Oakton MultiParameter PCSTestr 35

Variable Guide

Total Dissolved Solids, Electrical Conductivity, and Salinity are all very connected. The total dissolved solids in water consist of salts and dissolved materials and indicates conductivity.

Total Dissolved Solids

What are total dissolved solids?

- Dissolved solids refer to any minerals, salts, metals, cations or anions dissolved in water. Total dissolved solids (TDS) comprise inorganic salts (principally calcium, magnesium, potassium, sodium, bicarbonates, chlorides, and sulfates) and some small amounts of organic matter that are dissolved in water.
- In general, the total dissolved solids concentration is the sum of the cations (positively charged) and anions (negatively charged) ions in the water.

How do dissolved solids occur?

- TDS in drinking-water originate from natural sources, sewage, urban run-off, industrial wastewater, and chemicals used in the water treatment process, and plumbing
- Elevated TDS can be due to natural environmental features such as mineral springs, carbonate deposits, salt deposits, and sea water intrusion
- Other sources may include: salts used for road de-icing, anti-skid materials, drinking water treatment chemicals, stormwater, and agricultural runoff, and point/non-point wastewater discharges.

What are the effects of dissolved solids?

- An elevated total dissolved solids (TDS) concentration is not a health hazard. The TDS concentration is a secondary drinking water standard and, therefore, is regulated because it is more of an aesthetic rather than a health hazard.
- An elevated TDS indicates the following:
    1. The concentration of the dissolved ions may cause the water to be corrosive, salty or brackish taste, result in scale formation, and interfere and decrease efficiency of hot water heaters; and
    2. Many contain elevated levels of ions that are above the Primary or Secondary Drinking Water Standards, such as an elevated level of nitrate, arsenic, aluminum, copper, lead, etc.
- For aesthetic reasons, a limit of 500 mg/l (milligrams per liter) has been established as part of the Secondary Drinking Water Standards.
- Elevated dissolved solids can cause "mineral tastes" in drinking water. Corrosion or encrustation of metallic surfaces by waters high in dissolved solids causes problems with industrial equipment and boilers as well as domestic plumbing, hot water heaters, toilet flushing mechanisms, faucets, and washing machines and dishwashers.
- Indirect effects of excess dissolved solids are primarily the elimination of desirable food plants and habitat-forming plant species. Agricultural uses of water for livestock watering are limited by excessive dissolved solids and high dissolved solids can be a problem in water used for irrigation.

Electrical Conductivity

What is conductivity?

- Conductivity is a measurement of the ability of an aqueous solution to carry an electrical current.
- An ion is an atom of an element that has gained or lost an electron which will create a negative or positive state. For example, sodium chloride (table salt) consists of sodium ions (Na^+) and chloride ions (Cl^-) held together in a crystal. In water it breaks apart into an aqueous solution of sodium and chloride ions. This solution will conduct an electrical current.

There are several factors that determine the degree to which water will carry an electrical current. These include:

- the concentration or number of ions;
- mobility of the ion;
- oxidation state (valence) and;
- temperature of the water.

What are the effects of conductivity?

Conductivity is a measurement used to determine a number of applications related to water quality. These are as follows:

1. determining mineralization: this is commonly called total dissolved solids. Total dissolved solids information is used to determine the overall ionic effect in a water source. Certain physiological effects on plants and animals are often affected by the number of available ions in the water.
2. noting variation or changes in natural water and wastewaters quickly;
3. estimating the sample size necessary for other chemical analyses; and
4. determining amounts of chemical reagents or treatment chemicals to be added to a water sample.

Salinity

What is salinity?

- In natural waters, salts are chemical compounds made of carbonates, chlorides, sulfates, and nitrates (primarily in ground water), and potassium (K), magnesium (Mg), calcium (Ca), and sodium (Na).
- In most natural conditions, these salts are present in amounts that create a balanced solution.
- If there is a large rain with a lot of runoff, this balance is changed and most likely has a negative effect on the aquatic system.
- Salinity is the measure of salt present expressed in parts per million (ppm).

How does it occur?

- The natural amounts of salts are largely determined by the geologic bedrock underlying the area. Low salinity is expected in non-faulted areas like Wisconsin, which has igneous rock formations.
- High levels of runoff often happen in areas underlain by ancient marine sediments. As time passes, the salts are removed from the sedimentary rocks by wind and water erosion. These elements remain dissolved in surface waters.
- As water evaporates from existing water bodies, salt concentrations increase like in the Salt Lake area of Utah.

What are the effects of salinity?

- Sodium sulfate and magnesium sulfate levels above 2,500 ppm in drinking water may produce a laxative effect.
- Dissolved salts may either encrust or corrode metallic surfaces. Salt in intake water may interfere with chemical processes within industrial plants.
- If the salinity of a water body changes over time, the plants and animals in the area may also change. Salt-tolerant plants include greasewood, alkalai sacaton, fourwing saltbush, shadscales, saltgrass, tamarisk (salt cedar), galleta, western wheatgrass, mat saltbrush, reed canarygrass, and rabbitbrush.
- Salt may decrease the osmotic pressure, causing stunted growth and reduced yields.
- Salt water has a higher density than freshwater and tends to sink and form a dense layer in the bottom of the lake. This saline layer does not mix with remainder of the lake water, leading to decreased dissolved oxygen levels in the bottom regions.
- Inadequate drainage or excessive evaporation from agricultural fields may lead to an accumulation of salts in the soil.

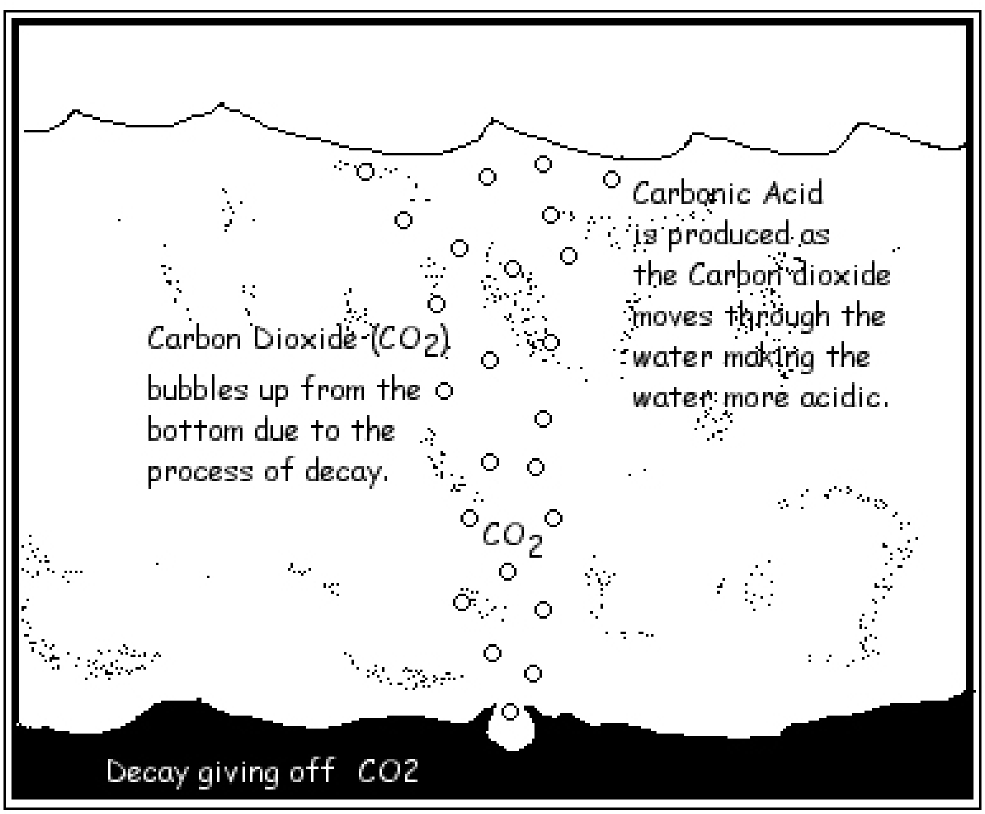
What's normal for salinity?

- Distilled, or pure, water has a salinity of 0.
- The average salinity of seawater is about 35,000 ppm. Freshwater lakes, rivers, and streams contain some dissolved matter—1,000 ppm or less. Brackish water is a mixture of fresh water and seawater, below 33,000 ppm. Hypersaline water is very salty seawater, sometimes found in tidepools and is above 38,000 ppm.

Information on pH Amounts & Water Quality

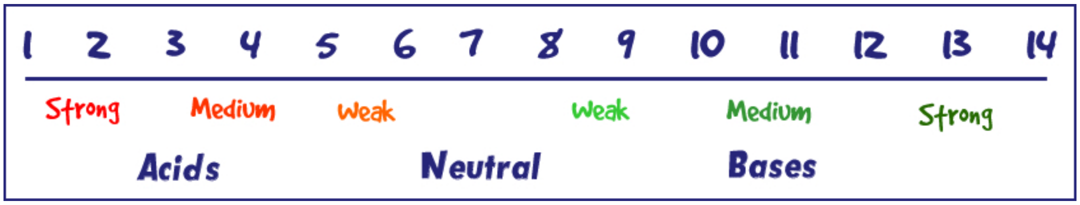
1. What is pH?

A. pH is the symbol standing for the amount or percentage of hydrogen ions.
B. Hydrogen ions determine the amount of acid or base in a solution of liquid.
C. If a liquid has a lot of H^+ ions then it is considered an **acid**, but if there are very few H^+ ions and many HO^- (hydroxyal) ions, then it is considered a **base**.
D. The ions (H^+ or HO^-) get into the water from carbon dioxide as it bubbles up to the surface from the decay bacteria on the bottom.
E. High amounts of carbon dioxide will produce an acid condition in the water.
F. In like terms, much decay by bacteria will produce a lot of carbon dioxide. Therefore a lot of decay will produce an acid conditioned lake.



2. What is the pH scale?

A. The pH scale tells us how much **H+ ions** are in the water.
B. The scale runs from 1 to 14, with 1 being a very acid condition and 14 a very basic condition.



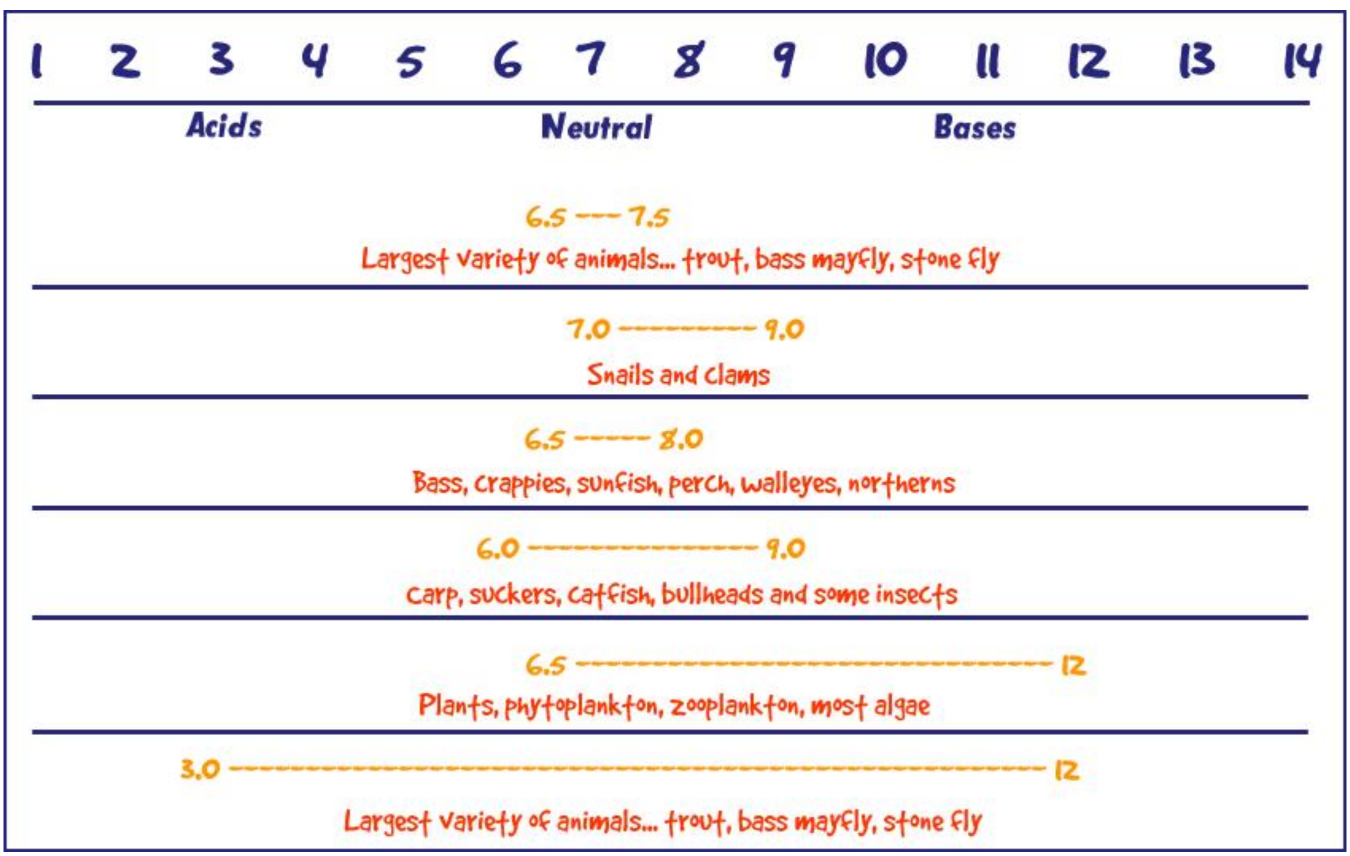
3. How does pH affect a body of water?

A. When a lake is young, it is usually slightly alkaline; as the lake ages, the decaying in the lake causes it to become slightly acidic.

Young lake - pH 8 to 9
Medium Aged Lake - pH 7
Old Lake - pH 7 to 6
Swamp or pond - pH 6 to 5

4. How does pH affect fish in the lake?

A. Fish types are limited by the amount of acid or base in a lake.
B. Most fish live between a 5 pH to a 9 pH value.
C. The chart below shows specific pH limits for different organisms.



Black Earth Creek & Limnology Minifacts & Analysis

Sheet 8

Temperature Levels

Information on Temperature Levels & Water

1. Some Basic Facts

A. Water, (H_2O) freezes at 0° C and boils at 100° C.
B. Cold water is heavier than warm water and sinks to the bottom of lakes. However if water gets so cold that it turns to ice, it will float.

2. Temperature and Aquatic organisms

A. Most aquatic organisms are 'cold blooded'; their body temperature changes with the temperature of the environment.

1. Warm temperatures will speed up the metabolism (life functions) of aquatic organisms.
2. Colder temperatures will slow down their metabolism.

3. What Happens as Water Temperature is Increased?

A. The amount of O_2 (oxygen) required for life is increased. This is called increasing the BOD (*biological oxygen demand*).
B. The amount of dissolved O_2 that the water can hold is decreased.
C. A sudden change of 5° C (or more) will instantly kill most fish.
D. Any pollutants in the water become more poisonous.
E. Algae 'blooms' (algae population explosions) occur.
F. The rate of rot and decay (decomposition) increases; this requires even more O_2.
G. Desirable species of plants die – blue-green algae (scum) multiply.

4. What Factors Affect Water Temperature?

A. Cold incoming spring water will cool lakes and streams.
B. Weather conditions (air temperature, sun, and wind) will change water temperature.
C. Man usually warms water by changing stream banks and by pollution discharge (thermal pollution).
D. The greater the amount of water, the slower it is to change in temperature.

5. Some Terms to Remember

Preferred Temperature - temperature range at which an organism likes to live.
Breeding Temperature - temperature at which organisms reproduce. Fish eggs require colder temperature than what most adults prefer.
Lethal Temperature- temperature at which the organism dies. When this occurs we say that the temperature is a limiting factor for that species.

Temperature Conditions for Aquatic Organisms
Temp. °C

Organism	**Breeding T**	**Preferred T**	**Lethal T**
Desirable plants		4 to 25	
Undesirable plants		25 to 30	
Lake Trout	8	10	26
Brook Trout	10	15	26
Game fish Northern, Walleye, Bass, Musky		18 to 25	32
Pan fish		19 to 27	32
Rough fish			
Bullheads & Catfish		19 to 29	32
Carp & other RF		30	32
Minnows			29 to 37
Macroinvertebrate			
Bottom organisms		4 to 27	32
Stonefly, Mayfly,		10 to 20	29
Water Beetles,		10 to 20	29
Water Strider		10 to 20	29

6. Special Facts

A. As you increase the temperature you decrease the quality of the aquatic environment.
B. Above 26° C, *it is impossible for any species of fish* (naturally found in Wisconsin) *to reproduce.*

Temperature preferences by organism:

Figure 4

Preferred temperature ranges for common Dane County stream organisms

Trout streams (up to 72°F / 22°C)	Warm water streams (72 to 84°F / 22 to 29°C)
brown trout	bluntnose minnow
rainbow trout	common shiner
brook trout	crappie
mottled sculpin	bluegill
white sucker	carp
brook lamprey	caddisfly
creek chubs	mayfly
mayfly	dragon fly
caddisfly	many algae
riffle beetles	sago pondweed
scuds	
watercress	
crisp pondweed	

7. Measuring temperature

It is easy to measure the temperature of a stream site. Any water-resistant household thermometer will register stream temperature in about two minutes. An unbreakable thermometer is best. In deeper streams, you may want to measure the temperature near the surface and close to the bottom to discover any variation.

The stream's temperature variations are more informative: sun to shade, day to night, week to week, maximum to minimum, or upstream to downstream.

For example, when water reaches a certain temperature fish will die. However, it has to stay at that temperature for a while. So, brown trout, which are expected to die at temperatures above 78° F (26° C), may survive if the temperature goes up slowly enough and goes down again fairly soon.

Researchers have set temperature limits for fish by experimenting with them in a laboratory. The standard is a 12-hour median tolerance limit (TLm). This is the temperature at which half the fish will die if held there for 12 hours.

Compare sun and shade - Check and record the temperature of your stream in a shady spot and in a sunny one. Are they different? By how much? If they are not different, consider which factors may be affecting the temperatures. For example, was the shady spot only a small area downstream of a long sunny stretch? Water warms and cools slowly, so there may not have been enough shade to cool the stream where you measured it.

Measure upstream and downstream - Measure the temperature at two points on your stream about a mile apart. Compare the two. Observe the area around your recording site. Try to explain why they are the same or different. (How much shade is there? Are the widths and depths different?)

If natural factors do not seem to explain a difference of several degrees, check the stream banks for possible sources of thermal pollution.

Check temperatures over time - Set a max-min thermometer in your stream. Check it every day for a week or every week for a month and write down the maximum and minimum temperatures it recorded at your measuring station. Using the Fish TLm chart, predict what types of fish could be living in your stream. Remember to consider the season. If you are measuring temperature in April or October, you won't get the year's highest temperatures.

Additional activities Factors which affect temperature - Experiment with some of the factors which affect temperature. Fill several identical containers with water. Set them in a sunny spot outside, in a sunny window, or under a heat lamp. Vary their conditions like this:

1. **Clear**
2. **Turbid**—Collect turbid water from a stream or lake.
3. **Shaded**—Use a cardboard box or large book to shade it.
4. **Light bottom**—Put 2-3 inches of sand in the bottom.
5. **Dark bottom**—Put dark colored rocks in the bottom.
6. **Volume**—Find a container that is at least twice the size of the others and fill it with water.

Effect of air temperature and drought on creeks - A trout stream in Vernon County, WI.

In the 1980s Robert L. Hunt, Wisconsin Department of Natural Resources fisheries research biologist was studying trout in Timber Coulee Creek. His study included 1988, one of the hottest, driest years on record. This is a slightly edited version of his comments on how temperature affected the trout. (The Treatment Zone and Reference Zone were two adjacent one-mile sections of the stream. The treatment related to changing fishing restrictions.)

Yearling and older brown trout in the Treatment Zone declined in number by 40% from April to October 1988. In the Reference Zone there was a 44% decrease.

These declines . . . were probably related primarily to environmental stress. A deleterious combination of severe drought, the most severe in Wisconsin since 1936 (U.S. Geol. Survey 1989), and abnormally high air temperatures persisted throughout the spring and summer of 1988.

A minimum-maximum temperature recorder was monitored weekly from July through September. Maximum water temperatures of 82° F in mid July and 79° F in mid-August were recorded, temperatures well above the preferred range for brown trout and several degrees higher than the 73° F maximum observed in 1984.