

## FFA - Environmental/Natural Resources CDE

Background info on parameters, what they test, range to be expected and Idaho State standards

Most info from Idaho DEQ

### Temperature

Temperature is a physical property of water that has a profound effect on organisms that live or reproduce in the water. This is particularly true of Idaho's native coldwater fish such as salmon, bull trout, and steelhead, and some amphibians (frogs and salamanders). When water temperature becomes too high, salmon and trout suffer a variety of ill effects ranging from decreased spawning success, to increased susceptibility to disease and toxins, to death. Water temperature also affects the toxicity of ammonia, and perhaps other toxic substances as well. For these reasons, it is important to protect the state's water from unnecessary warming. Idaho's temperature criteria are numeric.

#### Why Stream Temperature Is Important

*Stream temperature is an important part of water quality because:*

Coldwater fish such as salmon and trout need cold waters for optimum health during various stages of their lives. When temperatures are above optimum levels, fish are physically stressed and are more likely to get fungal infections and have difficulty getting oxygen, and, if the temperatures stay very long above the lethal limit (77-78 °F), most salmonids will die.

Colder water holds more dissolved oxygen than warmer water, so as stream temperatures go up, the amount of dissolved oxygen available for fish and other aquatic organisms goes down. To make matters worse, warm water can also cause the fish's need for dissolved oxygen to increase.

Colder water slows the growth of bacteria and algae in water. When algae grow excessively, algal blooms can use up the water's dissolved oxygen and cause changes in stream pH levels.

Stream temperature is the result of many different processes in the watershed. If stream temperatures are too high, other water quality problems may be present as well, such as eroding stream banks and excessive sedimentation.

Warm water can make other water quality problems worse. For instance, warm water can lead to increased bacteria and nuisance aquatic plant growth and intensify water chemistry problems involving dissolved oxygen and pH.

#### Causes of Elevated Stream Temperature

Elevated stream temperatures can result from both natural and human-caused events. Examples of natural influences on temperature include creeks and rivers heating if they travel long distances over terrain that can't support stream side vegetation or when fires or floods remove significant portions of riparian vegetation.

Land management (human activity) can increase stream temperatures through:

Removing vegetation along the banks of streams, which reduces the amount of shade over the water, which increases the amount of solar radiation reaching the stream.

Withdrawing water for various purposes, including irrigation, which reduces the amount of water in the stream during the summer, when streams are already low. A shallow stream is heated more quickly by the sun than a deep stream. In addition, the water in shallower streams moves more slowly than in deeper streams, which allows more time for heating.

Contributing excessive sediment (boulders, rocks, gravel, sand, dirt, silt) to a stream channel, which can result in a stream becoming wider and shallower, making it harder to shade and easier to heat. Sediment is a natural part of a stream system, but land management activities like road building, agriculture, forestry, and urban development have the potential to greatly increase the amount of sediment entering a stream, delivering higher amounts of sediment than the stream can handle.

Changing the landscape, which can cause increased storm runoff. In some streams peak stream flow can increase after changes to the landscape increase storm runoff. These high flows can scour out the bottom of a stream, taking away gravel and rocks, leaving only bedrock. Bedrock absorbs the heat from the sun and later releases the stored energy and warms the water.

While all streams warm, the best way to keep streams as cool as possible as long as possible is to maintain their natural shading from streamside vegetation.

DEQ's stream temperature standards are designed to protect aquatic life uses, which are the only uses that have temperature requirements. The criteria vary by aquatic use-warm water, seasonal cold water, cold water, salmonid spawning, and bull trout (see table below). The latter two uses are subcategories of the cold water use. For all but bull trout, DEQ uses a pair of criteria, targeting daily maximum and daily average temperatures. Depending on the diurnal (day to night) temperature range in a given stream, one or the other of these paired criteria will limit the stream's warmth. Using a pair of criteria provides regulation over a broader range of streams than either alone could. For bull trout the criterion is for a seven-day rolling average of daily maximums. This rolling average regulates maximums while allowing a few individual days to be slightly warmer.

Idaho's Water Temperature Criteria

Use Metric	Warm Water	Seasonal Cold	Cold Water	Salmonid Spawning	Bull Trout
MDMT <sup>a</sup>	33 °C (91°F)	26 °C (79°F)	22 °C (72°F)	13 °C (55°F)	N/A
MWMT <sup>b</sup>	N/A	N/A	N/A	N/A	13 °C (55°F)
MDAT <sup>c</sup>	29 °C (84°F)	23 °C (73°F)	19 °C (66 °F)	9 °C (48°F)	N/A

<sup>a</sup>MDMT = Maximum Daily Maximum Temperature

bMWMT = Maximum Weekly (7-day average) Maximum Temperature  
cMDAT = Maximum Daily Average Temperature

## **Dissolved Oxygen**

Oxygen in water is necessary for aquatic life, just as oxygen in air is necessary for human life. The concentration of dissolved oxygen is a single, easy-to-measure characteristic of water that correlates with the occurrence and diversity of aquatic life in a water body. A water body that can support diverse, abundant aquatic life is a good indication of high water quality. A related problem is an excess of nutrients in water. Large quantities of nutrients in water can cause excessive growth of vegetation. This excessive vegetation, in turn, can cause low dissolved oxygen as it decays. Idaho's dissolved oxygen criteria are numeric.

### Cold Water designation (DO > 6 mg/L)

Does not apply to bottom 20% of water depth in natural lakes and reservoirs where depths are 35 m or less.

The bottom 7 m of water depth in natural lakes and reservoirs where depths are greater than 35 m  
Those waters of the hypolimnion in stratified lakes and reservoirs

### Seasonal Cold Water (DO > 6 mg/L)

Does not apply to bottom 20% of water depth in natural lakes and reservoirs where depths are 35 m or less.

The bottom 7 m of water depth in natural lakes and reservoirs where depths are greater than 35 m  
Those waters of the hypolimnion in stratified lakes and reservoirs

### Warm Water (DO > 5 mg/L)

Does not apply to bottom 20% of water depth in natural lakes and reservoirs where depths are 35 m or less.

The bottom 7 m of water depth in natural lakes and reservoirs where depths are greater than 35 m  
Those waters of the hypolimnion in stratified lakes and reservoirs

## **pH (6.5-9)**

A water's pH is a measure of the balance between hydrogen ions, which are acidic (sour) and hydroxide ions, which are basic (bitter). A perfect balance of the two is at a pH of 7. Most aquatic organisms prefer a pH of 6.5 to 9. The pH of water, like temperature, is a fundamental controlling property that affects many other chemical constituents (e.g., dominant form of ammonia and solubility of metals) as well as important biological processes such as the level of permeability of fish gills and amphibian skins (that is, how well gases can flow through the gills/skin, allowing the fish/amphibians to breathe).

## **Nitrate - (No standards for this in ID)**

Contamination of water by nitrates. Increased use of artificial fertilizers and land cultivation means that higher levels of nitrates are being washed from the soil into rivers, lakes, and aquifers. There they cause an excessive enrichment of the water (eutrophication), leading to a rapid growth of algae, which in turn darkens the water and reduces its oxygen content. The water is expensive to purify and many plants and animals die. High levels are now found in drinking water in arable areas. These may be harmful to newborn babies, and it is possible that they contribute to stomach cancer, although the evidence for this is unproven.

The Element Nitrogen is Essential: All living systems need nitrogen to exist since it is used to build many essential components such as proteins, DNA, RNA and vitamins, as well as hormones and enzymes. Higher organisms such as animals can not use simple forms of nitrogen such as nitrate and ammonium and must get complex forms of nitrogen such as amino acids and nucleic acids. Plants provide the bulk of nitrogen for all living systems (most microbes - like bacteria - can make their own complex nitrogen compounds).

Nitrate as Crop Plant Nutrient: In order for plants to make complex nitrogen compounds, the plants need a supply of simple nitrogen compounds and most plants prefer nitrate over ammonium. So over the eons as agriculture has developed, man has applied fertilizer to crops to enhance their growth and productivity. Nitrogen fertilizers have been applied in very large amounts to field crops since the 1950's in the US and many other countries.

Over-fertilization Results in Nutrient Rich Run-Off: Since crop plants often can not utilize all the nitrogen applied to the fields, some is left in the soil and can leach into ground water. In addition, not all the applied nitrogen gets into deeper soil and some is washed off the fields in the form of runoff and it flows into surface waters such as streams and rivers. The runoff problem is often greatest when manure is used as a fertilizer, such as it is now in many sites in the US where large commercial farms are used to produce cattle, pigs and chickens and these companies provide the manure to farms who grow the feed for the animals.

What is Nitrate? Nitrate has the chemical formula  $\text{NO}_3^-$ . Nitrate represents the most oxidized chemical form of nitrogen found in natural systems. Nitrate is a negatively charged ion (anion) and so must be paired with a positively charged ion (cation) as in the salts potassium nitrate,  $\text{KNO}_3$ , or sodium nitrate,  $\text{NaNO}_3$ . Nitrate is one of the most water soluble anions known. The dictionary defines nitrate (noun) as a radical or ion with the chemical formula  $\text{NO}_3^-$  or a compound containing the nitrate ion as in salts or nitric acid ( $\text{HNO}_3$ ). Nitrate is also defined as fertilizer consisting of sodium nitrate or potassium nitrate. (see <http://www.answers.com/nitrate>)

The Nitrate Problem: Nitrate is a wide spread contaminant of ground and surface waters worldwide (1, 2). The accumulation of nitrate in the environment results mainly from:

- \* non-point source runoff from the over-application of nitrogen fertilizers;
- \* point-sources such as Concentrated Animal Feeding Operations (CAFOs see <http://www.lpes.org/CAFO.html>, <http://epa.gov/guide/cafo>, & <http://www.factoryfarm.org>):

\* and point-sources from poorly or untreated human sewage.

In addition, nitrate-containing wastes are produced by many industrial processes including paper and munitions manufacturing. Burning of fossil fuels in power plants and cars, SUVs and all internal combustion engines results in the production of nitric acid and ammonia as air pollution.

**Acid-Rain and Atmospheric Dry Deposition of NITROGEN:** While most of the sources of nitrogen pollution result in contamination of surface and ground waters, air-borne nitrogen pollution leads to acid rain in the mid-west and east coast regions of US where rain falls on a regular basis. However, in the far-west, California, Colorado and other south-western states, where rainfall is rare, ammonium nitrate (combination of ammonia and nitric acid) is deposited in dry form (called dry deposition) on the plants and land. Thus, when rain comes in these dry regions, the nitrogen, along with other nutrients, is flushed from the soils into streams, rivers and lakes, and eventually into the estuaries of the Pacific Ocean. Furthermore, dry deposition may result in alteration of the natural flora and fauna of a region like coastal chaparral forests in California or high altitude lakes in Rocky Mountain National Park, Estes, Colo (for info on the National program for dry deposition monitoring see:

<http://www2.nature.nps.gov/air/Monitoring/drymon.htm>). For info on the extent of atmospheric deposition of nitrate and ammonium, see the National Atmospheric Deposition Program website: <http://nadp.sws.uiuc.edu>

**Risk to Human Health:** Nitrate is a potential human health threat especially to infants, causing the condition known as methemoglobinemia, also called "blue baby syndrome". Read about the impact of Nitrate in water used to make baby formula, on the infant. When Nitrate is taken in by eating food and drinking water, Nitrate is converted in the gut to nitrite, which then combines with hemoglobin to form methemoglobin, thus decreasing the ability of the blood to carry oxygen. Infants are more susceptible to nitrate toxicity than older children or adults. Fatalities are rare, but sub-acute methemoglobinemia can be asymptotic while affecting development, making the condition particularly insidious. Chronic consumption of high levels of nitrate may also cause other health problems, for example some cancers and teratogenic effects; data are inconclusive, but cause for concern (3, 4).