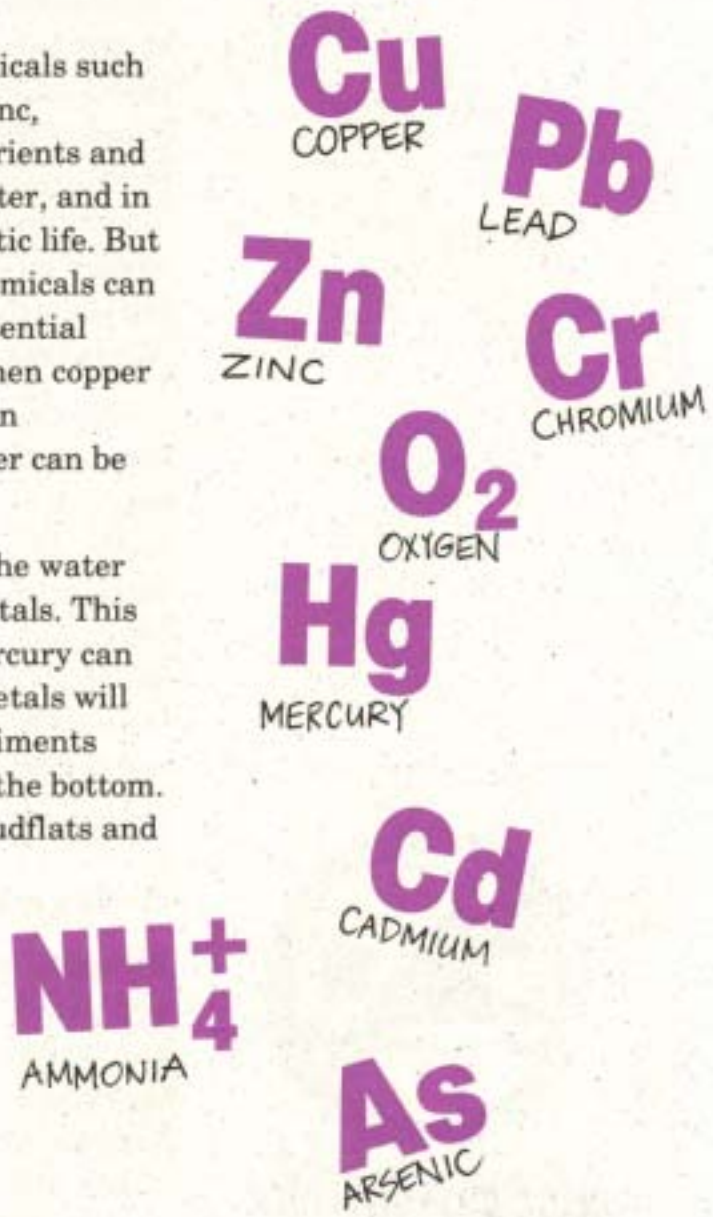
Some pollutants in an estuary are toxic to aquatic life even in minute amounts. For example, a single salt-grain-sized amount of copper (a toxic metal) dissolved in a bathtub of water would be harmful to fish. The same tiny amount of dioxin (a toxic organic contaminant often produced by pulp mills) in a swimming pool would endanger humans, if they were to take a drink of this water. There are numerous different inorganic and organic chemicals, along with various biological substances, that can degrade the quality of an estuary's water.

FIGURE 4-1
Water Quality Sampling

Inorganic Pollutants

Inorganic pollutants may include nutrient chemicals such as ammonia, and metals such as copper, lead, zinc, chromium, cadmium, arsenic and mercury. Nutrients and even metals occur naturally in fresh and sea water, and in proper and small amounts are essential to aquatic life. But when concentrations become too high, these chemicals can be harmful to life. Copper, for example, is an essential element in the blood of crabs and shrimp; yet when copper levels are elevated, it can kill the animal. Certain concentrations of ammonia dissolved in the water can be deadly to fish under certain conditions.

Sediment particles which are suspended in the water can serve as "attachment sites" for dissolved metals. This means that metal pollutants such as lead or mercury can become concentrated on suspended particles. Metals will then accumulate where these contaminated sediments settle out of the river flow and are deposited on the bottom. In this way, water pollution can contaminate mudflats and other places where sediment settles.



Organic Pollutants

Naturally occurring organic matter exists in particulate or dissolved form, and comes from living and dead plants and animals. This natural organic matter does not normally become a problem, because it is quickly recycled in the estuary by microorganisms and small detritus-eating invertebrates (see Food Chains and Food Webs in Chapter 1). However, even organic matter can cause pollution when too much accumulates and the estuary's natural recycling capacity is overloaded.

Too much organic matter stimulates the growth and activity of large numbers of bacteria and other microorganisms. As the bacteria "feed" on the organic matter, they use up much of the available oxygen in the water. This oxygen depletion can make it difficult for fish to breathe, and will often lead to their death.

Some organic pollutants are human-made, and these are of particular concern when they do not easily break down in the environment. PCBs (Polychlorinated biphenols, found in the cooling oil of large transformers); some pesticides (used to kill agricultural and garden pests); and dioxins and furans (chemical byproducts of industries such as pulp mills) are toxic organic pollutants that, once introduced into the environment, do not easily break down into harmless components.

Dioxins are an environmental hazard not only because they are very toxic, but also because they can be long-lasting in the environment. Natural recycling processes do not work very well with dioxins. Rather than being broken down into harmless products after they enter the estuary, they are often taken up and concentrated in aquatic organisms. This concentration of toxic substances in aquatic plants and animals is called "bioaccumulation," and is a potentially serious problem in any ecosystem.

Biological Pollutants

Biological pollutants consist of harmful bacteria, viruses and parasites that come from disease-carrying human and animal wastes. When these pollutants enter the estuary, they can be dangerous to people who come into contact with the water. Biological pollutants can cause a number of health problems in humans, including intestinal disorders (e.g., gastroenteritis), blood diseases (e.g., hepatitis) and parasitic infections (e.g., tape worms). To avoid the spread of human disease organisms, sewage is chlorinated (a disinfection process) before being discharged into the estuary during the summer months.

Those of us who like to eat oysters, clams and mussels must also be concerned about biological pollutants. This is because these animals feed by filtering large amounts of estuarine water through their gills. If the water is contaminated with biological pollutants, these animals will concentrate the pollutants in their body and pass them on to the person who eats them. This is precisely the reason why Boundary Bay, along with all other areas of the estuary, has long been closed to the harvesting of molluscan shellfish.

Bioaccumulation

As discussed in the section on dioxins, "bioaccumulation" is the term used to describe the uptake and retention of chemical contaminants which aquatic plants and animals obtain from food, water or sediments. Bottom-dwelling organisms such as worms, clams and groundfish that feed off the river bed can easily take up pollutants that have settled out with the sediment. Toxic organic pollutants which are not easily degraded by natural means tend to remain inside the bodies of these bottom-dwelling organisms.

Consider the case of a toxic chemical that is discharged into the estuary. It may enter the estuary in a number of ways: from a discharge pipe, from a ditch, from surface or groundwater, or even from the air. Once the chemical enters the water, it is usually diluted to a concentration that is too low to measure with even the most sensitive instruments. However, by providing numerous attachment sites on its surface (Figure 4-2), an organic sediment particle can concentrate the toxic chemical.

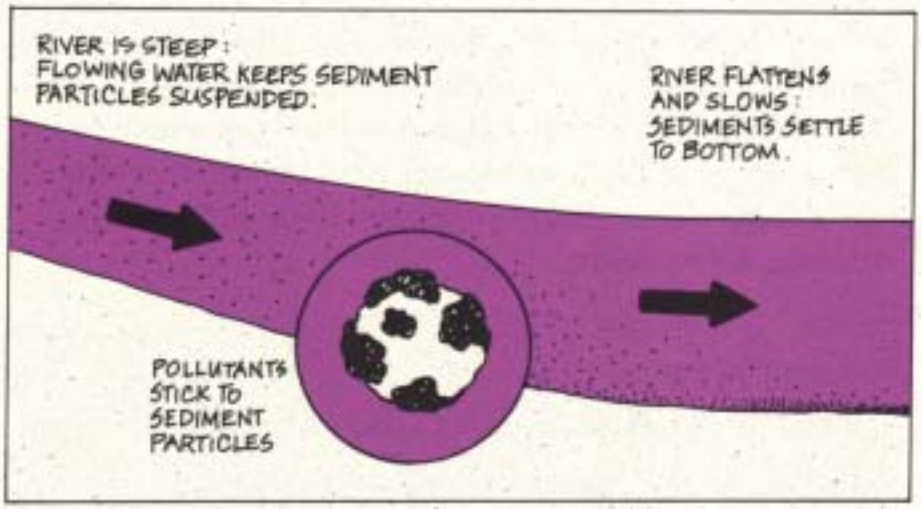
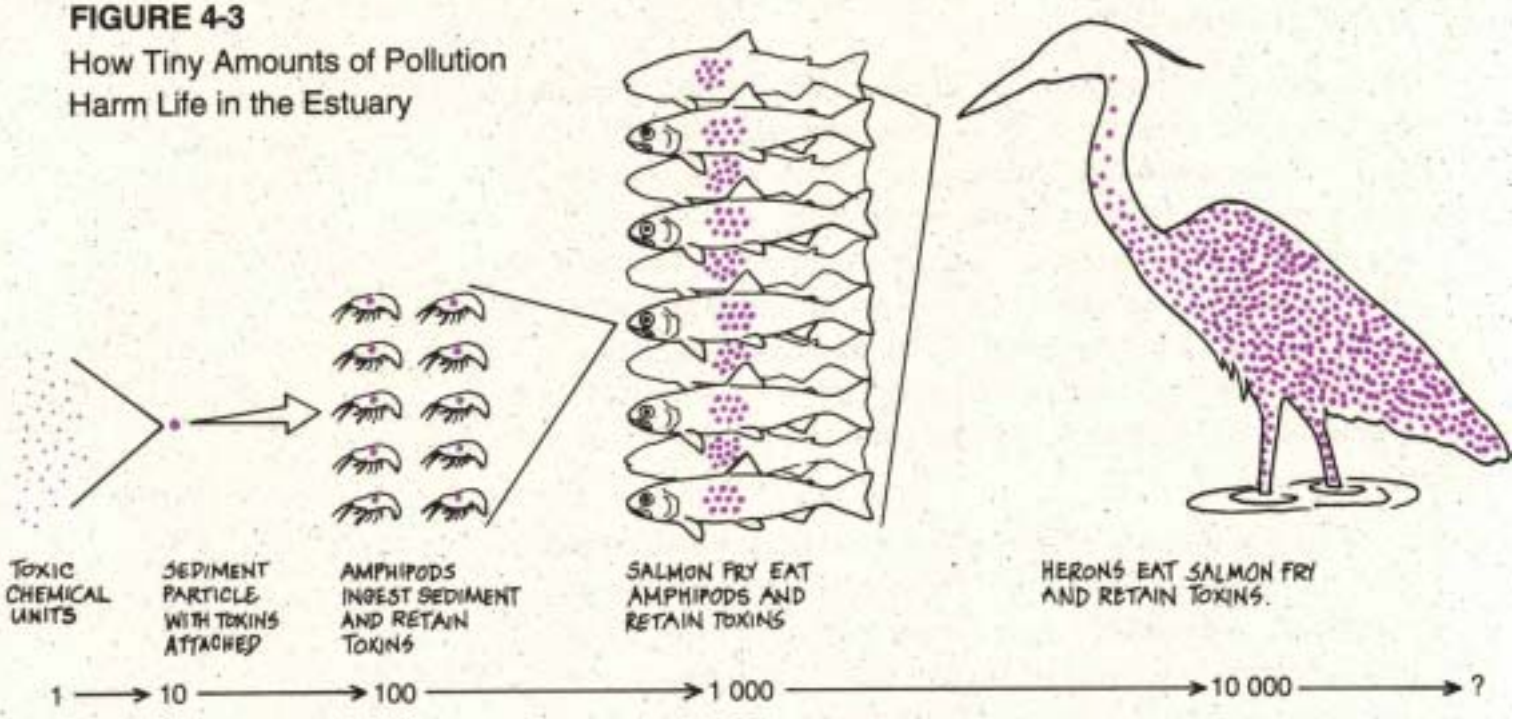


FIGURE 4-2
Pollution of Sediment Particles and River Bottom

The process of bioaccumulation is illustrated on the following page, Figure 4-3. In this example, a dissolved toxic chemical is concentrated ten-fold as it is attached to organic sediment particles which eventually settle to the bottom. There, bottom-dwelling amphipods are shown to consume ten of these contaminated particles. A small fish feeds on ten of these contaminated amphipods, and a Great Blue Heron then feeds on ten of the contaminated fish.

FIGURE 4-3
How Tiny Amounts of Pollution Harm Life in the Estuary



At each step of the food chain, the toxic contaminant is bioconcentrated ten-fold. By the time the toxic chemical reaches the Great Blue Heron, it has been biomagnified ten thousand times from its original minute (unmeasurable) concentration in the water. The unfortunate animal (perhaps a Bald Eagle, crow, seagull or coyote) that eats one of these sick or dead herons may have its life threatened as a result.

ACTIVITY 9: THE ESTUARY'S NATURAL FILTER

(adapted from: *Discover Wetlands, A Curriculum Guide*, Washington Department of Ecology, 1988)

Estuaries are the final receiving water for a wide variety of pollutants. Marshes help to keep the estuary's water clean and healthy by filtering and removing these harmful pollutants. This natural filter has the following properties:

1. As water currents are reduced in marshes, suspended sediments, along with any attached contaminants, settle to the bottom. Water flowing out of the marsh is therefore cleaner and purer.

2. Marsh plants can absorb most dissolved toxic contaminants. Some of these pollutants can actually be turned into harmless products inside the plants. Other pollutants end up below the soil in the plant roots. Here the pollutants are incorporated into the soil or are rendered harmless by bacteria.

Objective:

You can study the powerful ability of plants to absorb dissolved substances by doing the following experiment which simulates how pollutants can be absorbed into a living organism.

Procedure:

Step 1 and 2 of this experiment should be prepared one day ahead.

1. Prepare a coloured solution in a glass container by adding several drops of food coloring (red is a good color) to water. Think of the food coloring as representing pollution by a toxic substance.

2. Cut a small piece off the bottom of a celery stalk and place it in the water overnight (Figure 4-4). Over time, the colored water will visibly travel (by a process called osmosis) up the stalk. This shows how plants can absorb pollutants with the water they "drink." If the colored water is not visible on the outside of the stalk, break it open to reveal the color inside.

3. Imagine that the celery stalk represents a marsh plant, and that millions of these plants growing in a tidal marsh are absorbing pollutants from water in the estuary.

There is, of course, a limit! Plants can store and degrade only a limited amount of pollutants. Some of these stored pollutants can be released back into the aquatic environment as the plants die and decompose. Too much pollution, especially toxic chemicals which are persistent in the environment, will eventually harm and destroy life in the estuary. The best solution is to reduce pollution — or better yet, to eliminate it.

FIGURE 4-4

Down the Drain!

Many common household products contain substances that are toxic to aquatic life. Household chemicals such as toilet and oven cleaners, bleaches, household paints and thinners, insecticides, camping fuels and antifreeze all contain toxic chemicals.

Many people don't realize that these products are toxic to aquatic life and most of us don't know how to properly dispose of these hazardous materials once we are finished with them. As you can see in Figure 4-5, the worst way to get rid of left-over products is to flush them down the toilet, pour them into the kitchen sink, or dump them into a curbside stormdrain. If we do this, these toxic chemicals will eventually end up in our estuary where they can harm the aquatic life.

If you do not want toxic chemicals in household products to harm your estuary, dispose of them properly. Contact your local municipal hall or the Recycling Hotline (see Appendix 3) to find out the best way to dispose of your household chemicals.

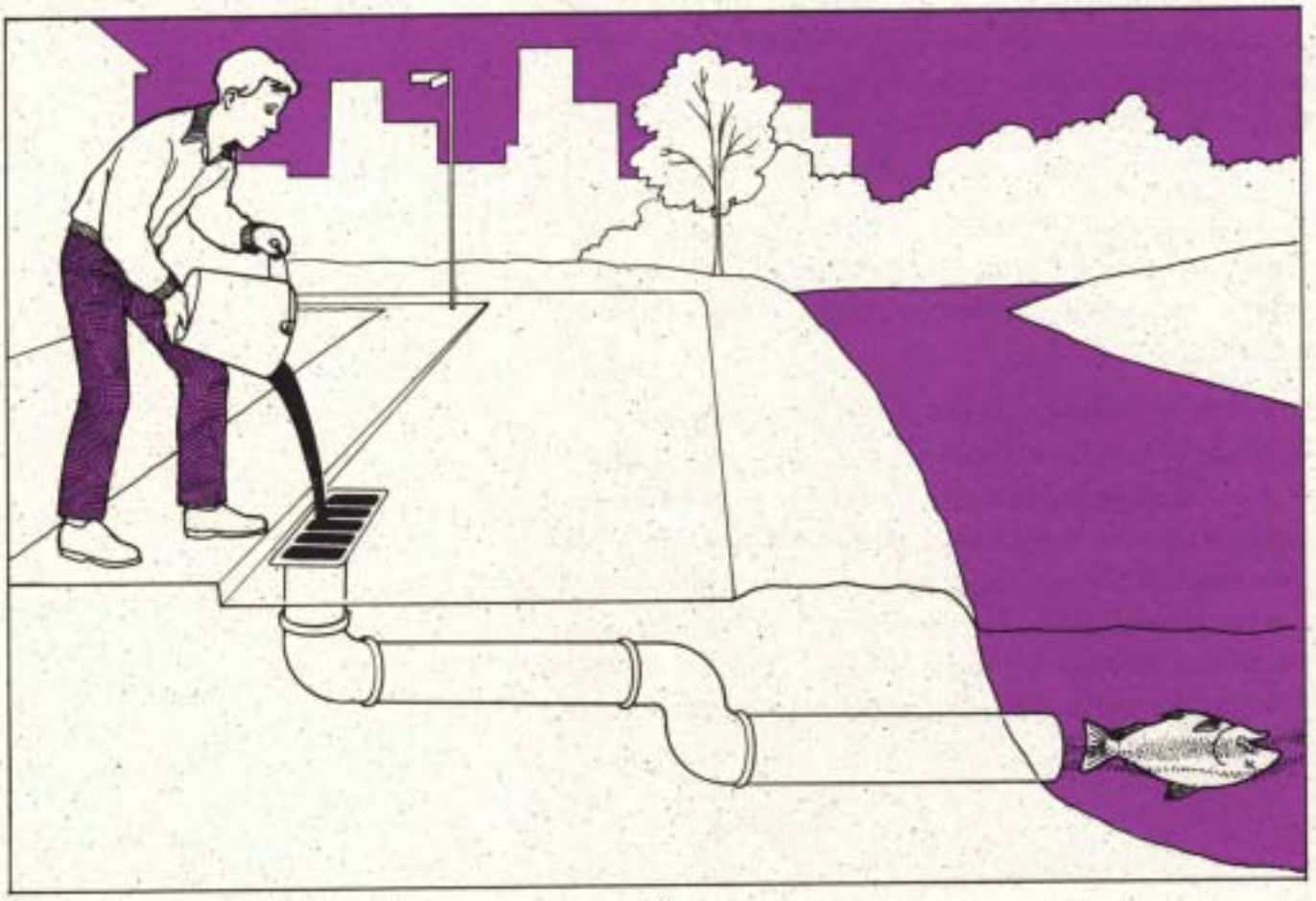


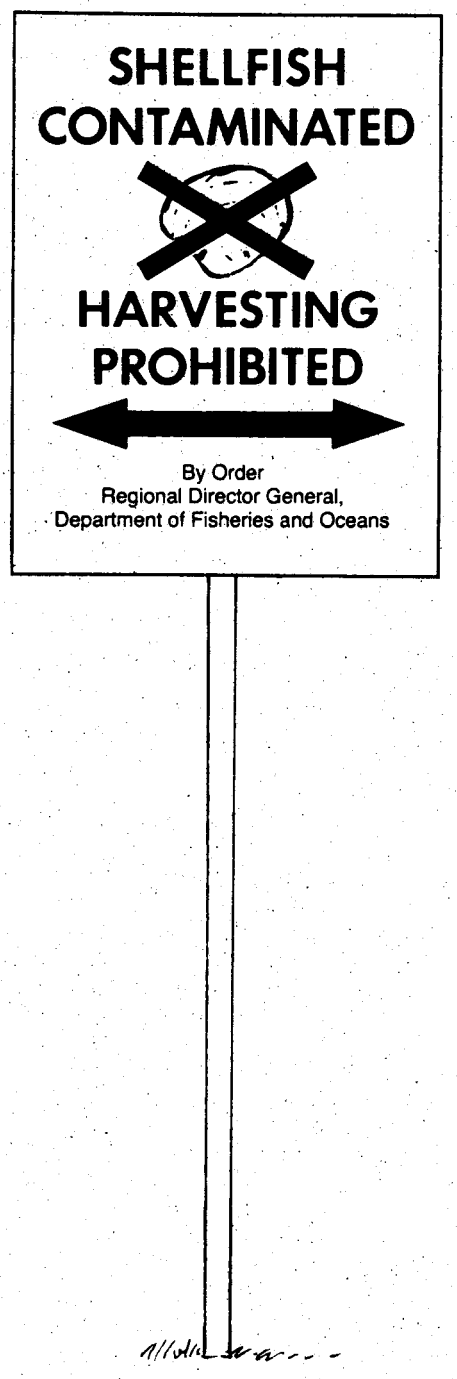
FIGURE 4-5
Never Use a Storm Drain for Disposing Waste Materials!

Too Much of a Good Thing!

It is a well known fact that animal manure serves as an excellent soil fertilizer by providing plant nutrients to enhance the growth of crops. However, too much nutrient supply in aquatic ecosystems will often result in problems. This was the case during the 1980's, when heavy rainfall flushed large amounts of nutrients (animal manure and other agricultural fertilizers) into drainage canals and sloughs that eventually fed into the Nicomekl and Serpentine Rivers. These nutrients stimulated excessive growths of algae. When the algae died off in the fall, there was a large biological oxygen demand which rapidly depleted the dissolved oxygen levels in the river water. This sequence of events resulted in major fish kills in the Serpentine and Nicomekl Rivers.

When animal manure is flushed into local drainages, it can introduce high numbers of coliform bacteria into adjacent parts of the estuary. Both the Serpentine and Nicomekl Rivers drain into Boundary Bay. The continuous high levels of coliform bacteria discharged each year into Boundary Bay have resulted in chronic bacterial contamination of molluscan shellfish. As a result, shellfish harvesting has been banned since 1962, eliminating one of the most important oyster production areas in British Columbia.

FIGURE 4-6



ACTIVITY 10: MATCHING POLLUTANTS AND SOURCES

The various types of pollution described in this chapter can originate from many different sources in the estuary. The nature of the pollutant usually provides some clues to its source. Identifying pollution sources is an important step towards protecting the water quality of the estuary.

The objective of this activity is to match the various pollutants with their potential sources, as shown in Table 4-7. Place a mark (X) in any box of the table where a pollutant matches a potential pollution source. Once you have filled in the table, think about the following questions.

How do these pollutants get from the source to the estuary?

Do you think this pollution could be prevented or reduced?

Can you think of any other potential pollution sources?

What type of pollutants could originate from these other sources?

Answers in Appendix 1, page 112.

TABLE 4-7
Chart for Matching Pollutants and Their Sources

POLLUTANTS	POLLUTION SOURCES			
	Household	Pulp Mill	Farm Field	Automobile
Bacteria				
Copper				
Dioxins				
Herbicides				
Lead				
Oil				