Virginia 4-H Marine/Aquatic Education Program

What Do You Know About Water Quality?

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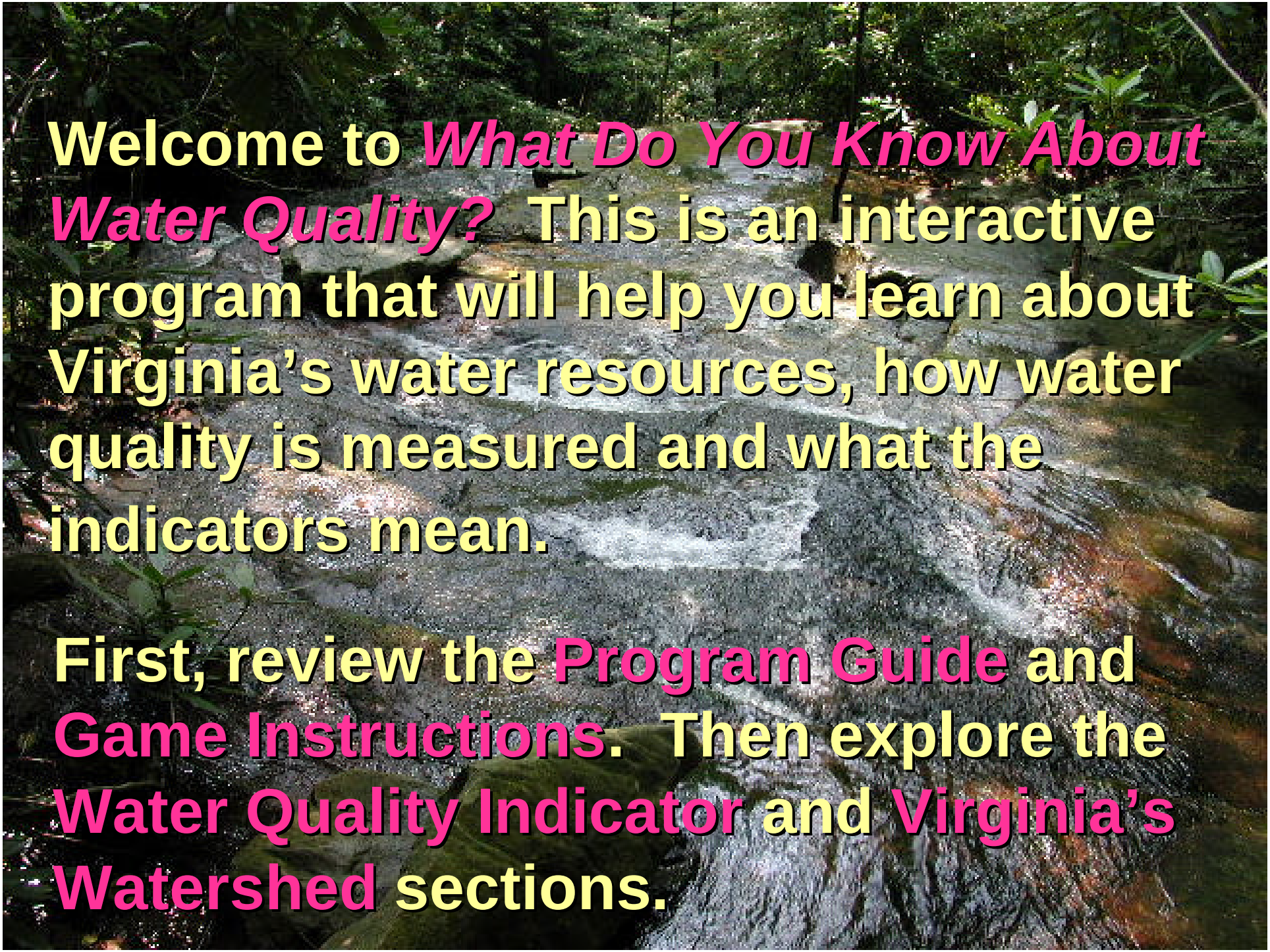
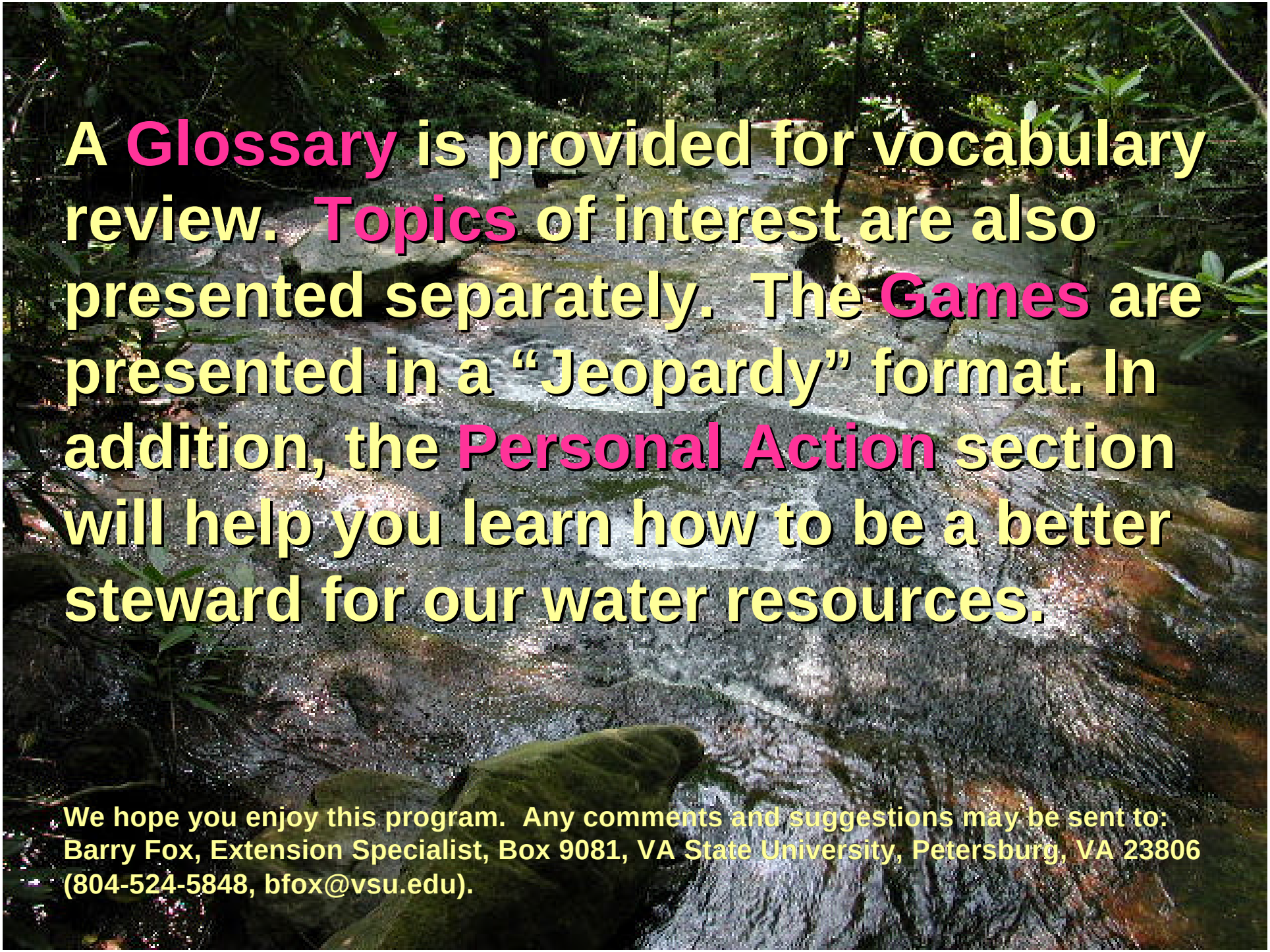


Welcome to *What Do You Know About Water Quality?* This is an interactive program that will help you learn about Virginia's water resources, how water quality is measured and what the indicators mean.

First, review the Program Guide and Game Instructions. Then explore the Water Quality Indicator and Virginia's Watershed sections.



A Glossary is provided for vocabulary review. Topics of interest are also presented separately. The Games are presented in a "Jeopardy" format. In addition, the Personal Action section will help you learn how to be a better steward for our water resources.

We hope you enjoy this program. Any comments and suggestions may be sent to:
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(804-524-5848, bfox@vsu.edu).

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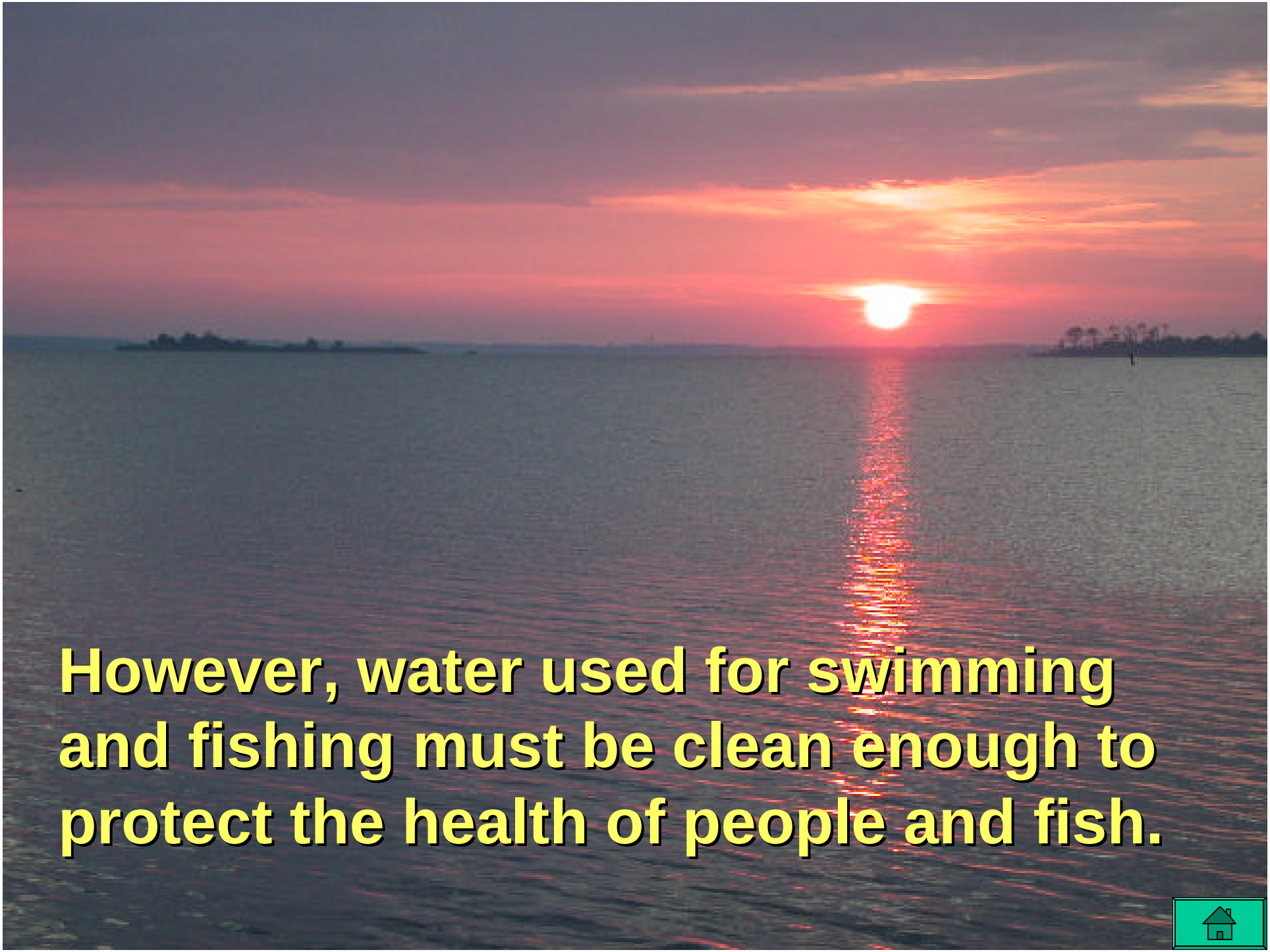
INTRODUCTION

We all need clean water. We need it not only for personal use, but also for:

and many other uses.

Water quality refers to the condition of the water. How water is used determines what the condition needs to be.

Drinking water must be in better condition (cleaner) than water used for swimming and fishing.



However, water used for swimming and fishing must be clean enough to protect the health of people and fish.

Regardless of how water is used, good water quality is a must. However, nearly everything we do affects the quality of water.

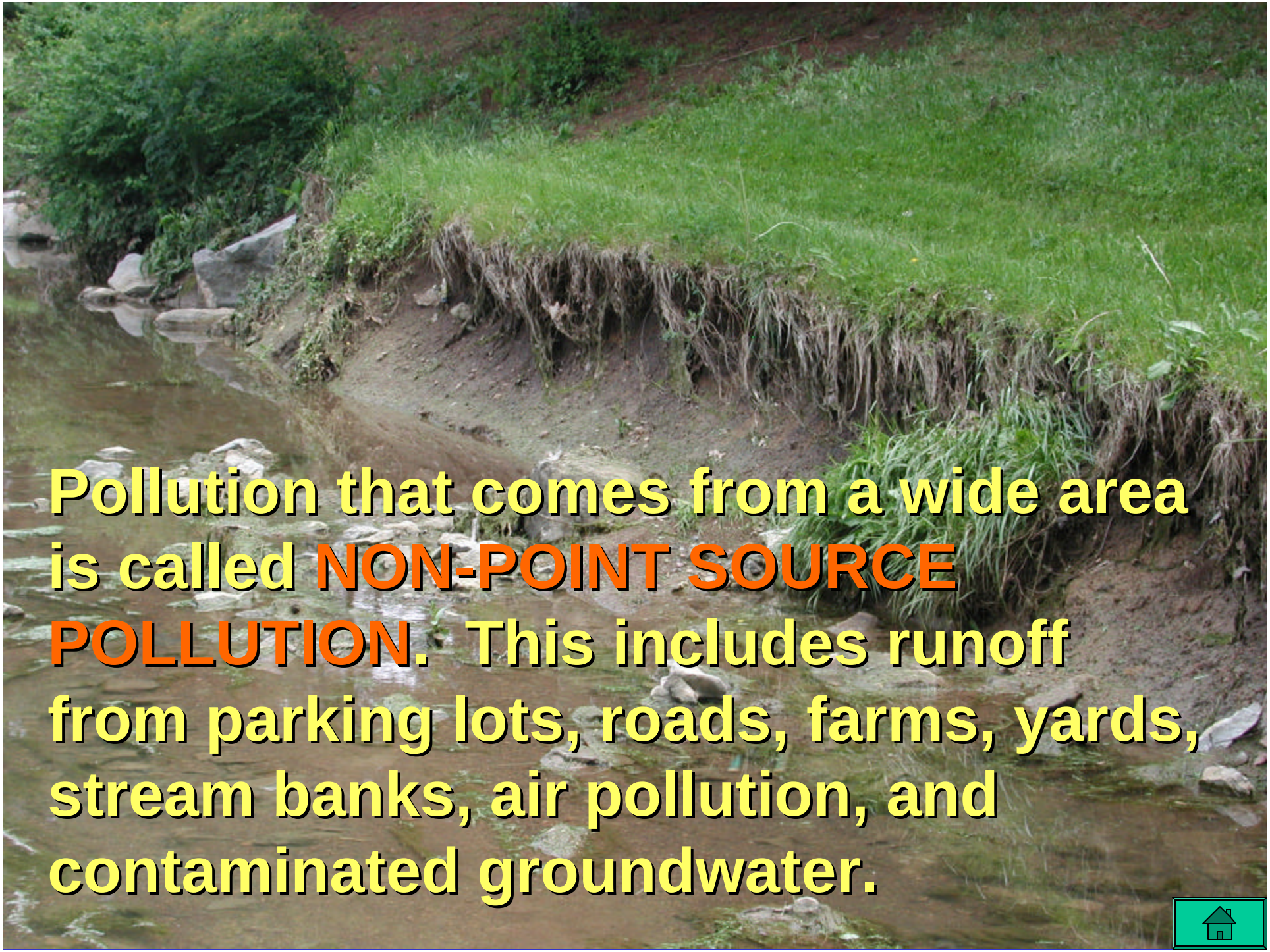
Vehicles, industry and natural events create air-borne particles and gases that enter waterways with dust, rain and snow.

Sewage treatment adds nutrients and other pollutants to waterways.
Agriculture and yard care produces sediment, nutrient and pesticide pollution.

Many types of chemicals can enter rivers, lakes and groundwater through improper use and storage.

Motor oil and other automotive chemicals can enter waterways from parking lots and highways.

There are many sources of water pollution. Pollution that originates from a specific place is called **POINT SOURCE POLLUTION**. This includes outflows from sewage plants, factories, landfills, feed lots and underground storage tanks.



Pollution that comes from a wide area is called NON-POINT SOURCE POLLUTION. This includes runoff from parking lots, roads, farms, yards, stream banks, air pollution, and contaminated groundwater.

Water pollution can also originate from natural sources. Mineral-rich soils, natural oil seepage, coastal saltwater, wildlife and natural disasters can all affect water quality.

There are many types of water pollution. Some of these include:

- Petroleum Products
- Nutrients
- Sewage
- Solid Wastes
- Pesticides
- Toxic Wastes
- Bacteria
- Sediments
- Heated Water

and others.

The most widespread types of pollution are sediment, nutrients and bacteria.

Erosion moves soil into waterways. The soil creates suspended sediment that blocks sunlight, smothers aquatic life and adds contaminants.

Primary plant nutrients include nitrogen, phosphorus and other elements. Excess nutrients increase algal growth. The algae die and the resulting decay consumes oxygen.

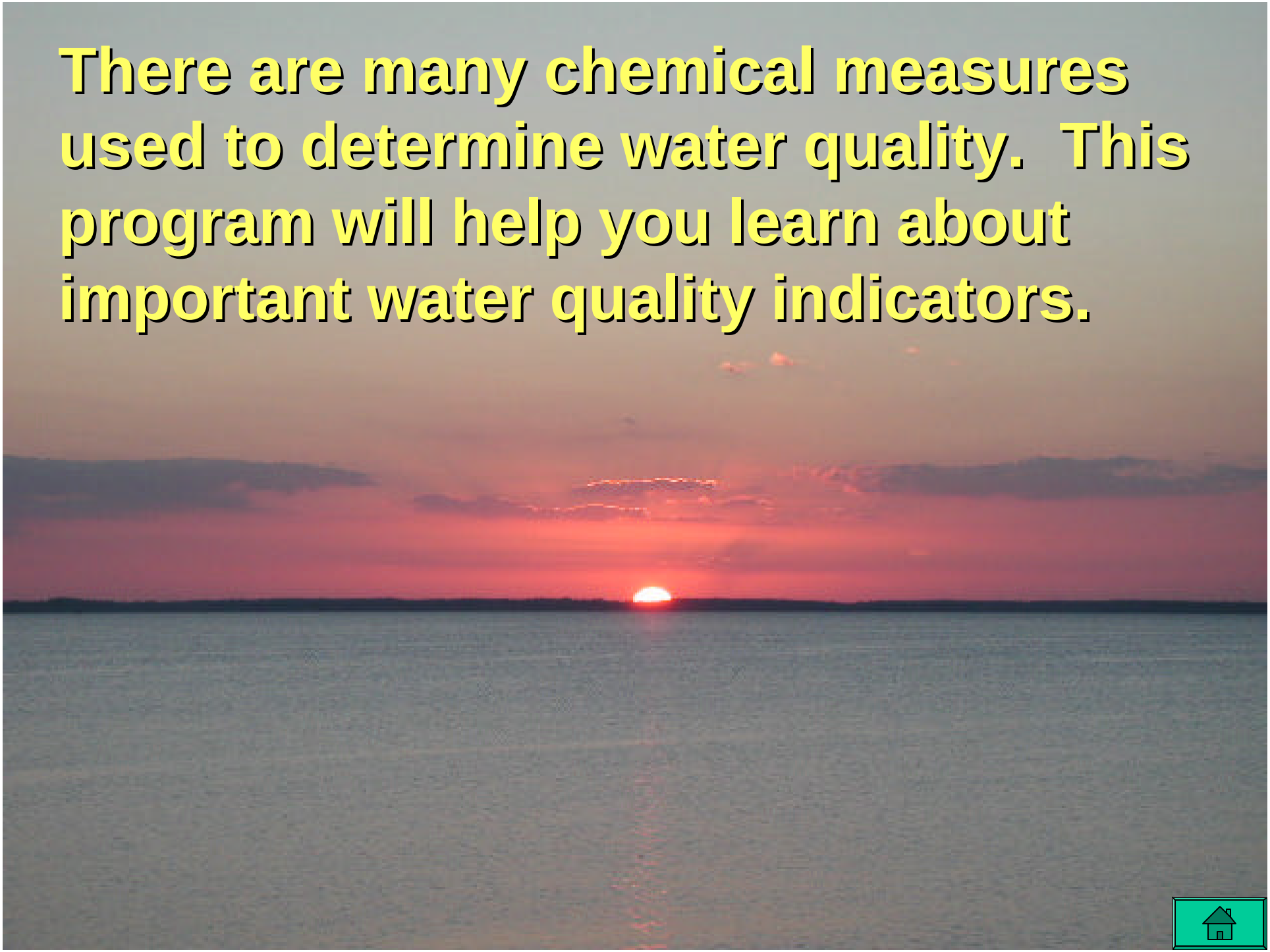
Partially treated sewage, farm runoff and animal wastes are major sources of nutrients and bacteria.

Bacterial contamination is becoming a chronic problem in many waterways. The most prevalent sources are poorly treated sewage and wildlife, pet and livestock waste.

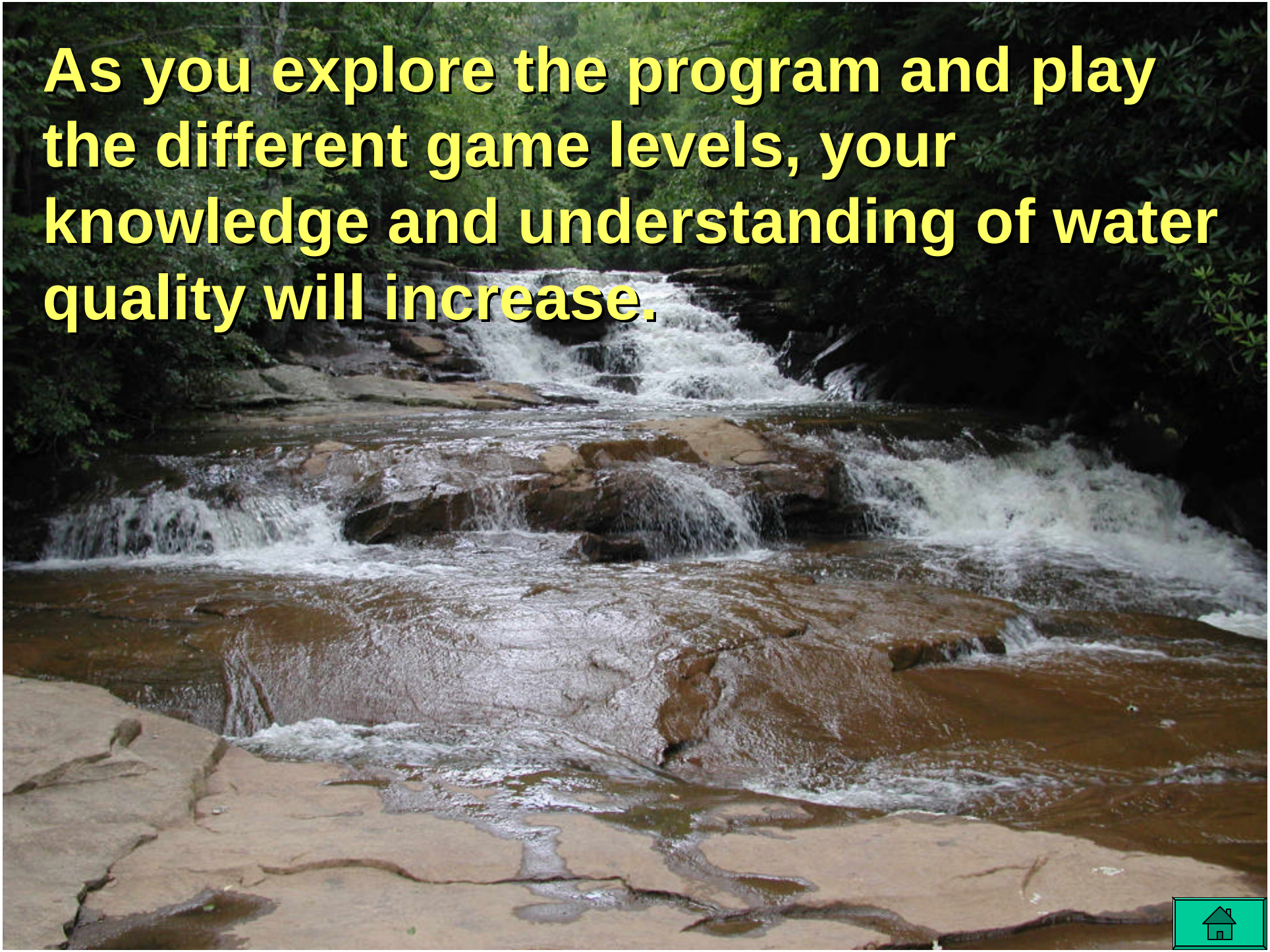
Virginia Beach water quality monitoring sites.

In addition, petroleum products, farm and garden chemicals, heavy metals and other toxic substances can severely affect water quality.

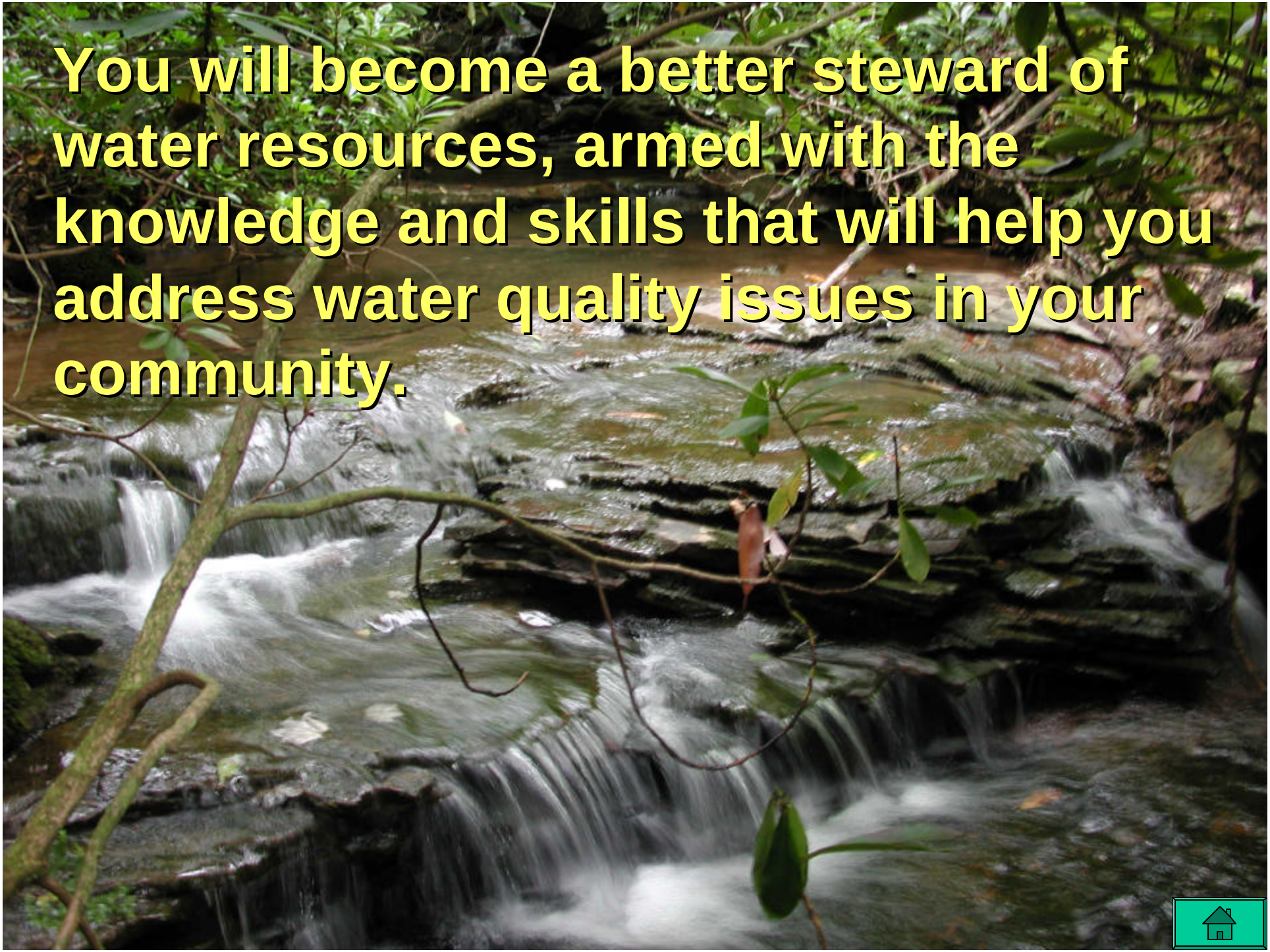
An important concern is the long-term exposure to low levels of these pollutants. Cancer is a possible risk. However, these substances may also affect hormone and immune systems.



There are many chemical measures used to determine water quality. This program will help you learn about important water quality indicators.



As you explore the program and play the different game levels, your knowledge and understanding of water quality will increase.



You will become a better steward of water resources, armed with the knowledge and skills that will help you address water quality issues in your community.

WATER QUALITY INDICATORS

Select a water quality indicator to learn more about it.

Alkalinity

Ammonia

Bacteria

Conductivity

Dissolved Oxygen

Hardness

Nitrate

Pesticides

Parts Per Million

More Indicators

WATER QUALITY INDICATORS

pH

Phosphate

Salinity

Sediment

Temperature

Toxic Chemicals

Total Dissolved and Suspended Solids

Turbidity

Puzzle Games

Valuable Water Quality Web Sites

USDA Water Quality Information Center

U.S. Environmental Protection Agency

U.S. Geological Service

Chesapeake Bay Program

Return to Preparation

ALKALINITY

Alkalinity refers to the water's ability to neutralize acids.

Alkalinity is produced by minerals such as limestone.

Limestone is a type of ocean sediment composed of calcium carbonate.

Limestone bedrock areas often have caves and sinkholes, known as Karst.

Powell River Limestone Spring

Water with low alkalinity is usually acidic.

AMMONIA

Ammonia is produced by the decay of protein matter and animal waste.

Ammonia is toxic to most aquatic life, especially at high pH.

Bacteria readily convert ammonia to nitrate (a plant nutrient).

Ammonia is a form of nitrogen and part of the Nitrogen Cycle .

BACTERIA

Most bacteria are important in nutrient and other biological cycles.

Excess nutrients cause algal blooms. As algae die and decay, the high bacterial load rapidly consumes dissolved oxygen.

Fish kill due to low dissolved oxygen.

Certain types of bacteria indicate animal and human waste pollution.

Escherichia coli **are coliform bacteria found in the intestines of warm-blooded organisms. Most strains are harmless but one *E. coli* strain can cause severe diarrhea and kidney damage.**

Testing water for bacteria.

CONDUCTIVITY

Conductivity measures the water's ability to conduct an electrical current.

Pure water is a poor conductor.

The addition of dissolved solids, especially salts, increases the conductivity of water.

Salts and other compounds form ions (charged particles) in water.

The electrical current is measured using a conductivity meter.

Conductivity is measured in micromhos (µmhos/cm) or microsiemens (µs/cm) per centimeter.

Healthy freshwater lakes and streams have a conductivity of 150 – 500 µmhos/cm.

DISSOLVED OXYGEN

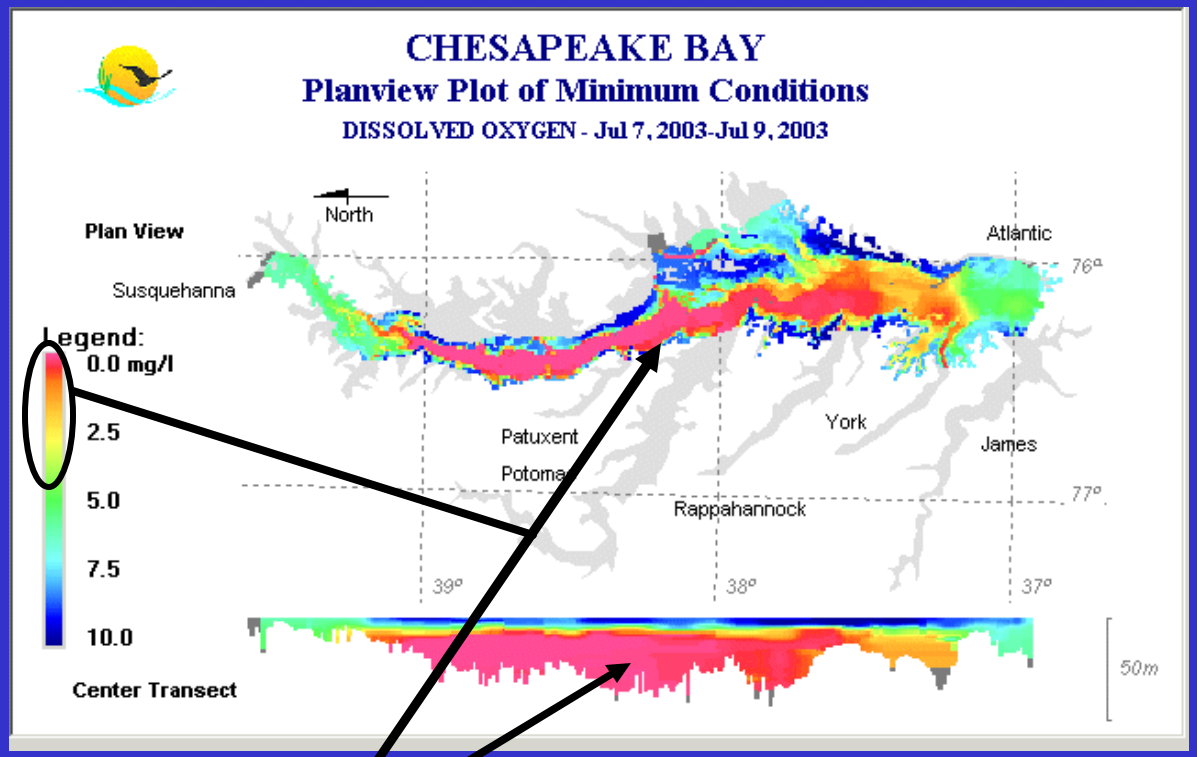
Dissolved oxygen is a product of photosynthesis and diffusion.

The warmer the water, the less oxygen it can hold.

Water does not hold much oxygen, up to 15 ppm.

Suspended sediment and dissolved substances reduce the amount of oxygen water can carry.

Oxygen is needed for biological and chemical processes in water.



A large part of the Chesapeake Bay has low dissolved oxygen.

HARDNESS

Hardness refers to the concentration of calcium and magnesium in water.

Hard water has high concentrations of these elements. Soft water has low concentrations.

Water hardness often originates from limestone.

River and lake basins with quartz or granite rocks usually have soft water.

Areas of the U.S. with limestone bedrock have hard water.

Hard Water

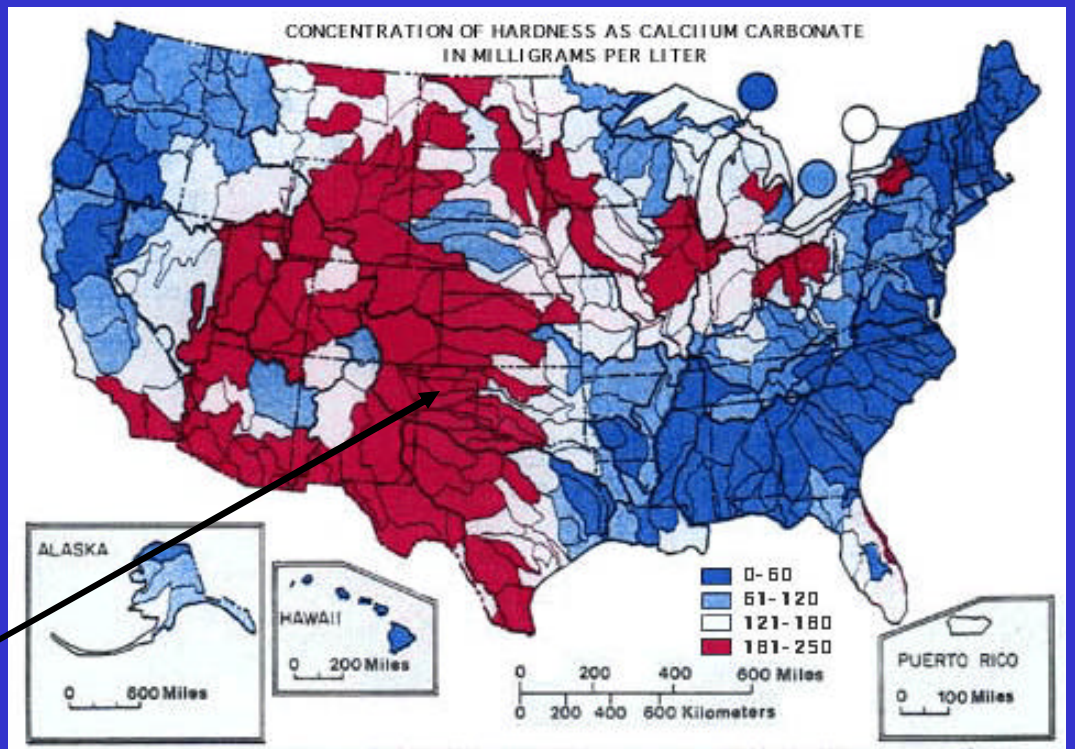


Figure 5.–Mean hardness as calcium carbonate at NASQAN stations during 1975 water year. Map at bottom is colored to show station data representing flow from the accounting unit.

Excessive hardness causes several water quality problems.

NITRATE

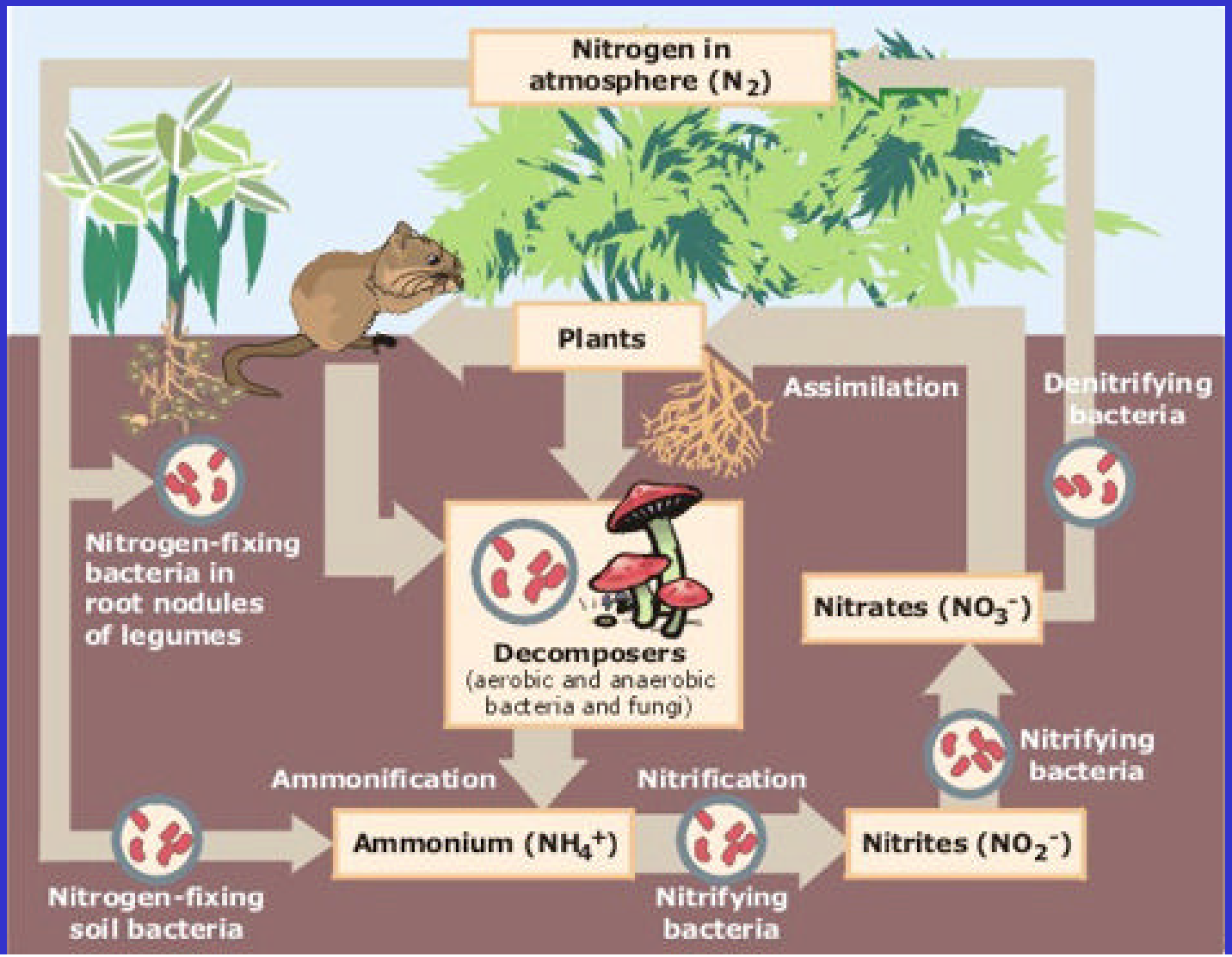
Nitrogen makes up 80% of the atmosphere.

Nitrate is a primary plant nutrient.

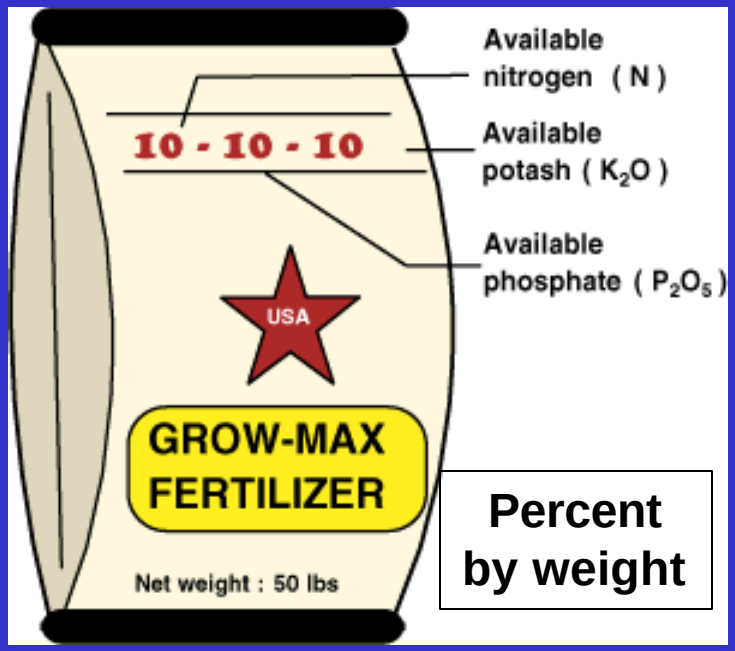
Nitrate is water soluble and moves easily from surface to groundwater.

Excess nitrate causes algal blooms that reduce water quality.

Nitrogen is changed to different forms through the nitrogen cycle.



Nitrate is the first nutrient listed in a fertilizer.

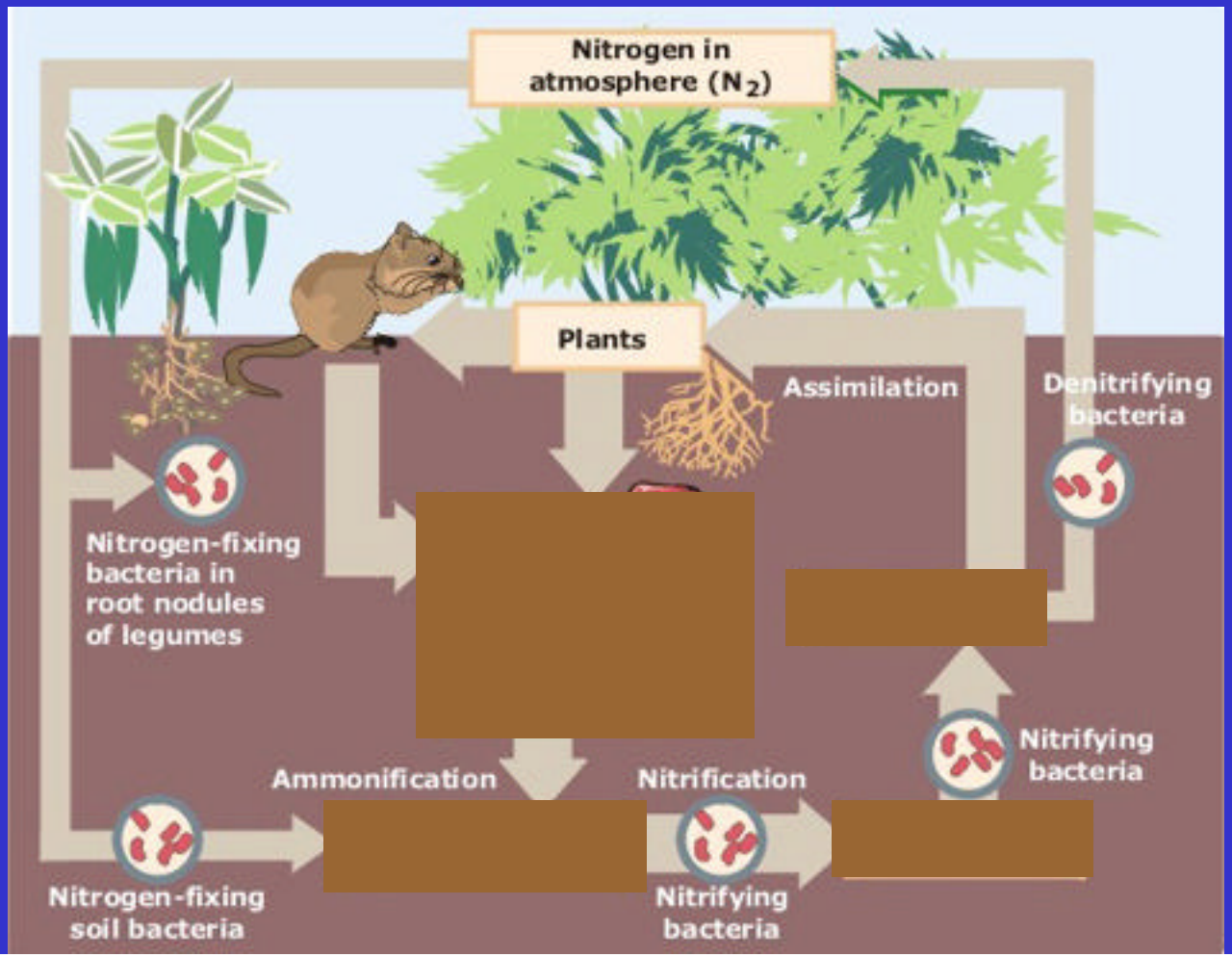


Learn more about the Nitrogen Cycle.

Learn more about soil nutrients.

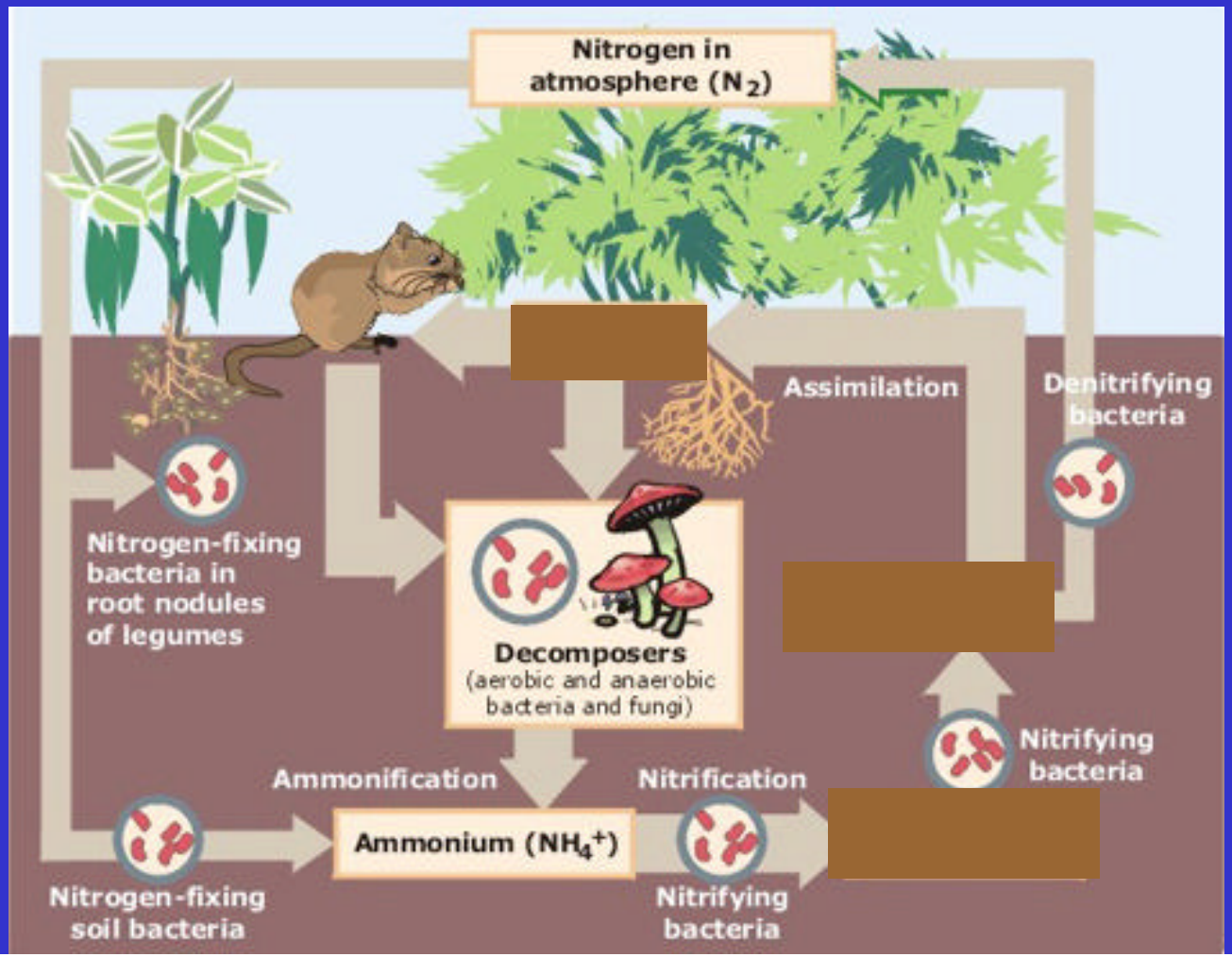
Nitrogen Cycle

Nitrogen exists as protein, ammonia, nitrite, nitrate and as free nitrogen gas. As animal and plant proteins decay, ammonia is released.



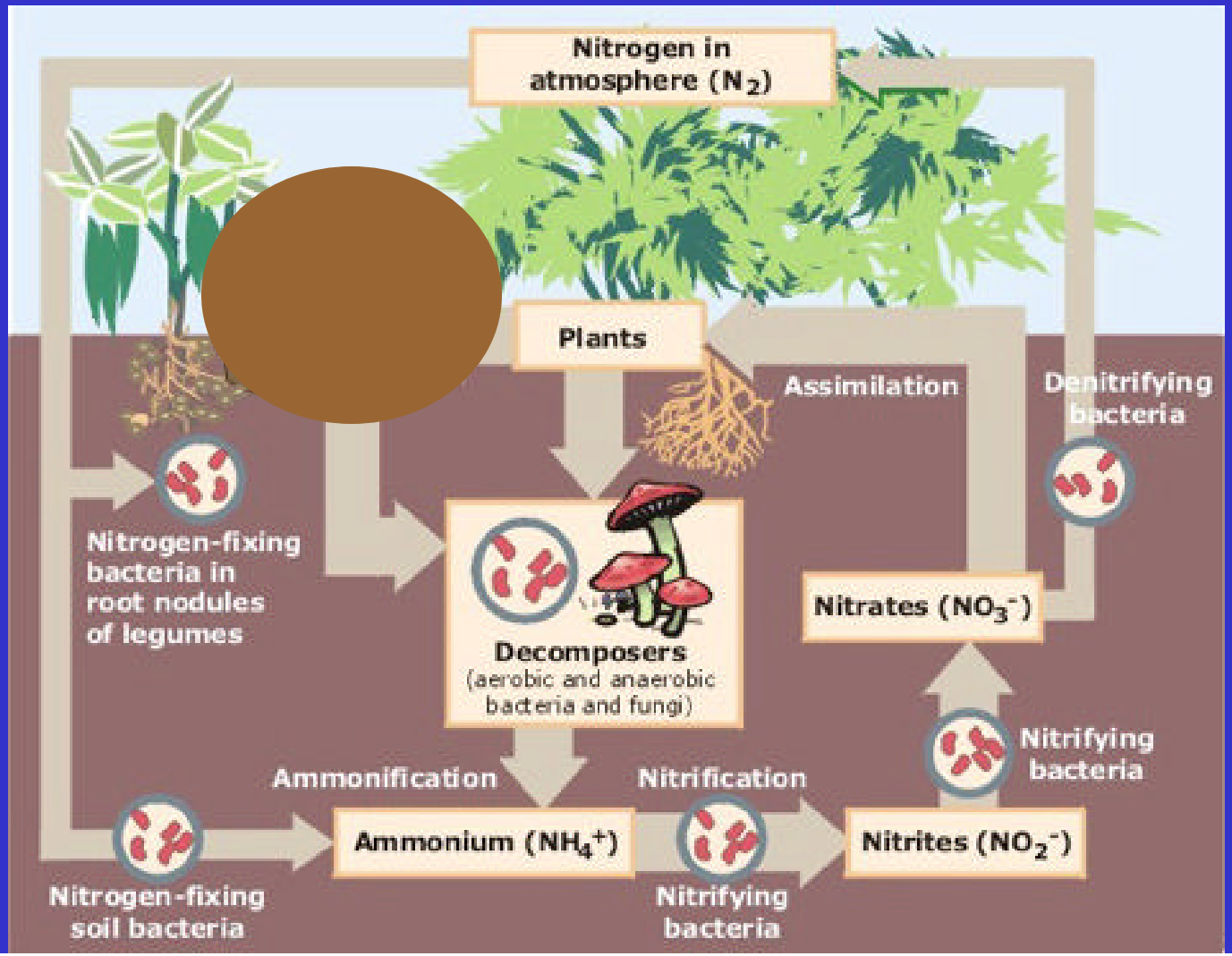
Nitrogen Cycle

Ammonia is converted to nitrite and then nitrate by nitrifying bacteria. Nitrate is utilized by plants as a primary nutrient.



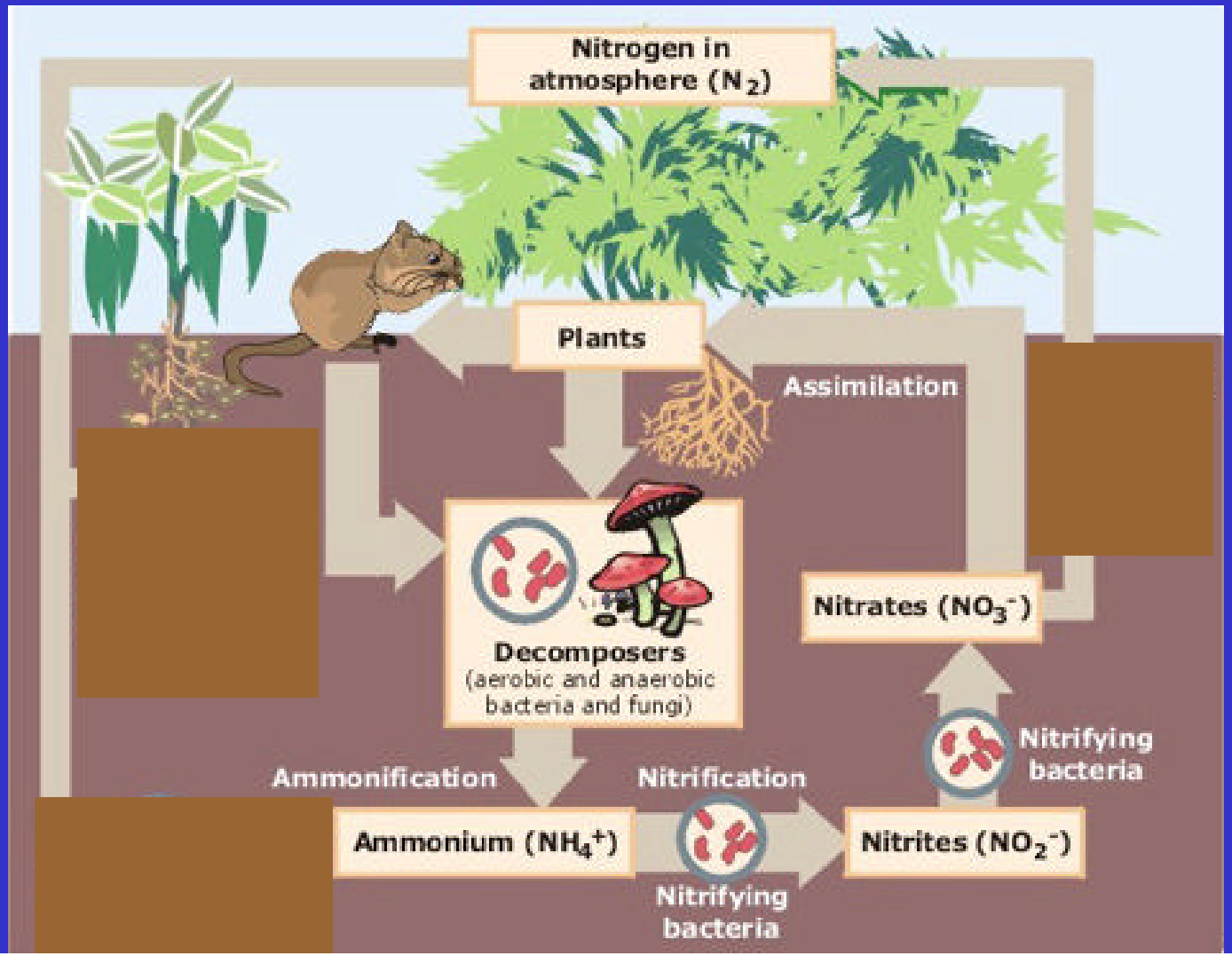
Nitrogen Cycle

Animals consume plants and other animals and use the proteins to build their proteins.



Nitrogen Cycle

Free nitrogen is produced by bacteria or lightning and converted to nitrate by nitrogen fixing plants.



Nitrogen Cycle

Return to Topics

Under normal conditions, the nitrogen cycle keeps the amount of available nitrogen in balance with the demands. However, excessive use of fertilizers and nutrient-rich sewage release have created a surplus of nitrate in waterways. The result has been eutrophication from excess algae and bacteria with reduced dissolved oxygen.

ALLIANCE FOR THE CHESAPEAKE BAY
BAY JOURNAL

Bay's water quality lives up - or down - to scientists' predictions

By Karl Blankenship (September 2005)

Chesapeake Bay water quality this summer fared the way scientists had expected it to: It was poor. In early August, about 41 percent of the main stem of the Chesapeake was suffering from low-oxygen conditions, and almost 10 percent had virtually no oxygen at all—creating a true biological "dead zone."

PARTS PER MILLION

Most dissolved substances found in water are measured in parts per million (ppm) or even smaller amounts. This means that for every one million parts (units) of water there is a certain number of parts of the substance.

It is also expressed as milligrams per liter. There are 1000 milliliters in a liter and 1000 milligrams in a gram. For example, a dissolved oxygen reading of 8 ppm means there are 8 milligrams of oxygen for every 1000 milliliters of water.

8/1000 gram ¸ 1000 milliliters =

8/1,000,000 (8 parts per million)

Concentrations of certain substances are also measured in parts per billion, parts per trillion and so on. These are very small amounts but certain substances can be harmful even at these very low concentrations.

PESTICIDES

These chemicals are very complex.
They are rated by a number of factors:

- How well they adhere to soil.
- How water soluble they are.
- How long they last in the environment.
- How they affect organisms.

and other factors.

Some types of pesticides include:

Herbicides	Insecticides	Fungicides
Algicides	Miticides	Rodenticides

There are four main groups of chemical pesticides that use more than 120 active ingredients.

All pesticides should be handled safely and according to instructions.

Take a look at Atrazine.

Learn more about pesticides

A look at one herbicide - Atrazine

Trade Names: Aatrex, Actinite PK, Akticon, Argezin, Atazinax, Atranex, Atrataf, Atred, Candex, Cekuzina-T, Chromozin, Crisatrina, Cyazin, Fenamin, Fenatrol, Gesaprim, Griffex, Hungazin, Inakor, Pitezin, Primatol, Radazin, Strazine, Vectal, Weedex A, Wonuk, Zeapos, Zeazine

Persistence – Moderate to very

Long-term effects on mammals – Cancer, immune and hormone effects

Effects on other organisms – Moderately to highly toxic to bees, molluscs, aquatic insects, amphibians and fish.

Pounds used each year in the U.S. – 70 – 80 million

The decay of Atrazine is a complex cycle. It may persist from one week to one year, depending on soil conditions.

Little is known about the effects of the various Atrazine metabolites (by-products) on organisms.

Atrazine is currently being studied for its suspected effects on amphibians and other organisms.

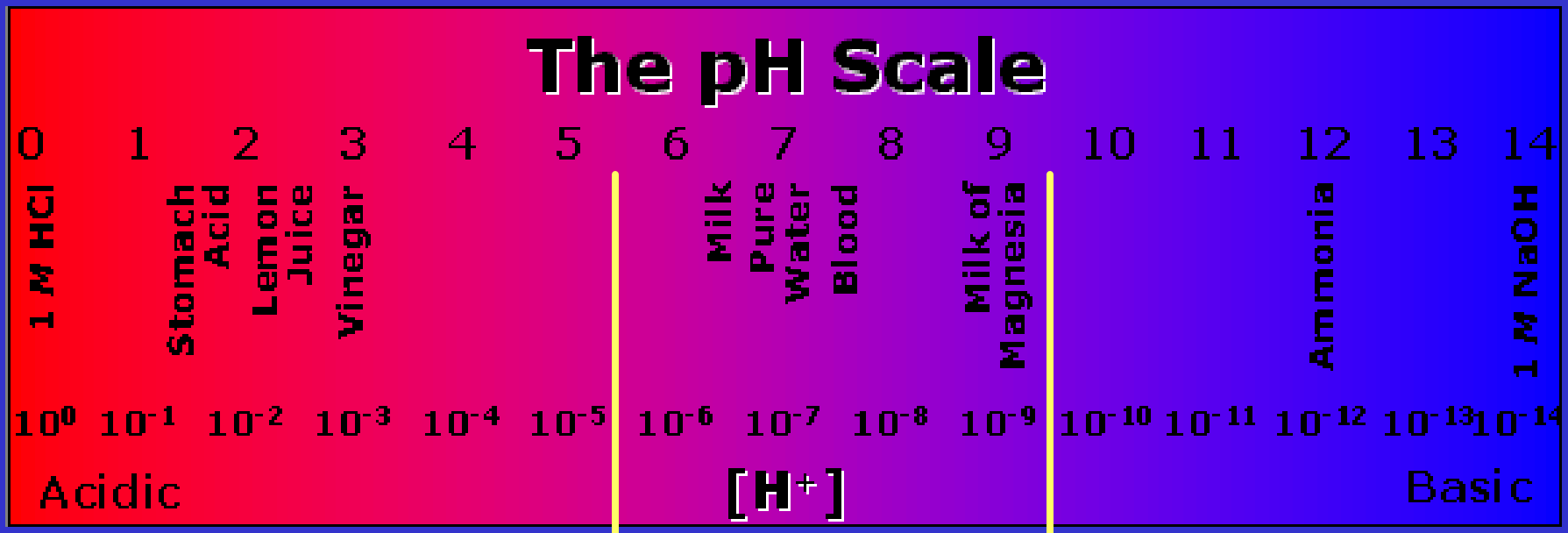
pH

pH is the measure of the hydrogen ion (H+) concentration.

The pH scale is zero to 14. Seven is neutral, below seven is acidic, and above seven is basic (or alkaline).

Most aquatic organisms exist within a pH range of 5.5 to 9.5.

Carbon dioxide reacts with water to form a weak acid called carbonic acid.



pH tolerance for most aquatic life

PHOSPHATE

Phosphate is an important plant nutrient used for root growth.

Phosphate binds to soil particles and is not usually water soluble.

Most phosphorus mineral is obtained from mining.

Phosphate exists in both organic and inorganic forms.

Excess phosphate can cause algal blooms and reduce water quality.

Chicken and swine production are major sources of phosphate pollution.

SALINITY

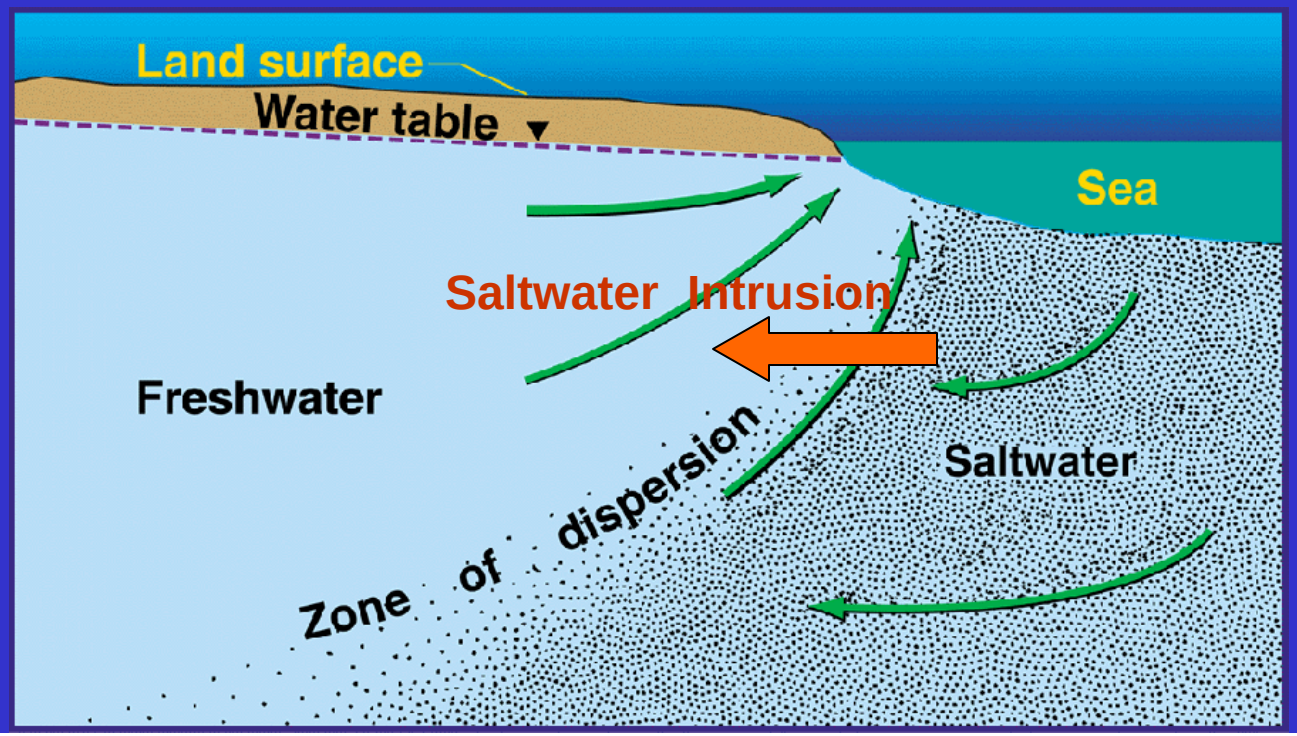
Salinity refers to the salt concentration in water, mostly sodium chloride.

Salinity is measured in parts per thousand (ppt) or grams per liter.

Ocean water has a salinity of about 35 ppt.

Brackish water has less than 20 ppt salinity.

Saltwater can cause problems when it replaces fresh groundwater in coastal areas.



SEDIMENT

Erosion causes loose soil to enter waterways.

Heavier sediment particles quickly settle out of the water.

Suspended sediment blocks sunlight and reduces dissolved oxygen.

As suspended sediments settle, they can smother bottom (benthic) organisms.

Sediments can carry many types of man-made chemicals.

TEMPERATURE

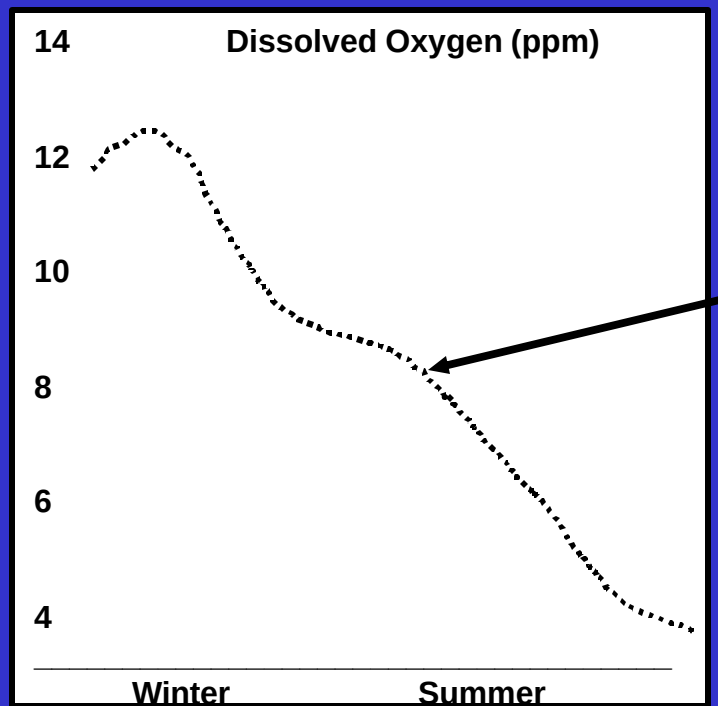
Temperature is measured in Fahrenheit and Celsius degrees.

Temperature can be measured using field thermometers but digital probes are much more accurate.

Most aquatic organisms live within a temperature range of +32º F (+0º C) to 90º F (32º C).

Rapid temperature change and temperature extremes can stress aquatic organisms.

Temperature affects the oxygen-carrying capacity of water.



As the water warms, the amount of dissolved oxygen decreases.

TOTAL DISSOLVED SOLIDS (TDS)

TDS is the measure of the material dissolved in water.

This measure is related to hardness, salinity and conductivity.

Hard water has more TDS than soft water.

TOTAL SUSPENDED SOLIDS (TSS)

TSS is the measure of the sediment suspended in the water.

TSS is related to turbidity.

Water with high TSS usually has high Total Dissolved Solids (TDS) as well.

TOXIC CHEMICALS

Toxic chemicals usually come from industry and energy production.

The effects are often not known until years after they have entered the environment.

Toxic chemicals include heavy metals (lead, mercury), organic compounds (DDT, PCB), inorganic substances (arsenic) and others.

Many common household chemicals are toxic to aquatic life (cleaning fluids, paints, thinners, polishes, etc.)

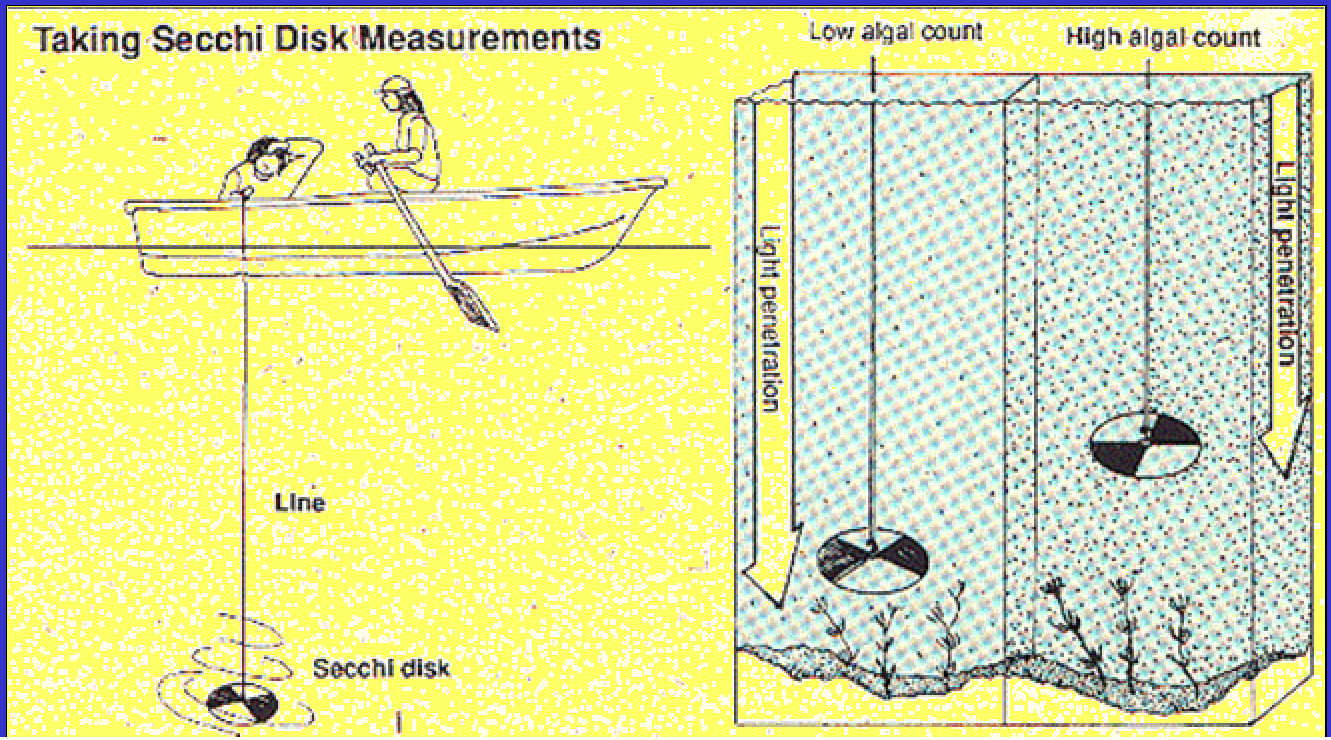
A description of some of the “Toxics of Concern” is available at this link (Toxics).

TURBIDITY

Turbidity refers to water clarity.

Sediments suspended in the water increase turbidity.

Clay and silt particles produce most of the turbidity.

High turbidity prevents light from reaching submerged aquatic vegetation (underwater plants).

A secchi disk is one type of instrument used to measure turbidity.