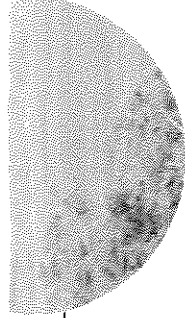


# WARM WATER

## a good thing?

### RESEARCH ARTICLE



*Temperature changes in the water affect water quality and the health of any aquatic habitat. Air and water temperature often determine the variety of species in the habitat and which animals and plants survive and grow well. But, how does temperature affect water quality? Do humans add to the negative effects of temperature changes?*

#### **Why is Temperature important?**

Temperature affects the chemistry of water and the behavior of aquatic life. Warm water holds less oxygen than cold water, therefore the dissolved oxygen level in warm water is lower than in cold water. Low oxygen level affects animal behavior. It also affects animal and plant growth, reproduction, and may even cause death.

Air temperature is important, because it is linked to weather factors that can increase or decrease water temperature. When the temperature in the water increases, photosynthesis increases. This means that the habitat can support more aquatic plants which can lead to more dead plants. When the aquatic site has heavy plant growth, plants use a lot of oxygen. As plants die they are decomposed by bacteria which use more oxygen in the process. When oxygen levels in water are very low you can sometimes detect a rotten egg smell.



#### **- Vocabulary**

**Dissolved Oxygen.** The amount of oxygen dissolved in water. It is usually measured in milligrams per liter (mg/L).

**Ecosystem** A group of organisms together with its environment, seen as a unit.

**Habitat** The environment where a particular plant or animal is normally found.

**Photosynthesis** The process by which plants harness the energy of the sun to make food. In photosynthesis, plants absorb carbon dioxide (CO<sub>2</sub>) and give off oxygen (O<sub>2</sub>). Thus, there is an overall accumulation of carbon (C) in the plant.

**Plankton** A small freely floating group of organisms (plants and animals).

**Thermal Pollution.** An increase in water temperature caused by adding relatively warm water to a body of water at a lower temperature.

**Watershed** An area of land that delivers runoff water, sediment, and dissolved substances to surface water bodies, such as rivers or lakes. All watersheds consist of boundaries, a basin and collection areas.



# WARM WATER

## a good thing?

Aquatic animals are sensitive to water temperature changes. If temperatures in the water change too much, many organisms can no longer survive. This makes it difficult for other animals to find food. Usually fish cannot survive temperatures below 0°C, and very few can tolerate temperatures above 36°C. If the temperature increases or decreases by just a few degrees Celsius, fish will swim to a different area to regulate their body temperature.



### What factors affect temperature changes?

Seasons and weather can affect temperature dramatically. Your field study results may be different at different times of the year. Water temperature changes in response to daily changes such as shade, sunlight, and air temperature. A decrease in air temperature usually causes a drop in water temperature. Small water bodies will be influenced by air temperature faster than larger water bodies.

Vegetation is another factor that affects water temperature. Trees shade the water from sunlight. The shade prevents water temperature from rising too fast on sunny days. Some narrow streams are almost

completely covered with overhanging vegetation.

Water clarity also affects the temperature of the water. The cloudier the water the more particles it contains and the more heat they absorb from the sun. Calmer water lets in more sunlight and slower moving water usually has a higher temperature. Deep waters usually are colder than shallow waters simply because they require more time to warm up. The volume of the water also plays an important role. The more water there is, the longer it takes to heat up or cool down.

The temperature of the water flowing into the aquatic site affects its temperature. Some sites get water from cold mountain streams or underground springs. Other sites are supplied by rain and surface runoff.

Humans affect the temperature in the water by thermal pollution. It happens when warmer water flows into colder water. The result is an increase in water temperature. It often occurs near power plants. The power plants use water to cool equipment. As the water heats up as it runs over the hot equipment. The power plants discharge the heated water into the aquatic sites. Urban runoff can also cause thermal pollution. It happens when water flows over warm streets, sidewalks, and

### Do humans affect temperature changes?

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## RESEARCH ARTICLE

parking lots. Those surfaces heat the water before it flows into the aquatic site.

Other ways humans affect water temperature is by cutting down trees, which leads to erosion. That means more soil ends up in the aquatic site. The soil in the water absorbs heat from sunlight and the water temperature then increases.

### What are acceptable temperatures for a healthy ecosystem?

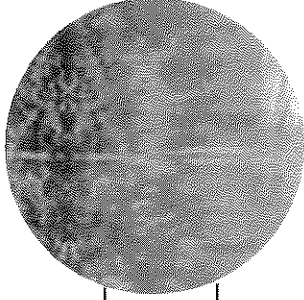
The maximum water temperature an organism can tolerate depends on the species. For example, the maximum temperature for survival of the Sockeye salmon is 22°C. The table lists the maximum temperatures for survival of various species.

Species	Maximum survival Temperature
Bluegill	35°C
Carp	21°C
Channel catfish	35°C
Largemouth bass	34°C
Rainbow trout	24°C
Sockeye salmon	22°C

*Adapted from EPA's Draft Volunteer Stream Monitoring: A Methods Manual.*



# When pH changes What happens?



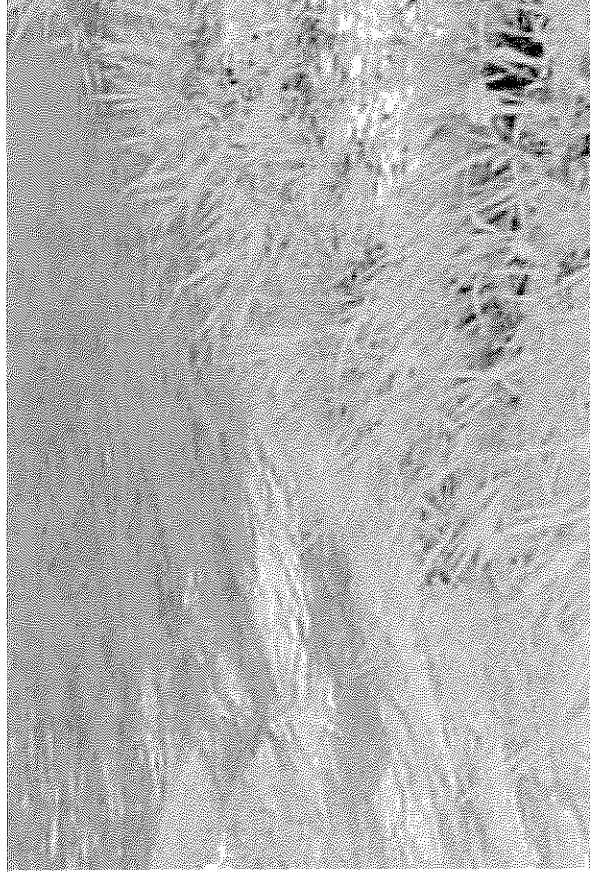
## RESEARCH ARTICLE

*Water quality is critical to our health and that of any ecosystem. Poor water quality can cause severe health problems to humans and to all life that depends on an aquatic site. But, what is pH and why is it so important to water quality?*

### What is pH?

pH is a measurement of how acidic or basic a solution is. It is measured on a scale of 0 (highly acidic) to 14 (highly basic). When a solution is not acidic or basic it is neutral and has a pH of 7. pH less than 7 indicates an acid. Lemon juice tastes sour and is acidic. It has a pH of about 2. pH greater than 7 indicates a base. Detergents are slimy and they are basic. They have a pH between 8 and 9.

One pH unit change represents a ten-fold change. For example if the pH of a water sample changes from pH 7 to pH 6, it will become 10 times more acidic.



### Vocabulary

**Acid** A substance that produces positively charged hydrogen ions ( $H^+$ ) when dissolved in water and reacts with bases to form salts.

**Acidosis** Condition characterized by abnormally high levels of acidity, which may affect aquatic life. Acidosis can also affect humans with abnormally high levels of acidity in their blood.

**Alkalosis** Condition characterized by abnormally low levels of acidity, which may affect aquatic life. Alkalosis can also affect humans with abnormally low levels of acidity in their blood.

**Base** A substance that produces negatively charged hydroxide ions ( $OH^-$ ) when dissolved in water and reacts with acids to form salts.

**Ecosystem** A group of organisms together with its environment, seen as a unit.

**Habitat** The environment where a particular plant or animal is normally found.  
**pH** A measure of acidity.

**Salinity** The amount of dissolved salt in water.

**Watershed** An area of land that delivers runoff water, sediment, and dissolved substances to surface water bodies, such as rivers or lakes. All watersheds consist of boundaries, a basin and collection areas.



# When pH changes

## What happens?

**Why is the pH of an aquatic site important?**

The level of acidity (pH) influences life in an aquatic site. The pH of the wet area around roots affects how plants take up nutrients. Aquatic organisms have adapted to life in water with a specific pH. If the pH changes, the organisms may die.

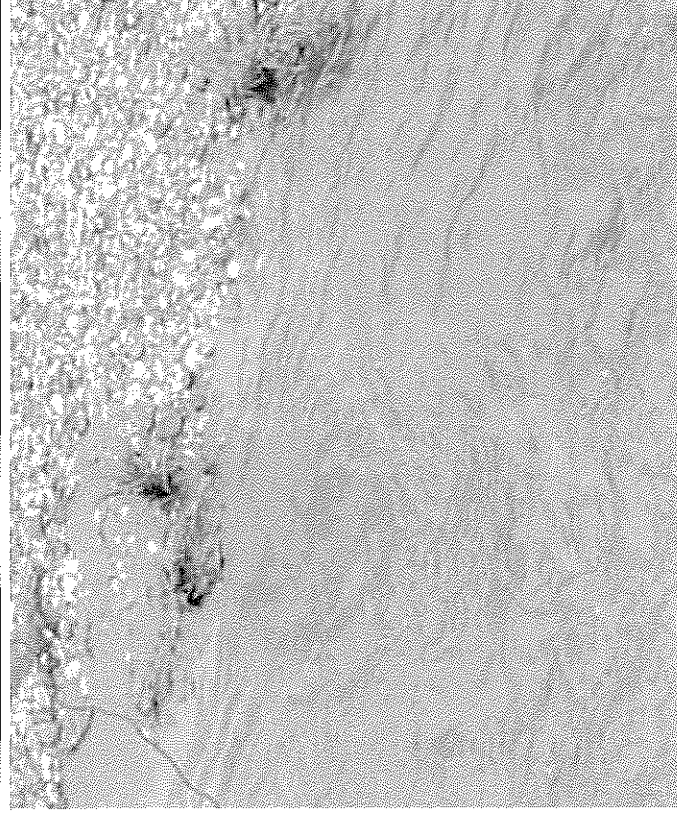
If the pH is too low, fish can get really sick. They may get a disease called acidosis (too much acidity in the water). When they have this disease they eat very little. Then they produce excess slime and rest on the bottom. If the condition worsens, their fins bleed. They may even die, but they can get better once the pH is brought up to a normal range. If the pH is too high, fish will gasp at the surface. This is a condition called alkalosis (water is too basic). Alkalosis is difficult to reverse and can kill fish.

Water with pH values between 4 and 10 has a minimal effect on human health. Water with pH values outside of this range may cause eye and skin irritation.

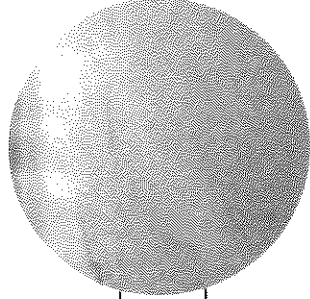
**How does the pH of an aquatic site change?**

The pH is influenced by many factors like water temperature, water salinity, amount of light, amount of algae or plants in the water, and more. Human activities can also affect the pH of an aquatic site. Air pollution, mainly from automobile exhaust and fossil fuel burning, increase sulfur and nitrogen oxides in the air. When it rains, these oxides turn into "acid rain" and increase the acidity of water. Runoff that contains industrial, agricultural, and domestic waste sends chemicals in the aquatic site that change pH levels.

Aquatic Organisms	pH
Bacteria	2-13
Plants	6-13
Carp	6-9
Some Insects	6-9
Bass	6.5-9
Snails	7-9
Trout	6.5-7.5
Fly Larva	6.5-7.5



# Does OXYGEN in the Water Matter?



## RESEARCH ARTICLE

*Without oxygen, life as we know it could not exist. Green plants produce oxygen during photosynthesis. We use this oxygen to breathe. But what happens in aquatic environments? How does oxygen get into water? How does the amount of oxygen affect the water quality of an aquatic site? How does it affect aquatic animals?*

### What is Dissolved Oxygen?

The amount of oxygen dissolved in water is called dissolved oxygen. It is usually measured in milligrams per liter (mg/L). This oxygen is used by fish and other aquatic animals for breathing. Adequate dissolved oxygen is necessary for good water quality. Oxygen needs depend on aquatic species.

### How does oxygen get into water?

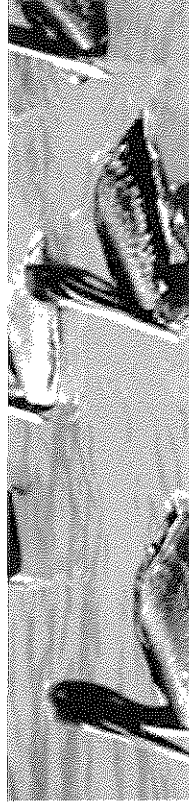
Oxygen is dissolved in water mainly by three processes:

- *From the air* — oxygen diffuses at the surface of the water
- *From waves and wind* — they cause aeration, which adds air into water. Rapids and water over falls also causes aeration.
- *From photosynthesis* — aquatic plants produce oxygen during photosynthesis.

Humans often use artificial methods to aerate an aquatic site and maintain healthy dissolved oxygen levels.

### Why is the dissolved oxygen of an aquatic site important?

When fish breathe they transfer oxygen to their blood stream through their gills. In fact, all aquatic life including insects and bacteria need oxygen to grow and reproduce. Excessive quantities of dissolved oxygen in water can be harmful to aquatic life. In some occasions fish and aquatic invertebrate may suffer from "gas bubble disease." Air bubbles block the flow of blood through vessels, which often causes death. Too much oxygen can also cause external bubbles on fins and skin. Most aquatic species need a minimum of 5mg/L to survive. However, the required range for dissolved oxygen varies from species to species.



*continued on page 2*

## -Vocabulary

**Diffusion** The movement of molecules (e.g., oxygen molecules) from an area of higher concentration (e.g., the air) to an area of lower concentration (e.g., the water).

**Dissolved Oxygen** The amount of oxygen dissolved in water. It is usually measured in milligrams per liter (mg/L).

**Ecosystem** A group of organisms together with its environment, seen as a unit.

**Gas bubble disease** This disease is most frequently seen in heavily planted or Algae-ridden aquariums or ponds. In such a scenario, oxygen production can be so great that it upsets the proper balance of dissolved gases in the water causing very small gas bubbles to form inside of the fish. If these bubbles move to the blood stream they can be fatal.

**Habitat** The environment where a particular plant or animal is normally found.

**Invertebrate** An animal without a backbone.

**Photosynthesis** The process by which plants harness the energy of the sun to make food. In photosynthesis, plants absorb carbon dioxide (CO<sub>2</sub>) and give off oxygen (O<sub>2</sub>). Thus, there is an overall accumulation of carbon (C) in the plant.

**Respiration** The process occurring in living organisms, whereby food is oxidized to release energy

**Salinity** The amount of dissolved salt in water.

**Watershed** An area of land that delivers runoff water, sediment, and dissolved substances to surface water bodies, such as rivers or lakes. All watersheds consist of boundaries, a basin and collection areas.





# Does OXYGEN in the Water Matter?

continued from page 1



## RESEARCH ARTICLE

the amount of dissolved oxygen. When such waste enters water, bacteria feed on them, using up oxygen. With so much food available, the bacteria multiply rapidly using much of the dissolved oxygen in the water. As a result other aquatic organisms cannot breathe. In 1995, waste that contaminated a river in North Carolina resulted in high levels of bacteria and algae growth consuming most of the dissolved oxygen. As a result an estimated 5,000 fish died!

Another factor that affects dissolved oxygen is aeration. Streams and rivers with white water increase the level of dissolved oxygen because more oxygen enters the water from the atmosphere. Salinity also affects dissolved oxygen levels. At a given temperature, fresh water can dissolve more oxygen than salt water.

When dissolved oxygen levels in water are low (below 5.0 mg/L), most aquatic animals are in danger. Low oxygen levels affect animal behavior, growth, and reproduction. Oxygen levels that remain under 1-2 mg/L for a few hours can cause the death of many fish. The table shows the minimum dissolved oxygen requirements of several organisms. Low oxygen level is a sign of pollution. Aquatic sites with good water quality have dissolved oxygen levels between 8 and 10 mg/L. When the level is between 4 and 5 mg/L, the site is polluted.

### What factors affect dissolved oxygen?

Oxygen, like most gases, dissolves better in cold liquids. When the water is warm it means that there is less dissolved oxygen. Aquatic environments at high temperatures can increase the number of bacteria and other organisms. They use much of the oxygen in the water and when they die, decay also uses up oxygen. This causes problems for fish.

Aquatic plants release oxygen into the water during photosynthesis. At night, photosynthesis stops and plants absorb oxygen through respiration. When an aquatic site has heavy plant growth, plants use a lot of oxygen. When dissolved oxygen levels are very low, you can sometimes detect a rotten egg smell.

Unfortunately humans are also responsible for unhealthy levels of dissolved oxygen in water. Biodegradable wastes such as sewage and waste from industrial plants can also cause a decrease in

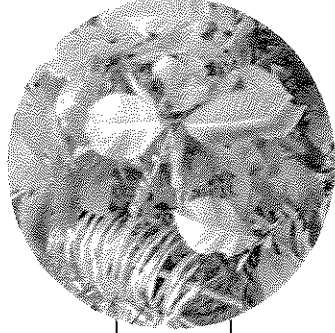
Aquatic Organisms	Minimum Dissolved Oxygen (mg/L)
Trout	6.5
Smallmouth bass	6.5
Caddisfly larvae	4.0
Mayfly larvae	4.0
Catfish	2.5
Carp	2.0
Mosquito larvae	1.0

### Do plants need oxygen?

Plants need oxygen too! As you know plants give off oxygen during photosynthesis. That does not mean they don't need oxygen. During photosynthesis plants take in water, carbon dioxide, and energy from the sun to make food (starch and sugar). In the process they release oxygen. Plants store starch and sugar and they use it to release energy needed for their own growth. But they need oxygen to do that. The process of



# Does CLEAR water mean HEALTHY water?



## RESEARCH ARTICLE

### Can you measure water clarity?

You can measure water clarity at your local aquatic site by measuring its turbidity. Turbidity measures the cloudiness in water. Murky water has high turbidity. Water with low turbidity is clear.

### More about turbidity

Turbidity is usually measured in Nephelometric Turbidity Units (NTU). The turbidity of surface water is usually between 1 NTU and 50 NTU. When turbidity is above 5 NTU you can see the cloudiness in the water. The standard turbidity for drinking water is between 0.5 NTU and 1.0 NTU. Many scientists say that the turbidity for drinking water must not be above 0.1 NTU. High levels of turbidity for a short period of time are less of a problem than lower levels for a long period of time.

### How does water get cloudy?

Often, the water of an aquatic site contains many particles, like soil, mud, sand, plankton, algae, and more. The more particles the less sunlight can go through the surface of the water and the cloudier it becomes.



### Vocabulary

**Dissolved Oxygen** The amount of oxygen dissolved in water. It is usually measured in milligrams per liter (mg/L).

**Ecosystem** A group of organisms together with its environment, seen as a unit.

**Habitat** The environment where a particular plant or animal is normally found.

**Photosynthesis** The process by which plants harness the energy of the sun to make food. In photosynthesis, plants absorb carbon dioxide (CO<sub>2</sub>) and give off oxygen (O<sub>2</sub>). Thus, there is an overall accumulation of carbon (C) in the plant.

**Plankton** A small freely floating group of organisms (plants and animals).

**Sediment.** Solid material that is washed into rivers, streams and lakes by winds and storms.

**Turbidity** A measure of "how cloudy the water is." It is usually measured in Nephelometric Turbidity Units (NTU).

**Watershed** An area of land that delivers runoff water, sediment, and dissolved substances to surface water bodies, such as rivers or lakes. All watersheds consist of boundaries, a basin and collection areas.



## Does CLEAR water mean HEALTHY water ?

### How do particles get in the water?

Soil erosion and runoff add particles in the water and increase turbidity. Various wastes such as industrial wastes, sewage, and pollutants also add particles in water. Particles in the water often include plankton and algae that can decrease water clarity. Aquatic animals also contribute to the amount of particles in the water. Animals that feed on the bottom stir up sediments making the water cloudy.

### What factors affect water clarity?

Erosion, waste, plankton and algae, and aquatic animals are some of the factors that affect the clarity of water. Heavy rainfall can speed up erosion, which results to more particles in the water. Water clarity is also affected by wind. Strong winds can stir up bottom sediments in an aquatic site. Vegetation at the bank of aquatic sites helps filter runoff and minimizes the amount of particles that enter the water. Unfortunately, far too often humans remove such vegetation causing problems to the ecosystem. Biodegradable wastes such as sewage and waste from industrial plants can also severely affect water clarity and threaten the health of plants and animals.



### How does water clarity affect aquatic habitats? How does it affect us?

Aquatic plants need light to grow. When water clarity is low, solid particles prevent sunlight from reaching plants below the surface and photosynthesis decreases. When this happens plants are in danger. Their growth is reduced and they may even die.

When clarity is low, particles absorb heat from the sun, raising the temperature of the water. In warm water dissolved oxygen levels drop (warm water holds less oxygen than cold water.) Also, with less photosynthesis plants produce less oxygen. Low oxygen levels affect animal behavior, animal and plant growth, and reproduction and may even cause death.

Particles in water clog fish gills, which can cause serious problems. Particles can also affect their growth and reproduction. Aquatic animals need light to feed. Poor water clarity blocks light and limits their movement, which makes it difficult to see their prey. Cloudy water also makes it difficult for predatory birds to see their prey.

Poor water clarity can make water unsuitable to drink and swim in. Some suspended particles support bacteria growth. The cost of filtering and disinfecting polluted water can be very high.

